



**SURFACE-COOLED SQUIRREL CAGE
THREE-PHASE INDUCTION MOTORS
NEMA 320 up to 440 Frame
INSTALLATION AND MAINTENANCE INSTRUCTIONS**

1. TECHNICAL DESCRIPTION

GENERAL INFORMATION

Motors with parameters as provided in the specification sheet meet the requirements of NEMA MG-1 and *the efficiency requirements of NEMA PREMIUM*.

The following motor designs are available:

- foot-mounted – type designation SIE T (S,4,6)
- foot-mounted, flanged – type C (FI) – type designation SIE TCL (S,4,6)
- type D (FF) – type designation SIE TDL (S,4,6)

OPERATING CONDITIONS

Cyclic voltage variation:	± 5%
Ambient temperature:	-30°C to + 40°C
Relative humidity of air at 25°C:	100%
Shaft axle inclination with respect to the horizontal plane:	0° ÷ 90°
Type of operation:	CONT (continuous)
Site altitude:	up to 1000 m above sea level

PROTECTION CLASS

Motors in basic design come with protection class **IP55**. On request, they can be manufactured with higher protection class, max IP66.

CASING

Motor's casing (frame, bearing shields) and terminal box are made from grey cast iron. The fan cover is made of steel sheet. Air intake is performed through the truss with dimensions to ensure protection class IP20.

WINDING, INSULATION

The stator winding and insulation materials correspond to insulation class F. On request, motors can be manufactured in class H. The squirrel cage is cast from aluminium.

Special execution (on request) – the following is built in the winding:

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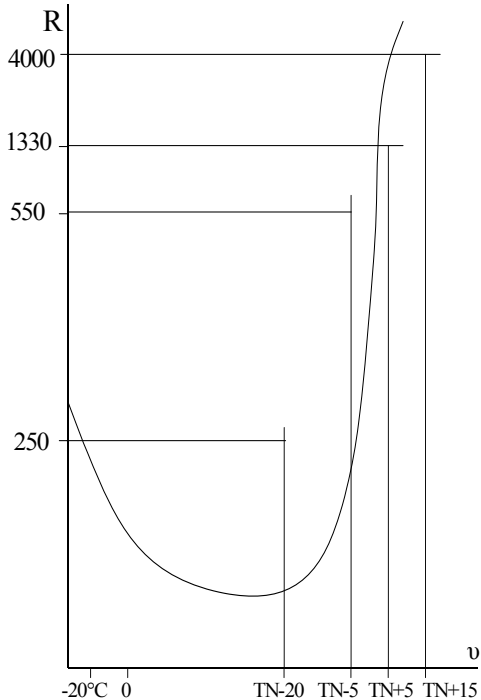
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- thermal protections – PTC thermistors
- heating elements (motor in the standstill state protected against condensation water inside)
- temperature-related resistors Pt100

Information:

Resistance and temperature characteristics of PTC thermistor (posistor).



Resistance [Ω]	Temperature [° C]
20 do 250	-20 do TN-20
< 550	TN -5
>1330	TN+5
>4000	TN+15

T_N – thermistor's rated temperature.

BEARING MOUNTING

The rotor bearing mounting is made with rolling bearings. For assignment of bearings to individual motor sizes, see table 1. The motors are equipped with grease nipples for bearing re-lubrication and grease drain plugs.

On request – bearing shields with thermal protection, e.g. PTC
 – bearing shields suitable for installation of vibration sensors.

TERMINAL BOX

The terminal box is located on the left-hand side of the motor when looking from DE side. Box frame with plugged hole(s) R2" or R3". The terminal box design allows the frame to be turned at 90°. Motors in basic design come with outputs (12 or 6) to the terminal box from rotor windings.

For connection diagram, see the data plate.

PROTECTIVE TERMINALS

The terminal for connection of protective conductor is located inside the terminal box. The additional external terminal for connection of earth conductor is located on the motor casing.

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MOTOR DRAINAGE

Motors are equipped with holes on bearing shields used to drain the motor's interior.

2. TRANSPORT AND STORAGE

Motors can be transported on any covered means of transport, without sudden shocks and strokes. They can only be lifted using eye bolts on the motor casing. Motors should be stored in rooms:

- with maximum relative humidity below 80% at 20°C,
- with ambient temperature between -30°C to +40°C,
- free of dusts, gases and corrosive vapours and other aggressive chemical fumes with damaging effect on the insulation or casing,
- free of vibrations.

