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Transmission Lines and Stations

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ANSE VISUAL

| Software to Analyze Substation Robustness

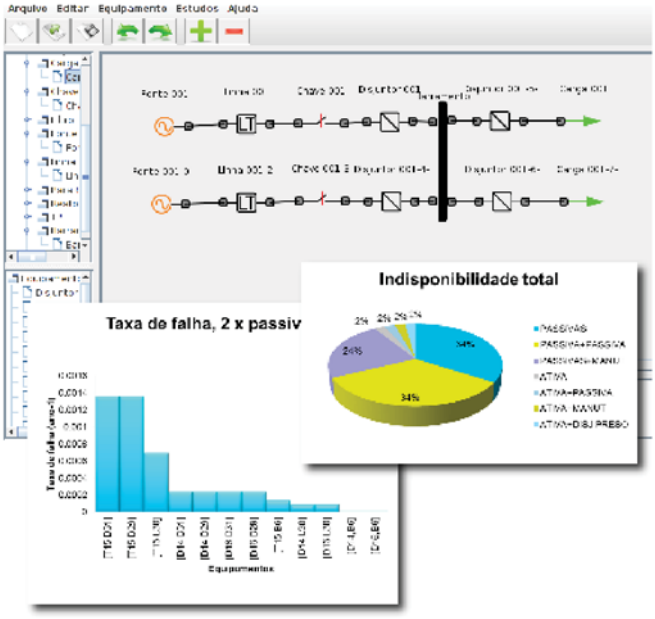
ANSE VISUAL, developed within the Institutional Project 1724, is a tool to analyze the robustness of electrical substations.

The software carries out a strict analysis of the internal structure of the substation, in particular its topology, considering the individual failure rates of components. Through probability methods ANSE VISUAL can estimate the unavailability of any function or load feeder in the substation.

It can also:

- set up topologies with a user-friendly interface;
- check paths between generations and loads;
- simulate the operation of circuit breakers for isolation of active faults, including the risk of a stuck breaker;
- report on unavailable values, failure rates and average duration, listed by contingency;
- graphical display and ranking of the results.

The main users of the program are Eletronorte and Light.



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GROUNDING | Grounding Grid System Design

Grounding is a computational tool with a graphical user interface (GUI) to calculate, analyze, and design grounding grids for distribution lines, transmission lines and electrical substations.

The tool has three main parts:

- SOIL: models the soil in two-layer configuration from on site measurements values of apparent resistivity.
- CURRENT: calculates the currents injected into the grounding grids by the interconnected electric power system.
- GRID: calculates the grounding grids, including the grid resistance, ground potential rise (GPR), and the step and touch voltage profiles and maps induced in the soil. The grids may be isolated or grouped. Each grid configuration can be regular or irregular of any shape.

The system uses reference models approved by professionals and electrical companies operating in Brazil and abroad.

The main users of the Grounding System are professionals within the Eletrobras System. However, the tool can also be used by electric utilities, as well as engineering service companies for distribution, transmission and substation projects.

