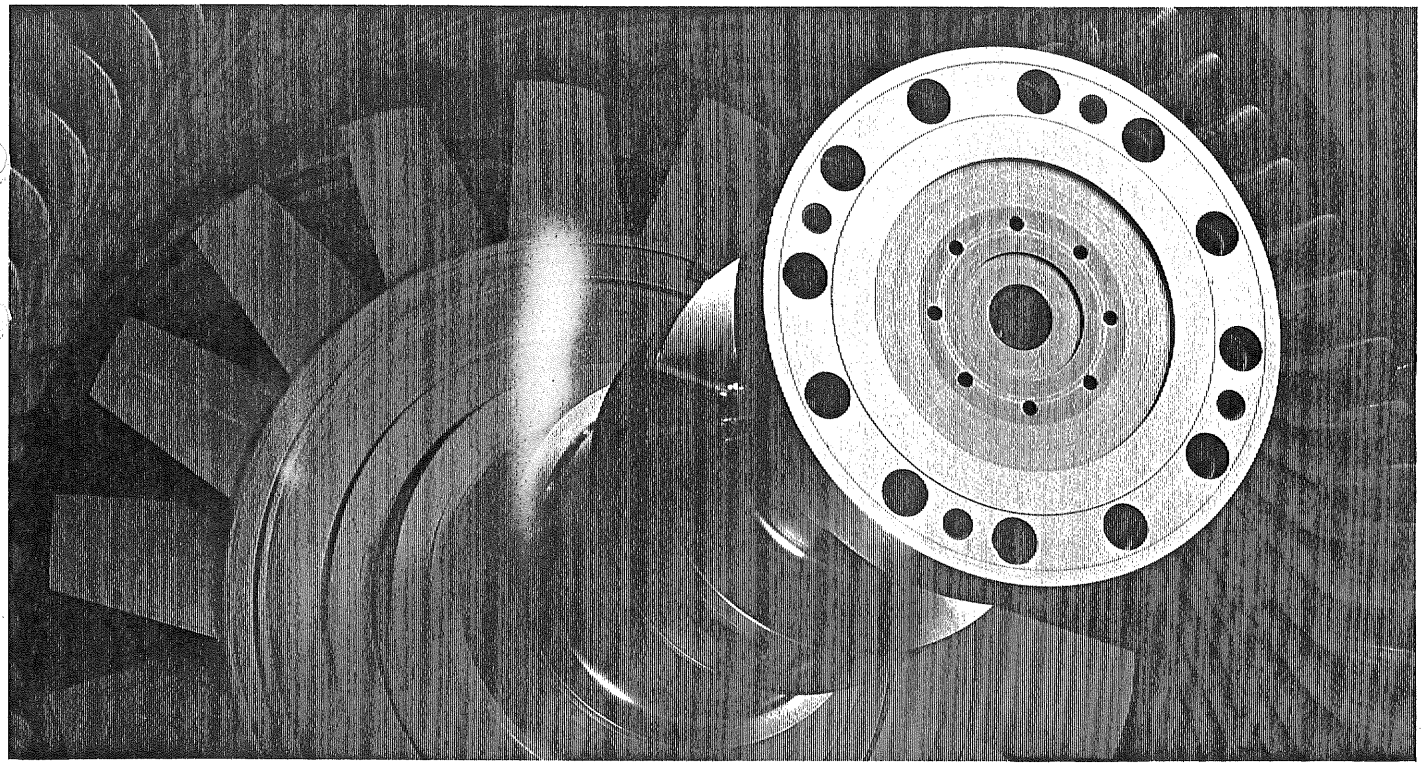
GBA-SYNCHRONOUS GENERATORS

4- and 6-pole brushless generators
6-15 kV, 50/60 Hz, 5-55 MVA



ABB

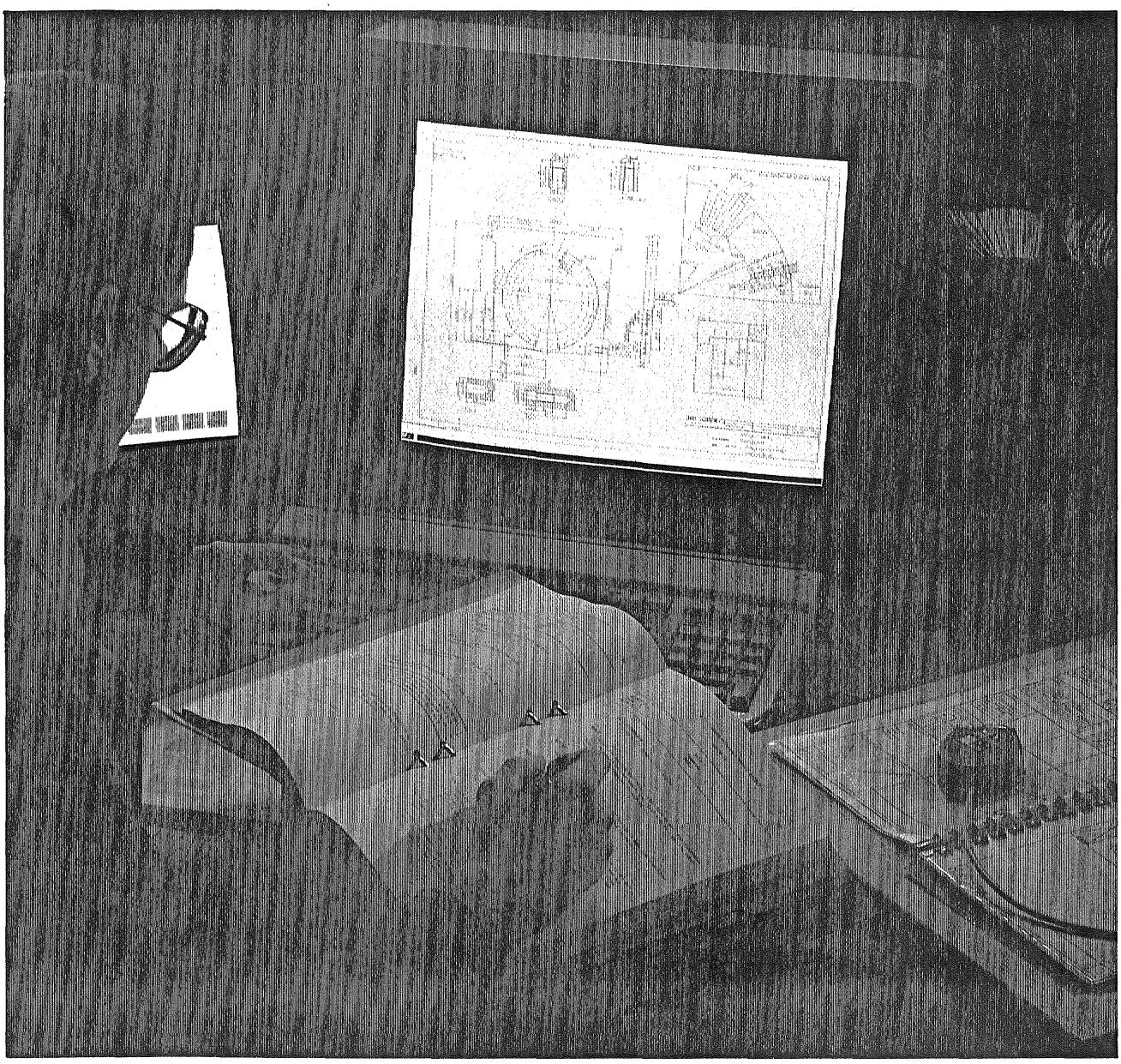
Experienced

The GBA type synchronous generator continues the tradition by ABB of building rugged high voltage 4- and 6-pole machines.

The extensive experience in difficult environments have contributed to an exceptionally reliable design. GBA type generators and motors operate in paper and pulp industry, onboard offshore platforms, in oil refineries, in air separation plants, in power utilities and in many other demanding applications. They are installed in ice cold northern countries as well as in the soaring heat of the tropics. Special attention has been paid to corrosion protection systems and materials selection for all the relevant environments.

