

## MONITORING THE OPERATIONAL BEHAVIOUR OF ELECTRIC EQUIPMENT - KEY FACTOR FOR THE TECHNICAL CONDITION EVALUATION AND MAINTENANCE POLICIES

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### ABSTRACT

*The data and information from operational behaviour monitoring (on the history of defects, results of measurements, operational parameters and maintenance applied) are used to quantify the technical condition of installations and their components. The technical condition is determined using calculation algorithms specific to each operational assembly and equipment, also taking into account their constructive parameters and main components.*

*The paper describes Transelectrica's (National Power Grid Company) concerns for an efficient asset management and in this context, for equipment and facilities behavioural monitoring, and also for using the data obtained in order to determine the equipment technical condition and the efficient measures increasing the equipment reliability, as well as the best maintenance policies specific to various categories of equipment.*

### INTRODUCTION

Against the background of sustainable development, asset management is a set of methods and procedures contributing to increased profitability, competitiveness of services provided by such assets and their uninterrupted operation at a high quality level.

Asset management is a manner to optimise the use of assets by acquiring and processing the relevant data obtained from maintenance, upgrading, investment decisions and performance monitoring.

Risk management also helps supervising and controlling risk levels in the operation of assets, in accordance with the Company's objectives of service quality, operational safety and installations security.

**The de-regulated business environment** makes the decision-making process for asset management to be based on a balance between risk assessment and future performance evaluation.

In these terms, fixed assets management within Transelectrica SA represents an evolved concept applied to the electricity transmission activity starting from the operation and maintenance of existing installations, with a view to minimise costs and maximise performance, up to activity management with a view to increase the mid- and long-term profitability, also providing quality service at highest standards, under acceptable risk conditions.

Therefore the optimum balance among **performance, cost and risk** is aimed at, by means of installations utilisation at highest level.

Asset management is an **iterative and evolving** process, as shown in Figure 1.

Maintenance falls under Transelectrica's asset management and, according to international practice, is a component part of it, following the coordinates of sustainable development.

According to ANRE's (National Energy Regulatory Authority) requirements, maintenance is carried out using a maintenance assurance plan (MAP) that carries out:

- regulation of activity;
- introduction of a modern optimisation concept and activity development;
- determining the strategy, mid- and long-term

objectives, responsibilities, requirements and their achievement with respect to the maintenance activity within Transelectrica SA.