Machined surfaces of stored motors should be protected against weather conditions by applying thick grease or easily washable anti-corrosion lacquer.

3. SAFE OPERATING RULES

To avoid accidents during motor operation, the following rules should be observed:

- before any adjustments and inspections or repairs, disconnect any power sources,
- motor must be installed according to general rules and regulations in force,
- in any case motor cannot be operated without its shields on,
- motor should be earthed according to regulations in force and condition of the earth (neutral) terminal should be checked from time to time,
- power cables must be properly protected against damage,
- after any emergencies (short-circuiting, winding overheating), motor should be dismantled, and rotor removed from stator, to ventilate its interior and prevent from possible explosion of fumes/gases accumulated inside.

4. MOTOR SET-UP

Before motor is set up in the workplace:

- remove bearing protection (if any),
- check whether motor has not been damaged during the transportation or storage,
- measure the insulation resistance to housing.

The insulation resistance should be at least 5MΩ in the cold state and 1000Ω in the heated state per 1V of working voltage. If the measured insulation resistance is lower, motor should be dried. While drying, create conditions so that moisture can be removed from winding – e.g. remove the terminal box cover to allow the exchange of air from inside. During drying, the winding temperature cannot exceed 80°C in any case.

If motor is equipped with winding heaters, the heating elements should be connected during motor **standstill** by supplying voltage to terminals marked “C, C”, as per the designation label.

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It is allowed to dry the stator, e.g. with a drier – while drying, the temperature cannot exceed 80°C. Motor should be dried as long as the required insulation resistance value is received.

Check the quality of grease in bearings – if motor has been stored for more than 2 years, replace the grease with MOBIL's POLYREX. When changing the type of grease, first thoroughly clean the bearings with petrol and dry.

Motor should be put in the workplace so that it can be easily accessible for inspection and maintenance. Put on the balanced flexible clutch or pulley onto the motor shaft neck. For this purpose:

- wash protective varnish off the shaft neck,
- apply grease or oil to the cleaned neck,
- put the clutch or pulley heated up to approx. 85°C onto the end neck by means of appropriate washer and M20 screw, using the threaded hole in the end shaft neck or any other suitable instrument. When putting the clutch or pulley onto the shaft, avoid impacts that may damage bearings.

After the assembly has been done, the non-concentricity between the axle of the motor shaft and driven equipment cannot exceed 0.1 mm. Maintain clearance of at least 1mm (1,5mm) between the clutch halves.

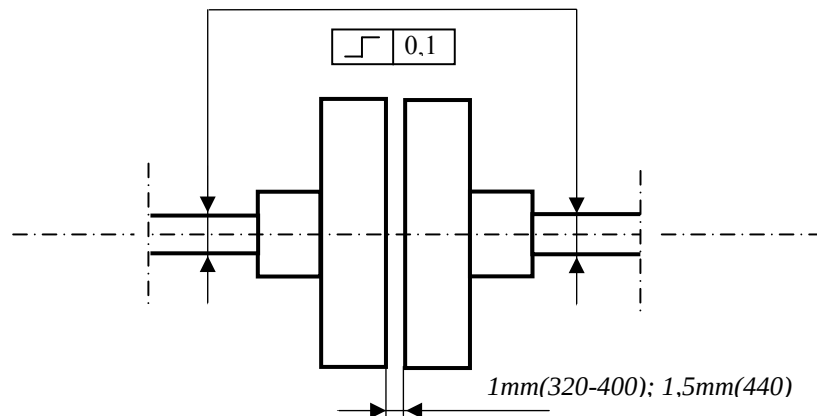


Fig.1 Concentricity between motor shaft and driven equipment

Loading of shaft end neck with transverse and axial force cannot exceed the admissible values in the specification sheet. In belt drives, avoid the excessive belt tension, as it results in shortening the life of bearings and overloads the shaft.

5. CONNECTION TO POWER NETWORK

Before motor is connected to power, compare data on the rating plate and network parameters. The designation and connection of winding is provided in the connection diagram on the rating plate.

