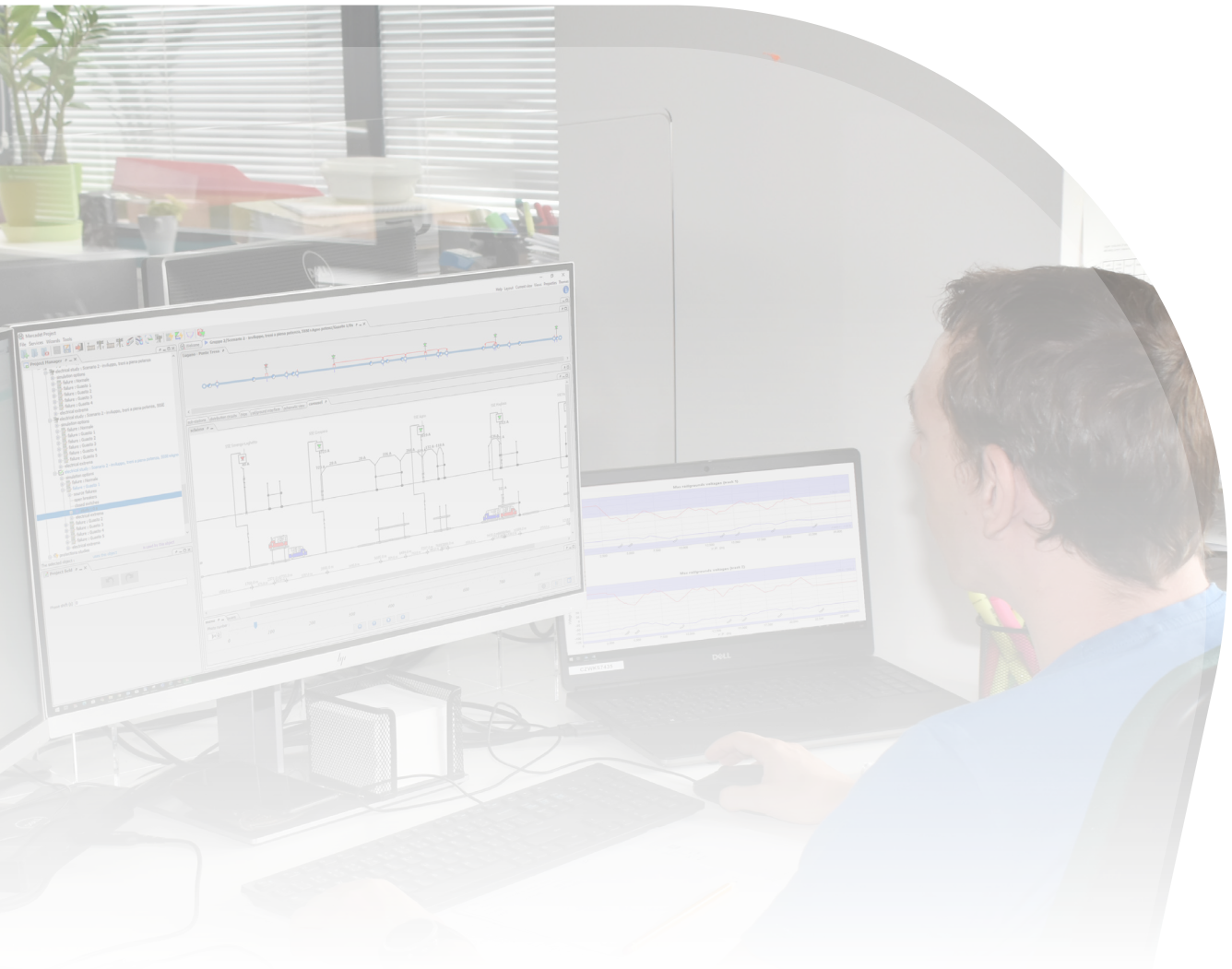
TRACTION
POWER
SYSTEMS

Sécheron

ENGINEERING SERVICES

Simulations



GENERAL INFORMATION

In the field of DC transport systems, more than anywhere else, providing an adapted, efficient and safe product is fundamental. With millions of users daily, installations must have the highest standards of reliability and security.

