SPARD®

DISTRIBUTION

PRODUCT OVERVIEW

Table <LVLINSEC> Count <587>

xpos1	ypos1	xpos2	ypos2	datum	xsize	ysize	ehode1	ehode2	conductor	neutral	equiptype	fequipment	fequiptype	length	kvnom
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381756,5	2036763,6	381781,7	2036767,5	0	0	0	COD8	COD369	1/0-6ACSR	2/0CU7	0		0	25,5	0,22
381823,7	2036807,4	381853,1	2036809,1	0	0	0	COD13	COD371	1/0-6ACSR	2/0CU7	0		0	29,4	0,22
381844,1	2036814,4	381853,1	2036809,1	0	0	0	COD12	COD371	1/0-6ACSR	2/0CU7	0		0	10,4	0,22
381860,2	2036829,8	381853,1	2036809,1	0	0	0	COD14	COD371	1/0-6ACSR	2/0CU7	0		0	21,9	0,22
381908,2	2036852,1	381936,3	2036860,9	0	0	0	COD18	COD373	1/0-6ACSR	2/0CU7	0		0	29,4	0,22
381933,8	2036865,5	381936,3	2036860,9	0	0	0	COD19	COD373	1/0-6ACSR	2/0CU7	0		0	5,2	0,22
381957,7	2036882,4	381936,3	2036860,9	0	0	0	COD17	COD373	1/0-6ACSR	2/0CU7	0		0	30,3	0,22
382016,8	2036917,9	382040,5	2036924,4	0	0	0	COD25	COD375	1/0-6ACSR	2/0CU7	0		0	24,6	0,22
382034,4	2036933,6	382040,5	2036924,4	0	0	0	COD22	COD375	1/0-6ACSR	2/0CU7	0		0	11	0,22
382055,8	2036941	382040,5	2036924,4	0	0	0	COD26	COD375	1/0-6ACSR	2/0CU7	0		0	22,6	0,22
382031,7	2036895	382040,5	2036924,4	0	0	0	COD58	COD375	1/0-6ACSR	2/0CU7	0		0	30,7	0,22

energy
COMPUTER SYSTEMS

SPARD® DISTRIBUTION

PRODUCT OVERVIEW
ELECTRIC NETWORK GIS AND ANALYSIS

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Energy Computer Systems keeps an ongoing research and development process for **SPARD**®. Therefore, performance improvements are continuously introduced. Although this document is updated regularly, sometimes it will not describe exactly the functioning of the **SPARD**® version given to the customer.

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PRODUCT OVERVIEW

Electric utility companies facing a more competitive environment, even the very small ones, are using more and more automated systems to manage, analyze and operate their distribution network, in order to reach high cost efficiency levels in investment, operation and maintenance, providing at the same time a reliable and client – friendly service.

The area of power distribution is now attracting attention for contribution to raise the efficiency of the companies, given the enormous possibilities for improvement in this area. Regulation requires tools more oriented toward providing efficient, high quality and reliable services.

Geographic Information Systems (GIS) have made possible the association of spatial information (geographic) stored in maps, with diverse databases like municipal water systems, electrical networks, coal and oil deposits, etc.

The **SPARD® Distribution** software from Energy Computer Systems is a specialized, stand - alone GIS, that goes beyond general GIS and traditional AM/FM systems, since it integrates:

- The creation and maintenance of the power distribution networks geospatial data, its connectivity as an electric network model
- Visualization, querying and plotting of the network and the land base map background
- Important applications for analysis, optimization, simulation, management of those networks, that are seamlessly integrated in the same GUI (Graphical User Interface)
- Editing and maintenance of the SDD (SPARD Distribution Database) that includes all of the equipment, the topology and the geographic positioning of the grid.

Therefore, **SPARD® Distribution** is a specialized, optimized GIS for electric distribution networks.

The fundamental characteristic of **SPARD® Distribution** is the total integration of the geographic and graphical system with the database and with the application programs. The user has to handle only one GUI (Graphical User Interface), through which all system functions are managed.

Among the integrated analysis applications, there are the balanced and unbalanced load flow (both for radial and looped systems), multiple load allocation options, short circuit analysis, transformer load

management, Power, Energy and losses balances by feeder, optimal network reconfiguration, optimal capacitor placement, optimal conductor, reliability indexes, affected customers by an outage and more.

SPARD® Distribution has its own module for geographic and graphical data management, different from other packages where often commercial CAD or GIS programs are used for that purpose, involving integration and interface problems between the graphical module, the databases and the applications - consequently making it difficult and troublesome implementation for the final user.

SPARD® Distribution, however, through custom interfaces, the multispeak standard, and/or the CIM standard, it can connect to present GIS systems. It also can import / export network information in SQLite format or any other implemented database administrator, such as Oracle®, SQL-Server®, etc. It has total connectivity to Windows applications, such as Microsoft's Office™ Suite. Any SPARD generated SQL query result table can be sent directly to an Excel™ file.

On the other hand, **SPARD® Distribution** differentiates from other analysis packages, as it works and manages its distribution database directly and doesn't need third party GIS or other application's database. When working with an SQLite database, no additional cost has to be incurred for a DBMS, such as Oracle®. SQLite can be used in utility companies up to 5,000 clients, though Oracle® or SQL Server® is needed for multi – user, client - server implementations.

In order to manage big databases including all low voltage circuits and it's complete inventory, the data model pays special attention to that part of the network, modeling in a detailed manner customer meters, street lighting circuits and bulbs, and even other equipment such as Cable TV amplifiers. In that way the utility company can be sure about the presence of third party equipment and charge the corresponding cost.

Since 1992, when SPARD® DOS-32 BIT, the first integrated geographical software for electric distribution analysis had been published, now it is used in many companies internationally. Recently, **SPARD® Distribution** is being used as a tool to comply with the requirements established by the regulatory entities with regard to subjects such as quality monitoring of energy supply, and asset valuation for tariff calculations.

SPARD® Distribution version available is a native Windows™ Client application with client-server architecture in connection with databases such as ORACLE®. It was developed using object oriented

technology in MS Visual C++ language. It uses renowned tools and library functions, such as Open GL, MFC, and OO Standards such as COM/DCOM.

The focus of **SPARD® Distribution** today, goes beyond that of a tool for electrical analysis of distribution networks, although these applications are included and significantly expanded over the prior versions. **SPARD® Distribution** is an open system defined as a corporate solution for handling distribution systems for a small utility company, with a proven data model in many installations, but expandable, both with respect to information content and to the addition of new applications that can be implemented, even by third parties.

Interfaces can be easily implemented to the Commercial Information System (CIS) and data readings at the substation level, or SCADA.

