

S E R I E S
→ **BZK**



SYNCHRONOUS
G E N E R A T O R S



Indar



INDAR ELECTRIC

INDAR, EXPERIENCE AND COOPERATION

INDAR Electric develops and manufactures electrical rotating machines to respond to customer needs.

Its experience is shown in the thousands of Indar Electric generators in operation all over the world.

Cooperation with the customer is part of the company's philosophy, through special personal attention as the basis for the relationship and with a clear common objective: to develop products and services that adapt to the characteristics of each project.

Indar Electric has modern facilities equipped with the latest technology in its different sections; sheet metal die-cutting, machining, coiling, assembly and testing.

Indar Electric is present in several continents through agencies and after-sales service centres, to guarantee a comprehensive service for its generators: technical assistance, maintenance, repairs and replacement parts.

— Indar Electric, an Ingeteam company, has worked for over sixty years in the design, manufacture and supply of electrical rotating machines.



CONSULTANCY

SUPPLY

MAINTENANCE

TECHNICAL ASSISTANCE

SYNCHRONOUS GENERATORS - BZK SERIES

The development of the BZK series has been based on the knowledge that Indar Electric has accumulated for decades in the manufacture of synchronous machines, combined with the use of advanced design tools that its R+D+i support unit uses.

Technological innovation is a basic element in the company's development and has become an essential factor in keeping the company competitive in a demanding market.

Synchronous brushless generators,
4,111 kVA - 1,000 r.p.m., 6.3 kV,
for a gas engine for Caterpillar.



Modular construction

The BZK series makes up a three-phase synchronous generator family designed for horizontal forms of construction. The equipment is designed to comply with different shaft centre heights and anchoring options. It can adapt to requirements on the basis of the drive through a modular design.



The construction of the BZK is divided into:

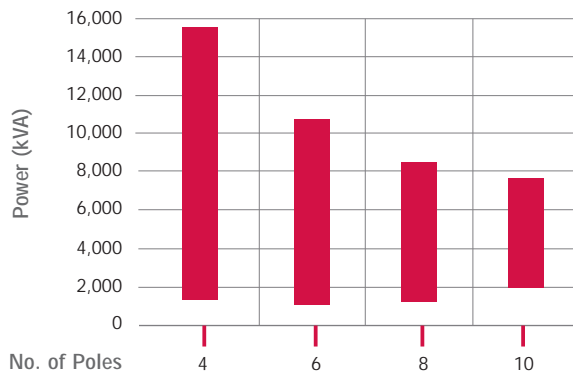
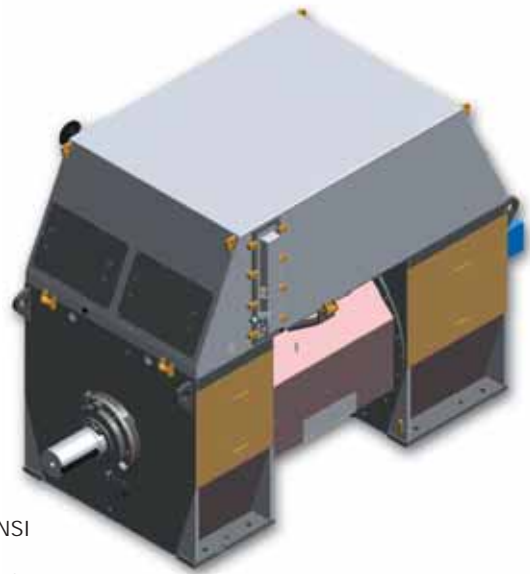
- **Casing:** The stator core is welded onto the outer ferrule in a cylindrical manner, thus creating the main structure of the generator.
- **Shields:** Made of mechanically welded rolled steel, both for applications with bearings and those designed to bear radial and axial loads.

CONSTRUCTIVE DESIGNS

Knowledge of the physical phenomena that occur in synchronous machines, together with the latest software to calculate finite elements, have meant that the electro-magnetic design has been optimised, with excellent performance.

