Alstom Grid | Services
GIS lifecycle management
Based on our manufacturing expertise and time-proven refurbishment experience, Alstom Grid offers the most cost-effective and efficient solutions to increase the life span of your gas-insulated switchgear and substation.

From onsite assessments, periodic inspections, mid-life overhauls through to complete life-extensions, we can customise the most appropriate program for your gas insulated substation type, age and ratings.

Our technical experts take care of your assets and we make sure that all quality and safety regulations are met and respected.

Our services include:
- Network consulting
- Erection, commissioning and supervision
- Testing, partial discharges measurements, analysis
- Long-term operation and maintenance contracts
- Renovation, modernisation and extension
- Maintenance, repair, emergency support
- Spare parts and strategic spare parts management
- Technical training and competence development programme

Make your equipment smarter and more sustainable based on field-proven expertise

At Alstom Grid, our mission is to ensure that your energy network is reliable, efficient and environmentally-friendly. We leverage the technical know-how of our equipment design and manufacturing engineers into customised service solutions.

An efficient, proactive monitoring system combined with Alstom Grid’s expert services team is the best way to prolong equipment life. Our condition monitoring solutions can drastically reduce the risks of failure. Alstom Grid brings you innovative technological solutions to keep your high voltage GIS equipment up-to-date, safe, reliable and efficient. Asset management optimises your infrastructure performance while keeping your operating costs under control.

Alstom Grid local services units around the world are managed by strict quality management systems - including our own methodology - and fulfil the requirements of ISO 9001, environmental standard ISO 14001 and OHSAS 18001.
After more than 40 years of operational experience, Alstom Grid is a leader in gas-insulated switchgear, ranging from 75 kV to 800 kV. The complete product portfolio can answer any customer need, indoor or outdoor. Alstom Grid offers services for all legacy gas-insulated switchgears.

**Gas-insulated switchgear (GIS)**

Gas-Insulated Switchgear is fundamental to obtain safe, protected and uninterrupted operating conditions. Alstom Grid provides networks and industrials with state-of-the-art GIS from 72.5 kV to 800 kV. Our GIS are suitable for all types of single-line diagrams, arrangements and building dimensions, for indoor or outdoor installations. They are perfectly adaptable to any operating situation and are suitable for future modifications and extensions, thus optimising capital costs.

**Gas-insulated line (GIL)**

Gas-Insulated Line enables optimal connections to overhead lines and power transformers. They are set up in trenches or in galleries, underground or above the ground. Alstom Grid has more than 100 km of GIL in operation throughout the world covering diverse application.

**Smart and compact GIS at all voltage levels**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>72.5 kV</th>
<th>145 kV</th>
<th>170 kV</th>
<th>245 kV</th>
<th>300 kV</th>
<th>352 kV</th>
<th>420 kV</th>
<th>550 kV</th>
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<tbody>
<tr>
<td>31.5 kA</td>
<td>B1</td>
<td></td>
<td></td>
<td>B2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>B/C/S/T65</td>
<td></td>
<td></td>
<td>B95</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>F35</td>
<td>GMT1</td>
<td>GMT11</td>
<td>B105</td>
<td>C105</td>
<td>S105</td>
<td>T105</td>
<td></td>
</tr>
<tr>
<td>40 kA</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>50 kA</td>
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<td></td>
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</tr>
<tr>
<td>63 kA</td>
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</tr>
</tbody>
</table>

GIS

GIL

GIL
PRODUCT LIFECYCLE MANAGEMENT

Taking care of your equipment components is essential to keep your assets safe and reliable. Alstom Grid offers comprehensive services to support you in getting the most of your assets.

Maintenance and repair plans must be carried out by a qualified field service supervisor with the prerequisite technical level. Our local teams support customers in emergency repairs, in time-based, predictive and corrective maintenances. According to the situations, necessary repairs are conducted.

When a replacement of the one GIS element is the best available solution, our specialists can propose replacement by the very same equipment. Services experts can also provide equipment-upgrading solutions to keep assets up-to-date with the latest technological benefits.

Customer challenge
Gas-insulated switchgear have been designed to optimise the reliability and efficiency of operating networks. Operators require efficient solutions to avoid unscheduled downtime, major failure and the subsequent penalties. Gas-insulated switchgear solution allows to energise/de-energise network and to clear faults downstream.