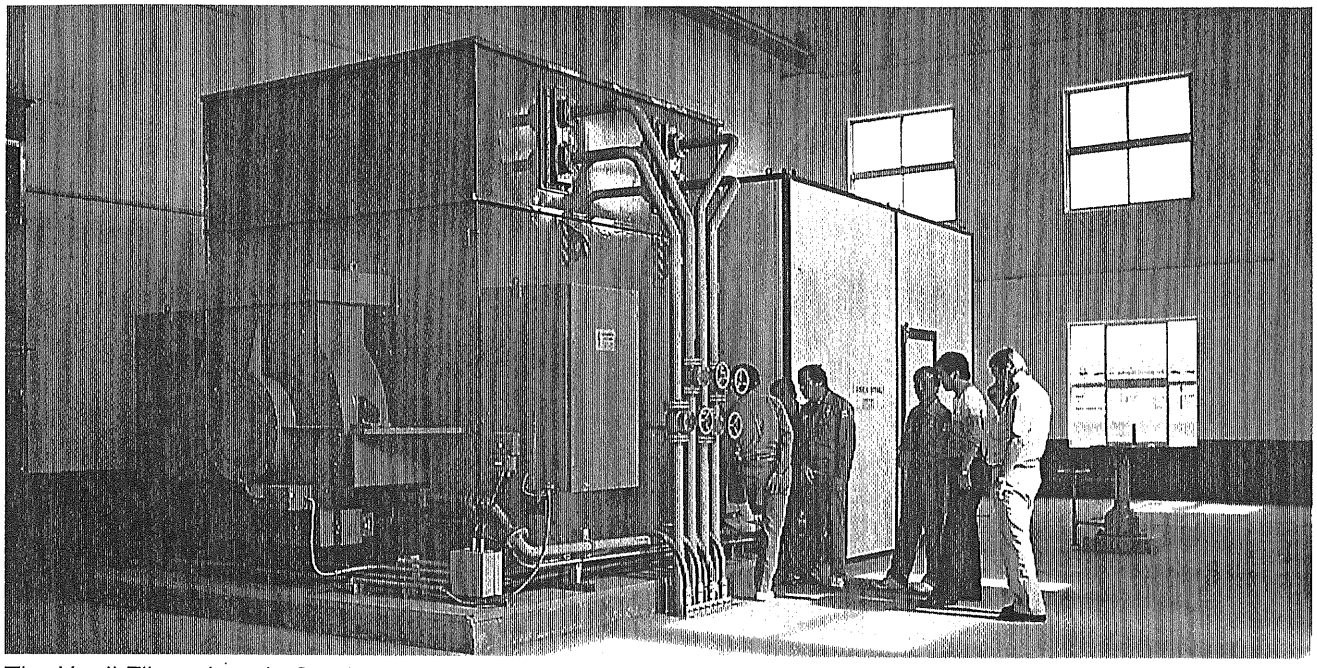
The GBA design concept makes very efficient use of the active material employed, resulting in optimal performance with good economy and an exceptionally low total weight. The vacuum pressure impregnated (VPI) stator core forms an essential part of the mechanical structure for the complete machine, thereby further limiting the need of non-active material.

Computer aided design enhances the possibility to tailor make the electrical characteristics of the GBA generator to the specific need of the grid system – within the concept of a standard design.



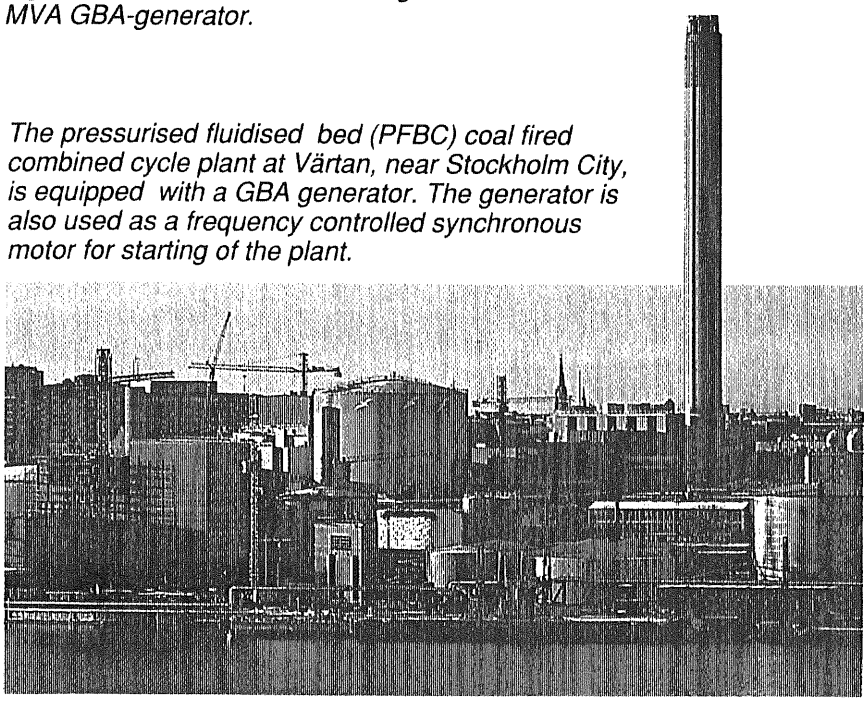
The attractive price of a 4-pole generator often makes it competitive to a direct driven 2-pole machine even when the cost for a reduction gearbox is taken into account. Turbine or engine speeds can thereby be selected for optimal performance and the gear will take care of the speed adaption.

Computer aided design is employed for the GBA concept which, in combination with the flexibility of a modern computerised production planning system, introduces unique possibilities to adopt each unit to special requests for electrical characteristics. We may, as an example, vary the synchronous reactance of the machine within wide limits, thereby adopting the machine to demands for high voltage stability or in other cases, reduce the short circuit loadings in the power supply system by increasing the transient reactances.

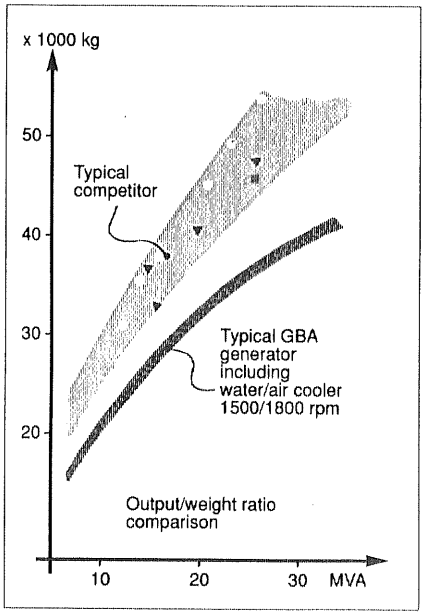


The Hanil Fibre plant in South Korea, manufacturing synthetic fibres, have installed a geared steam turbine unit driving an 18.3 MVA GBA-generator.

The pressurised fluidised bed (PFBC) coal fired combined cycle plant at Värtan, near Stockholm City, is equipped with a GBA generator. The generator is also used as a frequency controlled synchronous motor for starting of the plant.



High utilisation of active material gives a low weight to output ratio –as requested for example by the offshore industry.



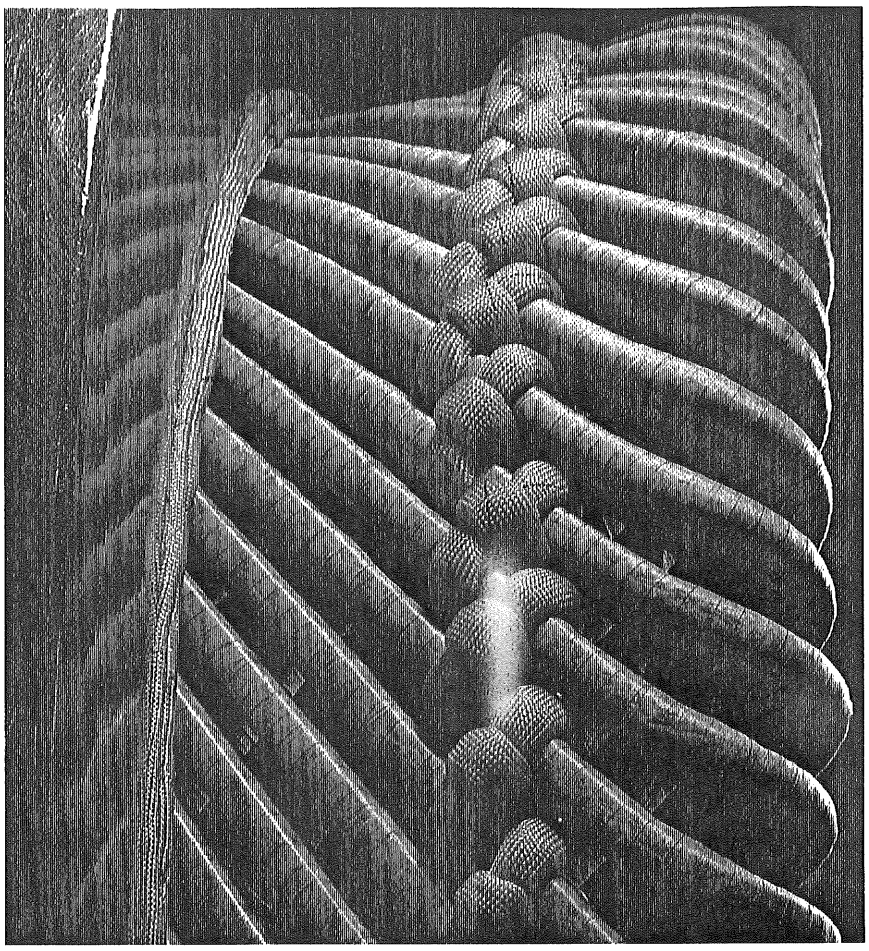
Ruggedly built

The GBA high voltage generator has been designed to meet the most stringent demands from the modern utilities and industry.