The standard database connection through ADO/OLEDB enables the direct use of different database administrators, such as SQLite, Oracle®, SQL-Server ™. The development of database and Web applications that access the database through browsers in corporate intranets, extranets or the Internet, are supported by Energy Computer Systems.

Energy Computer Systems also provides the SPARD® Geographical Viewer, a low – priced complement to **SPARD® Distribution**, for configuring and generating a wealth of views and thematic maps (for remote viewing), for the **SPARD® Distribution** database or any connected and interfaced GIS, Billing, and grid operation database.

An important issue in terms of implementation investment is network data gathering and conversion from any source (field, paper drawings, AutoCAD™ or compatible Drawings, other databases, etc.) which is being supported by SPARD®. The customer can obtain consultancy services on that subject from Energy Computer Systems - we do have a very large experience in this field.

WORKSPACE (DATABASE) MANAGEMENT

1.1 Database Implementation, Workspaces

SPARD® Distribution uses object-oriented state-of-the-art technology with Microsoft OLEDB/ODBC, allowing the implementation of different DBMS, like Oracle or SQL Server, in a client-server environment. The standard version for small data volumes has the database in SQLite format and doesn't need any additional investment in DBMS.

The **SPARD® Distribution** user defines and manages ¨Workspaces¨ which can correspond to any set of the distribution network, i.e., a circuit or feeder, substation, a city, state, or an entire system of a distribution company.

SPARD® Distribution doesn't have a practical limit as to the quantity of any network element (substations, feeders, nodes, poles, sections, switches, etc.); limits are only established by computer hardware. Big workspaces can be handled by partial loading into to the client computer employing the criteria of electric connectivity. New, partial workspaces can be created easily with the SWM Tool and converted between ORACLE® and dbf.

1.2 Setting up the Data Base

1.2.1 Electric Network Data:

Information from the distribution network can come from different sources, such as paper plans and drawings, gathering information in field surveys, files and computerized databases, graphical information and attributes in CAD and GIS systems, etc. According with available information, different methods are used to convert and enter data into the **SPARD® Distribution** database:

Direct editing with mouse on the graphical screen with the cartography (land base) and / or the grid map in DXF format already mounted. If no cartography background is available, the network can also be set up by coordinates.

- Special **SPARD® Distribution** version for network data gathering / digitizing.

- Import from CAD and GIS systems through conversion into SPARD® format.
- Batch processes for massive filed data collection and entering of large data volumes (not part of SPARD® Distribution standard functionality)

Energy Computer Systems has extensive experience in electric network data collection and conversion, and offers consulting services in this field.

1.2.2 Cartography (land base maps):

Autocad™ DXF format files are read directly by **SPARD® Distribution**

1.3 Data export

- Graphical data to DXF (Autocad), Web SVG (extra option) or pixel formats.
- Graphical data to .SHP (Shape) files.
- Electric network and cartographic data: Oracle®, SQLite or any SQL DataBAse Format conversion tools.
- Creation of export files based on one or several tables with SPARD® Distribution powerful SQL report generator to MS Excel®.
- Direct access to the database from Office and Windows applications.
- Data export to plotters, printers and text files.

GRAPHICAL USER INTERFACE

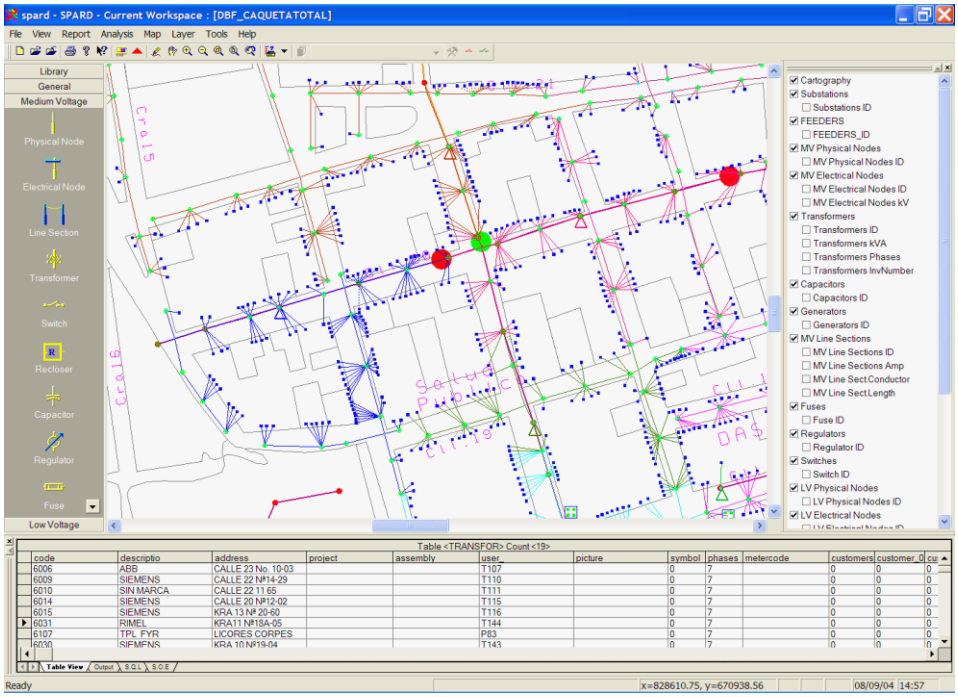

Figure 1.

1.4 Main menu (Top of Screen)

From here, the user selects the main options of SPARD® Distribution.

1.5 Icon bar (Left Side of the Screen)

- General Elements, Libraries, MV (Medium Voltage) Elements and LV (Low Voltage Elements). Each element can be added, modified, inspected and deleted. Inspection is also on a wide range of results of application programs,
- View by area: by Rectangle and Polygon shows all elements inside an indicated area in the bottom table view

1.6 Main map window

- Zoom and Pan functions (Screen displacements).
- Find: search by code of network elements, substations, transformers, etc., with automatic redrawing of the zone where the element is located.
- Cartographic (land base) map is an integral part of the visualization, cartographic layers can be turned on / off and its color changed

1.7 Layers bar (on the right side of the screen)

- Great assortment of visual layers of the electrical network elements, primary and secondary (low voltage) network or application programs results, feeders, etc.
- Cartographic layers and its color management.
- Label layers for basic text (e.g. ID and kVA of transformer, conductor type and length) and result of applications (node voltage, section current, etc.).

1.8 Data table and message area (Bottom Window)

- Simultaneous display (“view”) of data tables and graphical map. SQL query and Find function of graphical elements is integrated into Table View.
- Message display for possible application diagnostics (e.g. looped circuit at node N1000), SQL sentence errors.
- All diagnostics are being sent to a log file for possible later analysis.

