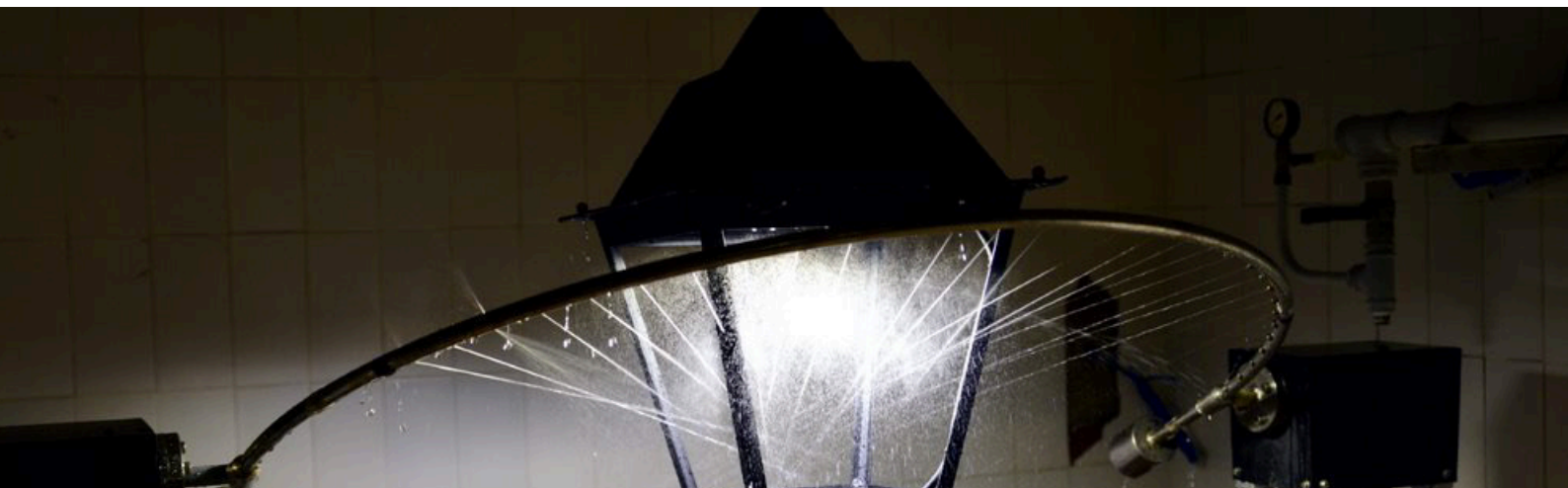




ELECTRICAL

Enhance Safety and Efficiency with Professional
Electrical Inspection Services



INTRODUCTION

Applus+ are specialists in electrical inspection and testing and our team of electrical testing experts can revise and analyse any electrical installations/networks in compliance with national and international standards and regulations. We test, measure, analyse and evaluate the inherent technical aspects of any electrical installation. We identify any critical or serious problems, allowing owners, users and maintenance staff to define actions to mitigate any risks.

SUBSTATION PROTECTION COMMISSIONING & MAINTENANCE TESTING

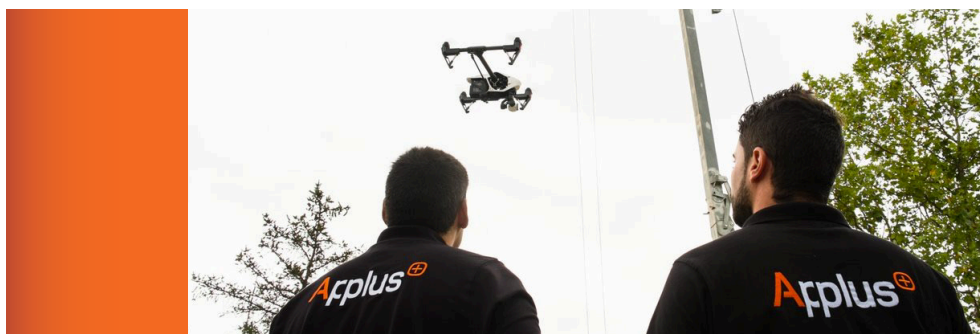
We provide predictive maintenance of all types of protection relays, electromechanical, electronic or digital, through automated testing with OMICRON equipment. We are able to commission services all over the world.