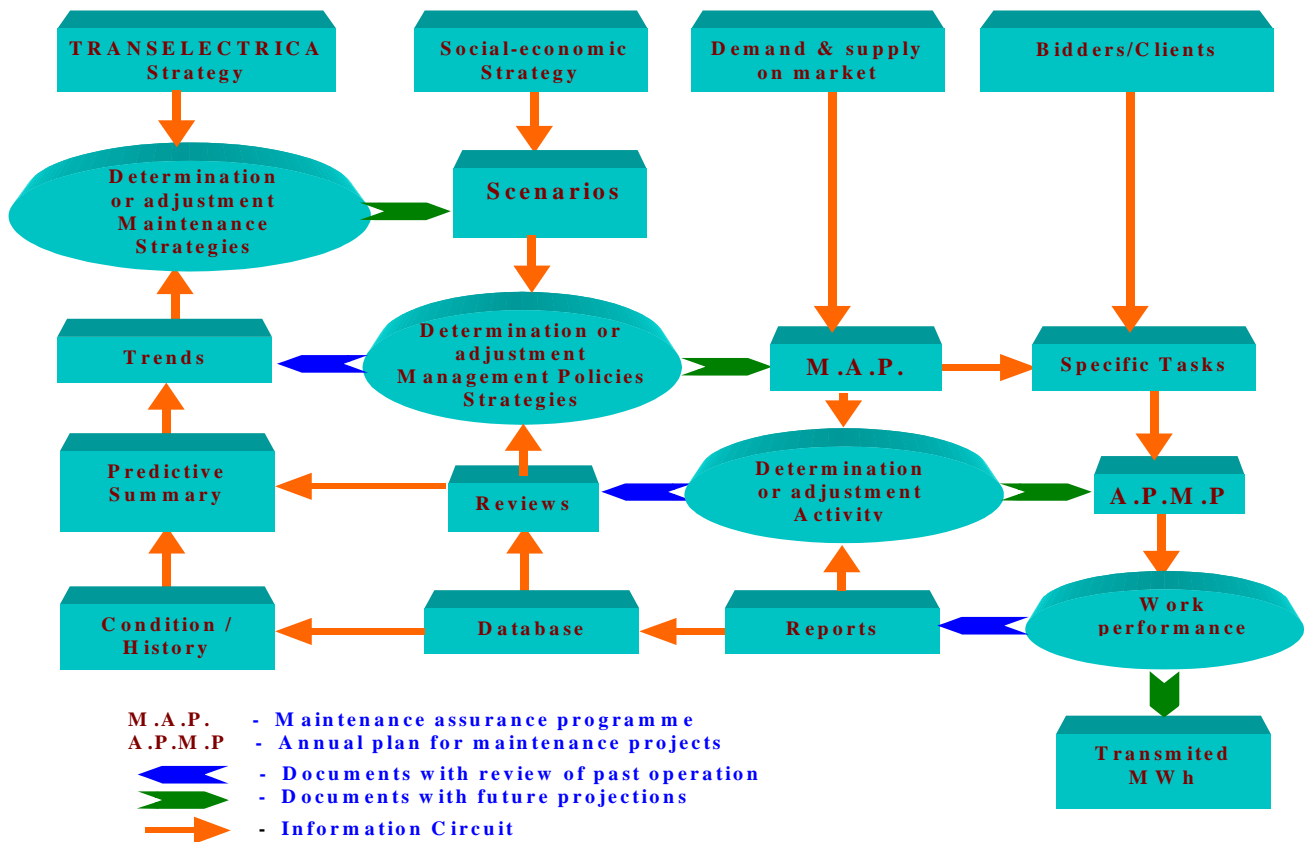
The maintenance assurance plan includes all maintenance components (technical, economic-financial, relational and organisational) that are applied to the structures, installations and components considered as fixed assets within the electricity transmission grid.

The primary (basic) data to be analysed using various methods for different purposes are taken from the operational behaviour monitoring, and based on them decisions are later made.

### MONITORING THE OPERATIONAL BEHAVIOUR OF ELECTRIC EQUIPMENT

Monitoring the operational behaviour is consistently performed in the electricity transmission branches (subsidiaries) and consists of acquiring, recording, validating, storing, processing and sending the information on installations, equipment and their components operation and maintenance.

The track record of operational behaviour and maintenance is used to review the performance development and trends for structures, installations, systems and components, and eventually to consider the maintenance efficiency.



**Fig. 1. Asset management process**

The data and information from operational behaviour monitoring - on the history of defects, results of measurements and maintenance applied - are used to quantify the technical condition of installations and their components managed by transmission branches.

A thorough review of the operational experience is used in order to obtain the reliability data by means of a judicial feedback beginning with equipment behaviour monitoring. The efficient utilisation of feedback improves the installations operation and maintenance as well as the operational safety in general.

The technical condition is determined using calculation algorithms specific to each operational assembly and equipment, also taking into account their constructive parameters and main components. Qualitative information is also quantified with respect to visual examinations, experience with such equipment based on questionnaires with pre-set answers.

Algorithms use statistical-probabilistic calculation methods.

Limit values/margins used for comparison of measurement results are taken from the norms.

The final maintenance programme and that for equipment taking out of operation follow by an iterative process.

### DATA AND INFORMATION USED TO IMPROVE THE MAINTENANCE STRATEGIES

In order to justify the decisions on enhancing the reliability and maintenance activity based on the information feedback, the following issues have to be considered: analysis of the defect occurrence frequency and analysis of the equipment operation features evolution to state the technical condition; analysis of the equipment significance within the National Power System (NPS); cost analysis.

All the aforementioned are included in the general philosophy of Reliability- Centered Maintenance (RCM), a systematic decision making process and a process of standardized approach of the maintenance activity.

The application of RCM principles to installations and equipment takes into account aspects regarding:

- the operational behaviour ascertained by annual recording and processing of statistic data;
- the technical condition of installations and equipment;
- the importance of installations and equipment within the National Power System.