REPORTS, QUERIES

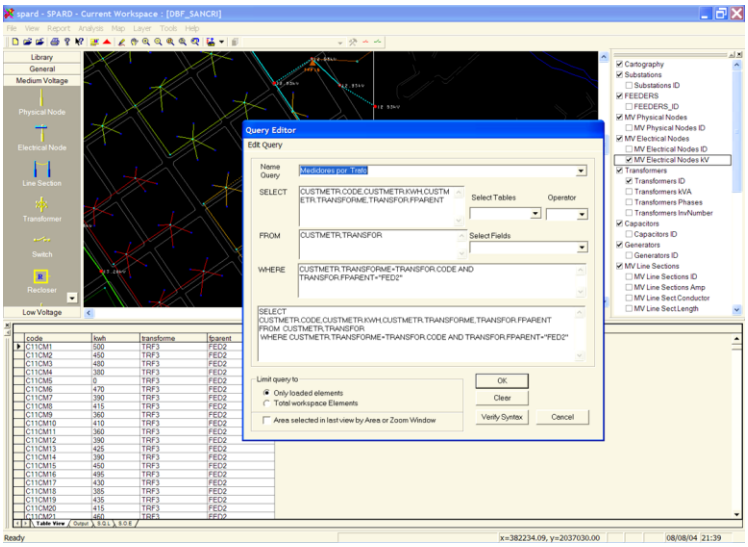

Figure 2.

1.9 SQL report generator

SPARD® Distribution has an SQL Report Generator (see picture above), for queries with logical and mathematical operators on one or several database tables. Data dictionary elements are displayed to help the user formulate a query.

Definitions of these reports can be saved with plain English titles in order to avoid repetition of query definitions. It generates reports from the total system, or a selected geographic area. It can also generate graphical selections, where the elements selected by a query are shaded on the Main Map Window. Any result table can be sent to a CSV text file or directly to Excel®.

1.10 Network element queries and results of the application programs

A great diversity of graphical results layers for Primary networks (Medium Voltage) and secondary (Low Voltage): Voltages, Currents, Line overloads, Transformers, Worst voltage, Flows, etc.

At each node (transformer, physical node, electrical node, etc.) there is plenty of information which is handled through standard "Tabs".

1.11 Special reports of the application

In addition to the Report generator and Node Query, **SPARD® Distribution** offers a series of specialized reports that are generated by almost all application programs (See applications list below).

These reports can be consulted directly or opened with any text editor / word processor.

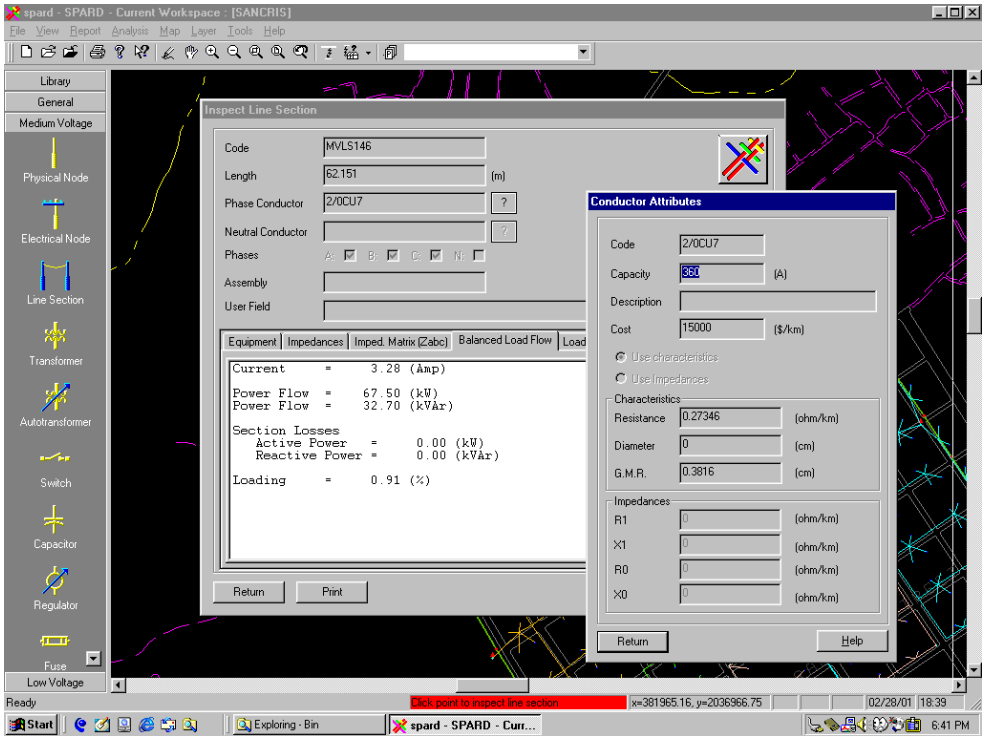

Figure 3.

OUTPUTS TO PRINTER, PLOTTER AND FILE

SPARD® Distribution has plotting functions for plotters or printers, as well as outputs to text files and graphical files in the Autocad® DXF format for post-editing in Autocad® or any CAD system that handles the DXF format.

MODELING THE DISTRIBUTION SYSTEM

The power distribution network in **SPARD® Distribution** is modeled starting at the substation, at the feeding points of the primary feeders. The medium voltage feeders can be of any voltage level: 11.4kV 13.8kV, 34.5kV, and any following transformation points are also possible.

The Medium Voltage Network, or primary, covers all elements and equipment (Poles, line segments, switches, capacitors, etc.), from the source bus at the substation till the distribution transformers.

From the distribution transformers till the customer meters and public lighting, the Low Voltage Network, or secondary, can be modeled for any voltage, 220V, 110V, etc.

As **SPARD® Distribution** is specifically designed for distribution systems, the substations are not modeled in detail at the transmission lines entry and power transformer system level, at the source bus from the points where the distribution network feeders do start. But, parameters, such as short circuit capacities of the source buses, voltage, nominal capacity and feeder readings (V, kW, kVAr, kWh, etc.) are modeled properly. (See also Energy Computer Systems SPARD® Power - Power Systems Simulator).

Also modeled are the three-phase and single-phase loads at any point of the medium voltage network, for example to connect industrial loads or to simulate loads from rural circuits.

Line segments and all other equipment are modeled taking into account exact phase connections.

By using the concepts of the electrical and physical node, in **SPARD® Distribution** it is easy to model parallel feeders or circuits that are using the same poles or underground connection boxes.

The Network database in **SPARD® Distribution** is independent of the topology (connectivity between network segments). The Configuration Program - Simulator is in charge of detecting any current configuration (tracing) of the primary or secondary network. **SPARD® Distribution** doesn't require manual coding or re-coding of the topology.