NOTE: While checking the thermistor sensor circuit, the measuring voltage can be max 1.5 V per thermistor.

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Motors with winding heaters come with heater strips installed at the stator winding overhangs. Heater strips should be supplied with voltage as specified on the designation label. During the work as well as during the motor inspection heater strips should be disconnected from power. In the terminal box of every motor, there is a properly marked neutral terminal and earth terminal on body foot or flange disk. Motor should be neutralised and earthed according to provisions in force.

After all the power and protection cables are connected, check whether connections are firm and then check seals of the terminal box and replace its cover.

6. MOTOR START-UP

Before motor is started up:

- check condition of motor winding insulation (and of temperature sensor circuit) and when the measured insulation resistance is too low, dry the winding; the insulation resistance measurement should also be taken in case of longer motor downtimes,
- check whether free cooling air inflow to ventilator is ensured,
- check the wiring system, action of the switch, meters and other auxiliary and protection equipment,
- check tightening of any clamping screws and elements that affect motor protection degree,
- check earthing and neutralisation quality,
- check readiness of equipment for commissioning,
- conduct a trial run.

During the trial run check:

- supply voltage,
- current value,
- motor revolution direction,
- motor for correct cooling and coupling with the driven machine,
- for excessive vibrations and other motor malfunctions,
- heating degree of individual motor components, such as bearing shields, bearings, body,
- start-up equipment and control and protection equipment for proper operation,
- electrical parameters obtained by motor and assess whether motor type selection is correct.

Carrying out the above-mentioned instructions and obtaining correct operation of motor and equipment can be considered as motor acceptance after installation.

7. MOTOR OPERATION DURING THE WORK

During motor operation, you should check the following on an ongoing basis:

- motor for correct operation,
- motor for correct cooling,
- bearing for correct operation – no knocking or whistling should be heard,
- motor for excessive vibrations,
- coupling between motor and driven machine,
- current draw which cannot exceed the rated value.

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Motor should be switched off immediately in case of:

- excessive heating up of casing,
- smoke or smell of burning from motor or installation,
- damage of motor ventilator,
- damage of driven machine,
- when, for any other reasons, further operation of motor and equipment is incorrect or pose a threat to environment.

Motor and equipment can be started again when all defects are rectified.

8. BEARING MOUNTING AND LUBRICATION

Motors are equipped with rolling bearings on drive and non-drive end. The bearing which determines rotor position is that on non-drive end. For bearing sizes for individual mechanical motor sizes, see table 1.

The admissible radial and axial forces of the end shaft neck provided in the specification sheet were calculated for life of approx. 30,000 hours of operation, alternatively for the ball and roller bearing on drive end of motor.

Motors come with bearings and bearing compartments filled with grease. Grease is filled up with grease pump through grease nipples **when motor is in operation**, if possible. Before re-lubrication of bearings, grease nipples should be cleaned and grease drain plugs removed. After re-lubrication and 1 hour of operation, drain plugs should be relocated.

Table 1 provides the approximate grease quantities for filling up and change for individual mechanical motor sizes.

Table 1

Mechanical size and no of gears	Bearings	Approximate quantity of grease per bearing for	
		Filling up [g]	Change [g]
320 2..8	6312 C3	20	100
360 2..8	6313 C3	23	120
400 2..8	6315 C3	30	170
440 2	6315 C3	30	170
440 4..8	6318 C3	40	260

Note:

With large radial forces acting on the end shaft neck, the ball bearing on drive end can be replaced by the roller bearing with the same dimensions.

Lubrication intervals (in working hours) for ball bearings in electrical motors working under nominal rating, in horizontal position, at ambient temperature 40°C

Mechanical motor size		3600 rev/min	1800 rev/min	1200 rev/min
320	re-lubrication	1100	1700	3300
320	change	5500	14500	23000
360	re-lubrication	1050	1600	3000

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Mechanical motor size		3600 rev/min	1800 rev/min	1200 rev/min
360	change	4000	13000	22000
400	re-lubrication	900	1400	2700
400	change	2500	9000	15000
440	re-lubrication	750	1200	2500
440	change	2000	6000	12500

Remarks:

- 1) *Faster ageing of grease with increase in temperature should be considered. The grease operating time should be reduced by a half for every 15°C of grease working temperature increase above 70°C.*
- 2) *Lubrication intervals for motors working in vertical position should be reduced by a half.*
- 3) *Lubrication intervals for motors working with roller bearings should also be reduced by a half.*

For lubrication of bearings POLYREX EM grease was used (type of grease is specified in the rating plate).