Alstom Grid solution
Alstom Grid offers complete services to cover all operation and maintenance needs for their customers to get the most of their assets and investment. Based on our manufacturing experience, Alstom Grid proposes efficient and customised solutions to increase the life of the gas-insulated substation according to the type, age and ratings.

• From network consulting and planning to operational implementation
• From asset diagnostic to condition-based maintenance
• From emergency support to full operation and maintenance
• From training your engineers to customised competence development programme

Project design
Whether for new installations or to improve the efficiency and performance of existing equipments, Alstom Grid offers an integrated range of consulting services:
• System planning and analysis
• Transient stability analysis
• Dynamic interaction assessment and reliability studies

Our network consulting experts allow you to anticipate future challenges, for a sustainable network as well as equipment reliability and performance.

Erection and commissioning
Our local teams ensure that the asset is erected, tested and commissioned according to state-of-the-art standards. Our certification process, based on "on job coaching" ensures the same high level of quality anywhere the asset is installed.

Maintenance and repair
In order to optimise equipment uptime, Alstom Grid offers maintenance and repair operations. Our local teams cover all needs:
• From single inspection to long term operations and maintenance partnership
• From emergency support to predictive maintenance

Customer benefits
• Complete range of services to ensure equipment continuity and full availability
• Reliable asset management
• Customised offers adapted to specific needs
• Project design recommendations
• Condition assessment and proactive detection of potential dysfunctions
• Proximity with local service personnel and remote operations support
• Improved return on investment
• Prompt response time with 24/7 emergency support
• Equipment life extension and increased reliability and performance
• Environmentally friendly solutions
• Increased safety for employees
• Alstom Grid’s vast and trusted experience and know-how based on worldwide installations and support
Condition-based maintenance

Transmission equipment constitutes an important capital investment and is critical to network stability. To prolong assets life and ensure their reliability, Alstom Grid offers condition-based maintenance. More than 100 gas-insulated substations around the world are equipped with condition monitoring tools representing more than 700 bays and 11,000 sensors.

Customer challenge

Transmission systems and their equipments have been designed for reliability. Energy managers require cost-effective applications and solutions to avoid unscheduled gas-insulated substation downtime, major failure and the subsequent penalties.

Alstom Grid solution

Continuous condition monitoring

The most effective solution to avoid potential GIS failure is through condition-based asset management with advanced detection. This is why Alstom Grid has developed the BWatch monitoring system. The system is easy to adapt to switchgear types, is cost-effective and reliable. The BWatch monitoring system is a digital, open and modular system.

Alstom Grid has designed monitoring products to keep a constant watch over assets. Continuous condition monitoring allows shifting from a time-based maintenance to a condition-based maintenance strategy, providing a more cost effective service while improving capability to predict and prevent failures. On-line technology enables remote technical assistance and diagnosis for better customer support in the decision making process of operations and maintenance. Condition monitoring devices embed capabilities of generating alarms, on settable thresholds, in absolute value and time trend. The monitoring tool records SF$_6$ densities, partial discharges, circuit breakers and other GIS’s conditions (fast leakage alarms, centralised display of compartments status, circuit breaker security tripping and interlocking...) allowing predictive analysis for preventive maintenance.

SF$_6$ monitoring

Apart from the usual density thresholds (refilling request and minimum operating density), SF$_6$ monitoring also provides many valuable functions:

- Accurate density display
- Filling overpressure alarm
- SF$_6$ liquefaction detection
- Sensor status control
- Calculation of leakage rate
- Internal failure detection

Condition monitoring increases equipments performance and reliability. The internal arc localisation allows quick faulty compartment identification and helps secure the substation automatic reconfiguration through interlock. The solution is either online or offline.

UHF monitoring analysis

Internal partial discharges may be signs of possible problems. It may be therefore useful to monitor the ultra-high frequency (UHF) electromagnetic waves generated by the partial discharges. Such signals may be detected using antennas (capacitive couplers). Their analysis and comparison with typical signals determines their origin and localisation. A trained operator may then observe the signals and determine switchgear status.