The main characteristics of the BZK series are:

Power (kVA)	1,250 - 15,000
No. of Poles	4 - 10
Voltage (V)	690 - 15,000
Frequency (Hz)	50 - 60
Insulation	F (H if required)
Heating class	F
Ambient temperature	40° C
Standards	CEI, NEMA, VDE, ANSI
Vibration requirements	IEC 34-14 or ISO 10816
Other standards	Bureau Veritas, Lloyd's Register, Det Norske Veritas
Overloads borne without damage occurring	110% for 1 hour in a 6-hour period 125% for 15 minutes in a 6-hour period 150% for 2 minutes in a 6-hour period



**POWER RANGE
OF BZK GENERATORS**

SOLUTIONS FOR EACH APPLICATION

The modular structure of the series means that the generator can be adapted to a wide range of applications based on power, speed or voltage to respond to market needs.

The characteristics of the main drive or motor are also taken into account when configuring the generator, in terms of the level of cooling and protection required (adverse environments, high humidity, heat, etc.).

BZK generators provide an energy generation solution for a number of sectors:

- **Cogeneration:** Gas or steam turbines, diesel or gas engines.
- **Shipbuilding sector:** Main and auxiliary generation.

— BZK 710 (main generation) 6,750 KVA, 1,000 r.p.m., 690 V, for a dredger of the Belgian ship-owner Jan De Nul.



— *INDAR generators comply with current international legislation on the manufacture of electrical rotating machines: IEC, CEI, NEMA, etc.*

R & D AT YOUR SERVICE

The team is made up by highly qualified professionals with considerable experience in design and manufacture.

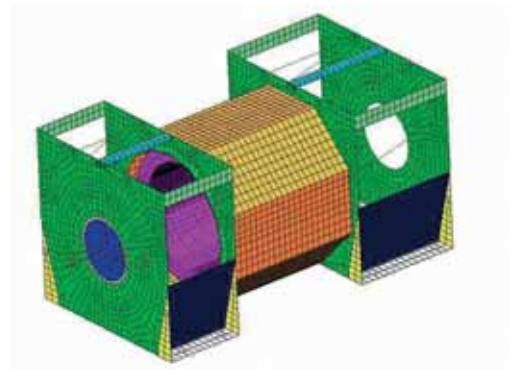
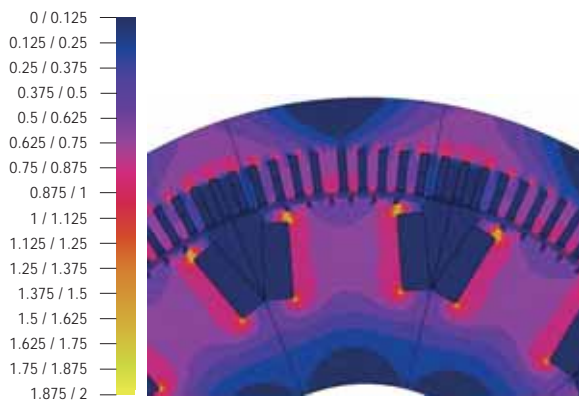
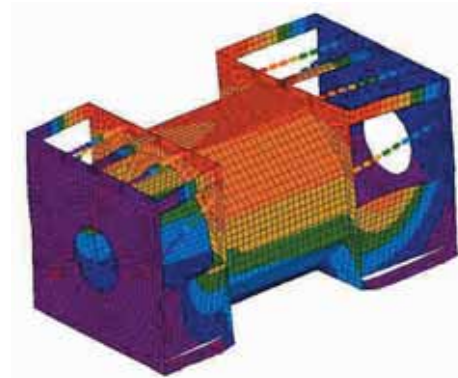
This, together with the application of modern simulation programs for finite mechanical elements and electromagnetic flows, means that we can provide solutions based on in-house technology to deal with customer requirements.



Electrical and mechanical optimisation studies have been made using a number of finite element simulation programs:

— Electrical optimisation:

Our knowledge of the physical phenomena that occur in synchronous machines, together with the latest software to calculate finite elements, has allowed us to optimise the electro-magnetic design of our machines and thus obtain higher performance.



COOLING AND PROTECTION

INDAR offers a range of solutions, depending on the demands of the application or customer requirements, ranging from open air-cooled machines to closed machines with air/water cooling systems.