The electric data model of **SPARD® Distribution** is taking into account current IEEE standards and papers for transmission and distribution.

1.12 Basic library data

Library Data are database master files that are referenced when handling network data, for example the code of the type of conductor is present in each record of the line sections of the network. The parameters of the conductor itself are stored only once in the conductor type library file. Library data are global data and are not geo - referenced.

- Types of Conductors
- Types of Structures
- Types of Transformers
- Types of Customers

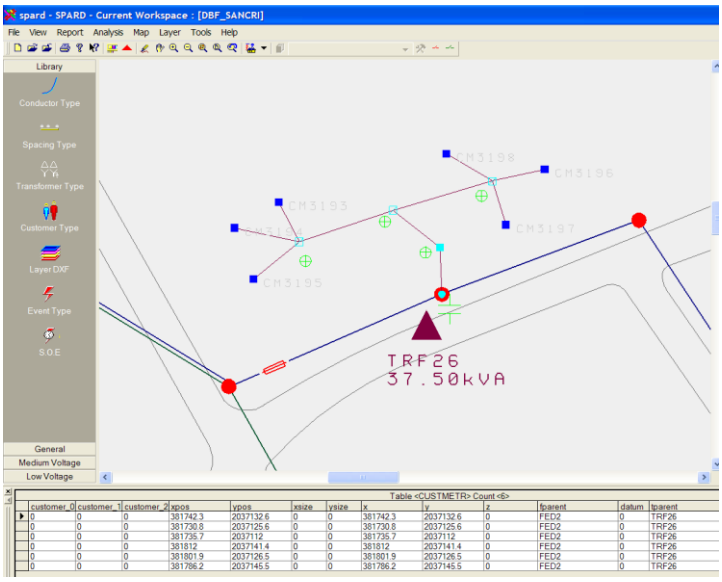

Figure 4.

1.13 Primary distribution network (medium voltage)

The following elements and equipment of the medium voltage network are part of the data structure of the database and are geo-referenced (or having geo - coordinates).

Modeling of the following elements and equipment (all those elements do have a graphical symbol):

- Substations
- Source bus of medium voltage feeders
- Feeding (starting) point of each feeder
- Readings of each feeder in the substation
- Poles, underground boxes (physical nodes)
- Conductor Spacing Structures (electrical nodes)
- Line Sections (Network segments between each electrical node)
- Distribution Transformers (single-phase, two-phase and three-phase)
- Capacitors

- Switches, circuit breakers, etc. (all types)
- Reclosers
- Regulators
- Fuses
- Generators

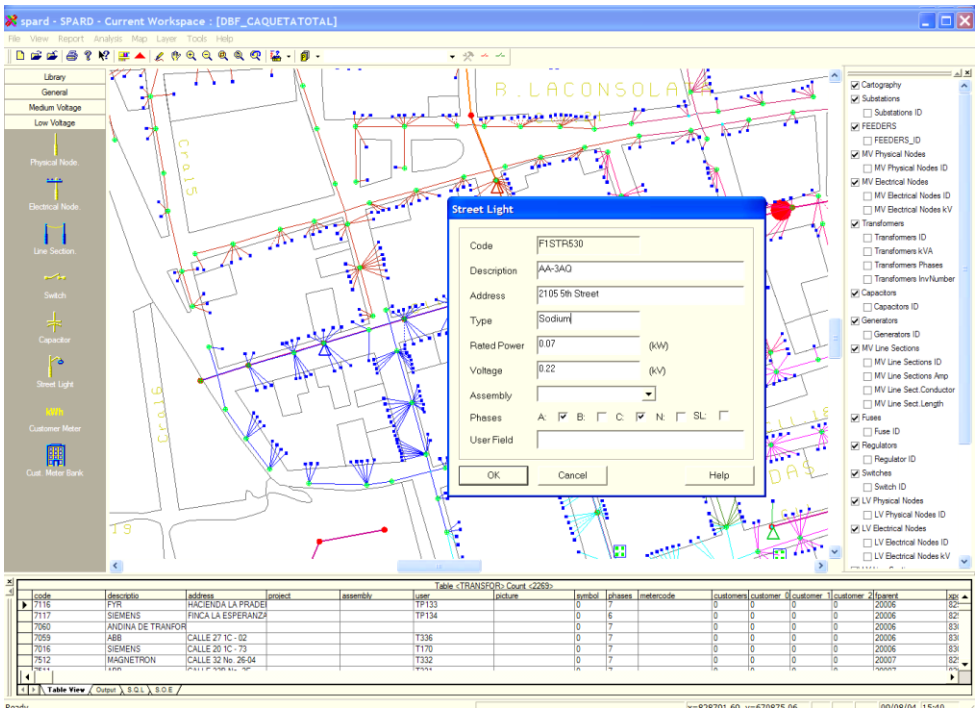

Figure 5.

1.14 Secondary distribution network (low voltage)

- Transformer secondary side connection
- Macro-Meters (meters consumption at low voltage exit of transformer)
- Feeding points of each secondary circuit at the distribution transformer
- Secondary Poles, underground boxes (physical nodes)

- Secondary Conductor Spacing Structures (electrical nodes)
- Secondary line sections (network segments between two electrical nodes)
- Street Lights
- Customer Meters,
- Customer Meter Banks (for modeling Buildings, etc.)
- Customers (clients)
- Other, third party equipment (Cable TV amplifiers, etc.)