Alstom Grid has designed a partial discharge monitoring system that minimises switchgear operation perturbation. Services supervisors use portable sensors that are fitted on insulating cone flanges and are connected to a portable analysis unit. This solution helps to avoid any unnecessary GIS shutdown. Our Alstom Grid local services centres can perform UHF scanning. We provide the portable equipment, all scanning and analysis, and present the full report with actions recommendation.

Data analysis expertise

Armed with the proper information received from our installed monitoring tools, we can provide a full assessment to evaluate the equipments in real time, define the scope of maintenance operations and plan actions for future execution (planning, operation, repair, replacement). This enables a better match of intervention teams, spare parts replacement and special tools management, saving downtime and costs, avoiding unexpected situations and maximising your electrical system’s availability. Alstom Grid can provide a 24/7 asset management.

Customer benefits

- Improved gas insulated switchgear performance and reduced failure rate
- Optimised maintenance: better scheduling, reduction of costs, planned outage...
- Continuous watch of asset conditions with condition monitoring tools with remote control
- Efficient control of equipments operations
- Cost efficiency
- Equipment life extension
- Efficient preventive failure detection
- Environmentally friendly
- Excellent asset management
- Increased safety and reliability of equipments
Strategic spare parts management

Although some parts have a mainly supporting role, they are vital for optimal operation. Any problem associated with any pieces of equipments can result in damage or failure of the equipment. Alstom Grid proposes strategic spare parts to avoid risks. It is also necessary because urgent corrective maintenance is very costly, due to rush production and transportation costs. Replacement lead times can sometimes take months, causing penalties or loss of revenue. A strategic spare part stock focuses on main and critical components.

Alstom Grid solution
GIS availability is conditioned by its capability to rapidly re-energize after a major failure. This is why Alstom Grid recommends maintaining a stock of strategic spare parts allowing fast repair of any major failure within a short time.

Alstom Grid product range has been continuously evolving to better match our customers’ needs and to fully comply with new specifications for electrical or environmental standards. As part of comprehensive customer support throughout equipment lifecycle, we can supply any part or equivalent component for all of our products, even for more mature Alstom legacy products. Service engineers define a strategic spare parts stock adapted to customer substation specifications. The strategic stock can be optimised using as many multi-functional components as possible (example: four outlet cross junctions can be used to replace either a 3 or a 4 outlet cross).

Depending of the level of availability needed, the customer has several options:

• The customer stores all necessary parts recommended by Alstom Grid. This option gives the best guarantee level of parts availability and minimises transportation time to the site.

• The customer signs a service contract which includes Alstom Grid’s commitment to supply any part within a specified time. (Spares manufactured by Alstom Grid and kept available at localised Alstom Grid storage areas.)

• The customer signs a “Spare Part Club” agreement with other owners of similar GIS and stores the specific parts which, then, remain available for several users. Stored parts are replenished as required.

Customer benefits

• GIS life extension
• Increased GIS availability and penalty fees reduction
• Reduced manufacturing and rush transportation costs
• Spare parts always available when needed
• Parts manufactured by the worldwide GIS leader so you know you are getting the best for your network.

Customer challenge
Most of first generation GIS are still active after more than 40 years old. The delivery time for out-phased product parts (no longer in our current range) can reach several months (up to 12 months depending on the part). Strategic spare part supplies are one way to reduce downtime, transportation and overall spare parts costs.
**SF₆ management**

According to potential environmental, health and safety impacts of SF₆ use, Alstom Grid supports its customers in efficiently managing SF₆ and shares its best handling practices for a permanent reduction in SF₆ emissions.

**Customer challenge**
SF₆ makes equipments more resistant to the effects of pollution and climate and more reliable over the long-term. The resulting size reduction allows equipments to fit better with customers’ needs in specific environment constraints. Operators have the responsibility to efficiently manage SF₆ in order to limit environmental impacts, as well as health and safety risks.

**Alstom Grid solution**
Alstom Grid offers service solutions for the customer to better manage SF₆. Local experts can support you in all SF₆ operations.

**SF₆ lifecycle management**
To ensure gas-insulated substations function efficiently, SF₆-filled devices need to meet gas pressure and gas quality standards.

Alstom Grid proposes services to manage SF₆ quality and pressure levels for all Alstom Grid products and equipments. This offer includes:
- A gas pressure check
- Topping-up when required
- A gas quality check

For Alstom Grid, the goal is to offer customers the most economical and simple solution for the management of SF₆ in their installed park.