Due to our long experience in the DC traction domain, Sécheron has developed an excellent knowledge and understanding of DC system design.

Today, Sécheron can offer a large range of services for DC traction network parametrisation and simulation in order to ensure the correct design and protection of the system.

It is essential to understand all the subsystems of a traction network such as the AC network interface, DC power supply substations, DC network and vehicles, and our engineering team has proven to be successful and effective in this.

Available for clients looking to establish or to improve existing equipment or services, Sécheron is able to apply its extensive professional experience to a variety of situations.

Our offer includes a wide range of services from dynamic network simulation to measurement on-site and in the laboratory, through various calculations and tests on transformer-rectifier sets and short-circuits.

We offer consulting expertise and are able to answer any questions you may have about DC traction network design and calculation.

MAIN BENEFITS

- Optimisation of DC electrical network for vehicle power supply and energy recovery
- Support for strategic decision analysis for railway infrastructure
- Precise results from simulation to fine-tune DC protection

DYNAMIC DC NETWORK SIMULATION SOFTWARE

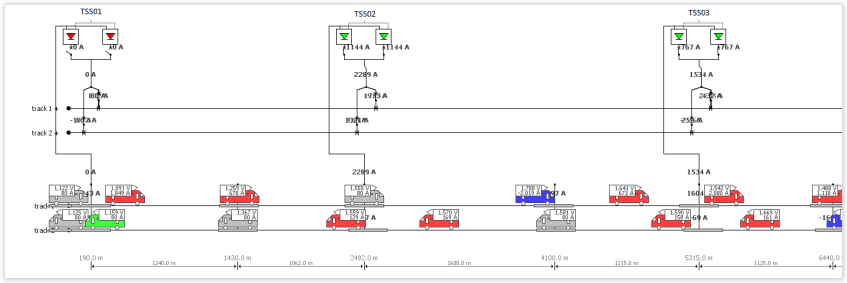
For DC railway applications, a good knowledge and understanding of the entire system's behaviour is highly important.

It is fundamental to know if the electric system is capable to sustain the foreseen traffic.

To take into account the huge number of parameters and the complexity of the interaction between all parts of the system, Sécheron proposes a DC network simulation service relying on the innovative and proven Marcadet software developed by RATP.

With this software it is possible to analyse all kinds of networks, from the simplest ones (one segment only) to complex ones (with a lot of branches, single/double track), and even with interconnections between them both (track interconnections or electrical links).

The simulation takes into account the foreseen service between different lines even with diverse headway and rolling stock.



STANDARDS

- **IEC 60076** | Power transformers
- **IEC 60146-1** | Semiconductor converters – General requirements and line commutated converters
- **IEC 62590 (EN 50328)** | Railway applications – Fixed installations – Electronic power converters for substations
- **EN 50122** | Railway applications – Fixed installations – Electrical safety, earthing and the return circuit
- **EN 50124** | Railway applications – Insulation coordination
- **EN 50163** | Railway applications – Supply voltages of traction systems
- **EN 50327** | Railway applications – Fixed installations – Harmonisation of the rated values for converter groups and tests on converter groups
- **EN 50329** | Railway applications – Fixed installations – Traction transformers
- **EN 50388** | Railway Applications – Fixed installations and rolling stock – Technical criteria for the coordination between electric traction power supply systems and rolling stock to achieve interoperability
- **IEEE 1653.2** | Uncontrolled Traction Power Rectifiers for Substation Applications Up to 1500 V DC Nominal Output
- **IEEE C57.12.01** | Standard for General Requirements for Dry-Type Distribution and Power Transformers