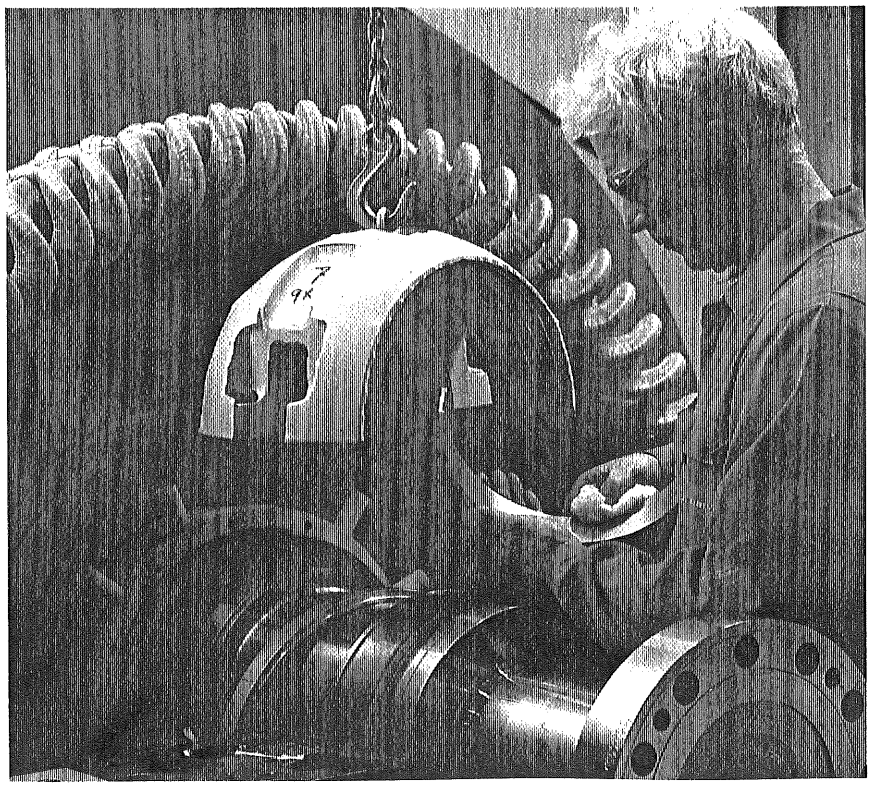
Special emphasis has been placed on designing a machine with good mechanical stability. The box-shaped machine base design allows the stator core with windings to rest directly on the foundations, thus ensuring that all static and dynamic forces are transmitted directly into the foundation.

A combination of short distance between the bearing centres and rigid bearing supports placed under the centre of each bearing, minimises the level of vibration. Traditional sleeve bearings of split type design are employed. The bearing liners are easily replaceable.

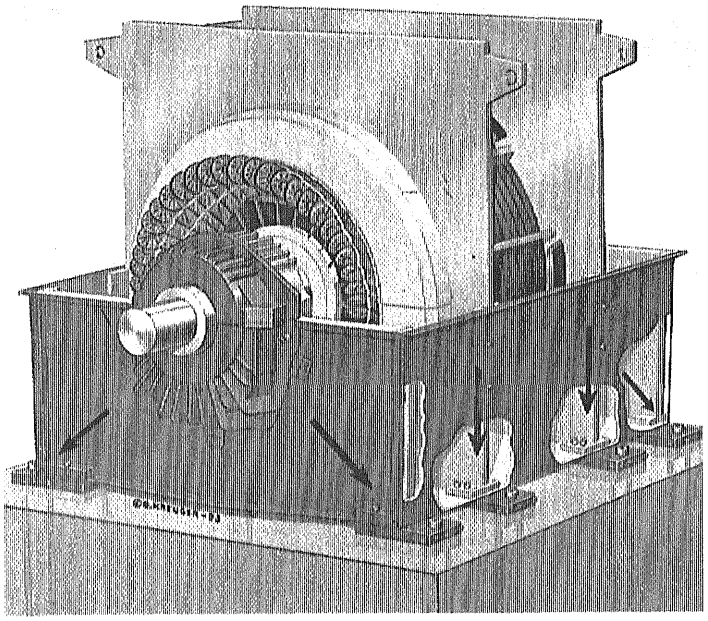
The rotor is of salient pole design running below the first lateral critical speed with a safe margin. A very high thermal capacity is characteristic for this rotor design.



Proper bracing of stator coil ends by glass fibre rope, that have been subjected to vacuum pressure impregnation with epoxy resin (VPI), gives an exceptionally rigid stator winding – that will withstand short circuit conditions.