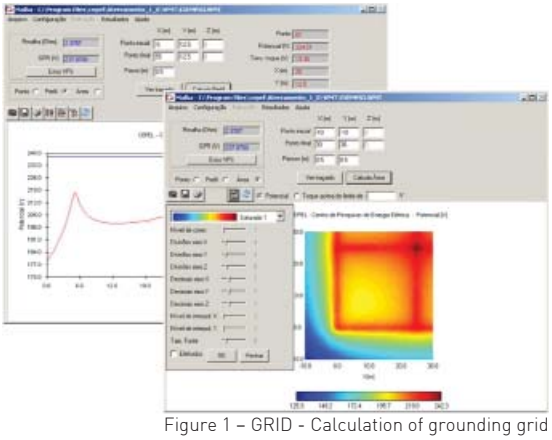

Figure 1 – GRID - Calculation of grounding grid

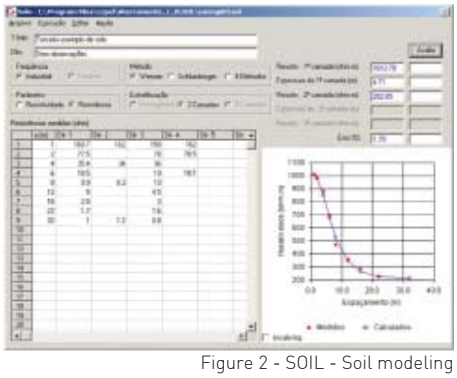

Figure 2 - SOIL - Soil modeling

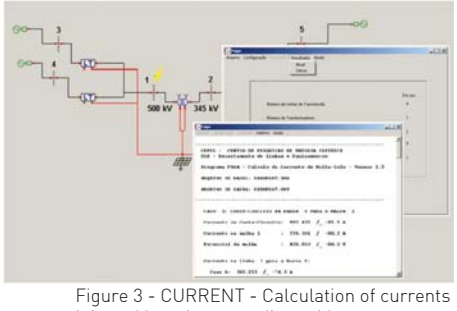

Figure 3 - CURRENT - Calculation of currents injected into the grounding grids

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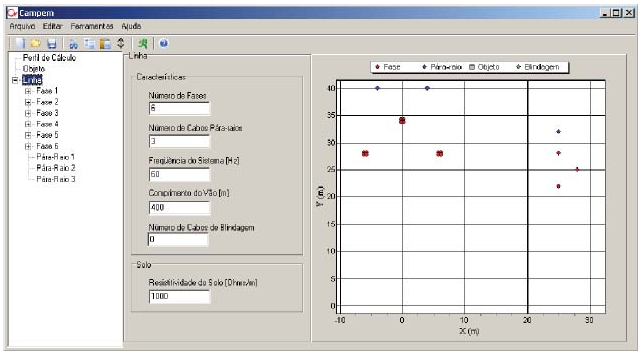
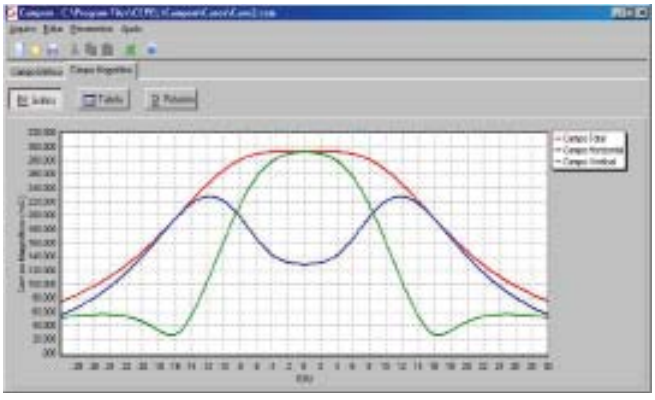
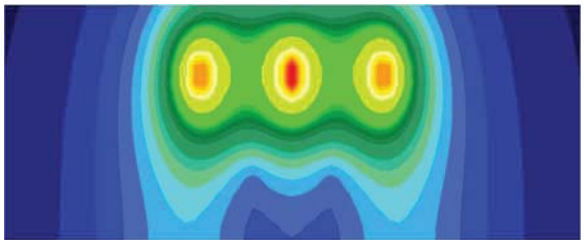
CAMPEM | Calculations of Electrical and Magnetic Fields and Induction Effects

The CAMPEM software calculates electric and magnetic fields produced by transmission lines and the electrostatic inductions due to the contact with metallic objects in the vicinity of those lines.