**SF₆ leak detection and repair**
Alstom Grid proposes a gas density monitoring system that detects leaks as soon as they start and measures the leak rate.

Once a gas leak is located, gaskets can be sealed off or exchanged. The Alstom Grid leak detection and repair service can be performed on any equipment containing SF₆.

**SF₆ recycling**
To perform SF₆ recycling, Alstom Grid uses a mobile recycling cart to proceed with recuperation and recycling at the customer’s site. Gas recovery is performed with state-of-the-art reclaimers, with the best recovery capacity, thus losses are insignificant. Alstom Grid team manages the whole SF₆ recycling process meaning that gas must be handled only by trained and certified workers.

**Customer benefits**

**Reduction of industrial waste**
- Lifetime extension
- Equipment is designed to work with high quality SF₆: a minimum gas pureness of 97% for circuit breakers.
- Low quality gas is hazardous for equipment and considerably reduces its lifetime and reliability

**Reduction of SF₆ emissions**
- SF₆ management is done by certified specialists
- SF₆ is recycled to IEC level
- SF₆ / CF₆ / N₂ mixed gas separation
- SF₆ and CF₆ recycled with proper documentation
- On-site gas bottle contamination testing

**Improved safety conditions**
- SF₆ management is done by certified workers
- Employee awareness is increased

**Cost-efficiency**
- The specific quantity of SF₆ required is delivered and invoiced
- Reduction of training and certification costs as SF₆ handling and recycling is managed by Alstom Grid experts
- Reduced downtime, since workshop is brought to customer’s site. No transportation lead time
- Reduction of cost of gas released into the atmosphere
Technical training and competence development

To benefit from the best performance when operating your substation and to maintain it efficiently, well trained collaborators are mandatory. You will then be able to face electrical incidents or operations outages avoiding the related costs. Training has the quickest and strongest return-on-investment rate when it comes to increasing your company’s personnel competencies and enhancing your current electrical installation performance. Alstom Grid offers over 200 training courses in its 15 Technical Institute centres located around the world.

Discover our training offer on www.alstom.com/grid/trainingoffer/

Customer challenge
Because power service continuity is your concern, the acquisition of technical expertise in GIS operations and SF₆ handling is crucial to develop efficiency and safety at work.

Alstom Grid solution
Alstom Grid Technical Institute offers a full range of training in electrical grid safety, operations, maintenance, protection, control and management. These high value-adding courses encompass all aspects of electricity fundamental to in-depth equipment knowledge. Trainees benefit from trainers’ expertise in techniques and field experience combined with pedagogy.

Considering equipment operation and maintenance, theoretical study is necessary but not sufficient to optimise site personnel reactivity. What makes a real difference is the experience site personnel can gain through practice. At Technical Institutes, trainings combine theory with practical hands-on with real size equipments. Trainings are provided on all gas-insulated substations and condition monitoring tools.

Standard training courses:
- GIS fundamentals,
- GIS maintenance and breakdown repair per type,
- BWATCH³ status monitoring system for GIS,
- PDWatch monitoring system
- High Voltage test with PD/UHF measurement on GIS,
- SF₆ gas recovery regulation for inexperienced or experienced personnel.

Customer benefits
- Improved employee technical knowledge
- Increased efficiency and safety at work
- Adapted training to a wide audience (operators, managers, engineers, ...)
- Benefit from exchanges with field experienced trainers
- Choice of training methods: e-learning, class room course, practical work, set curriculums, 3D modules, competence development
- Up-to-date contents according to local regulations, notably the latest SF₆ care ones, and new technologies

Competence development: a turnkey approach to performance

Needed when...

Competence level is required
“Competence assumption” is not sufficient! E.g. safety issues and certification

Competence creation is necessary
Growth leads to an important increase in young or new recruits
Health, Safety and Environment policy contributes to leading position

Companies have to face competence losses
Massive departure of senior generations

ANALYSING
- Needs analysis
- Evaluation quiz
To evaluate trainees’ knowledge level

PREPARING
- Course design
- e-Learning Planning
To optimise the course

TEACHING
- Teaching
- Learning Application at site
To learn required skills

QUALIFYING
- Evaluation quiz
- Knowledge validation
To check knowledge acquisition & deliver competence certificate

To know more....
technical.institute@alstom.com

Technical Institute Centres of Excellence for Gas Insulated training are located in France, Switzerland, India and China. They all offer practical hands-on with real equipments for trainees.
RENOVATION, MODERNISATION & EXTENSION

Alstom Grid provides condition assessment of substations on all types of GIS equipments. Based on the situation, services experts offer Renovation, Modernisation and Extension solutions to improve performance or to resolve some obsolescence issues.