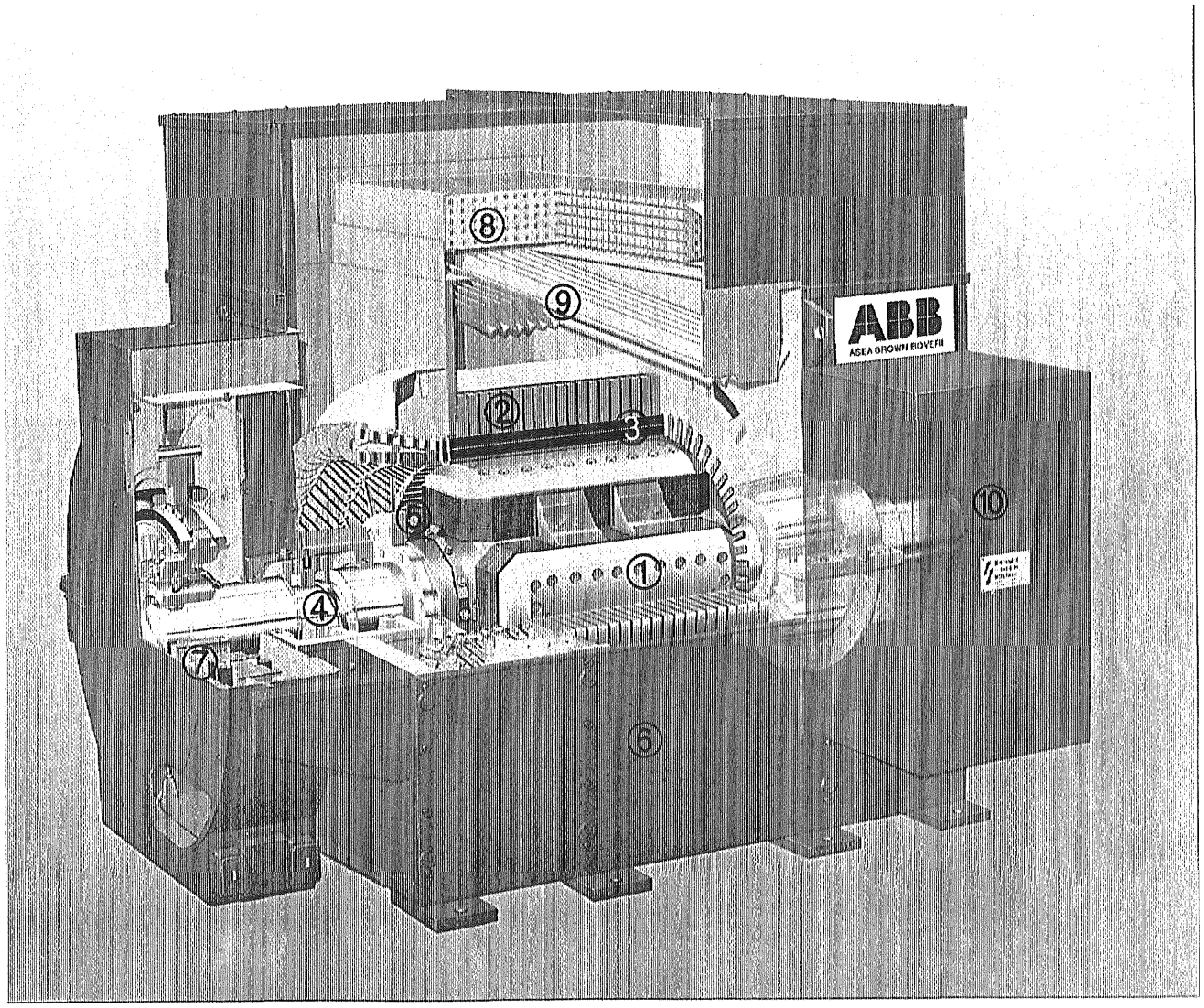


To avoid shaft currents both bearings are insulated and a disconnectable earth strap is connected to one. The bearing liner can be replaced easily.



Dynamic and static forces are transferred directly into the foundation.

① Salient pole rotor
② Laminated stator core with slots for cooling air
③ High voltage stator coils
④ Cylindrical sleeve bearings
⑤ Shaft mounted fan (2 off)
⑥ Box–shaped machine base
⑦ Brushless exciter
⑧ Water/air cooler (ICW 37 A81)
⑨ Drip tray for condensation water
⑩ Terminal box



Quality windings

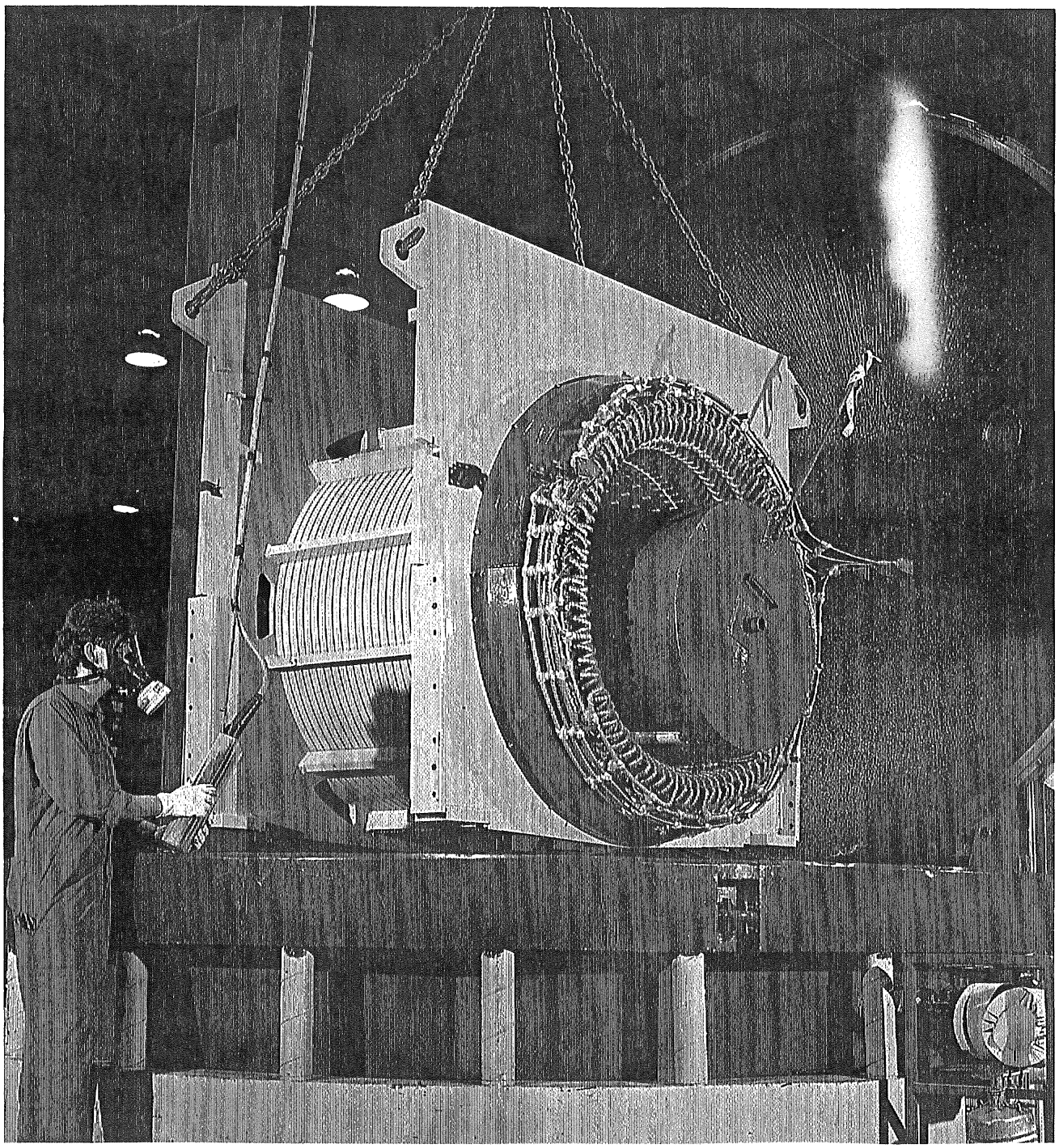
The GBA stator design is utilising the unique MICAREX® class F insulation system combined with vacuum-pressure impregnation.

Form-wound coils have their straight sections formed under the influence of heat and pressure. This ensures that the coil fits exactly into the stator slot.

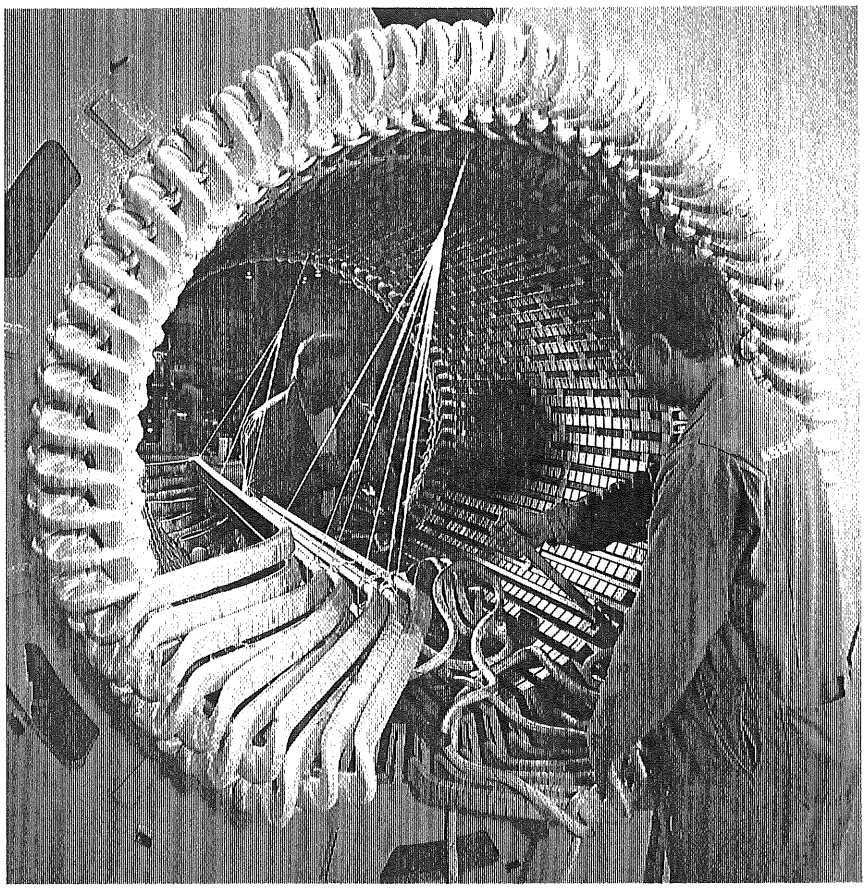
Individual coils are subject to high voltage and surge testing prior to and after insertion into the stator. The winding is wedged and braced to withstand the considerable electromagnetic forces that might occur at operational disturbances.