We adapt our services to customer needs, performing the tests for the commissioning of protection and control systems:

- Checking project engineering
- Verification of instrument transformers
- Checking VAC and VCC power supplies
- Checking control and signaling circuits
- Verification of electric protection and related circuits
- Automata and remote-control dispatches testing
- Functional tests
- IEZ61850 Protocol

Main Testing Equipment

- OMICROM CMC 356
- OMICROM CMC 256
- OMICROM CPC 100



To provide predictive maintenance we offer:

- Analysis and resolution of incidents in protection systems
- Assistance with the replacement of obsolete or faulty equipment

Advantages

- **To reduce**
real-time commissioning of the installation
- **To decrease**
risk of unavailability and equipment damages
- **To detect**
inappropriate, poorly parameterized or faulty equipments

PROTECTION SYSTEMS

We perform and review basic and detailed engineering of protection systems in electrical networks and industrial plants and generate the "As-built schemes" once the commissioning has been done.

We define the values of the parameters of the protection systems by modeling and simulating the system behavior for the different types of defects.

Services

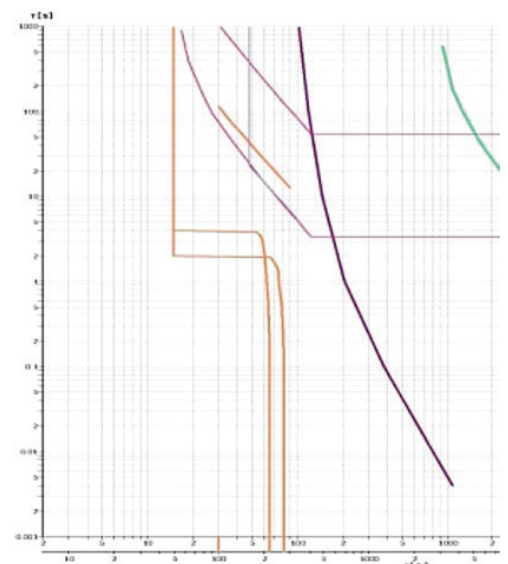
Supported by software tool modeling and analysis of power systems (ETAP y PSS, SKM POWER TOOLS, DIGSILENT, etc.), we conducted:

- Electrical facilities modelling
- Load flow studies
- Short-circuits studies
- Selectivity and coordination of electrical protections

Our Experience

We have a broad knowledge in:

- Combined cycle power plants
- Power transmission and distribution substation
- Renewable energy plants (photovoltaic, hydroelectric and thermosolar power plants and wind farms)
- Petrochemical plants
- Nuclear power plants
- Large industries
- Nuclear power plants
- Airports



Advantages

- **To ensure** the proper operation of the facilities
- **To reduce** the risk of the downtime and equipment damage
- **To minimize** operating costs and maintenance
- **To avoid** incorrect tripping of equipments or parts of the facilities

