Alstom is a world leader in electricity transmission and distribution, offering its customers a complete range of products and solutions for enhanced grid stability and energy efficiency.

Optimising your investments

Utilities are looking for flexible, reliable, cost-effective and sustainable solutions to optimise the lifecycle performance of their electrical grids. Alstom’s Network Expertise teams are close to our customers to provide them with the professional engineering support needed to satisfy their technical and economic requirements.

In addition to the guarantees of an acknowledged world leader in the power industry, our network analysis and expertise services will help you to:

- Optimise your investments
- Reduce your operating costs
- Extend the lifecycle of your electrical equipment
- Improve the security of persons and equipment
- Provide more reliable detection, tripping and analysis of electrical disturbances

Electrical network analysis and expertise

ELECTRICAL NETWORK ANALYSIS OVERVIEW

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<th>ANALYSIS</th>
<th>OBJECTIVES</th>
<th>TYPE OF APPLICATION</th>
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<td>Load flow report and voltage drop</td>
<td>• Identify weak points in the grid and improve operating costs&lt;br&gt;</td>
<td>• On any new or existing installation&lt;br&gt;</td>
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<td>• Reduce losses&lt;br&gt;</td>
<td>• In case of a change in architecture or mode of operation</td>
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<td>• Propose network architecture and modes of operation</td>
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<td>Neutral rating specification</td>
<td>• Ensure the safety of persons and property&lt;br&gt;</td>
<td>• On any new installation&lt;br&gt;</td>
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<td>• Optimise the detection of grounded faults</td>
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<td>Short circuit</td>
<td>• Equipment sizing&lt;br&gt;</td>
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<td></td>
<td>• Reduce the risk of damage</td>
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<td></td>
<td>• Optimise the detection of faults</td>
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<tr>
<td>Measurement reducer specification</td>
<td>• Reduce the purchase costs of current and voltage measurement reducers&lt;br&gt;</td>
<td>• On any new installation&lt;br&gt;</td>
</tr>
<tr>
<td></td>
<td>• Ensure proper operation of protection relays and measuring devices</td>
<td>• In case of change in architecture or mode of operation or protection plan</td>
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<tr>
<td>Selectivity and settings files</td>
<td>• Rapidly eliminate the area of the network disturbed&lt;br&gt;&lt;br&gt;</td>
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<td></td>
<td>• Improve the security of persons and equipment&lt;br&gt;</td>
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<td></td>
<td>• Optimise network operating quality</td>
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<tr>
<td>Dynamic stability, motor starting and re-acceleration</td>
<td>• Reduce the risk of damage&lt;br&gt;</td>
<td>On any facility involving rotating machines (generators, synchronous or asynchronous motors)</td>
</tr>
<tr>
<td></td>
<td>• Reduce the risk of operating loss</td>
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LOAD FLOW AND VOLTAGE DROP ANALYSIS

- Balance the power production/power consumption ratio
- Avoid under-sizing of electrical equipment
- Reduce losses
- Regulate voltage across the network

Methodology
For each operating mode, the analysis determines:
- The contribution of the generated and consumed power at all points in the network
- Total losses in the network
- The peak operating conditions of equipment: the reactive power limit of synchronous equipment, the upper or lower tap limit of power transformers with tap changers, the maximum load limit of cables and overhead lines, etc.

Items included in the analysis
The analysis is carried out using CYME International’s PSAF-FLOW software, acknowledged worldwide and used by many research and engineering specialists. The analysis report includes the following:
- A summary of the entire data and the assumptions used for the analysis. The collection of the technical data needed to execute the analysis is based on a document that is sent to the customer on receipt of the order
- A complete single line diagram of the network
- A detailed technical note commenting on the results of simulations and the technical and economic choices
- A report on the transit values at all points and branches of the network, as well as weak points identified

NEUTRAL MODE SPECIFICATION ANALYSIS

- Optimise the detection and removal of earth defects
- Avoid the phenomena of overvoltage transients and temporary overvoltage when clearing the earth fault risk of destruction of equipment
- Verify the proper performance of high voltage equipment on short circuit to earth (thermal and electro-dynamic)

Methodology
Define the optimal neutral rating mode of the network depending on:
- The required level of protection and security of persons and equipment
- The short-circuit capabilities of the equipment in the network
- The operating strategy chosen

Items included in the analysis
This analysis takes into account the technical requirements associated with any change of neutral rate and can be carried out in two ways:
- Specify one or several neutral impedances to obtain a neutral rate congruent with the original specification transmitted by the customer
- Make a number of technical proposals for the neutral rate, depending on the rules applied for the protection and security of persons, equipment and on the strategy chosen for network operation
SHORT CIRCUIT ANALYSIS

- Size the settings for protection relays to ensure co-ordination of the protection
- Verify the proper sizing of metering reducers connected to the protection relays
- Verify the proper sizing of the equipment regarding the thermal and electro-dynamic withstand in the short-circuit rate: busbar, OT lines, wires, etc.
- The ability to cut off circuit-breakers

Methodology
Calculate, at all strategic points in the network, all the parameters (current, voltage, power) relating to multi-phase faults and earth faults.