CAMPEM is applied to the study and design of transmission lines as well as checking their operational performance and, more recently, has been widely used to check compliance with ANEEL Resolutions 398/413







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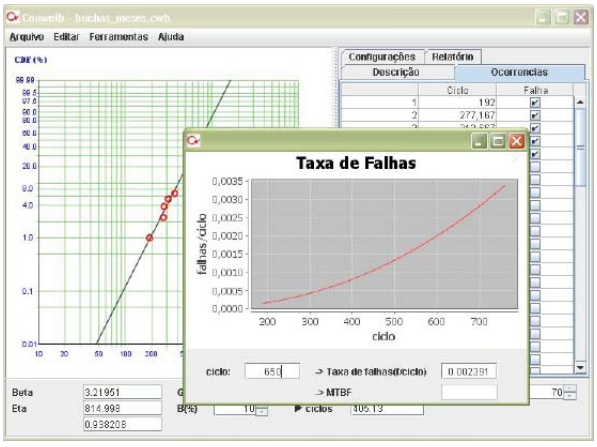
CONWEIB | Software for Statistical Analysis of Risk Failure

CONWEIB is a statistical tool to analyze the risk of equipment failure based on their operational performance. The program was set up by CEPEL, within the Institutional Project 1724, to model the probability of equipment failure, and using this to calculate quantities for reliability studies, such as average life-span, percentiles and failure rates.

The current version of CONWEIB can evaluate equipment that is considered repairable (Poisson model) and non-repairable (Weibull model).



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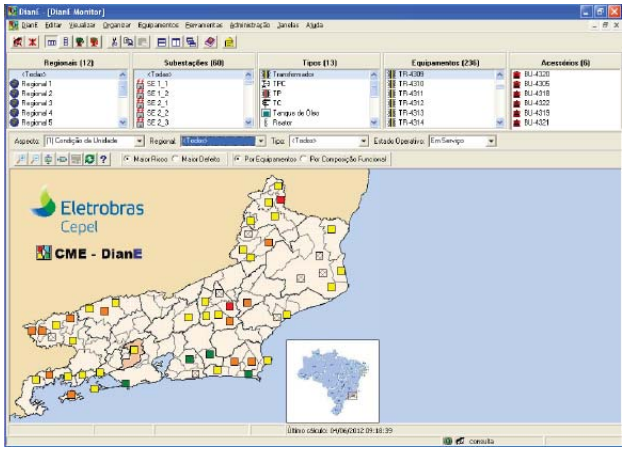
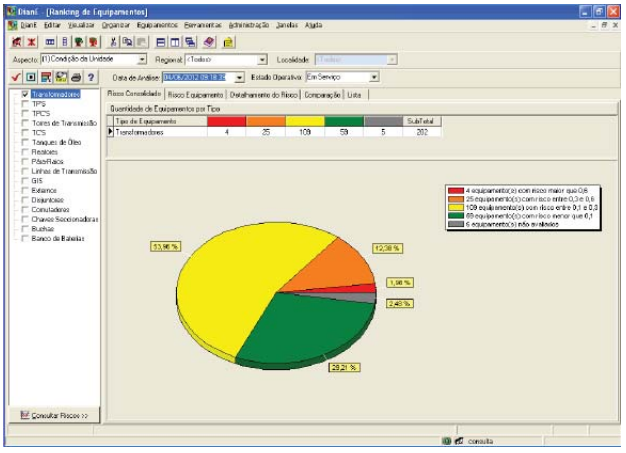
DianE | System for Equipment Analysis and Diagnosis

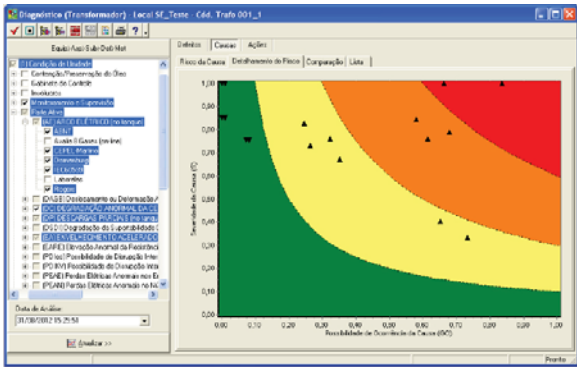
This system is designed for the analysis and diagnosis of high voltage substation equipment. It was developed in close collaboration between CEPEL and the Eletrobras System and was based on knowledge from 15 years research carried out following the Reliability Centered Maintenance (RCM) philosophy.

