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The importance of customizing
bushing designs for
Wind Turbine MV
Transformer Applications.

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As technology evolves and MV transformers are located in the turbine nacelle next to the generator, it is more important than ever to have the appropriate transformer bushings. Higher ambient temperatures, higher transformer insulating temperatures, frequent vibrations, smaller spaces, and costly possible repairs translates into the critical choice of the right bushing design.

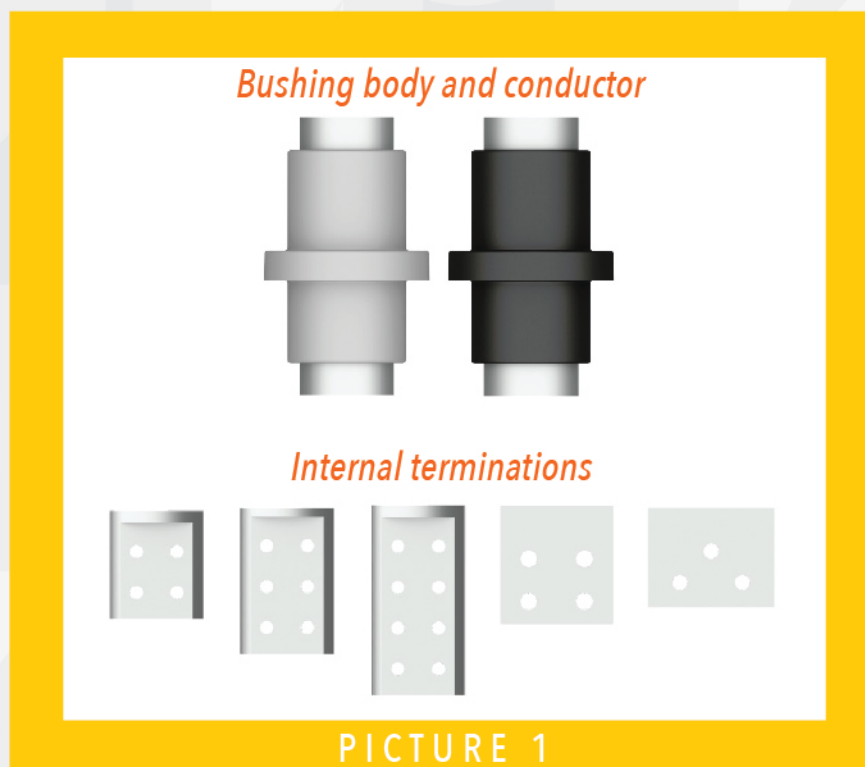
Fortunately, epoxy resin bushings can be adapted to match each application. The combined efforts of the turbine manufacturer, transformer manufacturer and bushing manufacturer can result in a successful design.

To verify new bushing designs efficiently, it is imperative to have an in-house high voltage test lab capable of handling the numerous tests needed, initially for R&D and later for production. The epoxy resin bushings line is tested in concordance with table 5 - IEC60137-2017 Standard.

Following is an overview of potential bushing customizations:

Internal connection from winding to bushing.

Smaller size in transformer designs with a higher power has created requirements for custom internal terminations, allowing transformer manufacturers to optimize their designs. Typical terminations can include milled flats, spades, or threaded studs. Dimensions such as length, width, and thicknesses can be adjusted. The size, shape, and number of holes could be adapted to the transformer's internal connection needs, as well as the spade orientation, which could be rotated or even be offset. **Picture 1.**