The subsequent vacuum pressure impregnation will further strengthen the bracing and insulation. The coil end bracing is designed to withstand a full 3-phase short circuit.

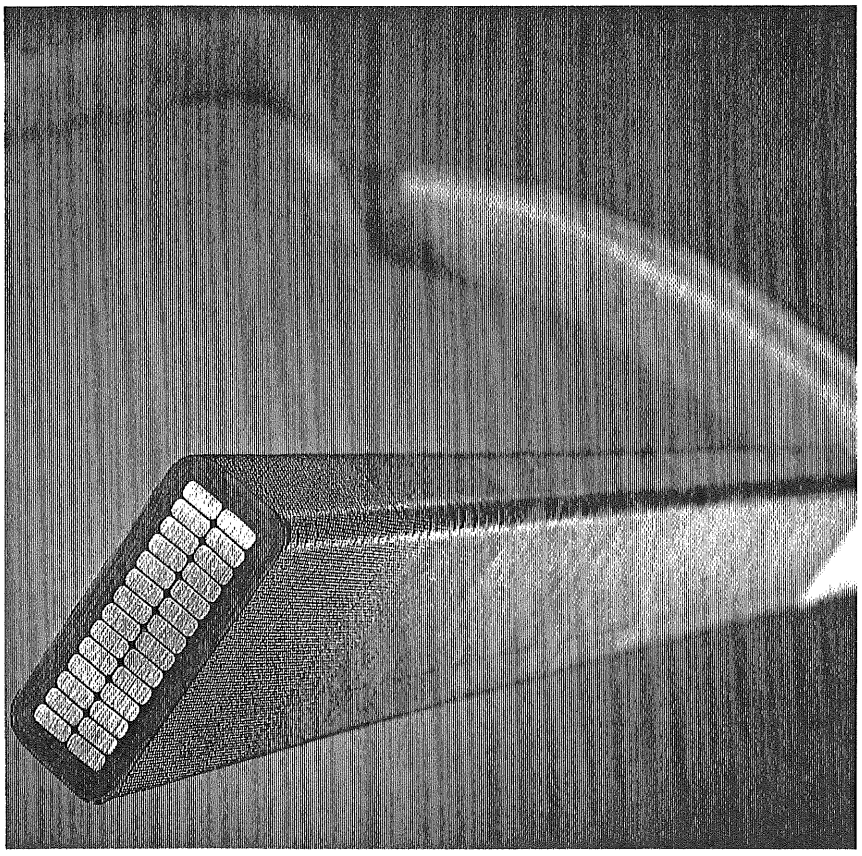
After the insertion and interconnection of the stator windings, the complete unit is impregnated in a vacuum-pressure process (VPI) - providing the most dependable insulation available.



The stator has a 3-phase diamond winding with 2 coil sides per slot. When the coils have been inserted they are locked with composite wedges.



MICAREX® class F insulation system provides a high quality insulation that copes effectively with electrical, thermal and mechanical stresses.



The stator coils have their straight parts formed to exact dimensions under influence of heat and pressure. An exact fit into the slots in the stator core is achieved —improving the performance.

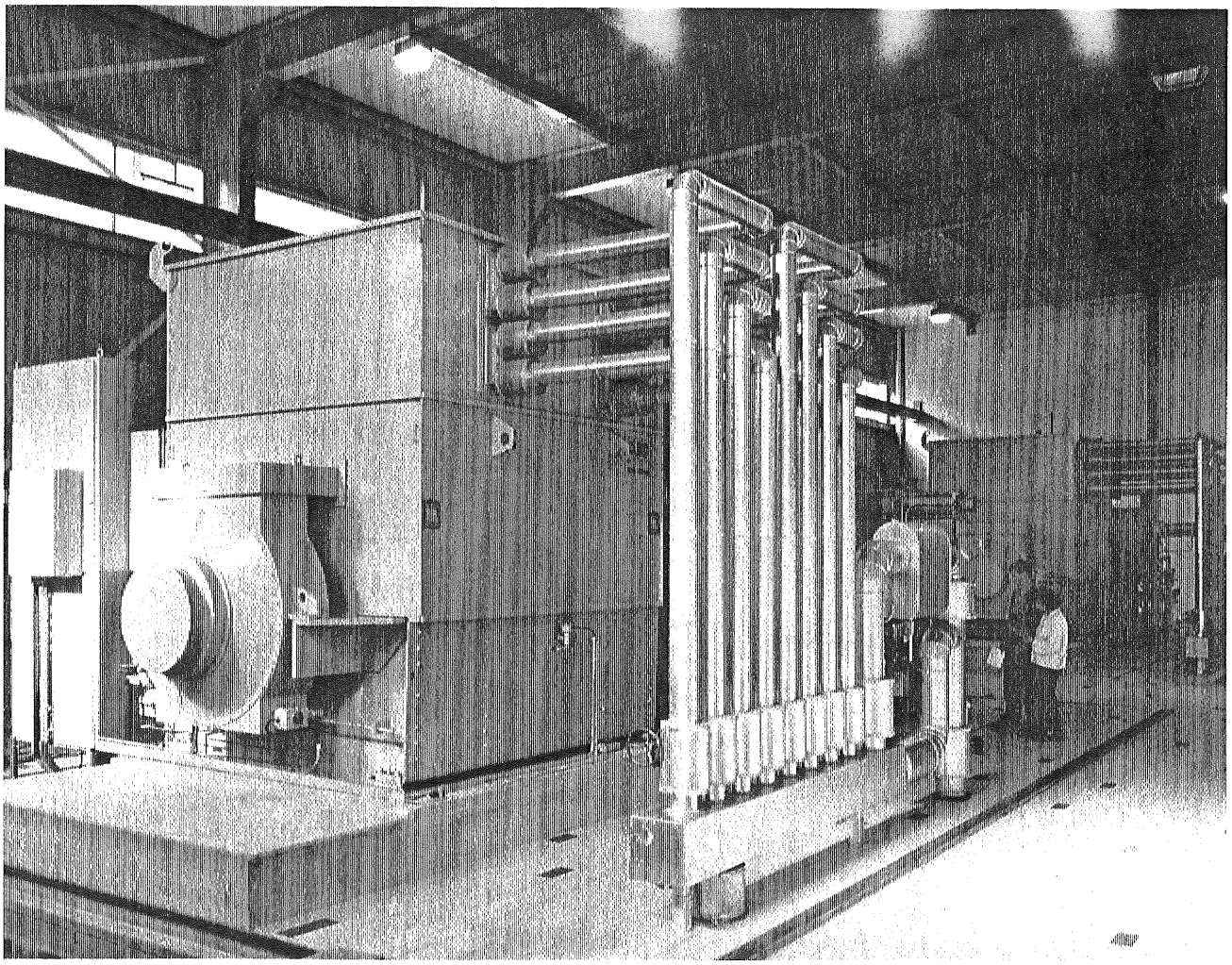
Properly cooled

Typically the GBA machine is built with the protection form IP54, i.e. a totally enclosed unit with an integral heat exchanger, or with flange connections for cooling air from the outside.

If an air/water or air/air heat exchanger is chosen, it will be located on the top of the unit. The GBA is also, of course, delivered as an open drip proof machine with IP23 protection, or with extra weather protection according to NEMA WP2.

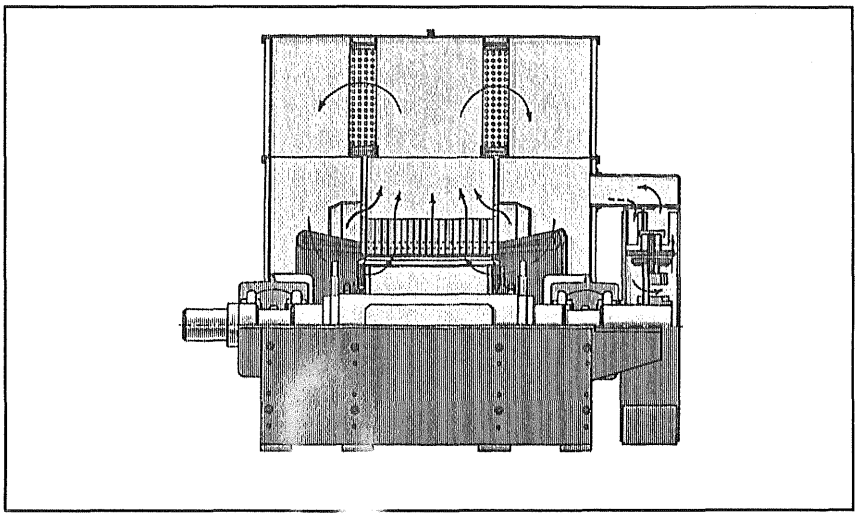
The air/water cooled machine has its cooler sections mounted on the top of the stator, however equipped with a drip tray to take care of possible condensation water. The cooler elements are mounted transversely with water connections on either side at the customers request. Tube plates and water headers are extended outside of the generator enclosure on both sides for extra protection against possible water leakage into the machine. Several hundred machines with this arrangement have been in operation for up to 20 years with nothing but the best result.