The RCM is capitalizing the classical theory of reliability which directs the maintenance actions towards the vulnerable spots in the installations and where these activities are justified by the economic efficiency. Therefore it was progressively change from the time-based maintenance activity to the condition-based maintenance work, namely the reliability-based maintenance activity

The main maintenance philosophy objectives based on reliability are as follows: maintenance undertaking at the optimum time and in the optimum amount; cutting down the maintenance costs; diminishing the decommissioning periods of time; providing the requirements on the investment work promotion; correlating the maintenance and rehabilitation programs.

Priority of the preventive maintenance work is set function of the technical condition of equipment/facilities quantified based on statistically processing the information on the operational behavior: frequency and duration of the accidental failures, evolution of parameters and operational features, maintenance history, costs and considering their importance for the NPS.

Integrating the results related to the technical conditions of all functional equipment/facilities owned by each transmission branch and the importance of facilities for NPS, it results the program on annual maintenance activities required at the level of each functional category unit, as well as suggestions for the rehabilitation/investment plan.

The final maintenance program, followed by the one on de-energising activity is the result of an annual iterative process as per the specific operational procedures.

Managing the maintenance activities under all aspects of interest: management of work orders, identification of the facility to undergo the maintenance work, other installations de-energized as a measure of the labour protection norm, date, period of time, action type and content, costs, conversion costs, parts and material utilised, transport of tools, invoices for services and products suppliers etc. is performed by using the monitoring of all the dedicated data and specific software. The information application allows the acquaintance with and storage of the maintenance activities history which had been performed at each functional unit, work orders issuing and forwarding.

Primary information on the power grid facilities operation is capitalized by its being processed and by issuing reports based on the data collected from monitoring the facilities behaviour in operation.

In an operative system of observation, recording, information on the accidental events (incidents, technical failures) occurring at the power grid facilities, regulated through the Technical Norm "Regulation on accidental events record and analysis on heat and power transmission and distribution facilities" (Figure 2).

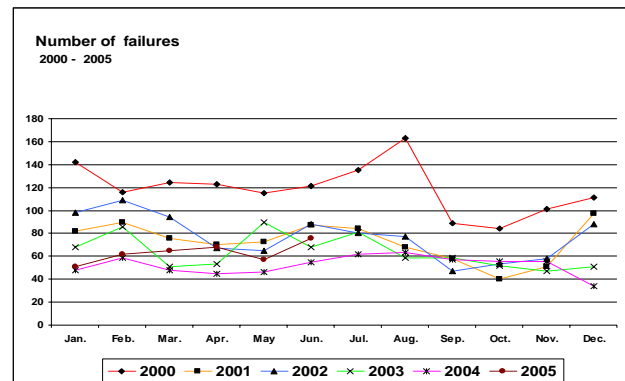


Fig. 2 . Incidents statistics

Based on the specific application instructions and on the specific procedures, the corrective maintenance actions are initiated to remedy the defects and restore the facilities to operate at the designed parameters.

Monitoring of the facilities operational behaviour is systematically made at the power transmission branches and consists of collection, recording, validation, storage, taking over and forwarding the information on operation, maintenance of power grid equipment and their component parts when of the communication between equipment supplier and purchaser is of utmost importance.

The system of checking the maintenance results consists in monitoring the operational behaviour of facilities, before and after carrying out the maintenance work, respectively. The history of the maintenance work and of the operation behaviour points out the equipment operational trends, the weak points, improvement needs.

Since there is an obvious need to have a single and transparent flow of data and information regarding the maintenance activity, which should provide all available data and control facilities for their quality, a specific database was set up for maintenance. An IT system (Figure 3) was established as well in order to manage, optimise and coordinate all maintenance activities, with also the possibility to have an interface with the other IT systems- GIS, MIS etc., as used within the specialised IT system.

The efficiency of maintenance can be assessed using the following:

- Technical criteria of maintenance efficiency
- Economic criteria of maintenance efficiency
- Criteria of service quality
- Statistical indicators

## CONCLUSIONS

- The assets management process within CN Transelectrica SA in all its complexity, is meant to provide the reliable operation of the National Power Grid and the National Power Sector in

general, justifying the decisions on maintenance and/ or rehabilitation, setting the maintenance strategy, the requirements and the way of meeting them in terms of ensuring the maintenance activity.

