1 RIP Technology
Function of High Voltage Bushing

- Uncontrolled (natural) electrical field
- Capacity-controlled electrical field

100% to 0%
<table>
<thead>
<tr>
<th>Type</th>
<th>O I P Oil Impregnated Paper</th>
<th>R B P Resin Bonded Paper</th>
<th>R I P Resin Impregnated Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Insulation</td>
<td>paper, oil impregn.</td>
<td>paper, resin bonded</td>
<td>paper, resin impregn.</td>
</tr>
<tr>
<td>Housing cover</td>
<td>yes, on both sides</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Oil-expansion chamber</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Oil-gauge</td>
<td>yes</td>
<td>no, only oil-tight</td>
<td>no</td>
</tr>
<tr>
<td>Gas-tight</td>
<td>yes</td>
<td>&lt; 0.015</td>
<td>yes</td>
</tr>
</tbody>
</table>

- **O I P** Oil Impregnated Paper:
  - Main Insulation: Paper, oil impregnated.
  - Housing cover: Yes, on both sides.
  - Oil-gauge: Yes.
  - PD: < 10 pC.
  - IEC max.: < 0.007.

- **R B P** Resin Bonded Paper:
  - Main Insulation: Paper, resin bonded.
  - Housing cover: No.
  - Oil-gauge: No.
  - Gas-tight: No, only oil-tight.
  - PD: < 0.015, < 250 pC.

- **R I P** Resin Impregnated Paper:
  - Main Insulation: Paper, resin impregnated.
  - Housing cover: No.
  - Oil-gauge: No.
  - Gas-tight: Yes.
  - PD: < 0.007, < 10 pC.
Production of R I P Bushings

Conductor:
- Al, Cu,
- solid, tube

Special creep paper

Aluminium foils
Production of R I P Bushings

1 Winding process

2 Drying process:
   - vacuum
   - heating

3 Under vacuum epoxy resin impregnation process

4 Curing process
Production of R I P Bushings

5 Machining

6 Assembly

7 Routine Tests

Micafil Ltd., Zurich
RIP - Technology is today’s state of the art

- Simple
- Small
- Reliable
- Safe
- Environmentally friendly

SF6 - side of copper bar
Resin Impregnated Paper - R I P Bushings
Main Advantages (1)

HIGH TECHNICAL STANDARD
- Low dielectric losses (tg delta < 0,35%)
- PD free up to double service voltage
- Excellent mechanical strength
- High thermal strength (class E, 120° C)

SUPERB IN DESIGN
- No porcelain shell, except for outdoor use
- Easy adaptable dimensions, customer-tailored bushings
Resin Impregnated Paper - R I P Bushings
Main Advantages

**STORAGE, INSTALLATION AND SERVICE:**
- Simple and reliable
  - Each position allowed (vertical to horizontal)
  - Dry, oil-free = simple in handling

**ENVIRONMENTALLY FRIENDLY**
- Pressure-free = explosion proof, fire resistant
- No pollution by outflowing oil
RIP - Technology: summary of main advantages

▲ High technical level
- excellent mechanical strength
- low dielectric losses
- partial discharge free up to the double rated voltage
- high thermal strength (120° C)

▲ Flexible in Design
- Adaptable on different transformer and plant constructions
- compact & robust
- no porcelain except for outdoor conditions
- silicon sheds possible
- any installation possible (vertical, horizontal)

▲ Operation safe, service-friendly
- no damage risk on the bottom part
- no explosion risk with influence of the transformer
- gas tight
- heavy inflammable
- high operation safety also by damages of outer insulation
- no porcelain on transformer side

▲ Environmental friendly
- oil free
- no explosion and fire risk through oil leakage
- no environmental risk through oil leakage
- maintenance friendly
- earthquake proof
R I P - Resin Impregnated Paper technology vs. O I P - Oil Impregnated Paper technology

The following table shows comparison between two most common technologies in producing the bushings. The comparison is only qualitative with following notes: "+" = very good; "0" = moderate; "-" = bad