DYNAMIC DC NETWORK SIMULATION STUDIES

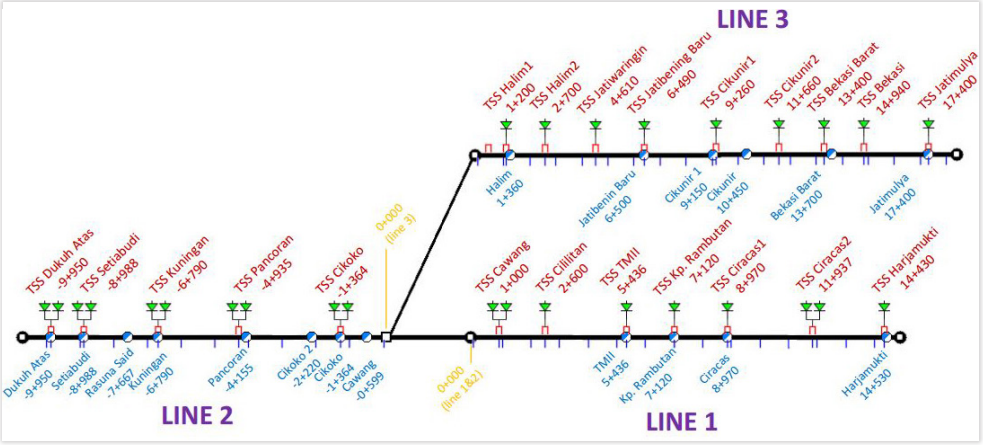
Sécheron has conducted various studies for different systems of railway (such as railways, light rail, metro, monorail, trolleybus, etc.) all over the world: Asia, Europe, Middle East, South America and Pacific.

As a manufacturer, Sécheron can complement these studies with advice on the selection of well adapted hardware and make propositions of actions to be done to fix problems and avoid critical situations.

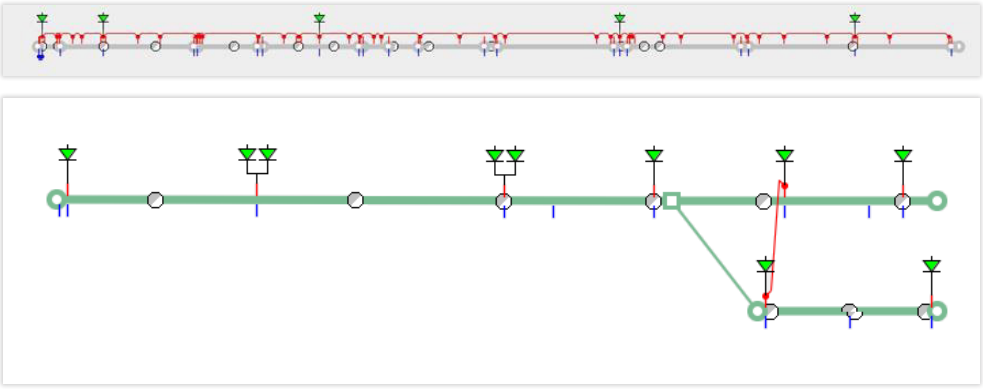
Studies provided by Sécheron can, among other things, answer the following questions:

- Where to install the substations and how many?
- What power and which overload capability are required for the rectifier set?
- What rating shall be provided at each level of the feeding system (DC circuit breakers, disconnector switches, cables and catenary feeder, etc.)?
- What will be the voltage drop along the line?
- What happens in case of failure of one substation?
- What is the efficiency of the system and how can it be increased?
- What will be the negative rail to earth voltage along the track? Are VLD-O required and where?
- Is the installation of inverter relevant? Where and what power?

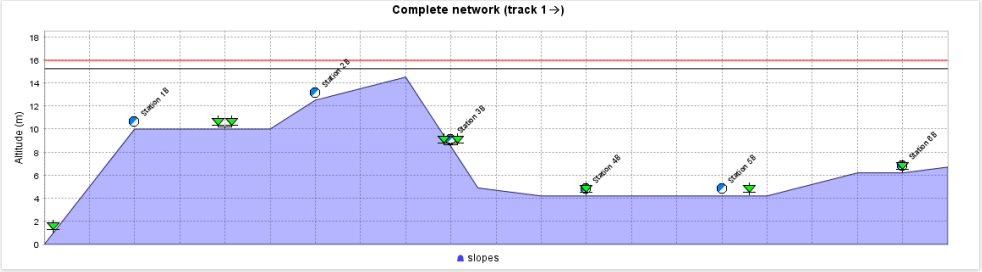
Services scheme



Rail network



Electrical diagrams of the line



Altimetric profile of the line

Simulation for different cases and time offset

Simulation for normal case (all substations in service) and abnormal cases. Without information from the customer, one substation out of service has been considered for abnormal cases. If the customer need other failures type (for example two consequently substations out of service), this can be done but must be specified as input data.