Items included in the analysis
The analysis is carried out using the PSAF-FAULT software, acknowledged worldwide and used by many research and engineering specialists.

A default simulation scenario can be established in accordance with international standards IEC 60909, ANSI C37.010 and C37.05 standards.

The analysis report includes the following:
- A summary of all data and the assumptions used for the analysis. The collection of the technical data needed to execute the analysis is based on a document that is sent to the customer on receipt of the order
- A phase and earth short-circuit analysis
- For each measurement reducer (measurement coil and protection coil):
  - A detailed note describing the calculation methodology
  - The values of parameter specifications

These parameters are subsequently transmitted for manufacturing operations.

MEASUREMENT REDUCERS SPECIFICATION ANALYSIS

Lower the cost of the measurement reducers (current transformers (CT) and voltage transformers (VT) by:
- Specifying the design parameters necessary for the proper operation of protection relays
- Optimising the homogeneity of the system measurements: primary network CT/TP and secondary wiring protection

Methodology
Specify the current and voltage transformers in accordance with international standards IEC 44-1, IEC 44-6 and BS3938.

Items included in the analysis
The analysis report includes the following:
- A summary of all data and the assumptions used for the analysis. The collection of the technical data needed to execute the analysis is based on a document that is sent to the customer on receipt of the order
- A phase and earth short-circuit analysis
- For each measurement reducer (measurement coil and protection coil):
  - A detailed note describing the calculation methodology
  - The values of parameter specifications

These parameters are subsequently transmitted for manufacturing operations.

Short circuit analysis
**SELECTIVITY ANALYSIS AND SETTINGS FILES**

- Co-ordinate the whole protection plan to be able to rapidly isolate the area of the network affected by a fault while maintaining all non-fault areas in service
- Improve the protection and security of persons and equipment
- Optimise network operating quality and availability

**Methodology**
Optimise a protection plan in terms of functions and equipment, taking into account the network specifications and all operating techniques.

**Items included in the analysis**
The analysis is carried out using CYM-TCC software, acknowledged worldwide and used by many research and engineering specialists. The analysis report includes the following:

- A summary of all data and the assumptions used for the analysis. The collection of the technical data needed to execute the analysis is based on a document that is sent to the customer on receipt of the order
- A complete single line diagram of the analysed grid
- A phase and earth short-circuit analysis
- The selectivity phases and earth curves (on LOG/LOG time/current graphs) created using expert software
- A detailed technical note commenting on and justifying the protection settings and highlighting the technical challenges
- A settings file for each protection relay (Alstom Grid or other). For the MiCOM range of protection relays, the settings are made and then loaded directly into the relay using the MiCOM S1 Agile settings software

**MOTOR STARTING AND RE-ACCELERATING ANALYSIS**

Analyse the transient phenomena caused either by starting and re-accelerating motors in a normal phase of operation, or from the result of the occurrence / elimination of faults.

The recommended solutions allow verification that starting or re-accelerating motors will not involve:

- Tripping of the protection relays (and therefore operational losses)
- Risks of unacceptable voltage drops (specification of load shedding automatisms)
- The non-stability of the network (risks of partial or total blackout)

**Methodology**
Starting and/or re-accelerating asynchronous motors involves disruptive phenomena such as:

- Significant current peaks
- Voltage drops due to such current peaks

**Items included in the analysis**
Transient phenomena resulting from disturbances are the focus of this analysis. Therefore, the approach and content are similar to those of a dynamic stability analysis carried out using the PSAF-STAB software from CYME International.
TECHNICAL STUDIES AND EXPERTISE SERVICES

Examine the electrical network onsite, with particular focus on substation control and monitoring.

**Examination No. 1: study of the electrical network and expertise**

Prior to carrying out the examination of the electrical network, it is necessary to collect and analyse the technical data concerning the network. This preliminary phase can be executed by specialists from the Alstom competence centre for analysis, expertise and training via site surveys (level 1 or level 2), with a series of measurements and complementary tests.