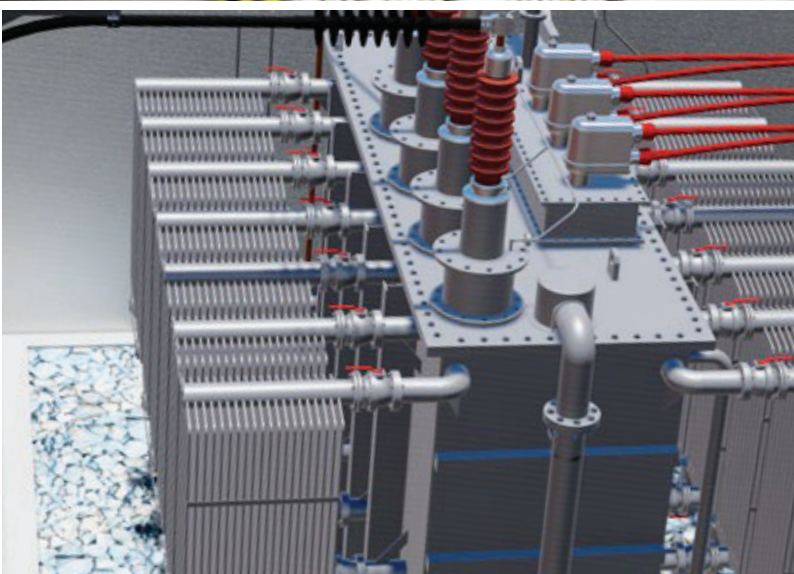
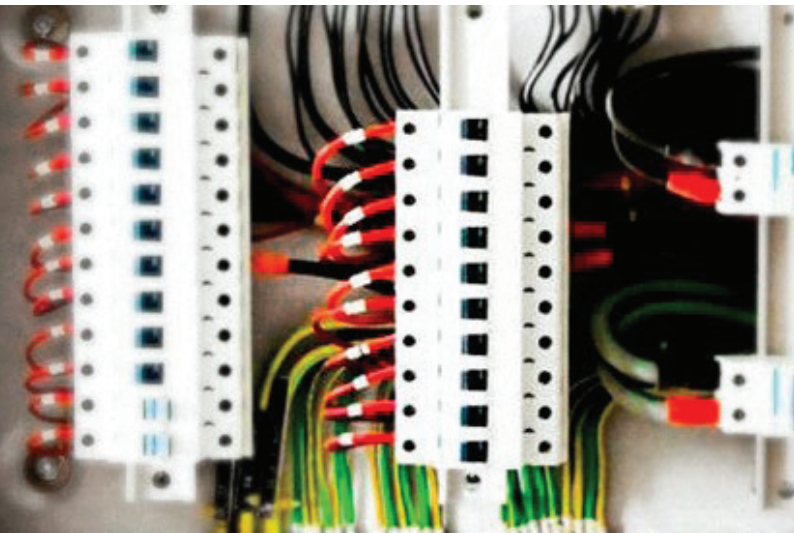
KNOWLEDGE AT ELECTRICITY GRIDS

Electrical Inspection

- Statutory inspection
- Low Voltage inspection
- Verification of electric measurement units
- OHL Aerial inspection

Electrical Technical Assistance

- QA/QC support services (3rd party)
- High, Medium and Low Voltage Supervision
- Electric works site management
- Studies and technical consultancy
- Inspection & maintenance management support



Electrical Engineering

- Relay protection & control engineering
- Substation engineering
- Distribution systems engineering
- Powerlines (up to 400KV)
- BIM modelling

Electrical Testing

- Substation commissioning plan development
- Relay testing
- Diagnostic and Predictive maintenance in:
 - Transformers
 - Generators
 - Motors
 - Circuit-breakers
 - Power cables
 - HV apparatus
- Insulating oil analysis
- Testing of earthing systems

Technological supports

BÚHO SYSTEM: Aerial inspections (by helicopters) for Medium and High Voltage overhead power lines using gyrostabilized platforms and geopositioning recording data (HD VT & Video; IR; UV; LiDAR, etc.).

PSS, DIGSILENT, ASPEN, SKM, Powertools, PLSCAD, TOWER, CYPE, REVIT: studies, engineering and power grids design.

DOBLE, OMICROM, TEXAS INST, IRIS, BAUR, THECHIMP, MEGGER: electrical equipments diagnosis and monitoring systems.

TRAZA Platform: Electrical Network Management Tool based on a geographical information system for maintenance.



POWER TRANSFORMER TESTING

Power transformers are one of the most critical apparatus in any substation. High-quality transformer testing is required for a reliable assessment of its condition. Acceptance Tests provide confirmation of the machine's condition before commissioning, as well as a baseline for future diagnostics. Maintenance Testing provides a diagnosis of the machine's condition, avoiding service failures and unnecessary preventive actions and optimizing the management of the transformer during its useful life by means of Condition-Based Maintenance.