Since the results are affected from the instant of departure of trains, for each case are considered several simulations, applying an offset of departing time of the train. In this way, we are able to find the worst case, where it happens to have more trains in the same electrical section accelerating at the same time.

The results for each case are the envelope of the results of each single simulation with a different departing time offset. So, for example, the values shown for normal case are for each instant the worst value taken out of the simulations with different offset.

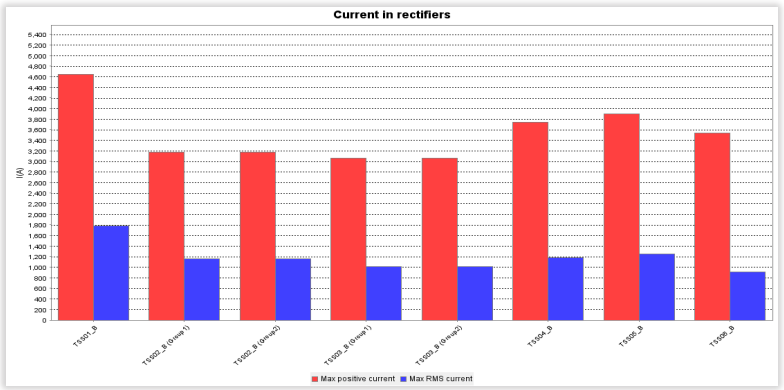
All RMS values (except for those where a different time is specified), are calculated as RMS on the whole duration of the simulation which is the headway or the least common multiple value, in case of two or more services with different headways.

SIMULATIONS RESULTS

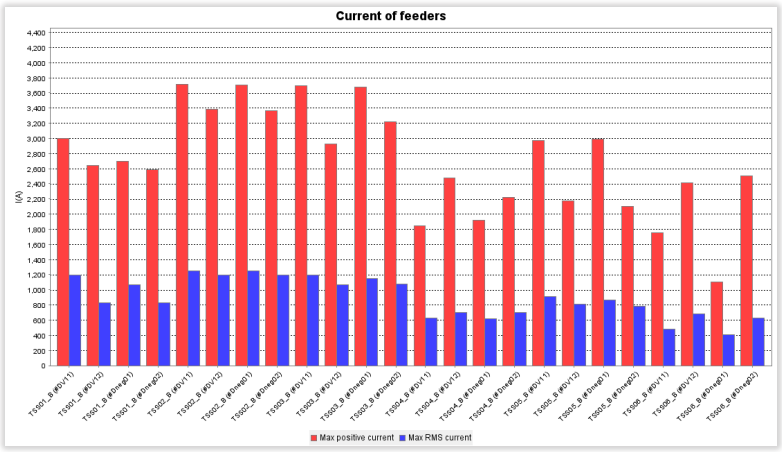
Sécheron can provide the following simulations results:

	Symbol	Unit
Substation rectifiers		
Envelope of root mean square values of the current supplied by the substation rectifier.	Irms	[A]
Envelope of maximum instantaneous values of the current supplied by the substation rectifier. The duration of this current is always shorter than 60s.	Imax	[A]
Envelope of RMS values of the power supplied by the substation rectifier.	Prms	[kW]
Maximum RMS current that can be supplied by the substation rectifier.	In_max	[A]