Two 28. 75 MVA n turbine driven GBA 1120 ronous generators at Zuck G, Uelzen, Ger ny. Double a ter heat-exch gers are pro l for cooler redu ncy.

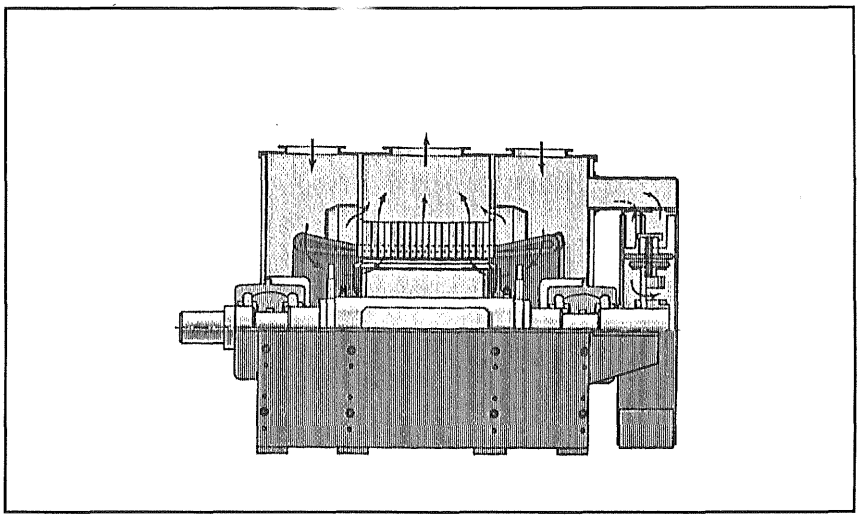


The most common combinations of protection and cooling forms:

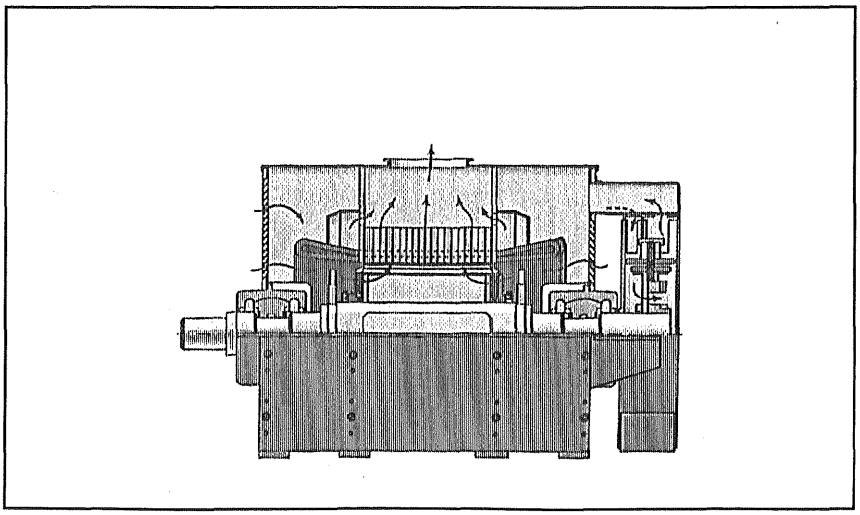
IP54/ICW37A81 (TEWAC)
Totally enclosed version with top mounted air/water heat exchanger(s). Extra cooler sections for redundancy are possible. This version affords the best opportunity for quiet running and simple installation when cooling water is available.



IP54/IC31
Totally enclosed version where cooling air is ducted to and from the unit. This version may be used in hazardous environments where cooling air is supplied from a safe area.



IP23/IC21
Open ventilated version with separate outlet duct for cooling air. With this version, the discharged cooling air can be diverted away from the machine hall.



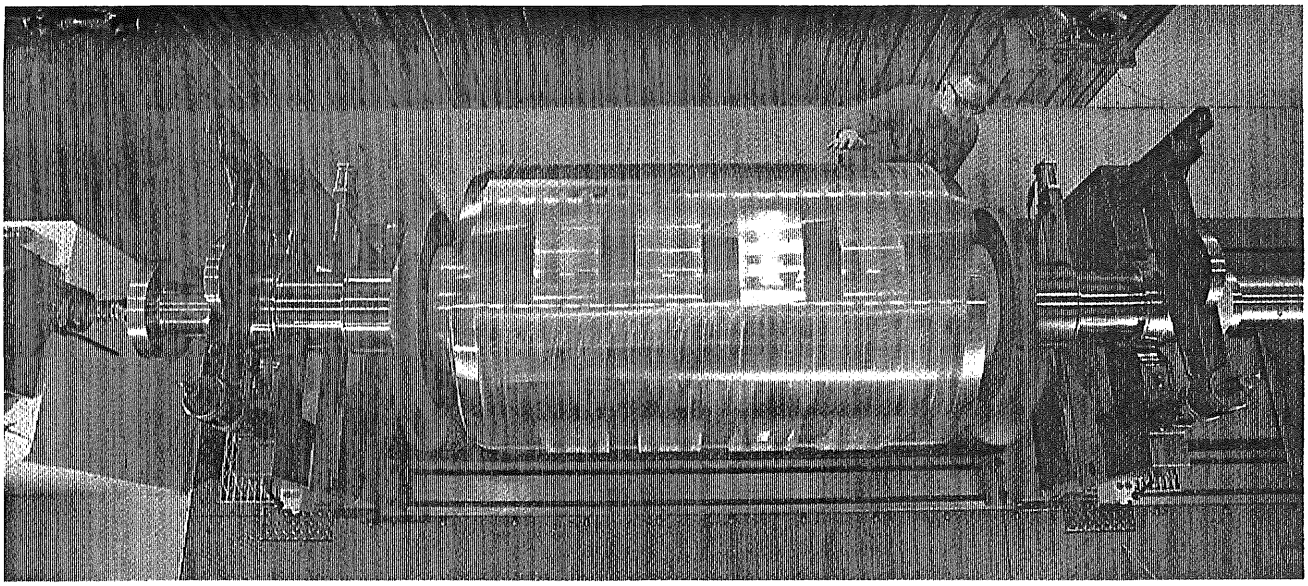
Other protection and cooling forms have been delivered by ABB on special request. One exemple is IP 54/IC 0161 (TECACA) for severe environments where cooling is scarce.

Tested throughout

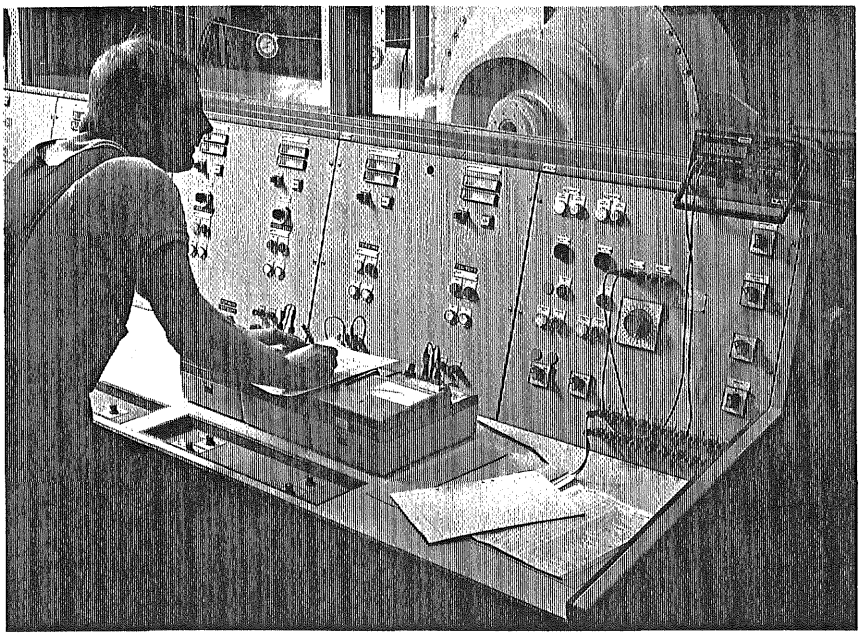
Every single GBA generator is subject to an extensive test programme before it is allowed to leave the production facilities.