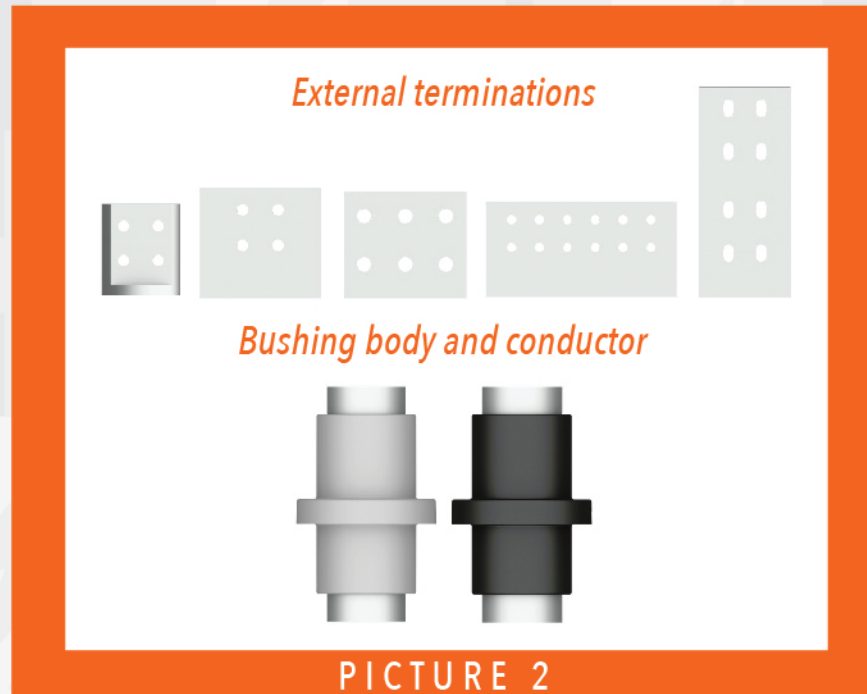
PICTURE 1

Internal connection from winding to bushings - Example for 7500A LV Bushing Series

External connection from generator to bushing.

Turbine manufacturers face several challenges when optimizing the space within the nacelle and defining the optimum connection mechanism with the transformer, such as flexible connectors, fixed copper bars, quick connection boxes, among others. External terminations are easily customized to the application in order to fulfill the space and connection requirements.

Picture 2.

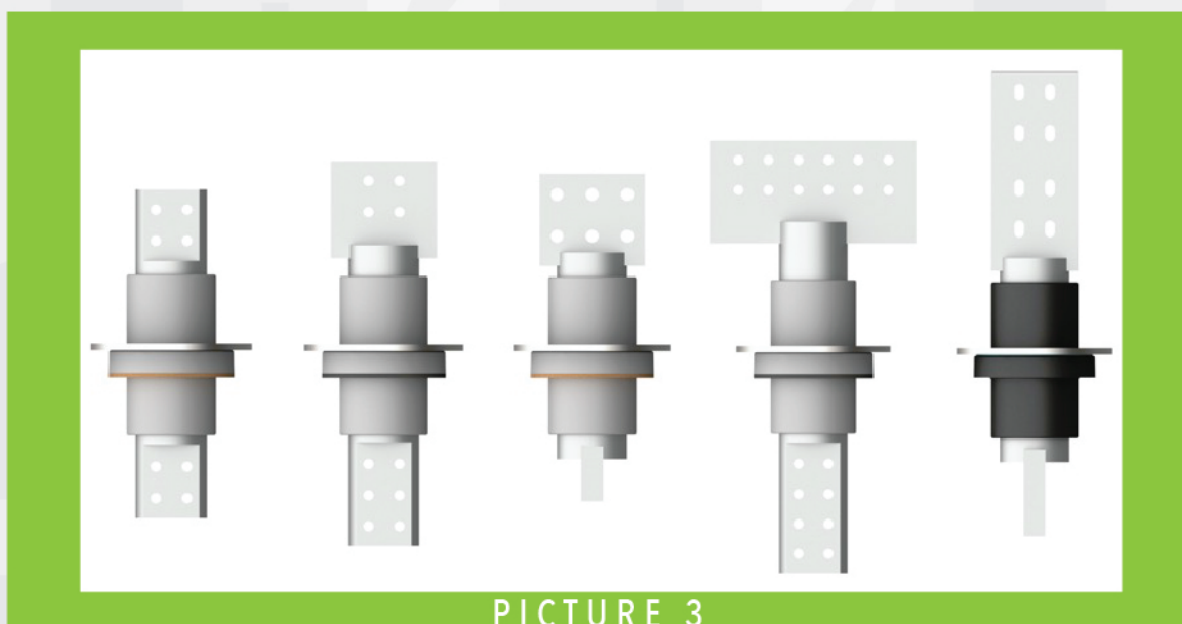


PICTURE 2

External connection from generator to bushings - Example for 7500A LV Bushing Series

Combination examples for 7500A LV Bushing series with the internal and external terminations