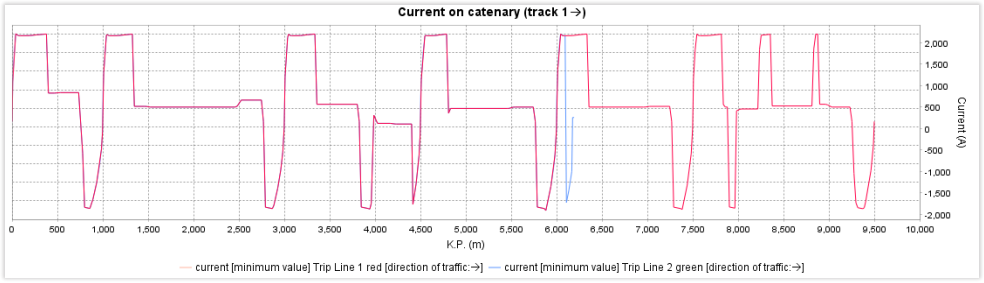
Current delivered by each rectifier



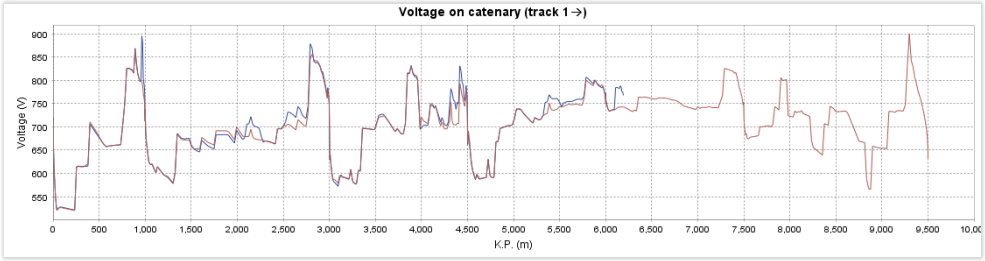
	Symbol	Unit
Substation feeders		
Envelope of RMS value of the current passing through a feeder.	Irms	[A]
Envelope of RMS value, calculated on a period of 30min, of the current passing through a feeder. If needed, it is possible to change the period of time for the RMS calculation.	Irms 30min	[A]
Envelope of maximum instantaneous value of the positive current passing through a feeder.	Imax pos.	[A]
Envelope of maximum instantaneous value of the negative current passing through a feeder.	Imax neg.	[A]



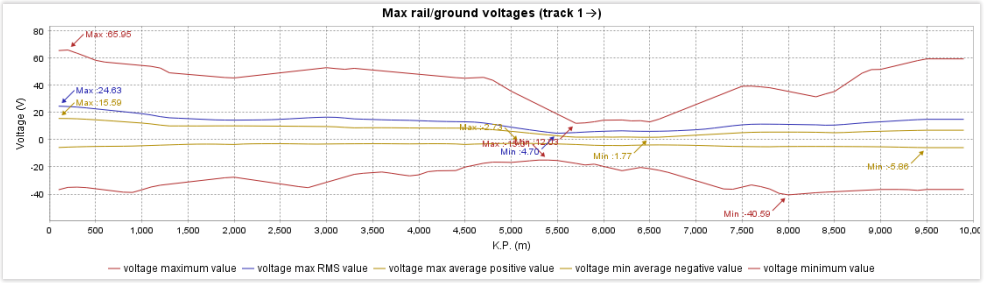
Current delivered by each feeder



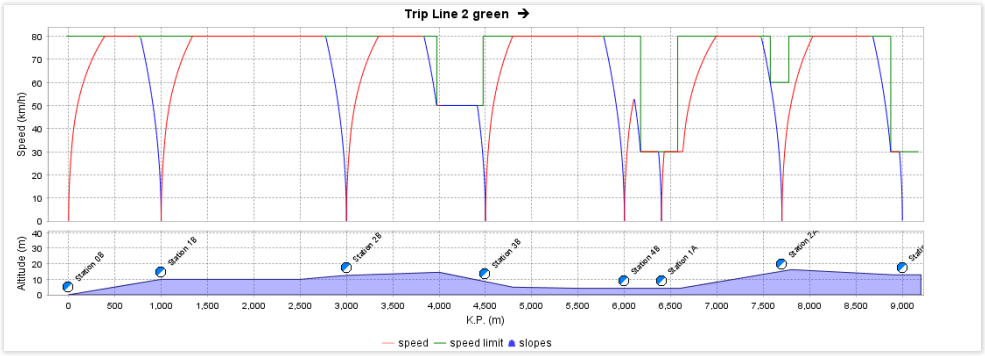
Catenary/third rail and running rail/fourth rail current along the line
Envelope of maximum catenary or third rail and running rail or fourth rail RMS and instantaneous current along the line and its location. For instantaneous current, the time duration of the peak is also indicated.



Catenary or third rail voltage along the line
Envelope of minimum catenary or third rail voltage along the line and its location.



Rail-to-earth voltage along the line
Envelope of maximum rail-to-earth absolute value of voltage along the line and its location.



Dynamic results for each scenario

With the simulations results, Sécheron will provide a general conclusion with detailed recommendations concerning all presented results.

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