<table>
<thead>
<tr>
<th>Feature</th>
<th>R I P</th>
<th>O I P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial Discharge free</td>
<td>very good</td>
<td>good</td>
</tr>
<tr>
<td>Tan δ</td>
<td>very good</td>
<td>very good</td>
</tr>
<tr>
<td>Porcelain housing</td>
<td>outdoor appl. only</td>
<td>always</td>
</tr>
<tr>
<td>Thermal strength</td>
<td>high, 120° C</td>
<td>105° C</td>
</tr>
<tr>
<td>Mechanical strength of main body</td>
<td>good</td>
<td>poor</td>
</tr>
<tr>
<td>Service position</td>
<td>each position allowed</td>
<td>restricted (special design for horiz.)</td>
</tr>
<tr>
<td>Assembly space in transformer</td>
<td>short</td>
<td>lower part with porcelain</td>
</tr>
<tr>
<td>Waiting time before testing</td>
<td>no waiting time</td>
<td>yes, because of oil</td>
</tr>
<tr>
<td>Transportation, handling, storage</td>
<td>simple, no limits</td>
<td>careful, limited position</td>
</tr>
<tr>
<td>Check points</td>
<td>check-free</td>
<td>oil pressure, oil level</td>
</tr>
<tr>
<td>Safety for staff and equipment</td>
<td>high, no pressure inside</td>
<td>moderate, over-pressure</td>
</tr>
<tr>
<td>Fire resistance</td>
<td>high</td>
<td>moderate</td>
</tr>
<tr>
<td>Environment</td>
<td>friendly, no oil</td>
<td>oil leakage possible</td>
</tr>
<tr>
<td>Emergency service if outdoor porcelain breaks</td>
<td>possible</td>
<td>not possible</td>
</tr>
<tr>
<td>Life time</td>
<td>more than 30 years</td>
<td>more than 30 years</td>
</tr>
</tbody>
</table>
NEW RIP Transformer Bushings

GO WITH US AND GET THE MAYOR ADVANTAGE AGAINST YOUR COMPETITION!!
In modern metal enclosed switchgear SF$_6$ gas is used as an extinguishing and insulating medium, ensuring highest security standard for operating staff and residents, especially in most confined and dense populated areas.

As a result, today’s space saving design requires excellent mechanical and electrical performance of all components involved.

Micafil’s contribution to this world-wide development is its new product range of GARIP bushings. These have been designed for the direct single phase connection between power transformers and gas insulated switchgear (GIS) for rated voltages of 72.5 kV up to 550 kV.

Since more than 40 years Micafil AG produces high voltage bushings made with Vacuum Resin Impregnated Paper Technology (RIP).

We are proud of our leading position in this field, making available to our customers profound expertise in the latest state of the art technology, which is based upon more than 50 000 RIP - bushings successful in operation.

The insulation body of the GARIP condenser bushing series consists of a robust and solid core, made of wound crepe paper and inserted aluminium foils for field control, carefully vacuum dried and subsequently impregnated with special epoxy resin.

The basic procedure for this new kind of manufacture was originally developed by Micafil AG in Switzerland already in 1958 and continuously improved in the course of four decades.

Advanced standardisation, highly skilled craftsmanship and computer-aided engineering guarantee today’s most reliable and advanced insulation system for every voltage level.

Main advantages of Micafil’s RIP-technology

- Short delivery times
- Low dielectric losses (tan δ ~ 0.35%)
- Partial discharge free up to double service voltage
- Fully dry, maintenance free
- Oil-free and environmental friendly
- Highest mechanical and thermal properties
- Robust design and vandalism resistant
- Option for any operating position
- Gas and oil tight
- Easy handling
Technical Data and Dimensions

**Dimension drawing**

- **RTKG 362-1300 / 2000**
- **RTKG 420-1550 / 2000**
- **RTKG 525-1800 / 2000**
- **RTKG 72.5-350 / 2000**
- **RTKG 72.5-350 / 2500**
- **RTKG 123-550 / 2000**
- **RTKG 123-550 / 2500**
- **RTKG 145-650 / 2000**
- **RTKG 170-750 / 2000**
- **RTKG 245-1050 / 2000**
- **RTKG 245-1050 / 2500**

**View A:** SF₆ side

- Sealing area Ra = 1.6 (N7)
- Copper, thickness 30 mm

**View B:** Oil side

- Sealing area Ra = 3.2 (N8)
- Aluminium, silver plated

**Flange dimensions for:**

- **RTKG 72.5-350 / 2000**
- **RTKG 72.5-350 / 2500**
- **RTKG 123-550 / 2000**
- **RTKG 123-550 / 2500**
- **RTKG 145-650 / 2000**
- **RTKG 170-750 / 2000**
- **RTKG 245-1050 / 2000**
- **RTKG 245-1050 / 2500**

**View A:** SF₆ side

- De-aeration of transformer opposite to test tap

**View B:** Oil side

- Sealing area Ra = 1.6 (N7)
- Copper, thickness 30 mm

De-aeration of transformer opposite to test tap

**Types 123kV - 245kV**

- Shields removable

**Types 362kV - 525kV**

- Shields removable

**Flange dimensions for:**

- **RTKG 170-750 / 2500**
- **RTKG 245-1050 / 2000**
- **RTKG 245-1050 / 2500**
- **RTKG 362-1300 / 2000**
- **RTKG 362-1300 / 2500**
- **RTKG 420-1550 / 2000**
- **RTKG 420-1550 / 2500**
- **RTKG 525-1800 / 2000**
- **RTKG 525-1800 / 2500**