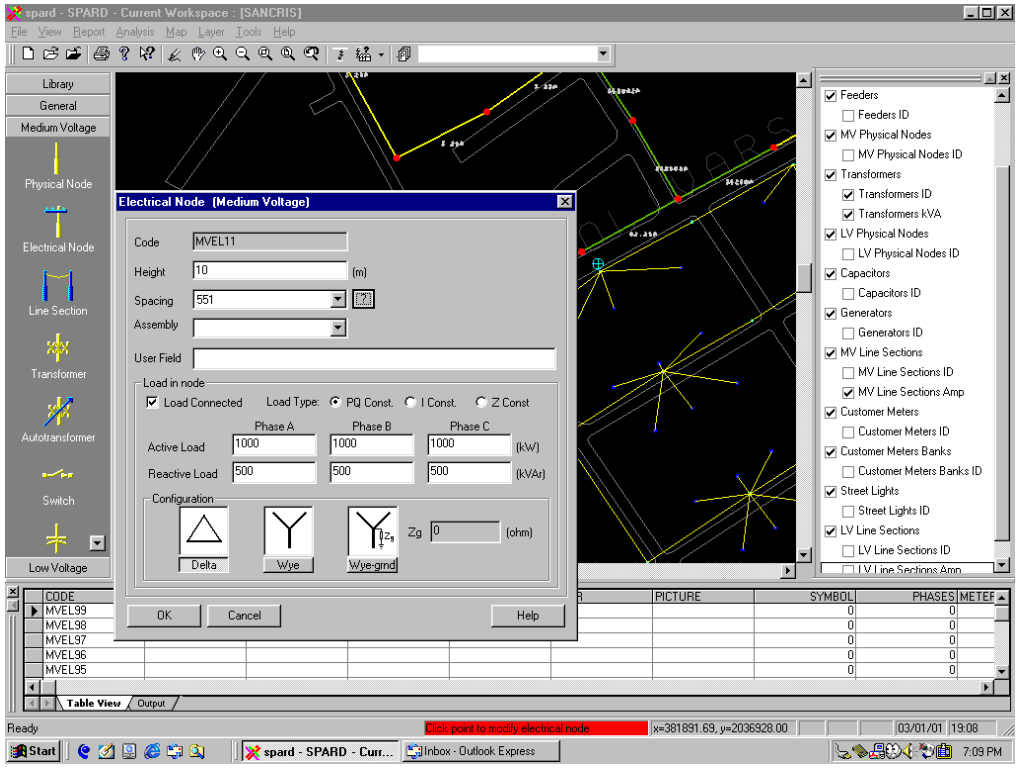

Figure 6.

1.15 Loads

In distribution transformers and electrical nodes: single-phase two- and three-phase loads

Assortment of methods to assign loads in distribution transformers, based on substation readings, customer consumption associated to distribution transformers (TLM), direct network load readings. (See Load Allocation Applications). Equally distributed loads for all transformers.

Simulation of load growths.

DOCUMENTATION, HELP

SPARD® Distribution has an ample documentation, which includes a Tutorial and a Comprehensive online User Manual.

The user also will find detailed contextual help on some screens.

LANGUAGES

The **SPARD® Distribution** software is available in English and Spanish (help and documentation).

CURRENT AND FUTURE VERSIONS

With SPARD DOS-32Bit, Energy Computer Systems introduced in 1993 a new concept for managing and analyzing geo - referenced electrical distribution network data in an integrated GUI – geographical environment, the first kind of such a system on the IBM-PC platform.

Having gone a long way of development and application at many sites, guarantees very mature and proven software, which is one of the most important aspects when acquiring a new software package.

Energy Computer Systems supplies all future upgrades under special conditions to our current customers.

Energy Computer Systems is always up to date with technological advances with respect to operating systems, development tools, software functionality and features. This way our customers can benefit from optimal tools and performance. For additional technical details please refer to the supplementary brochures and information on Internet (see http://www.energyco.com) and in digital or paper form sent to our clients and prospects.

HARDWARE AND OPERATING SYSTEM REQUIREMENTS

Minimum requirements for a single user of **SPARD® Distribution** or a client workstation are:

- IBM - PC - compatible computer
- 1.8 Ghz MHz Intel o compatible processor
- 1 Gb RAM Memory (2 Gbytes for Windows™ Vista)
- 100 Gbyte Hard Disk
- 128 Mbyte not shared video card (recommended)
- 17" Super VGA (minimum resolution 1024x768) Monitor
- Windows 7

Optimal specifications are:

- Intel or compatible 2.8 Ghz or c2d Processor
- 3 Gbytes of RAM
- 160 Gbyte Wide SCSI Hard Disk
- 256 Mbyte not shared video card
- Better than 1024x768 resolution Flat Color Monitor, 17” or bigger
- Windows 10

Hardware specifications and dimensioning for network and client/server configurations depend on the data volume and transaction load, therefore they must be determined based on a case by case analysis.

The required operating system to operate networks under client - server architecture is for the clients: Windows™ 7 or 10.

SPARD® Distribution also operates with Oracle® on other server operating systems, such as UNIX - Linux. Please inquire for more information on this issue.

SUMMARY OF INTEGRATED APPLICATION PROGRAMS

In this following chapter, the **SPARD® Distribution** application programs are shortly explained. Running the applications is simple and totally integrated within the graphical user interface. The majority of the programs are executed, as for example the load flow, choosing some options from a menu and then indicating the feeding point at the substation graphically or from a list. Results are shown in a variety of ways, (see Chapter 4).

The analysis applications are totally integrated into the programs GUI. For further and more sophisticated analysis, such as protection coordination, harmonic analysis and transient stability analysis, feeders can be read directly from the SPARD® database into our Power Systems Simulator SPARD® Power.

Important Note: Please request information on different **SPARD® Distribution** versions and on available and/or included applications. There are full, educational and special versions available.

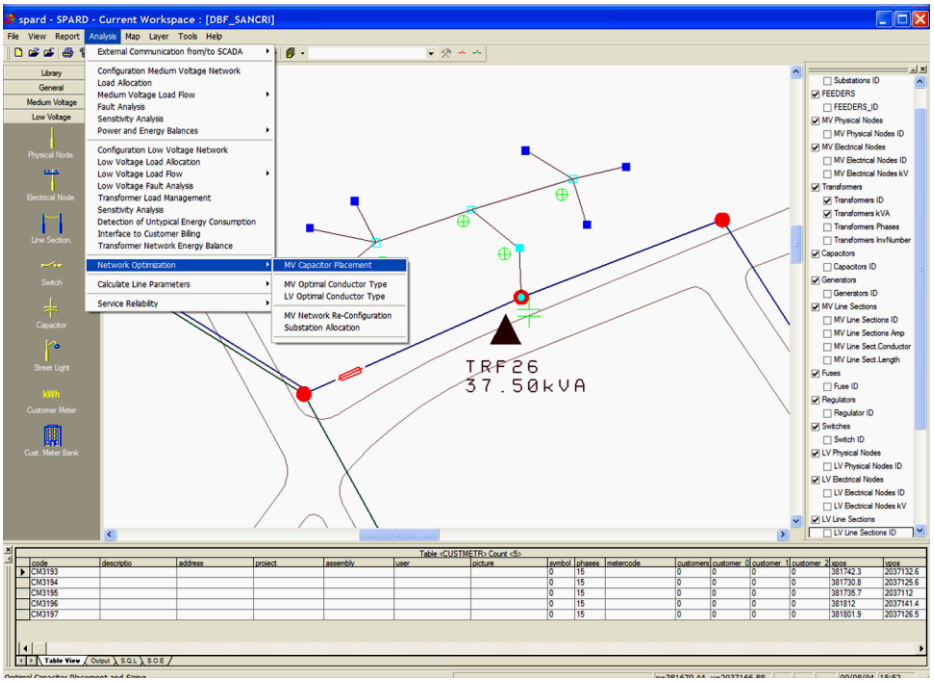

Figure 7.