The integration of the analyses and diagnoses offered by DianE brings together different techniques to evaluate equipment defects and then lists priorities and possible causes. A list of recommended actions for each situation is also given to help in the decision making process.

Developed to include a historical assessment of all equipment, and still allow open interaction with other programs, DianE is closely integrated with SAGE (Open System Power Management) for analyses based on historical data. This analytical and diagnostic system can also interact with other supervisory and control systems that are available on the market.







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ELEKTRA | Design, Cost, Analysis and Optimization of AC and DC Transmission Lines with Generic Bundled Conductors

ELEKTRA is a computational tool with a graphical interface for the design, cost, optimization, checking, and technical and economic analysis of AC and DC transmission lines (TLs).

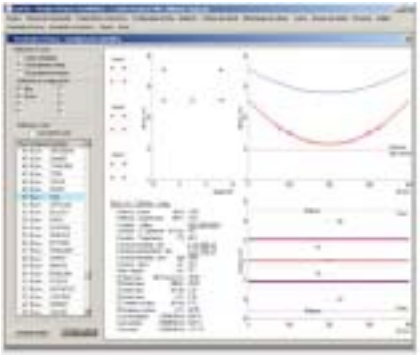
Applications:

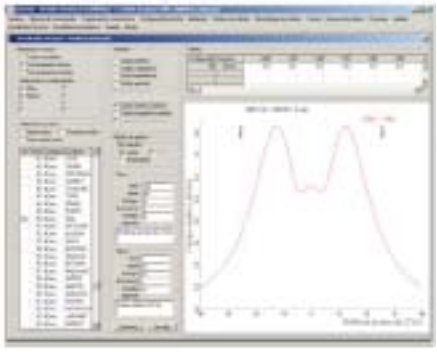
ELEKTRA is used for:

- Basis of electromechanical TL projects, automatically taking into account the climate of the region where the TL is to be set up, electrical and mechanical constraints, and the respective TLs components costs (by using database from Eletrobras, from the Federal Regulatory Commission (Aneel), or simply considering user input data);
- Analysis of conventional and non-conventional TLs, such as high surge-impedance loading (HSIL) lines, long lines, AC 1000 kV lines, DC ± 800 kV lines, etc;
- Selection of the more economic conductors or bundled conductors, with any spatial subconductors geometry (conventional circular, expanded bundles, HSIL bundles, multiple circuits, etc), considering the TL installation and electrical losses costs;
- Comparisons between AC and DC transmission, between guyed or self-standing towers, among different bundle configurations, etc;
- Checking the performance of TLs;
- Analysis and optimization of TLs corridors, including the computation of the line right-of-way and the profiles of electric field, magnetic field and ionic current (DC), and electrostatic inductions produced by the line in the surrounding area

ELEKTRA constantly has its calculation models updated, such as those published in recent technical documents of Cigré and the models foreseen in the ABNT NBR5422 review.

Professionals from the Eletrobras System and the Energy Research Company (EPE) are among the main users of this tool. The program can also be used by professionals of engineering service companies for power transmission projects.