OPEN MACHINES

There are two configuration options:

- Those that take and expel the cooling air from machine room IC 01. They can be used in places where the air is relatively clean.
- Those that take ambient air from the machine room and expel the hot air through a duct outside of room IC 21.

CLOSED MACHINES

In cases in which the air is not sufficiently clean or not suitable for ventilation, the solution consists of completely closed generators with two types of cooling system:

- Those that take and discharge air outside through an IC 31 duct.
- Machines with IC-81W81W cooling have a closed air circuit. The air that is ventilated by the machine goes through the coolants located on the outside of the generator. The water that runs through the cooling units extracts the heat generated in the machine.

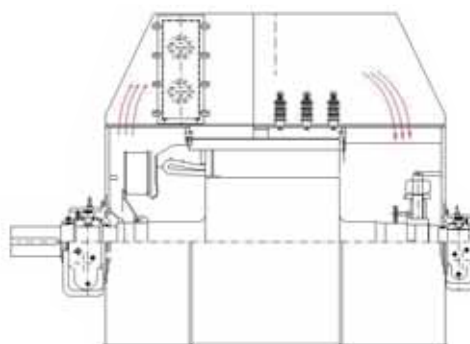
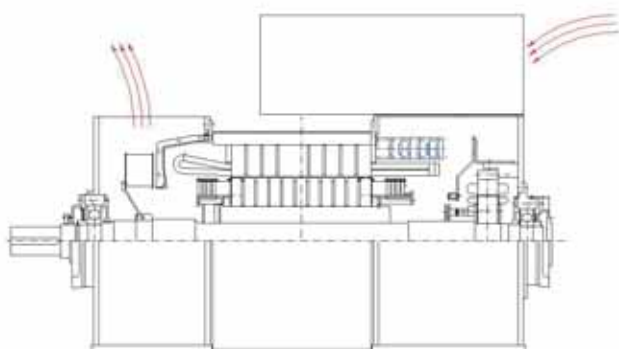
NOMENCLATURE OF PROTECTION CLASSES

IP: first number

- Indicates the level of protection against accidental contact between live parts and the penetration of solid bodies.
 2. Drives protected against objects larger than 12 mm.
 4. Drives protected against objects larger than 1 mm.
 5. Drives protected against penetration by dust.

IC-01 second number

- Degree of protection referring to the tightness of the drive against penetration by liquids.
 3. Drive protected against drops of liquid at an angle of 60° (rain).
 4. Drive protected against splashes in any direction.
 5. Drive protected against water jets.
 6. Drive protected against high seas.



S T A T O R

The stator package consists of low-loss thin sheets of magnetic silicon steel, which are die-cut and coated on both surfaces with insulating material to reduce losses from stray currents.

The spaces that make up the radial air ducts in the core of the stator are distributed to ensure efficient cooling.

The shields attached to the central part are studied by modern calculation methods such as Finite Element Modelisation (FEM) to bear the most demanding electro-magnetic stresses.

The bearings are located in the shields. They are designed to handle a range of cooling solution in terms of air inputs and outputs.



Magnetic core

The magnetic core is held in place by tie bolts that make up a pressure box on the outside, with the help of some pressure plates with pins located on either side of the core.

This system guarantees high mechanical rigidity of the magnetic core through an excellent compacting of the steel sheets.



The cooling of the magnetic core and coils is divided into a number of basic 'packages' with radial ventilation channels made up of sheet metal with spacers attached.

The spacer core is selected to achieve uniform distribution of the pressure applied during the formation of the core, thus guaranteeing low hydraulic resistance to obtain the necessary air flow for cooling.

Once the core has been formed a non-destructive test is carried out at low induction, with the aim of detecting short circuits between the plates.

COILS

Formation of coils

Each coil is made up of individually insulated copper platens. Once the coil is formed a number of layers of Mica tape are applied to ensure reliable insulation.

After insulation, protection is applied to the rated voltage of the machine.

The objective is to avoid differences of potential between the surface of the insulation and the iron of the magnetic package in the active part of the coil, and also discharges in the area around the head of the coil.

The insulation of the generator is guaranteed to the Class F Standard used by Indar Electric, but it depends on the working environment or the specific needs of the customer. Class H insulation can also be used.



Winding

An element that guarantees the performance of Indar Electric generators is the high level of insulation of its components.