1.16 Topology configurator / simulator for primary network

The configurator - simulator for the primary network models a circuit in current connectivity or simulates the topology of a circuit under certain conditions given to the program. The action of the configurator goes beyond simple color tracing, as all elements are dynamically reassigned to feeders / transformers according to the current position of the switches and breakers and the new grid configuration can immediately be analyzed by the program.

With this tool, for example, operations such as load transfers between feeders can easily be simulated and their effects evaluated (with the load flow program, etc.). A manual and an automatic configuration are available. In automatic operation, any changing of the status (open / close) of a switch automatically triggers running the configuration program.

For example, after a load transfer from one feeder to another, all elements (transformers, lines, etc.) are identified by the system as to belonging to the circuit that feeds them now.

1.17 Primary network load allocation

This program assigns the active and reactive load in each node based on the distribution transformer capacity, feeder meter readings, other parameters and results of TLM (Transformer Load Management kWh -> kW functions).

In particular, load can be allocated according to the following alternatives:

- Load of the node equals the capacity of the distribution transformer using a utilization factor (default factor is =1).
- The utilization factor of the distribution transformers is calculated proportional to the installed kVA and the readings at the feeder in the substation.
- Calculation of the load proportional to the consumption billing of the customers connected to the transformer and proportional the feeder readings (interface to Customer billing is necessary for that option)
- Loads assigned by the TLM program
- Load is calculated proportional to feeder readings and kWh of macro-meters, which measure total consumption at the LV transformer side.

- Directly metered load is entered at the electrical node.

1.18 Balanced Primary Radial Load Flow

This program calculates for a configured feeder, the voltages at the nodes, and the currents in the line sections, the power flows and the active and reactive losses (by section and total by feeder). It can calculate load flow at any point of a given, metered load curve (see feeder readings).

The load flow equation employed is exact, which permits to draw conclusions even with worst regulations.

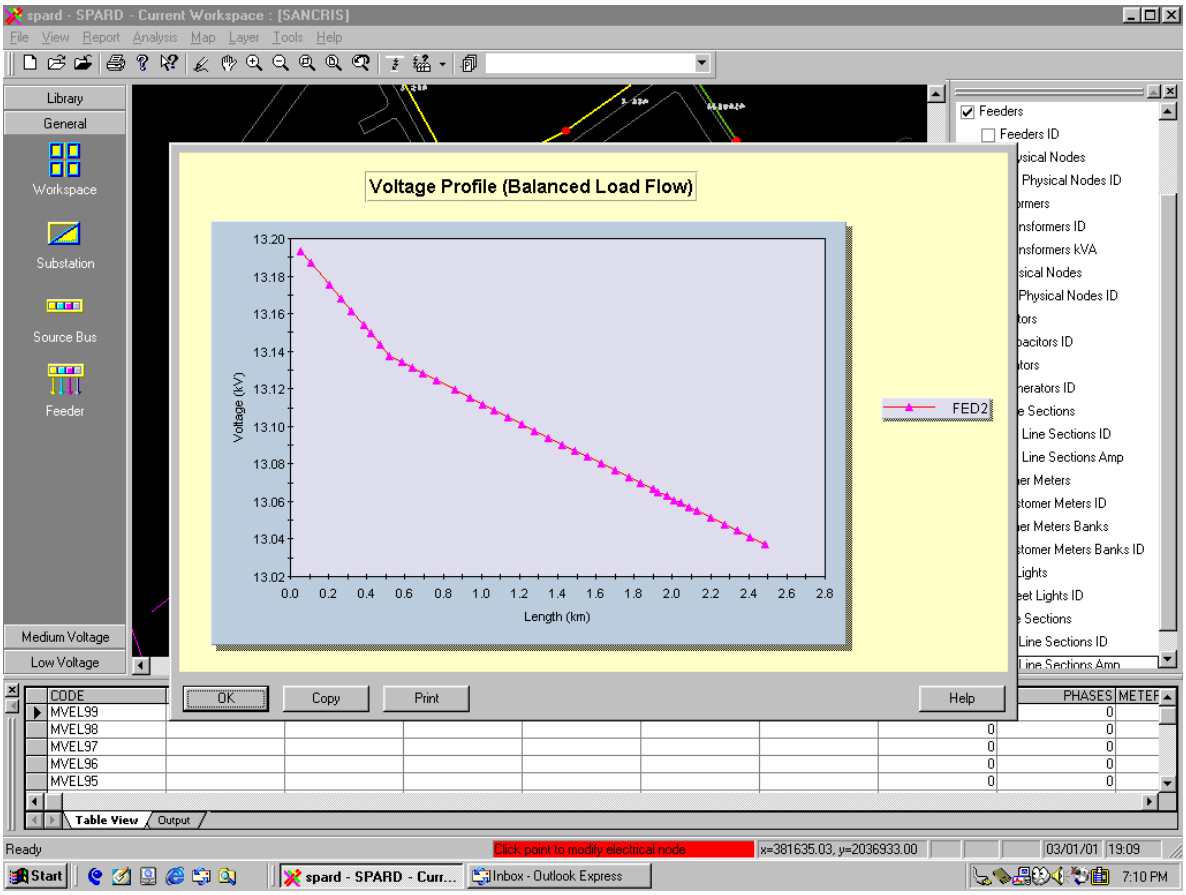

Figure 8.

1.19 Unbalanced primary radial load flow

This program calculates for a configured feeder, the voltages by node and by phase, the currents by section and by phase, the power flows by phase and by section and the active and reactive losses.

The program uses the impedance Carson formula for the calculation of the phase impedance and an algorithm for the unbalanced load flow that considers coupling among phases.

This application uses loads assigned by the Load Allocation Program or using loads calculated by the TLM (Transformer Load Management) program for each transformer.