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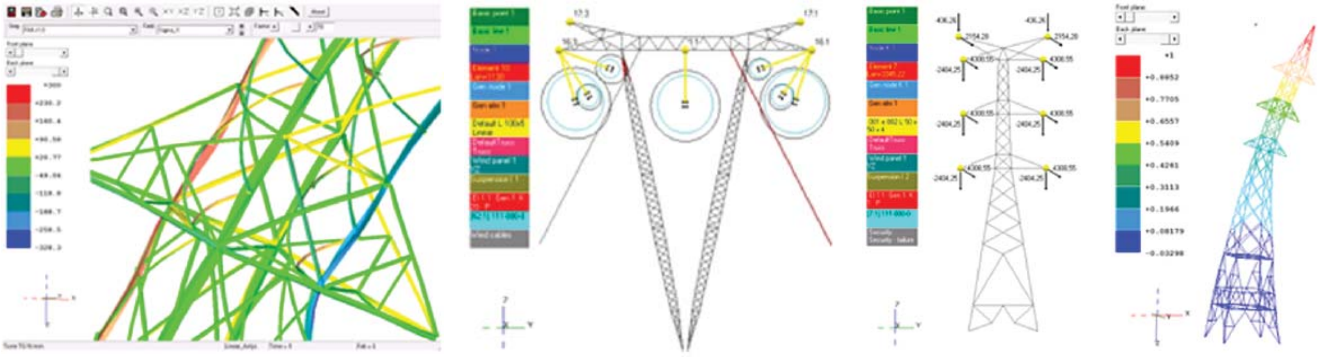
SAD-TLT | Software for the Structural Analysis and Design of Transmission Line Towers

This software is suitable for the structural analysis of trussed and framed metal structures, covering linear and non-linear geometric and material analysis; buckling modes, free vibrations and time dynamic analysis. It counts with 39 different cross sections. Its graphical screen allows for a spatial visualization of all structure data, including loads and results. The structures are stored in a single database, which can be accessed through the network.

The TLT module performs the design of transmission line towers. Some of its facilities are:

- Self-supporting and guyed tower design, including towers with one-mast, two-masts in V and cross-rope type.
- Fast structural modeling, based on the symmetry of the tower.
- Easy one command for the modification of an overall dimension of the tower.
- Automatic generation of the mast structure.
- Possibility to model each structural part of a tower separately and afterwards combine them to model the whole tower.
- Copying towers models between different databases via the network.
- Graphical verification of the conductor bundle electrical isolation.
- Accounts for the weight and the wind force on the secondary bars.
- Automatic generation of all load trees, although customized loads can be used.
- Graphical display of the results, showing the use factors and designing load of the members, displacements and forces.

Generation of a regression equation for tower weight: the TLT module is able to process a block of towers in a single click. All towers must be of the same geometrical type and voltage class, but can be of different heights and widths. Each tower is designed several times to cover all possible combinations required for conductor cables, bundle configurations, speeds and wind directions. The geometric and load parameters of each design are stored along with the calculated weight of the designed tower; each storing is considered as a point. Finally, the software calculates a regression equation for the stored points. The result of this regression equation is the weight of the tower as a function of the geometrical parameters and loads.



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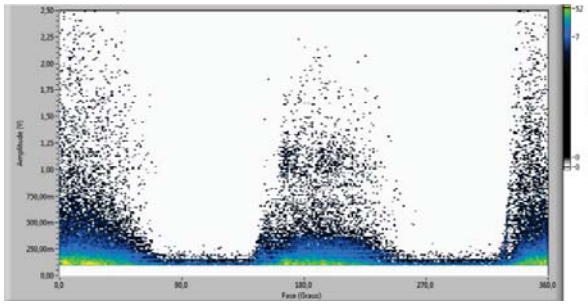
IMA-DP | Instrumentation for Monitoring and Analysis of Partial Discharges

Partial Discharges (PDs) in insulating systems of high voltage equipment is a symptom of weakness in the dielectric strength. PDs may ultimately have serious consequences for the equipment and the electrical system. The detection of PDs generated inside an insulating system is of extreme importance to evaluate the operating condition of the insulation system and predict premature or unexpected failure.

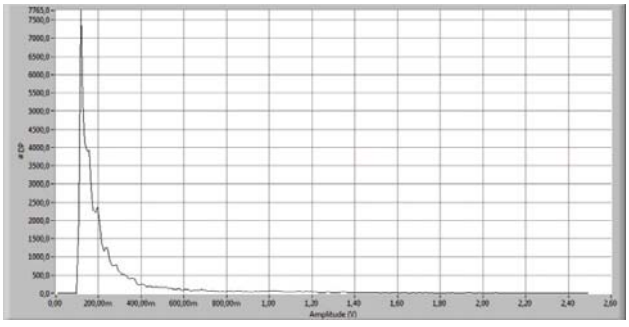
The original system developed by CEPEL was called IMA-DP. It was based on the IEC 60270 standard and can be applied to any high voltage equipment that has an insulation system. It has three integrated subsystems: measurement, operation and analysis.