The stator winding is three-phase and is insulated by the VPI System. This insulating system has excellent dielectric, thermal and mechanical characteristics.

Its reliability is backed up by hundreds of machines that have been manufactured in recent years using this system, not only under normal operating conditions but also under transient conditions.



Stator winding.
Individually insulated copper platens.

PROCESS OF IMPREGNATION

Indar Electric generators undergo the most reliable processes to produce machines that will operate for decades, even under the most adverse conditions.

As a result of this process of impregnation, the magnetic package, the coils, the wedges, the fastenings and the supports of the head make up a compact unit that is capable of supporting all the mechanical and electrical stresses the machine can be subjected to, even transient regimes as a result of discharges, disconnection operations, etc.

The windings are characterised by:

- High mechanical resistance in all parts of the winding, due to the fact that the coils, the magnetic package and the supports have all been impregnated at the same time.
- Uniform dielectric strength throughout the circuit.
- Total absence of gaps in the insulation. This guarantees excellent thermal conductivity and good dielectric properties.
- High thermal capacity. All the insulating materials comply with Class F, and may therefore be continuously subjected to temperatures of up to 155° C.
- The insulating materials are not affected by humidity; if water does get into a particular area the machine can started up again after drying the wet surface.
- It is not sensitive to oil and other contaminants, and the low roughness of its surface avoids the accumulated of dust.
- High resistance to the effects of radioactive radiation. This means the machines can be installed in areas of high radiation in nuclear plants.
- The insulation system is inflammable and self-extinguishing.



R O T O R

The design of the rotor is a key factor in the mechanical and electrical performance of the generator. The rotor of BZK generators is the best example of the work done by the company's R+D+i support unit in the ongoing optimization of the design of the generators.

— **For 4 poles rotors:** the rotor package consists of thin low-loss magnetic silicon steel sheets. They are die-cut and coated on both surfaces with insulating material to reduce losses from stray currents. These sheets are pressed against each other, leaving radial channels that reinforce the cooling of the rotor winding and thus ensuring efficient cooling of the generator.

The copper-insulated coils are inserted into the grooves and are insulated from the rotor sheet metal. The coils are held in place in the grooves by fibreglass wedges.

The assembled rotors undergo tests in the tunnel to ensure their correct operation. The tests include dynamic balancing and overspeed tests to check the structural integrity of the components after the tests.



The shafts used in the construction of the generators are manufactured with top-quality steel (forged or rolled) and then subjected to specific tests to check the homogeneity of the material. They are machined along their entire length and are polished on the surfaces where the bearings slide.

— **For 6, 8 and 10 poles rotors:** the rotor consists of rolled steel plates that are pressed together and welded to two discs to make up a compact core that is then linked to the shaft.



The poles manufactured from rolled steel create a compact unit consisting of the earth and the polar coil. They are then subjected to an insulation process that gives them great rigidity and avoids air inclusions in the spirals.

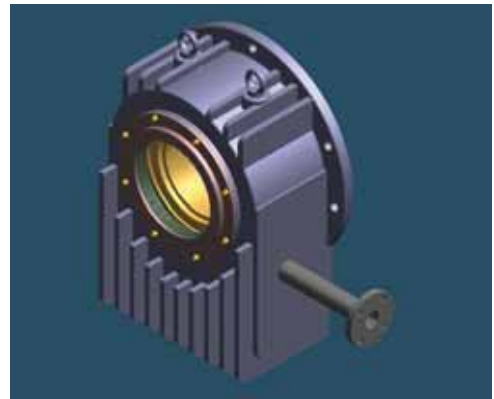
The rotor has a dampening coil that reduces the effect of unbalanced loads, improves the stability of the generators and dampens the oscillations caused by sudden load changes.



The field winding consists of insulated copper. The current to this winding is injected through an exciter/rectifier bridge or a set of rings.

BEARINGS

Indar Electric offers two solutions, depending on the type of application: ball bearings or slide bearings.



Ball bearings

Under normal operating conditions they have a forecast working life of at least 50,000 hours.



Slide bearings

These have a working life of over 100,000 hours. This is the recommended system for high-speed or high-vibration applications. They are installed under special manufacturing conditions (rotation speed, load-bearing capacity) or according to customer requirements.