Customer challenge

High Voltage substations are key contributors of the Grid assets value while they are critical for Grid reliability and availability. After decades of operations, Grid operators may foresee risks of increasing failure rate according to electrical and environmental stress. They may also address the needs for evolving power performance or the needs for standard or technological enhancement.

Alstom Grid solution

Alstom Grid service experts support the decision-making process providing the most cost efficient solution for substation and GIS renovation, modernisation or extension based on condition and life assessment.

Renovation

Alstom Grid offer solutions to expand the life of ageing equipment by replacing worn GIS, circuit breakers, control and protection. Services experts conduct for example GIS mid-life overhauling.

Modernisation

Modernisation of equipments is a way of getting benefits of new design and technology on equipments already in operation. It brings solutions for obsolescence issues on old equipments. Alstom Grid provides GIS modernisation, add-on condition monitoring system allowing optimised asset management.

Extension

Increasing electrical ratings such as uprating nominal current, short-circuit current, circuit breaker tripping time, auxiliary switch performances, protection performances and adding bays in existing substation are common demands addressed by the Alstom Grid Engineering team. Service teams can extend the life of equipments and their performance.

Customer Benefits

- Optimisation of reliability and performance
- Adaptation of equipment to current needs and technologies
- Environment friendly: up to 30% SF6 quantity reduction, reduction of waste by upgrading only what needs to be changed
- Cost efficiency and short lead time (savings up to 50% compared to purchasing new equipment)
- Higher return on investment with life extension up to 45 years
- Improved safety for employees
GIS modernisation and upgrade examples

**GIS modernisation versus GIS replacement**

- When facing the potential replacement of your GIS, it’s often only the major components that need replacement. Alstom Grid’s GIS modernisation concept is your most cost-effective, ecological option to extend your equipment’s life up to +45 years.
- The principle advantages of modernisation versus replacement are cost and time. The GIS downtime is reduced: the only ‘out of service’ area is the bay being modernised, if use of a redundant bay (to be detailed on a case-by-case basis).
- Besides upgrading your GIS bay, this type of modernisation technique permits your older equipment to benefit from the latest technical evolutions (CB spring mechanisms...), and the possibility to have access to spare parts from our standard manufacturing line.
- Environmental advantages:
  - By using new components with reduced dimensions, we save SF₆ quantity.
  - By replacing only the components which have to be changed, not the whole GIS, there is less industrial waste.

**GIS minor and major modernisation**

- **Minor modernisation:**
  - Fitting of latest generation of accessories such as SF₆ density switches, bursting discs...
  - Replacement of porcelain bushings with composite SF₆ bushings, voltage transformers...

- **Major modernisation:**
  - Replacing obsolete components (CB, disconnector...) inside an old substation with new adapted components.

Alstom Grid services engineers help you to choose between two alternatives: heavy maintenance on existing equipments or GIS modernisation that extends lifecycle.

**GIS upgrade**

**When to upgrade?**

- When modernising older GIS
- When replacing worn circuit breakers, switches, or control and protection equipment
- When the cost of new is too high and your equipment is not at the end of its lifecycle

**Upgrade major steps**

- Network analysis of current and future customer requirements
- Proposition of an individualised solution that not only upgrades performance levels but also upgrades quality, EHS, and technological standards with compliance with latest standards (IEC/ANSI, ...)
- Upgrades engineering
LONG TERM MAINTENANCE

Maintenance of assets is critical to achieve reliability of electricity supply and to comply with current regulations. With the goal of improving efficiencies and downtimes while lowering costs, utilities and industries have to get the most of their equipments over the long term. We support our customers in their challenges by providing Long Term Maintenance, a set of tailored expert services executed on a multi-year partnership.