Some examples of the multi combinations that can be developed. Picture 3

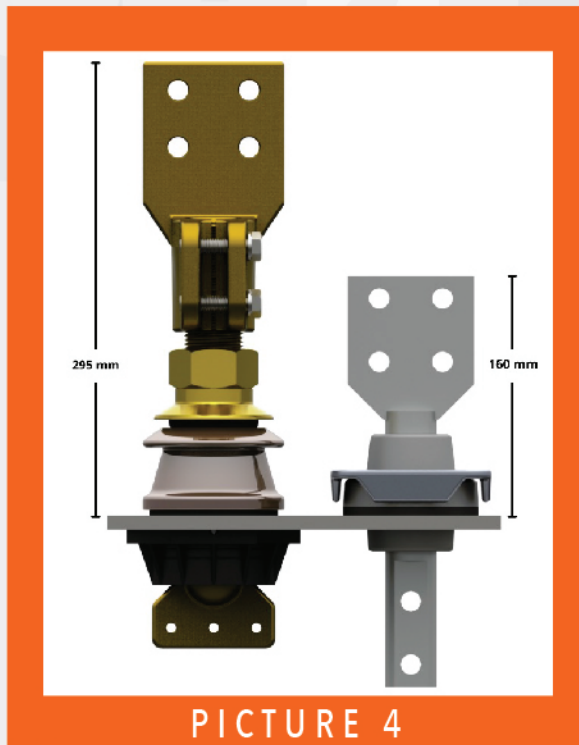


PICTURE 3

Customized examples for 7500A LV Bushing Series

Compact dimensions of epoxy body and terminals.

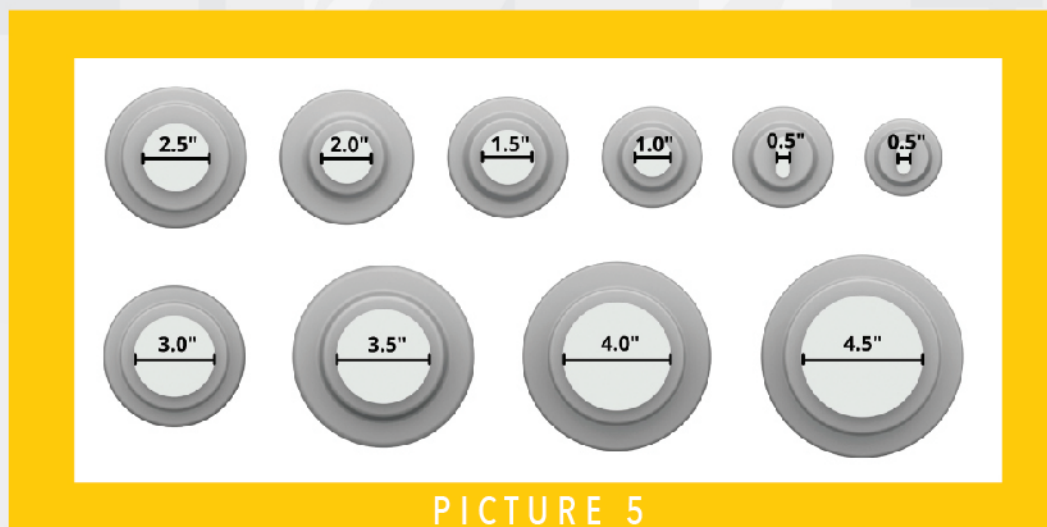
In addition to the terminals, the bodies and structure of the epoxy resin bushings are much more compact compared to other insulation options. The casting process allows for maximum creativity in bushing design for all applications. **Picture 4.**



*Comparison between porcelain bushing and epoxy bushing.
Same ratings 1.2kV, 2000A, 30kV BIL*

Easy offering of appropriate current rating.

An extensive portfolio of bushing bodies and conductor configurations are available for a wide range of voltage classes and current ratings. Our electrical ratings are adjusted to each customer's particular needs rather than our customers adjusting to a fixed portfolio. We have low voltage bushing designs ranging from 30 amps to 10,000 amps and voltages of 1.2kV, 2.5kV, 3.6kV and 5 kV. **Picture 5**