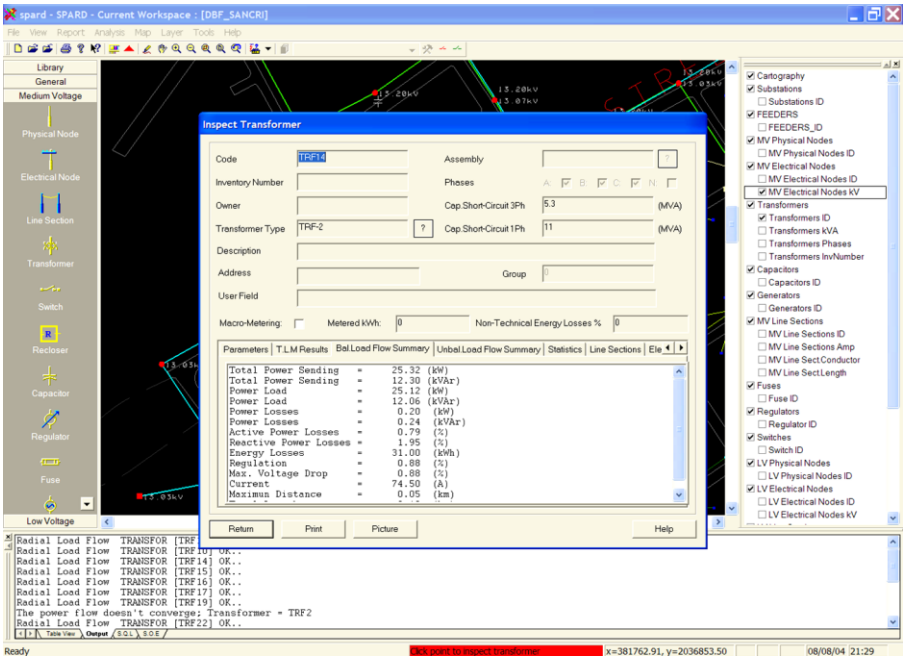

Figure 9.

1.20 Fault analysis – Primary and Secondary

Given the fault levels at the substation source bus, the program calculates the voltages and fault currents at all nodes of the feeder for all types of short-circuit: phase-ground, phase-phase, phase-phase-ground and three-phase.

In case of secondary circuits, the maximum fault currents are defined in the distribution transformer. Additional to the use for protection coordination, the Fault Analysis program is also of great usefulness for dimensioning of lightning arresters of the distribution transformers.

1.21 Analysis of the network state – Balance of power, Energy and Losses

This program summarizes the total losses, discriminated into losses in the primary network, the transformers and in the secondary network. Based on the substation data, it calculates the index of physical losses in the primary network of the system.

The difference between energy data read at the substation, physical losses, and customer billing gives the index of non-technical losses. This summary, besides a very detailed break up of each power, energy and loss component of the MV & LV system, also displays the contribution (in percentage) of each feeder to the total losses of the system. The Balance table can be exported to Excel™ for further analysis.

1.22 Optimal capacitor sizing and placement

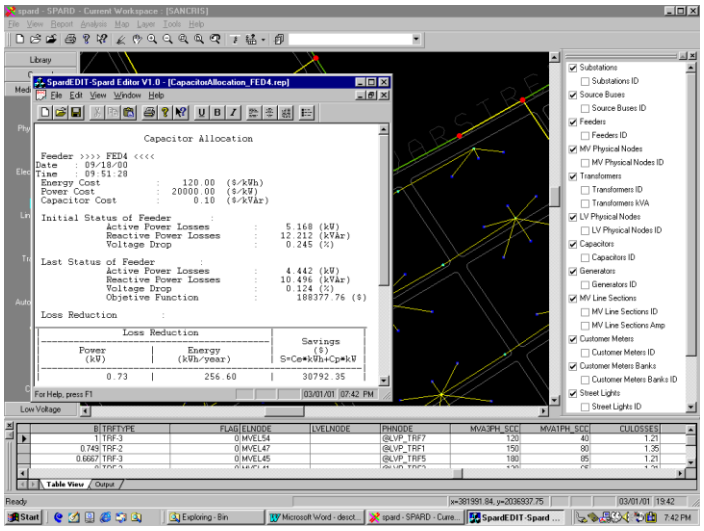

Figure 10.

This program solves, using Non - Linear Programming, the problem of minimizing an objective function in terms of investment cost in capacitors and the losses of the circuit, under the constraints of satisfying the equations of load flow for maximum and minimal loads without transgressing voltage limits in each node.

The program gives as result the quantity of reactive compensation required in each node of the circuit. Likewise it gives all the information of load flow, voltages and losses, using the located and calculated capacitor banks.

1.23 Optimal network reconfiguration (Primary and Secondary)

This program determines the optimum points of switching among circuits in such a manner that the total losses in the Entire City (system) or part of it (in the secondary or primary network according to the case) will be a minimum.

With this program the program interlaces the distribution network of the substations and feeders involved and the program finds, after an optimization analysis, optimum break points of such a form, that the network again turns radial but with a new topology and minimal global losses. With this program reductions of technical losses can be achieved, without meaningful investments.

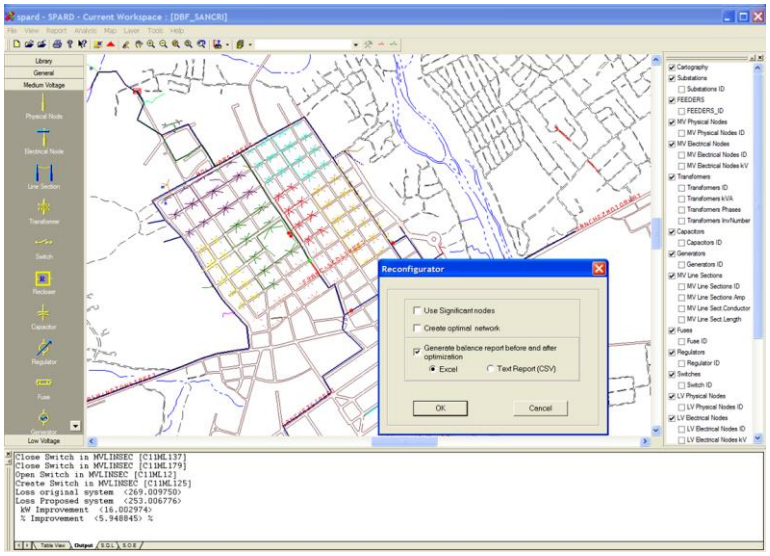

Figure 11.

1.24 Economical conductor (for Primary and Secondary network)

The basic idea of this program consists in finding for each conductor the optimum current under the criteria of maximum utilization of the conductor and minimal losses of energy. Under these conditions **SPARD® Distribution** selects for each section of the network the most adequate conductor according to the results of the load flow.

1.25 Voltage sensitivity analysis

The purpose of this program is to give immediate information to the engineer of the company attending new load requests, to approve or to reject new services.

The user requests the service for a given load and the system answers giving immediately the voltage conditions, in which the system would attend that load. In addition, this program can be used as a quick simulator of state changes that would occur under contingent loads or in the case of capacitor connections.

1.26 Secondary configurator – Simulator

This program operates in the same way as the primary configurator, except that it works on the database of the secondary network.