Testing Capabilities

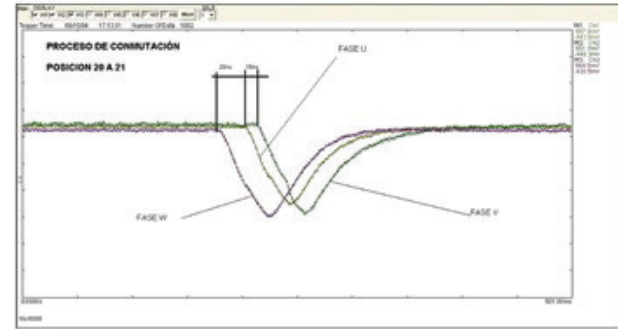
- Power factor and capacitance of Transformer Insulation and Bushing Insulation
- Transformer ratio
- Excitation current
- Winding resistance
- FRA or Frequency Response Analysis
- Leakage reactance
- FDS for estimating insulation humidity
- Dynamic resistance (for OLTCs)
- Partial Discharges detection

Main Testing Equipment

- Doble M4100 & M4110
- Megohmmeters
- Microhmeters with required power (Tettex, etc)
- FRA instruments: Doble, Megger, HP
- Omicron Ariadna
- Applus+ equipment for Dynamic Resistance Test
- TECHIMP PDCheck

Insulating Oil Analysis Capabilities

- Screening tests (physical-chemical tests)
- DGA
- Furanic Compounds
- Corrosive Sulfur



Advantages

- **To increase** reliability and availability of installations
- **To reduce** costs by avoiding unnecessary operations and actions
- **To optimize** managements of installation assets throughout their useful life



INSULATING OIL ANALYSIS

Power transformers are one of the most critical apparatuses in any substation, so assessing their condition is essential for appropriate maintenance of the installation. One of the most powerful and affordable tools for power transformer maintenance is analysis of the insulating oil, which provides information about:

- The oil condition, using screening or physical-chemical tests
- Detection of defects inside the transformer, such as hot spots or partial discharges, using the DGA (Dissolved Gas Analysis)
- An assessment of the degradation of the cellulosic insulating materials, using the Furan Compounds Test

Testing Capabilities

- Screening tests:
 - Dielectric strength
 - Interfacial tension
 - Water concentration
 - Dissipation factor (or power factor)
 - Acidity
 - Particles counting
- DGA: H₂, CH₄, C₂H₆, C₂H₄, C₂H₂, C₃H₈, CO, CO₂, O₂, N₂
- Furanic Compounds
- Corrosive Sulfur
- Others



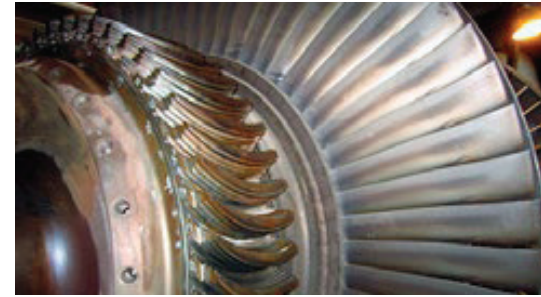
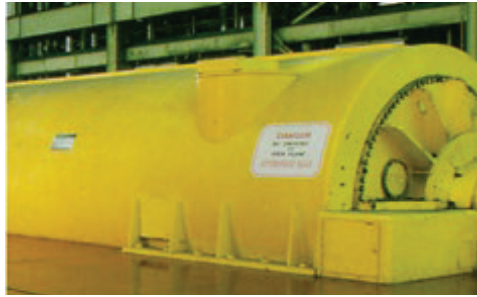
Advantages

- **To increase** reliability and availability of installations
- **To reduce** costs by avoiding unnecessary operations and actions
- **To optimize** maintenance decisions



ROTATING MACHINERY TESTING

Applus+ testing services include tests for assessing the condition of Generators and MV Motors, that are most of the times critical machines for Power Generation Plants and Industrial Processes. Acceptance Tests provide a confirmation of the machine condition during commissioning, as well as a baseline for future diagnostics. Maintenance Testing provides a diagnostic of the machine condition, avoiding service failures and unnecessary preventive actions, and optimizing the management of the transformer during its useful life by means of a Condition Based Maintenance.