The lubrication of the bearings can be done in two ways, depending on operating conditions: self-lubricating or through an external lubricating mechanism.



CONNECTION BOXES

In the BZK series, the connection box is assembled on top of the generator and includes the transformers required for excitation (T1 and T2).

It is designed to enable easy connection of the cables and the installation of the current and voltage transformers for measurement and protection. Cable connections in the standard series can be either on the right or the left side.

For high- and medium-voltage machines, the auxiliary connection box is located away from the main connection box.

It is mounted on the stator and provides all the connections for the connection and protection elements: temperature sensors, excitation, current transformer outputs, heaters and similar equipment.



The standard protection of the connection box is IP 54.

The main connection box complies with Standard DIN 42962 in terms of distance between terminals, insulators and walls.



TYPE OF EXCITATION

The BZK series has a range of options, depending on the application and the voltage of the machine. Basically, there are three systems of brushless excitation:

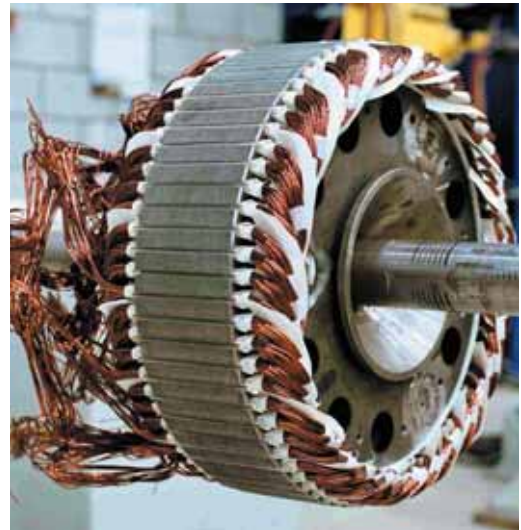
— Powered by ancillary equipment.

The AVR is powered by an external AC source. This is the simplest system although it is not always possible to apply it. If the power supply to the excitation equipment can be guaranteed it can comply with 3 In (and similar) demands.



— Powered by PMG.

The excitation equipment is powered by a Permanent Magnet Generation mounted on the opposite side from the main generator. The PMG supplies the power required by the AVR, even in cases when it is necessary to comply with demands such as maintaining a level of short circuit for a short period.



— Powered by terminals on the generator.

This is a system in which the equipment is powered by a transformer, whose primary is connected to the generator output and the secondary to the excitation equipment. In cases where 3 In is required or guaranteed, a Boost module is installed (with its corresponding transformer).