Customer challenge
Lack or absence of maintenance can generate deterioration or severe failures (Electrical: hardware failure, coil, relay... – Mechanical: peeling, loosening, parts breaking... – Dielectrics: leaks, moistures, electric heating...). Energy players need to make efficient decisions on equipments management to ensure their reliability and maximise their long term performance in a cost-effective way.

Alstom Grid solution
To support customers in the long term, Alstom Grid offers incremental tailored maintenance levels to answer customers’ needs.

<table>
<thead>
<tr>
<th>Expertise</th>
<th>Performance</th>
<th>Serenity</th>
</tr>
</thead>
<tbody>
<tr>
<td>To keep GIS operating efficiently and to ensure optimum performance, preventive maintenance is recommended for key components. Maintenance operations are regularly planned and range from visual inspections by trained specialists to the replacement of used parts. Preventive maintenance is the most effective way to avoid potential troubles before they occur. Through preventive maintenance, outages can be planned and executed within the shortest delays and with the least disruption.</td>
<td>Full management of GIS maintenance and operations guarantees the maximum output. Advanced data provided by condition monitoring and operating measures are proficiently analysed to plan strategical maintenance and operations. In case of failure or disturbance, experts are sent to site promptly to diagnose and repair. Alstom Grid manages spare parts strategic inventory to ensure high availability of main components.</td>
<td>Full management of substation equipments, is a valuable solution ensuring the optimised reliability and performance of the substation. All maintenance and operations are under the responsibility of Alstom Grid. Experts provide a complete record of all work carried out during emergency support or upgrade. Service solutions are completely tailored to customers’ needs and to the environment. Alstom Grid is fully responsible for the gas-insulated substation’s performance.</td>
</tr>
<tr>
<td>- Preventive maintenance</td>
<td>- Preventive and corrective maintenances on legacy GIS</td>
<td>- Full maintenance and operations on substation’s equipments, including Third Party</td>
</tr>
<tr>
<td>- Spare parts on request</td>
<td>- 24/7 Condition Monitoring</td>
<td>- 24/7 Condition Monitoring</td>
</tr>
<tr>
<td>- Planned operations</td>
<td>- Strategic spare parts</td>
<td>- Strategic spare parts management</td>
</tr>
<tr>
<td>- Maintenance and operations on legacy GIS</td>
<td>- Dedicated team with response time engagement</td>
<td>- Dedicated team with response time engagement</td>
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<tr>
<td>- Technical training upon request</td>
<td>- Technical training</td>
<td>- Technical training</td>
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</tbody>
</table>

> EFFICIENT SUPPORT | > CONTINUOUS PERFORMANCE | > OPTIMUM GUARANTEE
## GIS maintenance recommendations

Alstom Grid advises the following maintenance recommendations for GIS. Substation condition assessment by services experts will allow to determine the adequate maintenance, according to GIS type, age, usage and ratings.

<table>
<thead>
<tr>
<th>Visual examination. Every year. Bay energised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor examination. Every 4-6 years. Bay desenergised</td>
</tr>
<tr>
<td>Major examination. Every 12/18 years. Bay desenergised</td>
</tr>
</tbody>
</table>

- CB contacts examination. Every 5,000 operations. Bay desenergised
- Overhaul After 25 Years. Bay desenergised

### SF₆ checks

<table>
<thead>
<tr>
<th>X</th>
<th>X</th>
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<tbody>
<tr>
<td>Pressure with permanent manometer and pressure with tool</td>
<td></td>
<td></td>
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<tr>
<td>Pressure with tool</td>
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<td></td>
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<tr>
<td>X</td>
<td>Moisture</td>
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</tr>
<tr>
<td>X</td>
<td>X</td>
<td>SF₆ percentage</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Density switch (including wiring) check from control room</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>Localisation of any SF₆ leaks (if more than one alarm per year)</td>
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<tr>
<td>X</td>
<td>X</td>
<td>Measurement of the SO₂ content (if no absorber)</td>
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### Circuit breaker

#### Poles

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<th>X</th>
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<tbody>
<tr>
<td>Operating time (main and auxiliary contacts)</td>
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<tr>
<td>Pole opening (contacts examination)</td>
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<tr>
<td>Replace capacitors (after 25 years of operation)</td>
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#### Spring Mechanism