Testing Capabilities

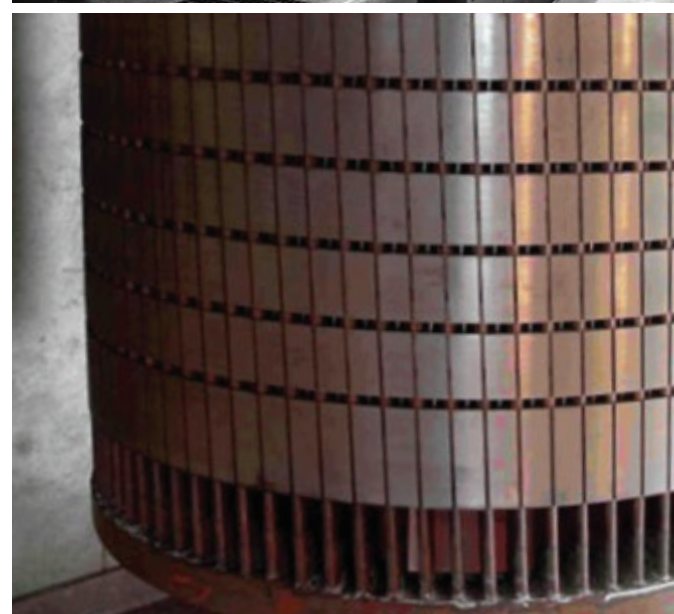
- Off-line stator winding testing:
 - Power Factor/Tan delta & Capacitance
 - Partial Discharges
 - D.C. testing: Resistance, P.I., absorption /reabsorption currents
- On-line Partial Discharges test
- Detection of defects in stator core: EL CID
- Rotor Winding insulation and pole balance
- Current Spectral Analysis, for detecting defects squirrel cage rotors of MV Motors
- Vibrations

Main Testing Equipment

- Doble M4100 & M4110
- Megohmmeters Megger BM25 and S1-1052
- IRIS PDA/TGB Instrument
- TECHIMP PDCheck
- EL CID
- PPM Probe

Advantages

- **To increase**
reliability and availability of installations
- **To reduce**
costs by avoiding unnecessary operations and actions
- **To optimize**
management of installation assets throughout their useful life



POWER CIRCUIT BREAKER TESTING

Applus+ testing services include testing any kind of power circuit breaker, from Low Voltage up to 400kv levels. Applus+ has extensive experience in testing CBs, with thousands of units tested and hundreds of different models in our database. Applus+' background allows it to test and diagnose the condition of power circuit breakers in order to assure their expected quality with acceptance tests, as well as detecting defects and deterioration indications performing maintenance tests.



Testing Capabilities

- Passive Contact Resistance
- Operation times
- Synchronization (Pole and contact spread)
- Travel curves: stroke, wipe, overtravel, rebound
- Coil Currents
- Motor Current
- Battery Voltage
- SF6 pressure and Check of SF6 devices
- Vacuum insulation
- SF6 analysis: purity, SO2, pour point, HF, air

Advantages

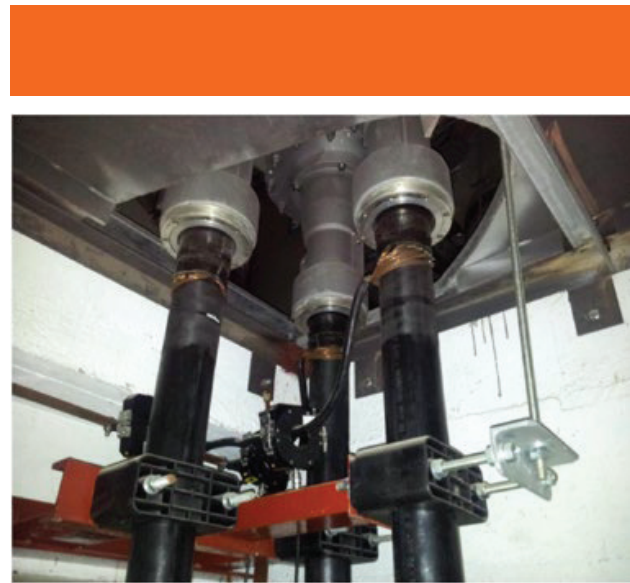
- **Reduction**
in revision and non-operational times
- **Savings**
in maintenance cost
- **Increasing**
longevity of switches

Main Testing Equipment

- MEGGER TM1740
- CBT 400
- MICROHMETERS
- Zero waste SF6 Analyzer

MV & HV CABLE TESTING

Applus+ Cable Testing Services can detect defects and diagnose the condition of cables, as well as locating faults (both insulation and sheath faults). Diagnostic tests can be performed to confirm the appropriate condition during commissioning, or for maintenance purposes during the life of the installation.