9. PERIODIC MOTOR INSPECTIONS

To keep motor in good working order, any defects noticed during the operation should be removed on an on-going basis. Notwithstanding the foregoing, the following periodic inspections are **recommended** for every working motor:

- **minor inspection** – every 6 months
- **major inspection** – every 10,000 h of operation, however no less than every 3 years

Remarks:

1. *Times between minor inspections (until major inspection) can be reduced if monitoring based on motor bearing vibration control and electric parameters of motor is conducted.*
2. *When motor operates under conditions where dustiness > 800 mg/m³, relative humidity > 80% or aggressive atmospheres occur, times between inspections should be reduced at least twofold.*

Minor motor inspection includes the following:

- disconnection of any power cables,
- external visual inspection and cleaning of motor,
- stator winding insulation resistance measurement,
- checking tightening of any contact and clamping screws,
- checking the condition of power cable and protective conductors and checking the insulation for damages,
- checking motor vibration level.

Vibrations of motor coupled with driven equipment and vibrations exceeding twice the admissible level for motor itself should be considered as excessive and requiring the explanation (requirements of driving equipment and vibration-related standard for the whole assembly should be considered). In this case, motor should be put out of operation and disconnected from the drive and vibration measurement should be repeated on elastic foundation, without half-coupling and with half-key. If vibration frequency exceeds the limit value of required vibration degree as specified in table 2, major motor inspection should be carried out.

Minor inspection may show the need of further checking the structural components of motor after disassembly.

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Table 2 – Limit vibration intensity [mm/s] of NEMA 213-440 motors

Vibration degree	Shaft height	213 < H ≤ 440
	Mounting method	mm/s
A	Free mounting	2.2
	Rigid set-up	1.8
B	Free mounting	1.1
	Rigid set-up	0.9

NOTE:

A – standard requirements; **B** – reduced vibration level

Major motor inspection includes the following:

- disassembly of motor,
- removal of rotor,
- inspection of stator with particular consideration given to winding condition,
- stator winding insulation resistance measurement,
- inspection of rotor,
- inspection of bearings and replacement, when necessary,
- grease change,
- inspection of start-up, protection and control equipment.

Any defects noticed during the inspection should be removed and worn parts replaced. It is advisable to renovate protective coatings. During the major inspection and possible repair, ensure that technical requirements specified in standard and provided on the motor rating plate are met. It is advisable to carry out the non-full test.

10. MOTOR DISASSEMBLY AND ASSEMBLY

To remove rotor from stator, perform the following operations:

a) on drive end (DE):

- remove key (17) from shaft and remove snap ring of labyrinth sleeve,
- remove external bearing cover (7) with labyrinth sleeve (9) using two bolts screwed into two threaded holes in the cover,
- unscrew bolts and remove DE bearing shield (4 or 5),

b) on non-drive end (NDE):

- unscrew grease nipple, tube and adapter,
- unscrew bolts and remove ventilator cover (16),
- unscrew bolts and slide NDE bearing shield (3) with rotor out of the body lock. After rotor is partially slid out of stator, use lifting device to carefully remove rotor, making sure that stator winding is not damaged by this operation,

c) disassembly of ND bearing shield:

- remove snap ring of ventilator hub from shaft,
- use puller to remove ventilator (15),

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- remove snap ring of labyrinth sleeve key from shaft,
- remove NDE external bearing cover (8) with labyrinth sleeve (9) using two M8 jack bolts,
- remove NDE bearing shield (3) from bearing,

d) disassembly of bearings:

- use puller to remove bearing from shaft.

MOTOR ASSEMBLY is carried out in the reverse order. Before putting on shaft, bearings should be heated up to approx. 80°C. When assembling, make sure that bearing shields are properly mounted with regard location of condensation water drainage holes, which should be in the lowest position of motor after installation.

NOTE:

In the warranty and after-warranty period, motors should only be repaired by the manufacturer or authorised service centres.