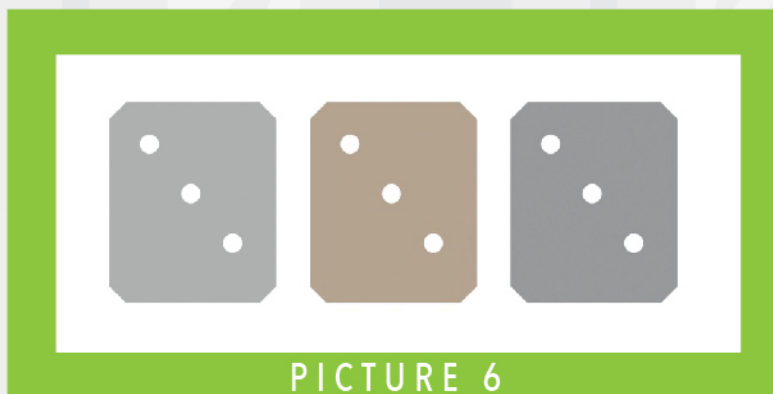


PICTURE 5

Extensive portfolio of bushing bodies and conductors to offer designs for currents up to 10.000A

Tin, Nickel and Silver plating available.

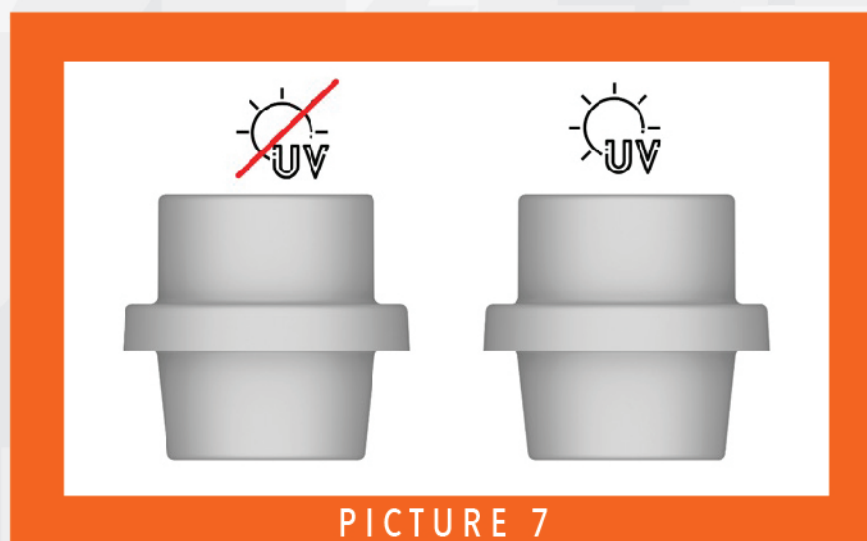
Tin, Nickel and Silver plating are available for our EPC Bushings. [Picture 6](#)



Plating options for EPC Bushings

Epoxy resin formulations available for indoor and outdoor exposure.

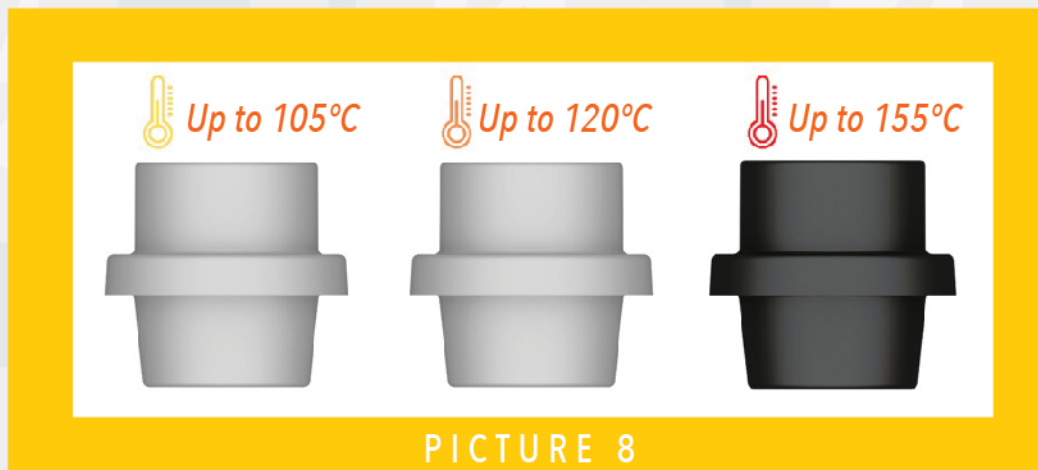
Our proprietary epoxy materials are designed and formulated in-house for both indoor and outdoor applications. [Picture 7](#)



Epoxy formulations for indoor and outdoor exposure

Ability to provide designs for 105C, 120C and 155C insulating systems.