Testing Capabilities: MV Cables up to 52kV

- AC withstand test (at VLF or DAC)
- Dissipation factor (at VLF)
- Partial Discharges (at VLF or DAC)
- Sheath & screen testing

HV and MV Cables

- On-line Partial Discharges
- Sheath & screen testing
- Location of main insulation faults and sheath faults

Advantages

- **To increase** reliability and availability of installations
- **To reduce** cost, avoiding unnecessary operations and actions
- **Faults located** in an efficient and non-destructive way

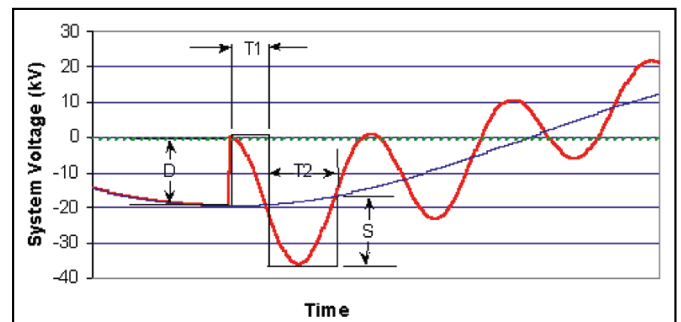
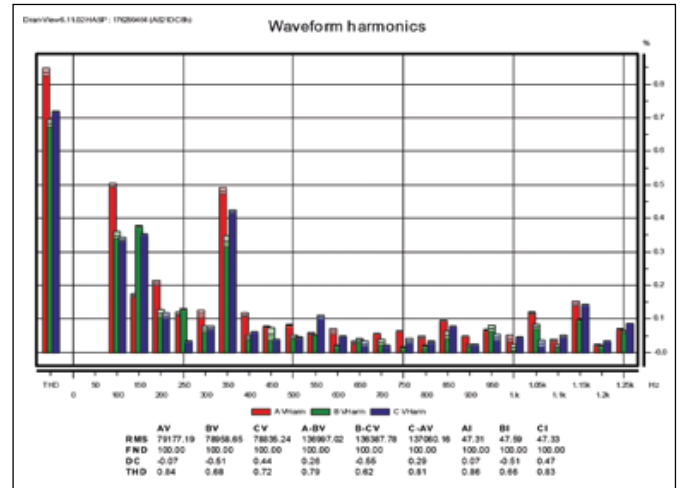


ELECTRICAL POWER SYSTEMS

We perform different studies to design electrical facilities and solve the problems during their operation.

- Insulation coordination
- Reactive power studies
- System stability studies
- Measurement and harmonic studies
- Load flows
- Analysis of incidents
- Root cause definition after equipment failure
- Electrical Arc Studies

We have the company's know-how in all aspects related to testing, diagnosing and engineering HV Equipment and Protection Systems accumulated over more than 20 years working with the main Spanish electrical companies and other industries.



Advantages

- **To define** the characteristics of the equipments to be installed
- **To optimize** the capability of the facilities (reactive power compensation, improved burden-sharing, etc.)
- **To reduce** operating costs and maintenance