Type testing is performed on new machine configurations to document their performance. The no load and short circuit curves are obtained. The no load losses are measured and a heat run performed at zero power factor in addition to the routine tests.

When the electrical characteristics for each type has been established, every consecutive unit is subjected to an extensive routine test programme to confirm that it meets with the expected performance and that it is sound in all respects. On the next page follows the main items of the standard test programme for each assembled machine.



The rotor assembly is dynamically balanced and an overspeed test is performed as standard.



Final testing of the complete machine is performed in our test room before each delivery – at rated voltage, current and frequency.

Routine test programme:

- Radial bearing clearance measurement
- Bearing control, axial clearance
- Air gap measurement
- Control of the insulation
- Resistance measurement
- Vibration measurement and balancing
- Shaft voltage
- Short circuit test
- No load test
- High voltage test

Type test programme:

- Routine test
- No load curve
- Short circuit curve
- Load point, p.f.=0
- No load losses, p.f.=1
- Heat run test, p.f.=0

In addition to these standard tests, optional tests may be performed on special request, e.g. to establish special characteristics like noise level or measuring waveform.

A complete description of all the QA-activities imposed on the ordered machine is collected in an Inspection and Test Plan. This plan also describes materials tests and tests of individual components before the assembly.

All stator winding coils are individually tested before assembly into the machine. Here the coils receive a high voltage test, an impulse test and the tan ∂ is measured.

Adaptable to any grid

The salient pole rotor is equipped with single layer copper field windings designed for high current and low voltage to give high operational reliability.

The field windings are fed with the correct DC-current from the brushless exciter through the rotating diode-bridge rectifier to give the desired voltage at the current load. The field winding DC-current can be controlled by changing the stator current of the exciter.

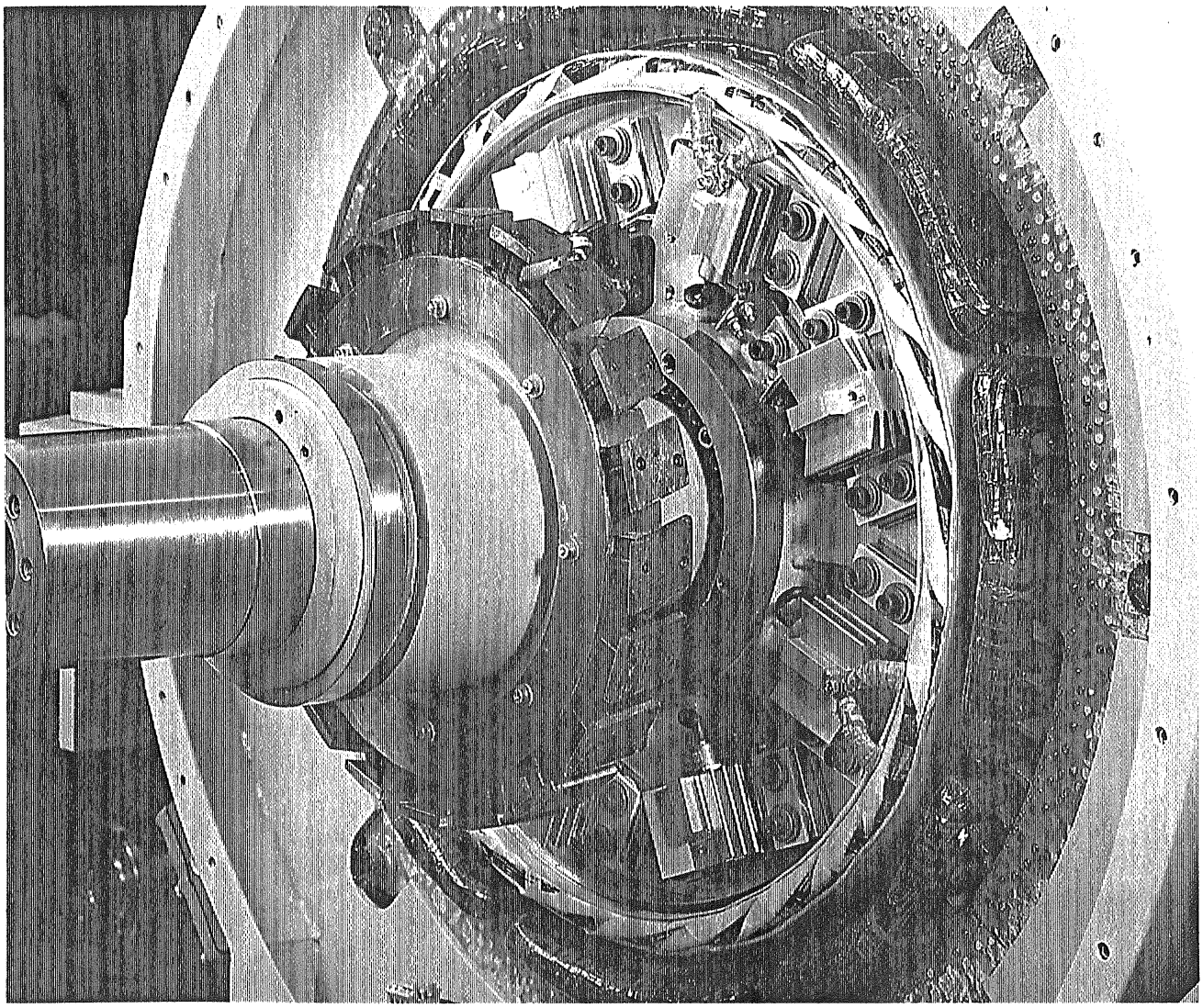
The exciter and the rectifier consist of one unit. The exciter is designed as a synchronous generator with the armature in the rotor and DC-winding in the stator. All windings have temperature class F insulation. The exciter rotor is mounted overhung onto the main shaft outside the non-drive end bearing. No separate bearings are therefore required. The main shaft is provided with a hole in its centre for the cables from the exciter to the field windings.

The exciter is typically provided with cooling air from the main machine. The exciter rotor circulates the cooling air over the exciter and discharges it back to the main machine.

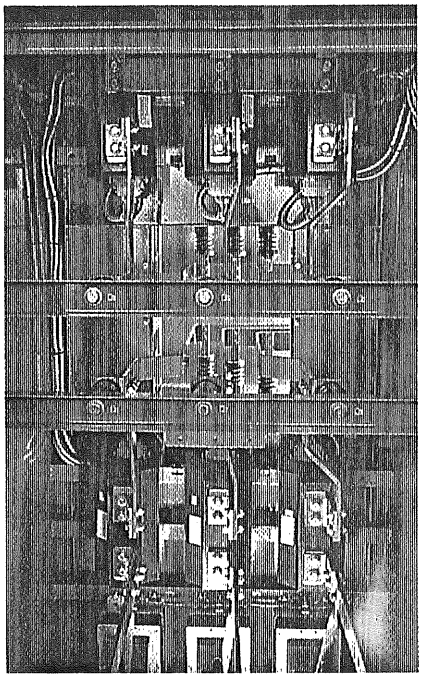
Most GBA generators are equipped with the standard option of a pilot exciter of permanent magnet type (PMG). The PMG is mounted on the main rotor immediately outside the main exciter and will then supply the automatic voltage regulator with the necessary power.

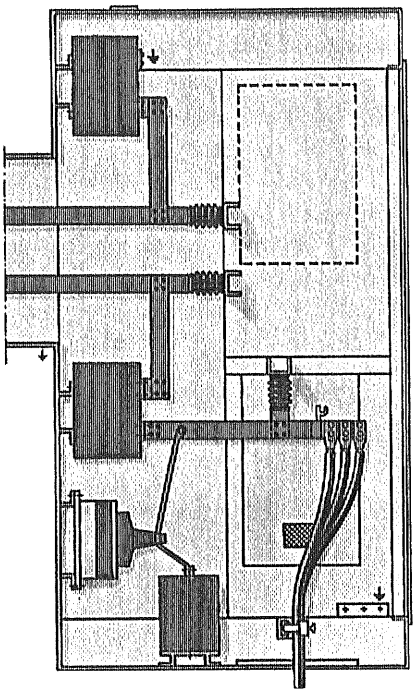
The PMG can be adopted for most types of automatic voltage regulation systems.