<table>
<thead>
<tr>
<th>X</th>
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<tbody>
<tr>
<td>Replace springs and pins</td>
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</table>

### Hydraulic Mechanism

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<thead>
<tr>
<th>X</th>
<th>X</th>
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<tbody>
<tr>
<td>Pre-inflation pressure</td>
<td></td>
<td></td>
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<tr>
<td>Control the pressure switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace pressure switch and pilot block</td>
<td></td>
<td></td>
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<tr>
<td>Oil level in tank</td>
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<td></td>
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<tr>
<td>Hydraulic circuit tightness</td>
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</table>

### Disconnecting switch

<table>
<thead>
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<th>X</th>
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<tbody>
<tr>
<td>Replace filter</td>
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<tr>
<td>Change oil</td>
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<tr>
<td>Maintenance of the rams and the hydraulic mechanism</td>
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<tr>
<td>Record the travel curves</td>
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</table>

### Earthing switch

<table>
<thead>
<tr>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical functions (stroke, overtravel, auxiliary contacts)</td>
<td></td>
</tr>
<tr>
<td>Lubrification, if applicable</td>
<td></td>
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<tr>
<td>Opening of the pole</td>
<td></td>
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</tbody>
</table>

### Surge arrester

<table>
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<tr>
<td>Measure the leak current</td>
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<td>Record the number of discharges</td>
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<tr>
<td>Visual examination. Every year. Bay energised</td>
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<td>Minor examination. Every 4-6 years. Bay desenergised</td>
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<td>Major examination. Every 12/18 years. Bay desenergised</td>
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<td>CB contacts examination. Every 5,000 operations. Bay desenergised</td>
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<tr>
<td>Overhaul After 25 Years. Bay desenergised</td>
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| Miscellaneous inspections |
|---|---|
| X X X X Optical indicators |  |
| X X X Label operating mechanisms and SF₆ filling valves |  |
| X X X Oil level in damping device (CB with spring operating mechanism) |  |
| X X X CB linkage adjustment |  |
| X X X Cubicle heating |  |
| X X X Connecting wiring |  |
| X X X Alarm function operations |  |
| X X Cubicle tightness |  |
| X X X Secure CB poles and mechanism |  |
| X X X Counters |  |
| X Replacement of SF₆ gaskets |  |

| Options |
|---|---|
| X X X X UHF scanning (detection of partial discharge) if S or T generation or if GIS is equipped with sensors |  |
| X X X X Maintenance of SF₆ gas handling device (gas inspection, filters replacement, tightness and operating condition, houses inspection) |  |
Gas-insulated substation references

LONG TERM MAINTENANCE

In 1993, a Chinese power generation company installed 14 T105 245 kV bays in Shenzhen. They signed a 10-year Long-term Maintenance contract, renewing it again in 2005. In 2005, the customer joined the T105 “spare parts club”: they purchased common parts in 2003 and specific spare parts in 2005. On August 21, 2005 at 7:16 am, an HV cable head exploded and consequently shutdown a group of GIS bays at the Mawan Power Plant. Alstom Grid’s GIS equipment was de-energised by this explosion on the cable side. At 11:45 China time (4:45 am in France), the Alstom Grid Chinese representative called Alstom Grid Aix-les-Bains. At 13:40 China time, an Alstom Grid Service technician arrived at Mawan and sent the first photos of the cable end explosion. Thanks to an effective strategic spare parts supply, emergency on site service (part of the LTM) and a coordinated effort between Alstom Grid Service teams in China and France, within one week, the cable box end, cable box casing, straight enclosure contact and conductor had been replaced and the compartment had been treated. The GIS substation was back in service one week after the flashover.

GIS MONITORING

In France, a major public transportation company, operating buses, regional trains, trams and the metro, needed to update their gas-insulated switchgear (GIS) density equipment since 100% reliability is necessary for any transportation system. In 2003, the customer wanted to renew the SF6 density switches throughout its network and the scope included renewal of Alstom Grid and also GIS from other manufacturers.

The BWatch-3 gas monitoring system was proposed as an alternative to conventional SF6 density switches. Part of the commercial activity was showing the extra features available through the use of our BWatch-3 system. In 2004, Alstom Grid was awarded the contract to install the BWatch-3 solution throughout their network. The BWatch-3 configuration was customised to meet the customer’s specific requirements; the SF6 monitoring systems were designed to be connected with numerical control integrated in their IEC 61850 network. Between 2004 and 2008, six GIS substations were equipped with SF6 monitoring systems: two 225 kV GIS and four 63 kV GIS for a total of over 200 compartments.