Technological Supports

- PSS
- ETAP
- SKM Power Tools
- Digsilent



INFRARED THERMOGRAPHIC INSPECTION

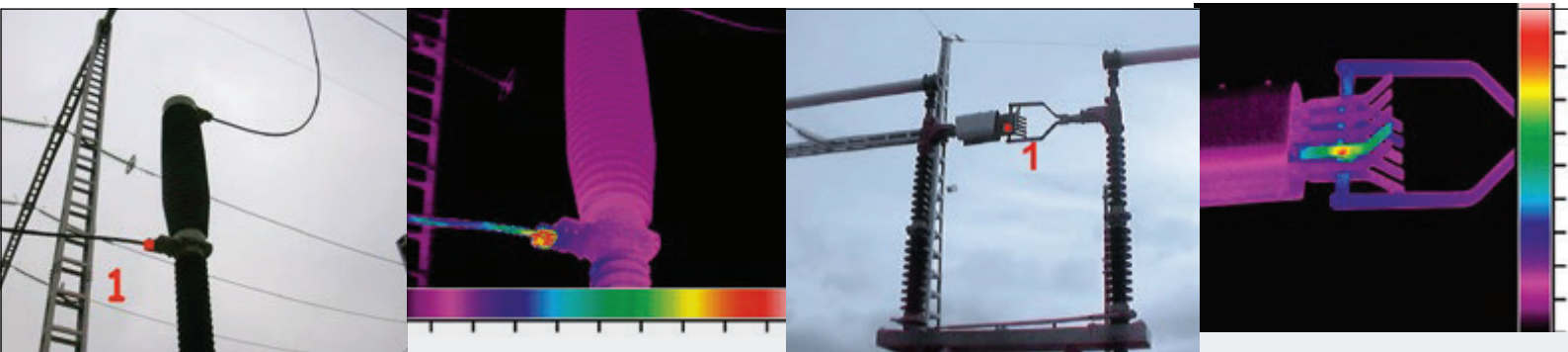
This type of inspection is based on the comparison of different temperatures, which are measured and observed across surrounding and similar components. This measurement is able to detect any thermal variation in order to reveal deficient or failing components of the electrical infrastructures.

What it is used for

- Predictive maintenance program
- Prioritization of repair interventions
- Cost optimization and avoidance of expensive repairs

Where it can be used

- Utility substations
- Energized poles and transformers
- Transmission power lines and distribution systems
- Main switchboards
- Windfarms
- Thermosolar plants
- Photovoltaic power stations
- Combined cycles
- Machine control panels



Advantages

- **To ensure** proper operation of the installation
- **To reduce** operating and maintenance costs
- **To minimize** downtime risk and equipment damage
- **To avoid** tripping or similar incidents

AERIAL SURVEY

Provides optimized and customized end-to-end solutions for Powerline Aerial Inspections by helicopter and UAV since 1995.



- + 25 years of experience
- + More than 700,000 km lines inspected
- + More than 25,000 flight hours



Advantages



Full charting inspection



Simultaneous inspection



Inspection time reductions



Criteria unification

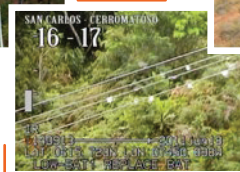


Cost optimization

Types of surveys

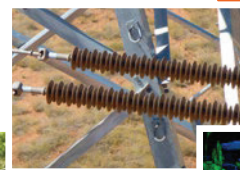


Thorough

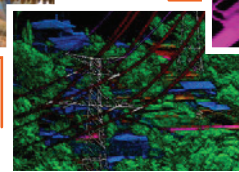


Ultraviolet

Standard



Thermographic



Distances

Owned equipment



Gyro-stabilized multi-sensor cameras



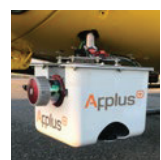
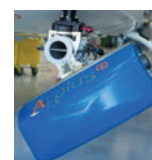
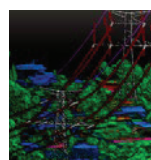
State-of-the-art LiDAR sensors