LIST OF MOTOR COMPONENTS

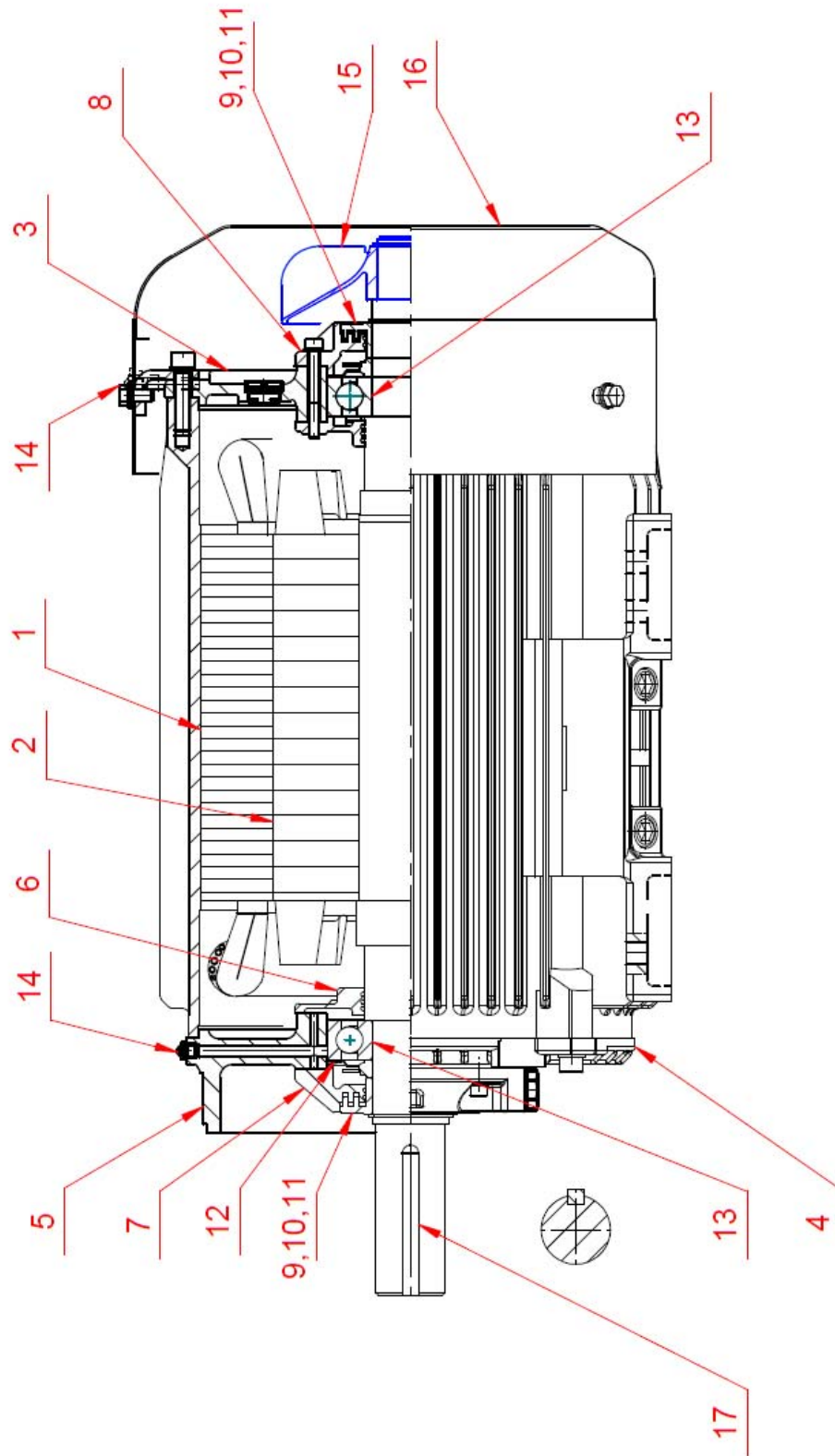
To facilitate ordering spare parts, the list of motor components is provided.