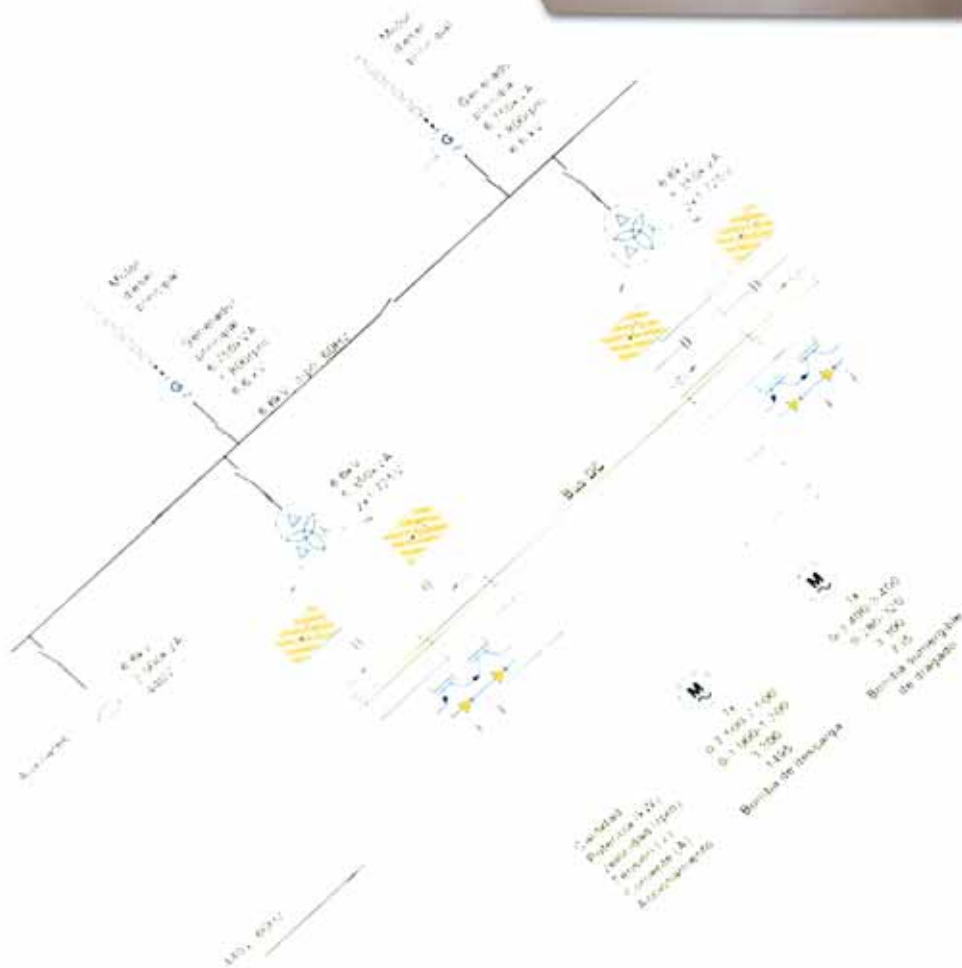


REGULATION

Regulation system

The regulation system is through a reliable microprocessor that can be custom-built. It regulates the output voltage of the brushless generators by controlling the current in the excitation of the generator field.

For operations in parallel with the main generator, the way the power factor control is designed allows a continuous supply of reactive current. When supplying insulated networks, a single voltage control is used.



GENERAL TESTS

Components and the different parts of the generator are checked and tested throughout the manufacturing process. The controls include: Quality control, test to ensure insulation, inspection on reception of products, etc.

These ongoing checks during the manufacturing process and the final tests guarantee the total reliability of Indar Electric generators.

The routine tests that Indar Electric applies to its generators are:

- Measurement of the winding insulation.
- Measurement of the insulation resistance.
- Phase sequence and direction of turn.
- Vacuum curve.
- Short circuit curve.
- High voltage test.
- Overspeed test.
- Dielectric strength test.
- Checks on auxiliary components.
- PT 100.
- Heater.
- Regulator.
- Visual checks.



Synchronous Machine.
 Test under Load.

Standard tests that Indar Electric carries out in accordance with Standard IEC 34 are:

- No load heating.
- Heating under short circuit.
- Determination of losses and efficiencies.

STANDARD ACCESSORIES IN THE BZK RANGE

PT-100 temperature sensors

These are temperature sensors consisting of a platinum filament surrounded by cylinder-shaped ceramic material in a metallic sheath (in the case of bearings) or flat in the case of windings.

All BZK machines have 6 PT-100 (2x3) installed in the winding, and 2 PT-100 in each slide bearings. If anti-friction bearings are installed, there is 1 PT-100 in each of these bearings.



Heating resistance

Heat resistors keep the air inside the generator at 5°C above ambient temperature. They are used to avoid oxidation from water condensation during long shutdowns of the machine, and to maintain the dielectric properties of the insulation.

Two single-phase power resistors are installed on both sides at the bottom of the generator.



Optional accessories

Indar Electric offer the following additional accessories. They can be included in the BZK range to cover any requirement.

- Cooling air filter.
- Air/water cooler with water loss sensor.
- PT-100 in hot/cold air.
- PT-100 in hot/cold water.
- Extra PT-100 in bearings.
- Thermometers.
- Current transformer for measurement and protection.
- Voltage transformer for measurement.
- Sea transport packing.



Power 4,111 kVA
Voltage 6.3 kV,
Speed 1,000 r.p.m.



Power 4,050 kVA,
Voltage 6.3 kV,
Speed 1,500 r.p.m.



Power 6,550 kVA,
Voltage 6.3 kV, Speed 1,500 r.p.m.

OUR FINAL PRODUCT



Power 3,750 kVA,
Voltage 690 V,
Speed 1,000 r.p.m.



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