4K UAV cameras

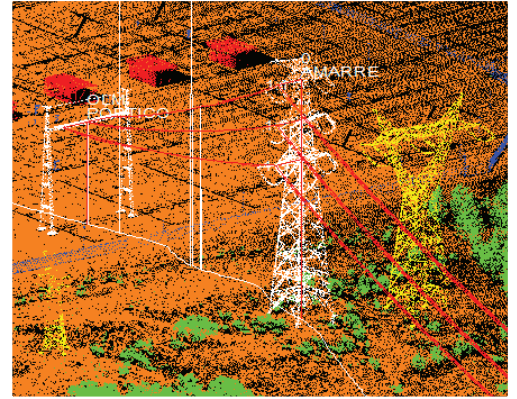
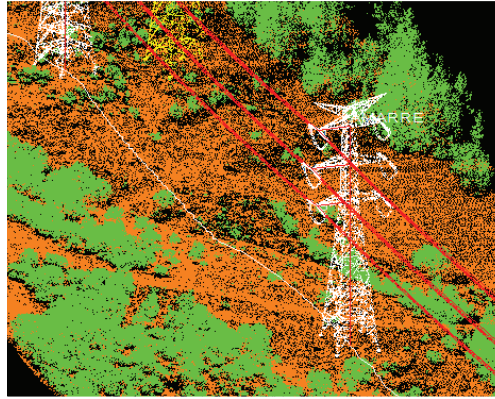
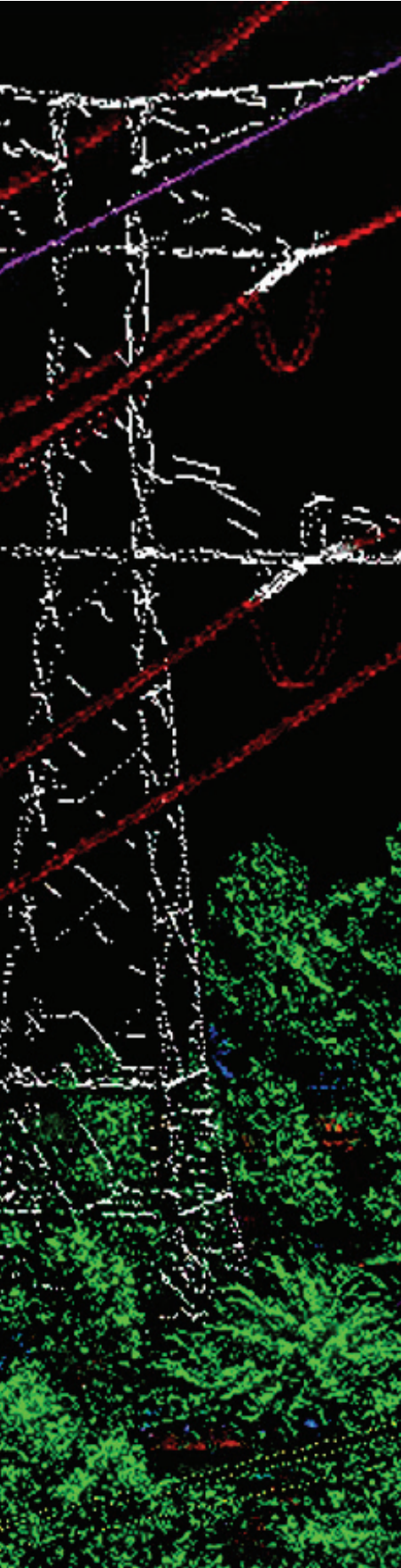


Analysis and data processing laboratories



AERIAL LiDAR SURVEY

Determines the distance from a laser emitter to an object or surface using pulsed laser beams creating a high density point cloud allowing a 3D model generation of the area of interest.



LiDAR Advantages



Better capacity and precision



Large amount of information



Optimal time saving



Access to otherwise inaccessible areas



Cost optimization

Valuable uses

- Topography
- Vegetation management
- Tower, chain and other components 3D modelling

Owned equipment



State-of-the-art LiDAR sensors



Analysis and data processing laboratories





As a **global leader**, we have the technology, human capabilities and resources to meet the demands of industries. No matter the size, scale or scope of the work, we always go beyond standards by delivering operational excellence with local knowledge and global competence.

We are a dynamic organisation; problem-solvers by nature. Where there is no existing answer to a challenge or problem, we will use our vast experience and in-depth knowledge to find one. By working closely with our clients, we have become a **trusted partner** who delivers new, innovative solutions with the highest integrity.

A **passion for improvement** drives our teams to safeguard client operations while delivering our services. We innovate to bring about advances in operational safety and this commitment to excellence is what makes us renowned as one of the best.