**View A:** SF₆ side

- De-aeration of transformer opposite to test tap

**View B:** Oil side

- De-aeration of transformer opposite to test tap

Copper, thickness 30 mm
Conductor loading
Rated current dependent on the bushing lower length (see "Technical Data" page 5 & 6, column 12). Bushings selected with Ir not less than 120% of the rated current of the transformer are considered to be able to withstand the overload conditions according to IEC Publication 60354 (Loading guide).

Recommendations for bushing installation
Transformer
The field strength in the oil on the surface of the shield insulation must be limited to values normal for insulated components. As a guideline minimum distances A to grounded transformer parts are given below:

<table>
<thead>
<tr>
<th>Type RTKG</th>
<th>AC test voltage (kV)</th>
<th>A (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>185, 230</td>
<td>130, 145</td>
</tr>
<tr>
<td>145</td>
<td>275, 310</td>
<td>170, 200</td>
</tr>
<tr>
<td>170</td>
<td>325, 365</td>
<td>210, 230</td>
</tr>
<tr>
<td>245</td>
<td>460</td>
<td>300</td>
</tr>
<tr>
<td>362</td>
<td>570</td>
<td>400</td>
</tr>
<tr>
<td>420</td>
<td>630, 680</td>
<td>450, 500</td>
</tr>
<tr>
<td>525</td>
<td>750, 790</td>
<td>550, 600</td>
</tr>
</tbody>
</table>

GIS
Observe the minimum enclosure diameter $D_{GIS}$ as well as the minimum operating SF$_6$-gas pressure (see "Technical Data" page 5 & 6, columns 17 & 18). Adjacent conductor parts should be well adapted to the bushing terminal.

General
Because the bushing is completely dry it can be operated vertically or horizontally or in any position.

Type designation
The type designation is included in an overall system. An example of nomenclature used to designate our GARIP bushings:

GARIP RTKG 245-1050 / 2000

- Nominal current (A)
- Lightning impulse voltage (kV)
- Rated voltage (kV)
- $R =$ RIP Insulation
- $T =$ Transformer application
- $K =$ Short oil side part
- $G =$ SF$_6$-gas application
- Bushing series

Testing of the bushing
Each bushing undergoes routine testing before leaving the factory, either according to IEC 60137 or IEEE CS7.19.00.

The standard tests include:
- $\tan \delta$, capacitance and partial discharge measurement
- Power frequency test
- Lightning impulse test (if applicable)
- Leakage test

Ordering particulars
When ordering please state:
- Type and catalogue no. see the table below
- CT space L6, see "Technical Data" page 5 & 6, column 20
- For 170 kV / 2000 A respective 245 kV / 2000 A only: choose the size of oil side shield depending on the transformer current; see "Technical Data" page 5 & 6, columns 26 & 27

<table>
<thead>
<tr>
<th>Bushing type</th>
<th>Catalogue no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>GARIP RTKG 72.5-350 / 2000</td>
<td>HLJM 154484</td>
</tr>
<tr>
<td>GARIP RTKG 72.5-350 / 2500</td>
<td>HLJM 154964</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2000</td>
<td>HLJM 154504</td>
</tr>
<tr>
<td>GARIP RTKG 123-550 / 2500</td>
<td>HLJM 154514</td>
</tr>
<tr>
<td>GARIP RTKG 145-650 / 2000</td>
<td>HLJM 154524</td>
</tr>
<tr>
<td>GARIP RTKG 170-750 / 2000</td>
<td>HLJM 154534</td>
</tr>
<tr>
<td>GARIP RTKG 170-750 / 2500</td>
<td>HLJM 154544</td>
</tr>
<tr>
<td>GARIP RTKG 245-1050 / 2000</td>
<td>HLJM 154554</td>
</tr>
<tr>
<td>GARIP RTKG 245-1050 / 2500</td>
<td>HLJM 154564</td>
</tr>
<tr>
<td>GARIP RTKG 362-1300 / 2000</td>
<td>HLJM 154574</td>
</tr>
<tr>
<td>GARIP RTKG 420-1550 / 2000</td>
<td>HLJM 154584</td>
</tr>
<tr>
<td>GARIP RTKG 525-1800 / 2000</td>
<td>HLJM 154594</td>
</tr>
</tbody>
</table>