The measurement system is responsible for the acquisition and recording of PD signals in the form of statistical maps (Φ, q, n). The operating system is responsible for setting and adjusting the measurement hardware as well as for on-request measurements. The analytical system includes tools for data visualization and treatment of the information stored in the IMA- DP database. A real time diagnosis (at the time of measurement) as well as a historical review with trend curves and classification of partial discharges can be produced.

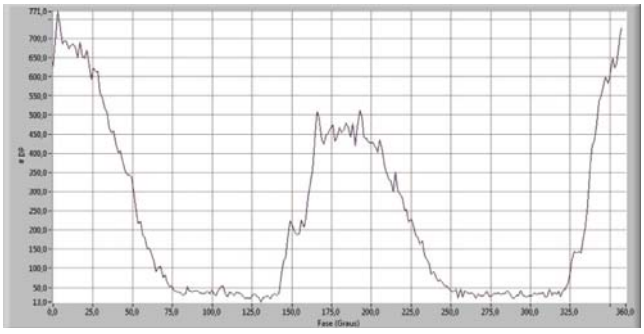
Information produced by IMA-PD in a report form:



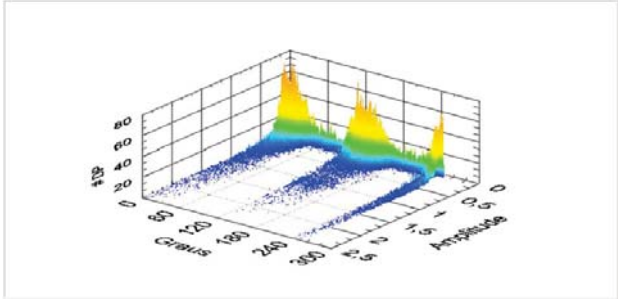
Statistical map



Amplitude histogram



Phase histogram



Three-dimensional

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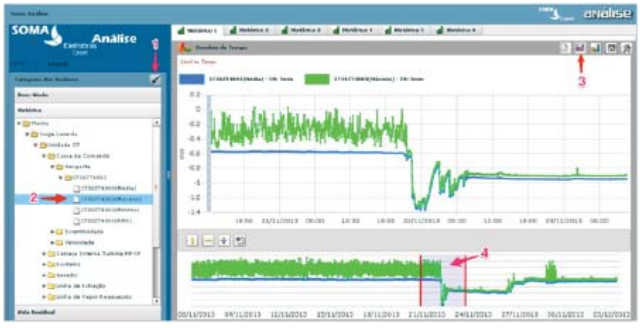
SOMA | System for Monitoring Engineering Assets

SOMA monitors the mechanical and electrical signals of rotary equipment. Data analyses and diagnoses of the operating conditions are based on computational intelligence techniques and can be monitored via appropriate graphical interfaces.

SOMA offers to the engineering maintenance department of a client company a tool that enables improved management for their assets (target equipment) through services and features for:

- real-time acquisition of the most relevant dynamic signals to characterize the operational condition of the equipment or installation;
- real-time (via internet) visualization of the signals acquired and the specific alarm level for each signal;
- processing and analyzing the monitored signals, both in their raw form and as historical data;
- appropriate graphical presentation of the acquired and processed signals;
- diagnosis of incipient faults and consequent prognosis of adequate operating time until maintenance shutdown;
- visualization of the theoretical behavior of the monitored item based on its mathematical model;
- integration of proprietary databases in scenarios where they are needed.

Implemented by the Laboratory for the Development of Diagnostic Systems for Generation Equipment (LabDEq -G), at Fundão, the system was developed under the research project "Monitoring and Diagnosis of Equipment and Facilities".



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