No.	Part name	Spare part	Remarks
1.	Stator	-	
2.	Rotor	-	
3.	NDE bearing shield	x	
4.	DE bearing shield	x	
5.	Flange bearing shield	x	
6.	Internal bearing cover	x	
7.	DE external bearing cover	x	
8.	NDE external bearing cover	x	
9.	Labyrinth sleeve	x	
10.	Sleeve with ring	x	
11.	Internal ring	x	
12.	Spring ring	x	
13.	Bearing	standard part	
14.	Grease nipple	standard part	
15.	Ventilator	x	
16.	Ventilator shield	x	
17.	End shaft neck key	x	
18.	Terminal box frame	x	
19.	Terminal box cover	x	
20.	Protective terminal	x	
21.	Eye bolt	standard part	
22.	Rating plate		
23.	Aretation plate	x	

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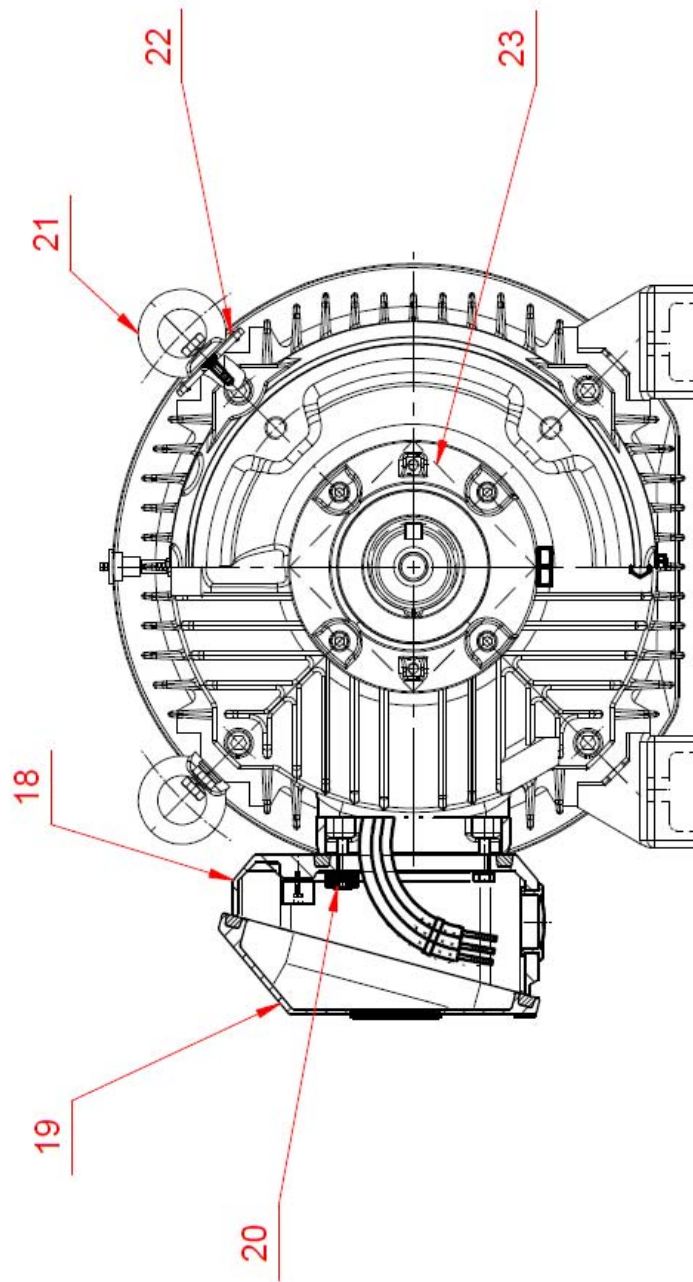
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HANDLING WITH MATERIALS AT THE END OF OPERATION

Subassembly / detail name	Management method
Body, bearing shields, bearing covers, box frame and terminal box cover	Iron scrap
Stator iron and rotor core	Steel scrap (generator sheet) – after removal of winding with insulation and melting of Al
Aluminium squirrel cage	Aluminium scrap – after melting
Winding with insulation	Copper scrap (insulation removal and utilisation in a specialist company)
Shaft, sleeves, steel ventilator, ventilator shield, fasteners	Steel scrap
Bearings	Steel scrap (after removal, grease to be utilised in a specialist company)
Rubber elements (seals, rings etc)	Utilisation in a specialist company
Plastic elements (terminal strip, ventilator)	Utilisation in a specialist company

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