Epoxy formulations for different temperatures, including one material suitable for high-temperature applications up to 155°C. Ideal for transformers installed in the nacelle, where the ambient temperature tends to be high. [Picture 8](#)



Epoxy formulations for different operating temperatures

Sealing options according to transformer and application needs.

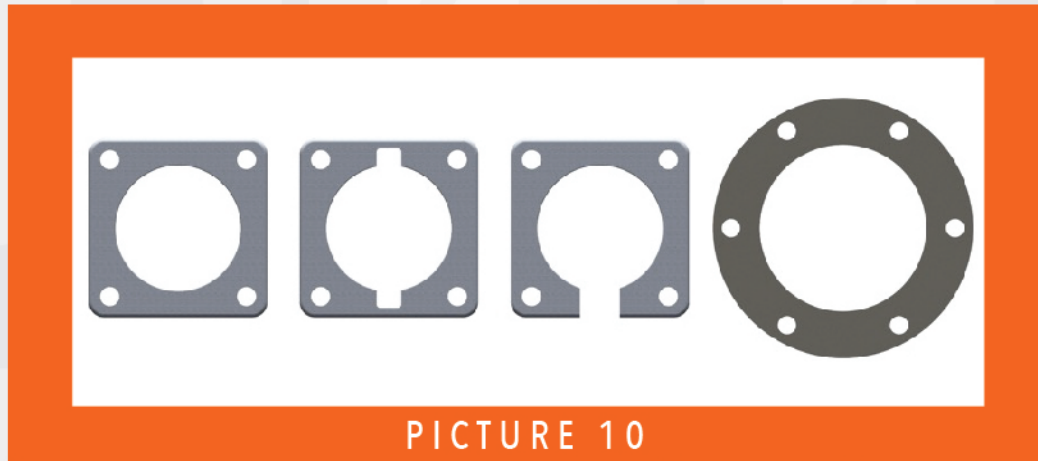
To fulfill different transformer sealing designs, bushings are available with options for flat gasket surfaces, gasket retaining grooves or flat gasket surfaces suitable for use with a machined tank surface with O-ring seals. [Picture 9](#)



Sealing Options

Adaptive fixing options.

Based on the design of the bushing and the application, the fixing clamp is adjusted or developed. [Picture 10](#)



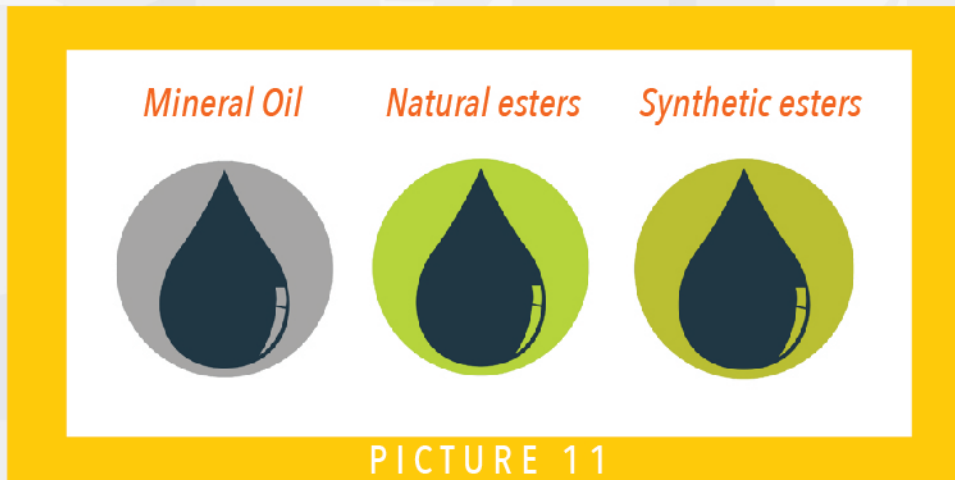
PICTURE 10

Fixing clamps designs - Examples

Compatible with various insulating fluids such as mineral oil, natural esters, and synthetic esters.

Epoxy bushings are compatible with the range of fluids used in current renewable applications.

Picture 11



PICTURE 11

Epoxy bushings compatibility

Variety of sealing gaskets

Based on the transformer design and the type of application, a need for a specific gasket may arise. The following gasket types are available for the EPC line: NBR, Viton, Amorim TD7000, and FVMQ.