1.27 Secondary load allocation

This program assigns the active and reactive load in each load node of the secondary network. The user can allocate load according to the following alternatives:

- The load at one customer meter is equal to the transformer capacity divided by the number of meters connected to that transformer. A utilization factor can also be used.
- The transformer capacity is distributed among the customers proportional to the kWh consumption of each customer.
- The transformer load that is calculated by the primary load allocation is distributed proportional to the kWh consumption of each customer. This last method allows - when using for primary load allocation the basis of kWh consumption - calculation of feeder energy balances (running load flow applications) and the calculus of technical and non-technical losses.
- Load is read directly from electric node
- Load is calculated on the basis of kWh metered at the secondary side of transformer (macro-metering)

1.28 Balanced secondary radial load flow

For a configured secondary circuit (which is accomplished by the secondary configurator), this program calculates the voltages at the nodes, currents in the sections and total losses by section.

It uses the same exact equation of the primary load flow; the assignment of the loads is made with the secondary load allocation program.

1.29 Unbalanced radial secondary load flow

This program calculates for a secondary network, the voltages by node and by phase, the currents by section and by phase, the power flows by phase and by section and the active and reactive losses.

It uses a Carson impedance formula for impedance calculation and an algorithm of phase load flow that takes into account coupling between phases. The program has the same options of load assignment as the balanced load flow and they are handled in the secondary load allocation program.

1.30 Transformer load management (TLM)

This program calculates the value of the peak kW load of the distribution transformer based on billing data of the customers connected to this transformer. It then offers a series of data and graphs related to transformer management.

The employed equation is of type:

$$kW\ max = f\ (kWh)$$

A statistics based function for each customer type has to be established. **SPARD® Distribution** accepts any function type. The corresponding parameters are introduced directly by the user.

When executing TLM, **SPARD® Distribution** goes to every distribution transformer of the system or selected feeder (or part of it) and sums up the energy consumption of all customers that belong to a transformer. Then the above mentioned function is applied for the dominant customer type of the transformer and the maximum load is calculated for the transformer.

Using a transformer related power factor or the power factor of the feeder; the active and reactive load is calculated. TLM also calculates transformer losses based on that max. Load. The load flow programs then use those data. By using this program periodically, the transformer loads are updated.

With the Report Generator, among other data, the total losses of the system in the transformers, the percentage from overloaded transformers and its distribution can be obtained. It is of noting that the system displays graphically a symbol on the overloaded transformers (when the corresponding layer of results is activated). Graphs can be obtained with load distribution ranges of transformers.

1.31 Interface with billing

This program permits to extract the information from the billing system of the company, in order to update the consumption values of each user. These data will be used by the TLM (Transformer Load Management) and Load Allocation program to estimate the value of the peak kW and the total losses of each transformer and by several other load allocation methods.

Furthermore it provides the data to calculate the non - technical losses, upon making a balance with physical losses obtained with the load flows and the TLM, and the energy and power measurements at the substations. For Reliability and Service Quality applications, the interface to the CIS (Commercial Information System) is essential. Custom interfaces may be needed depending on the data to be interchanged. Energy Computer Systems has developed and implemented several interfaces of this kind.

With this module only the periodical reading of a data from a text file format is accomplished.

1.32 Project and cost calculation

First, with this program the user of **SPARD® Distribution** can define network expansion projects, work under construction, etc.

Then, elements of the network, such as cross arms, poles, equipment associated with transformers, etc. can be defined with its respective material lists that contain assemblies and items. The items are defined in a separate database with their unit costs. The program calculates total costs for each element and the total cost for a given project. (This is a module called SPARD® Project and Cost and must be acquired separately).

1.33 Optimal transformer relocation

The program places on each node where there is a non - optimal distribution transformer, another existing transformer that will remain there loaded at an inferior load than the nominal load and that corresponds to the economic load for that distribution transformer.

The program exchanges transformers, if it is possible, in such a way that the cost of the movement and / or exchange is a minimum. (This application is only available on request).

1.34 Load Forecasting

Starting with a global (for the whole city) demand forecast by type of customers, future consumption is assigned to each feeder according to the customer type distribution. With different methods, the projected energy is converted to peak demand for each distribution current and planned transformer.

Using the forecasted loads, all the analysis programs of **SPARD® Distribution** to plan and design the future network can be used.

Thus, **SPARD® Distribution** is a great tool for optimal distribution system planning.

1.35 Fault statistics and reliability analysis

This application has the following modules:

- Recording of outages (place, event type, equipment, service re-establishment time (handles partial re-establishments for the same outage), etc.
- Calculation on the basis of elements affected downstream of quality indexes DES and FES (Duration and frequency of outages by circuit and customer)
- Statistics of outages by equipment for maintenance purposes (through SQL queries)

This module is not intended to manage big databases and simulate business processes. For this purpose and for corporate implementations, please refer to the module SPARD® OMS Outage Management and Service Reliability.

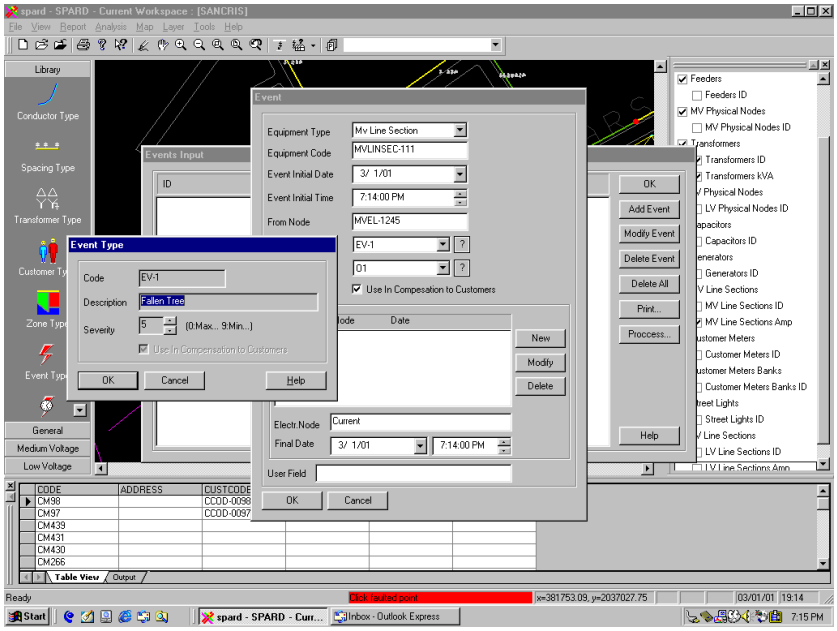

Figure 12.

1.36 Optimal Substation Placement

Using a function containing construction costs of substations plus costs of active losses, this program selects among several candidate points the optimal placement of the substation. Internally it works with

the Optimal Network Reconfiguration, and places the substation in such way, that the investment cost plus total losses will be minimal.