All components in the exciter are easily accessible by simply removing the end panel. Seen here is also the rotor of the optional pilot exciter (PMG).

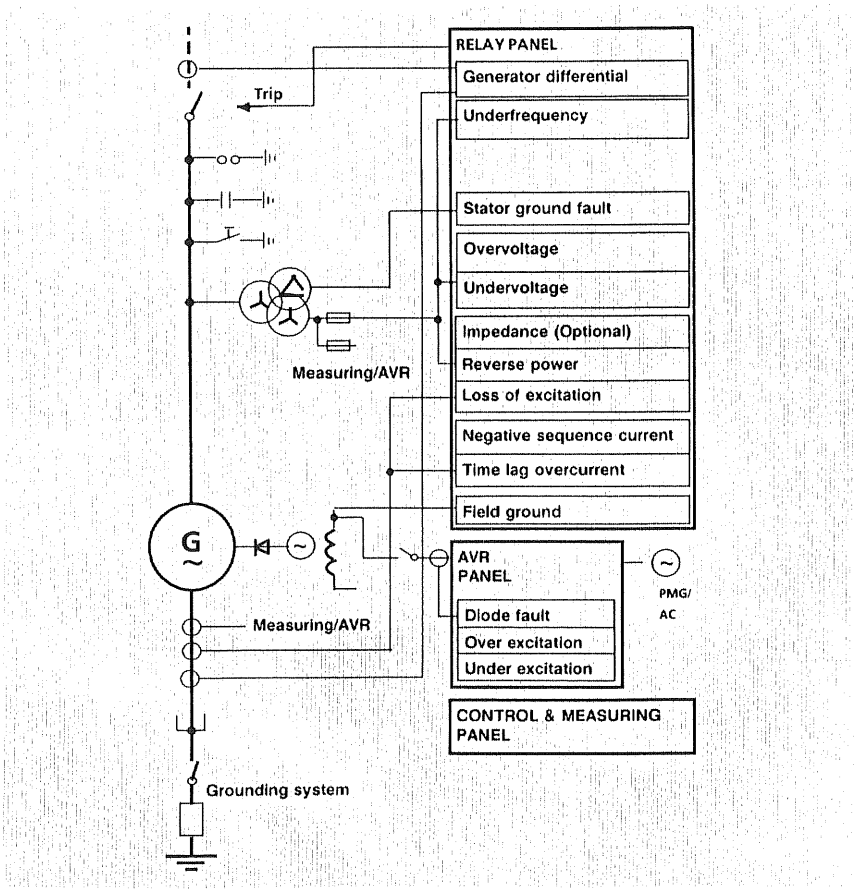


The terminal box can be located on either side of the machine. The box is as standard arranged for cable entry from below. On request an extra large terminal box may be supplied, with ample space for all the necessary measuring transformers, star point connection etc. As an alternative, separate line and neutral cubicles may be arranged on opposite sides of the machine.
The terminal boxes are all designed to minimise the risk for short circuit faults by careful installation, involving taping of stress cones to avoid electrical field concentrations, proper bracing to minimise the risk of gradually destroyed insulation and by the selection of the minimum creepage distance and clearances to match the rated voltage.





GBA type generators are designed to run at a high load factor for a large number of years and permit certain incidences of abnormal working conditions. Monitoring devices may reduce the incidences of abnormal working conditions down to a minimum, but despite the monitoring, electrical and mechanical faults can impose unacceptable conditions and protective relays are needed to quickly disconnect the machine from the grid or initiate a complete shut-down of the unit.
No international standards exist regarding the extent of the protective systems for generators in the GBA sizes. What is common practice varies between the different countries and applications. ABB recommend that static relays with low power consumption in the measuring circuit are used according to the schematic diagram shown here.



Always next door

Our GBA generators are sold all over the world by ABB sales companies in their respective country supported by expertise from the production site in Sweden.

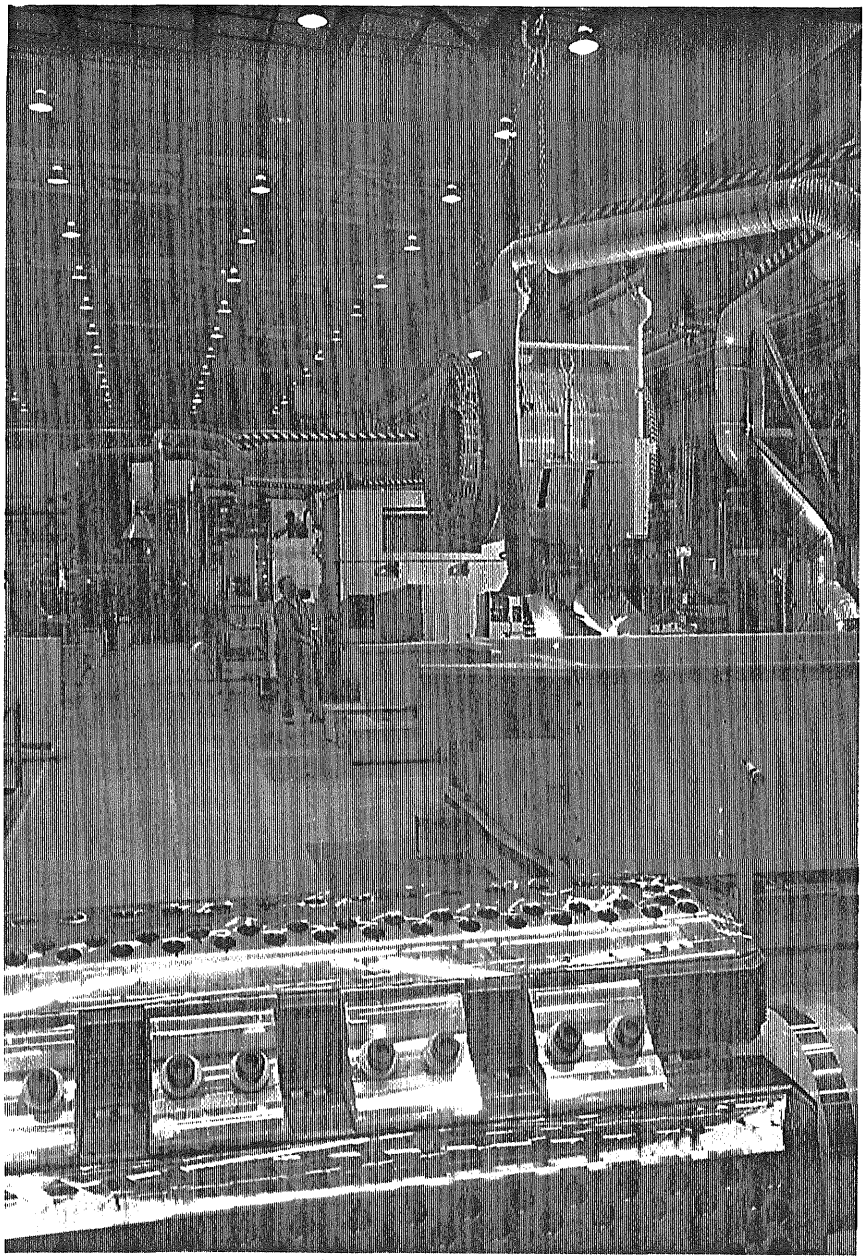
The development, production and marketing of synchronous generators and motors are concentrated mainly to Finland, Sweden and Switzerland, though resourceful, local manufacturing is at hand in France, Italy and Brasil.

This concentration to certain units will help to ensure that the most midern production resources can be urilised to hold down costs and will also help consolidate our leading position in this field.

Advanced R&D programme

Being our customers you also gain access to a Research and Development programme that can only be carried out by a specialised and profitable business. Moreover, this investment is expanded by other R&D done within the Asea Brown Boveri group of companies.

ABB will stay in the forefront of modern technology with our goal set at bringing the most modern and energy efficient products to the market.



Local service shops

ABB synchronous generators are designed and built to operate troublefree year in year out in the ardous environments in industry. But some inspection and maintenance is still required to ensure a continuous undisturbed operation. For this purpose ABB has its own or sub-contracted service shops employing some 2000 people in 35 countries. These service shops have facilities so that any problem can be looked after locally, saving valuable time and cost, ensuring your process is kept running.

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