- The information feedback based on the operational behaviour finally results in quantifying the technical condition and enhancing the operational reliability both through maintenance and operation specific actions and through joint actions carried out with the equipment suppliers in order to improve

their reliability and, on this basis, creating the possibilities to select some simplified layouts.

- On the power competitive market it is needed to develop a way to manage and predict the maintenance costs and the equipment-related risks as well.
- Considering that the power market deregulation pointed out the importance of cutting down the costs and increasing the power grid reliability, CN Transelectrica SA became more severe as regards its equipment and/or services suppliers.

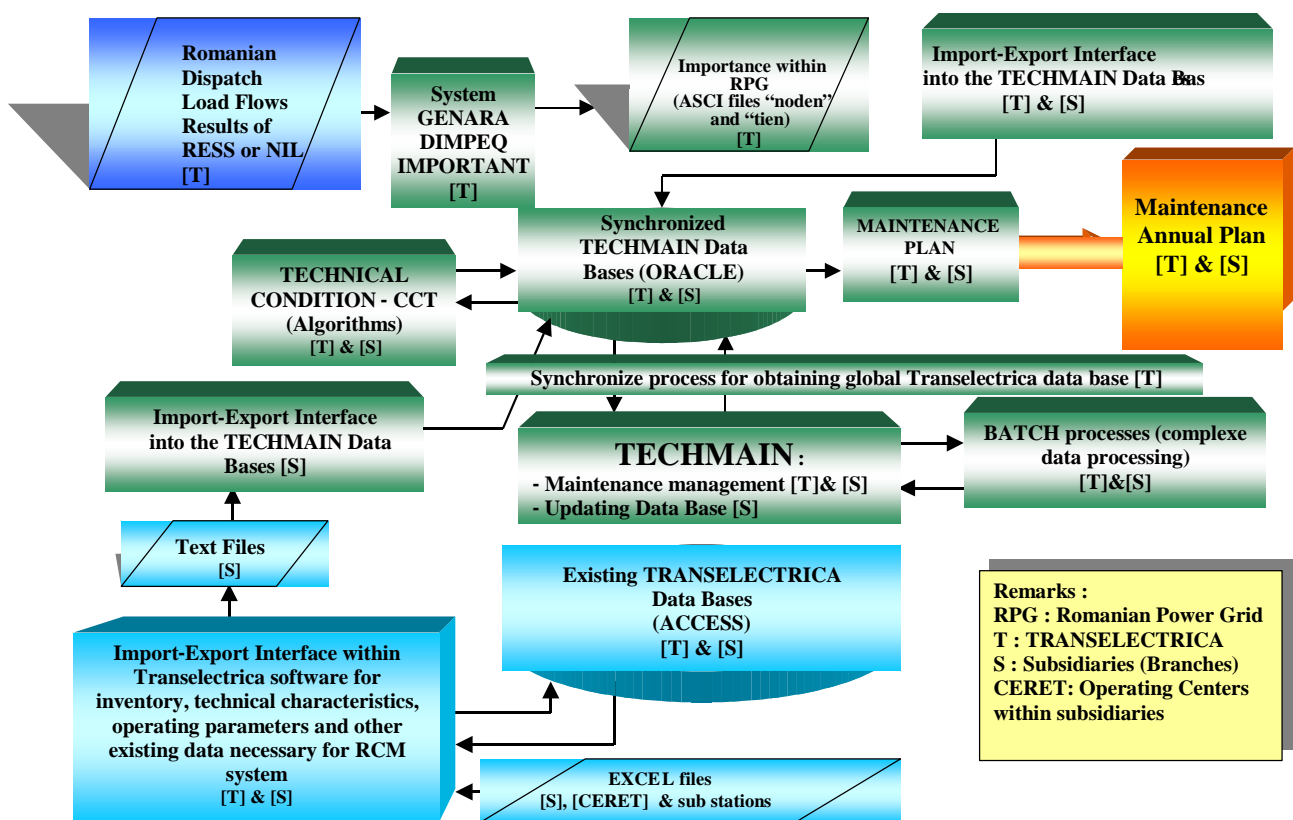


Fig. 3. Maintenance informational system

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