This service produces a survey report, with details and commentary describing all the characteristics of the equipment in the network architecture.

**Examination No. 2: seeking improvements in command-control**

An onsite equipment survey will highlight solutions to optimise the command-control system and protection systems for substations.

The survey inspections provide an analysis of operations, technical feasibility and the appropriateness of the installed command-control.

At the conclusion of these inspections any site weaknesses are identified, highlighting the improvements to be made to find the best technological solution.

**DYNAMIC STABILITY ANALYSIS**

Estimate the risks of damaging the rotating machines (alternators and motors) through losses of synchronism, swinging or insufficient damping and validate the regulating parameters of the machines and maximum tripping time of the protection relays.

**Methodology**

Some events can cause transient instability. These can be the appearance of an electrical fault, a modification of the network configuration, switching in island operating mode, starting of large motors, etc. The instability may involve large fluctuations in frequency and voltage (major risks of blackouts) and mechanical constraints that could damage the drive shafts of the rotating machines.

**Items included in the analysis**

The analysis is carried out using PSAF-STAB software, acknowledged worldwide and used by many research and engineering specialists. The analysis report includes the following:

- A summary of all data and the assumptions used for the analysis.
- The collection of the technical data needed to execute the analysis is based on a document that is sent to the customer on receipt of the order.
- The curves indicating the evolution of parameters (voltage, current, power, etc.)
- A detailed technical note commenting on the results of the simulations and curves, explaining the technical and economic choices to improve network stability and highlighting the technical challenges.

Simulations and analysis enable solutions for:

- Limiting voltage and frequency variations in time by specifying load shedding automatisms
- Protecting the rotating machines
- Limiting operating losses and avoiding risks of blackouts

Network stability study
We provide training sessions to transmit theoretical knowledge (at novice, advanced or expert levels) in a variety of fields: operations, maintenance and protection.

The themes covered in the network training offer include:
- Choosing the right methodology and protection for MV/HV networks
- Choosing the right methodology and digital control system for substations
- Communications protocols (IEC 61850, etc.)
- Topology for MV/HV networks
- Calculating methods for fault current
- Neutral specification methods
- Measurement reducers specification methods
- Co-ordination analysis
- Stability analysis
- Network simulation software

Substation Automation Solutions Technical Institutes provide a wide range of high-level professional training courses in the domain of protection and digital control systems. For detailed information:
- Global SAS training offer - refer to the online training catalogue http://www.alstom.com/grid/products-and-services/technical-training
- Customised training sessions (content, duration and location) tailored to customers' specific needs

The training sessions can be delivered:
- At Alstom premises
- At your site

With its long term vision, Alstom provides a large range of dedicated courses to help you maintain high levels of operational skills and expertise.
Substation Automation Solutions Technical Institutes provide a wide range of high-level professional training courses in the domain of protection and digital control systems. For detailed information:


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### KEY REFERENCES

**Electrical utilities transmission and distribution**

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<td>Accra Ghana, Elubo</td>
<td>33 kV/20 kV/15 kV/11 kV distribution networks</td>
<td>Short-circuit, measurement transformers specification, selectivity</td>
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<td>Essiama, Ahafo</td>
<td>330 kV/225 kV/151 kV/132 kV/90 kV transmission networks, transformation substations</td>
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<tr>
<td>Benin</td>
<td>Onigbolo, Sakete, Maria Gléa</td>
<td>33 kV/15 kV distribution network 400 kV/220 kV /132 kV/66 kV transmission networks, transformation substations</td>
<td>Short-circuit, power balance, power balance improvement, selectivity, harmonics, transient stability, contingence study, network planification for 2015</td>
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<tr>
<td>Ethiopia</td>
<td>Ef acec, EEPCD</td>
<td>Complete network - south &amp; north (distribution 30 kV/15 kV, transmission 225 kV/110 kV/90 kV, transformation substations, production)</td>
<td>Short-circuit, power balance, power balance improvement, selectivity, transient stability, shedding, networks planification, proposal for electrical control organisation</td>
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ALSTOM NETWORK EXPERTISE TEAMS

The network expertise teams’ ambition is to be the preferred partner of utility customers by providing a broad range of solutions aimed at optimising the lifecycle performance of electricity infrastructures and therefore helping improve business.

Alstom competence centres worldwide provide:

- Skilled and experienced engineering teams
- Considerable expertise to evaluate and audit medium, high and very high voltage electrical networks
- A broad palette of solutions to improve the quality and reliability of networks and to optimise systems protection, control and operations

The substation automation solutions network expertise teams:
Know-how and expertise at your service