STRATEGIC SPARE PARTS MANAGEMENT

The French distribution system operator has several gas-insulated substations (GIS) installed throughout their 420 kV network. Gas-insulated switchgear is strategic equipment that keeps electricity flowing in the network. Any unscheduled downtime can cause financial penalties. In 2008, after 28 years in service, a failure occurred in one of the 420 kV circuit breakers. The delivery time for a new circuit breaker would have been more than 12 months.

In order to minimize equipment downtime in case of failure, Alstom Grid had defined and proposed a strategic spare parts stock adapted to the client’s specifications. GIS component manufacturing time can be several months and, as substations are not always located next to GIS factories, transportation times and costs must also be considered. Alstom Grid’s solution is to maintain a strategic spare parts supply in order to have them available when needed. For planned maintenance or emergency repairs, strategic spare parts permit short equipment downtime. This stock includes the main GIS components: circuit breakers, disconnectors, earthing switches, voltage transformers, current transformers, bushings, bus ducts, etc. Using the available major components in the strategic stock and minor parts supplied during the emergency by Alstom Grid, the circuit breaker was repaired and the bay re-energized only 3 weeks after the fault. The French distribution system operator accepted Alstom Grid’s proposed solution and maintains its own strategic spare parts stock.
In 2010, Alstom Grid renovated the oldest GIS in the world. Equipments life extension is now a priority for Alstom Grid customers. Service unit in Aix-les-Bains (FSA) completed a significant renovation and modernisation of the first installed GIS in the world, the C105 de Vaise installed in 1966 on the french network of the French electricity operator. The complex operation started in 2007 with the condition assessment, after contract signature in 2009, FSA Service team delivered end of 2010 the renovated GIS. The field expertise team overcame particular difficulties such as assets supplying, reassembly, hydraulic system adaptation and tests.

In 2009, Alstom Grid modernised an obsolete GIS: a cost-effective solution to replacement

The Spanish generation utility and the transmission provider had to face the replacement of an obsolete 420kV GIS S155 Circuit Breaker (more than 25 years old) at their Teruel substation. The 420kV Teruel GIS was manufactured by Delle Alsthom in 1979. It was composed of three circuit breaker groups and two line circuit breakers. Each circuit breaker pole had four chambers operated by two hydraulic rams (FB4 type). The customers carried out the periodic preventive maintenance as recommended by Alstom Grid. In 2008, after 28 years of operation, it was time to replace the five circuit breaker capacitors and to overhaul the hydraulic equipment... a costly and time consuming renovation.

As an alternative, Alstom Grid proposed replacing the old circuit breakers with new two-chamber circuit breakers (T155) and new spring-operated mechanisms, thus effectively upgrading old Alstom Grid legacy equipment with new, state-of-the-art GIS equipment. The Spanish generation utility decided to test the solution by replacing the first circuit breaker. The order was placed for the new equipment and a short shutdown was programmed for the work to be accomplished. Alstom Grid Service experts and manufacturing teams worked together to meet customer’s objectives and the program was successful. The customer issued a second order for two more circuit breakers.

In 2005, Alstom Grid conducted state-of-the art modernisation on two 1975 gas insulated substations

The Ayer Rajah, Chon Chu Kang and Senoko substations in Singapore were built in 1975 and were no longer able to supply the necessary power ratings for their regions. The gas-insulated switchgear had been built with earth tank protection systems. In 2005, the Singapore utility decided to replace these protections by modern busbar protections, also upgrading power levels. The rest of the equipment needed to be adapted to meet the new ratings.

The upgrade from earth tank protection to busbar protection meant that the GIS required new current transformers close to the circuit breakers. Service engineers analyzed the substations’ individual requirements and offered a solution that included necessary design adaptations to install 300 new current transforms on 51 GIS bays as well as the new protection systems. The contract included complete project management and required that work be done on a bay-by-bay program so that power flow was never interrupted. This complete project resulted not only in life equipment extension but assets were meeting new quality and EHS standards.