

Design and Application of Corona and Grading Rings for Composite Insulators

Edward Niedospial, *Member IEEE*

Abstract— The addition of a corona ring to a polymer insulator will improve the insulators performance, but it must be the right ring used for the right reasons to realize the benefits. A corona ring should not be a quick fix to a problem; it may only mask a bigger concern or delay the inevitable. Selection of a corona ring is as critical a decision as picking the appropriate dry arc, leakage, or mechanical rating for the insulator. Beyond selecting the appropriate size ring for a specific voltage, other critical characteristics include attachment type, mating feature, hot stick-able design, ordering, and packaging.

I. Introduction

Corona / Grading rings have been a standard feature of composite insulators for HV and EHV applications since the 1970's. The function of the corona ring is to grade or disperse the electric field gradient, thus reducing the voltage stress on the rubber housing near the line end fitting. The corona ring can be attached to the composite insulator directly or as part of the hardware. When applied as part of the hardware, the grading device is commonly referred to as a Corona Shield. Where the corona ring reduces E-Field stress on the insulator, corona shields are typically used to prevent inception of corona on hardware.



Fig. 1. Typical corona rings: Opened & Enclosed Ring

II. Design

Corona rings are frequently an opened torus (circular geometry revolved about a center) made of conductive material, usually aluminum. The ring and attachment feature must be fairly smooth surfaces, free from sharp edges, burrs, or surface deformities. The outer torus can

be fully enclosed, or it can have an opening (C-Shaped). Functionally both provide equal corona grading, but the opened ring can be installed or retro-fitted to an insulator in service without having to break the insulator hardware connection. If the enclosed design is one continuous torus, then the ring would need to be installed prior to connecting the mating hardware unless the enclosed ring is made of two separate pieces (as shown in Fig. 1.).

The ring geometry (outside diameter, torus shape and size) is not governed by any industry standards. The design of these corona rings is determined by the insulator supplier and is based on historical performance or modeling. The size of the ring is proportional to the voltage. The higher the voltage, the bigger the corona ring needs to be to effectively grade the E-Field. If the ring is too small for a specific application / voltage, it may not provide the desired protection. Conversely, the ring could be too big, and not provide the intended protection. E-Field Modeling software is a good way to determine what corona ring size and shape is required for a specific application, and whether rings are needed on the hot and cold ends of the polymer insulator.

Table 1 – Common Corona Ring Diameters by Voltage						
	≤ 230kV		345kV		500kV	
	Line	Tower	Line	Tower	Line	Tower
Ø	8-10"	none	11-13"	*8"	15-17"	8-10"

*= Optional Corona Ring Use

The corona ring is needed at the line end of the insulator, right at the end fitting and rubber interface (area of highest electrical stress). As the application voltage increases, the diameter of the corona ring increases. At some EHV voltages, there is need for a corona ring on the tower end fitting as well as the line end. At 345kV it is common practice to add an 8" corona ring on the tower side of the insulator when used in a deadend application.

Dry Arcing Distance – when a corona ring is added to a polymer insulator, the dry arcing distance of the insulator will be reduced due to the addition of the corona ring. The reduction will range between 1"-3" depending on the ring design and location. Since the dry arc dictates the Flashover values for the insulator, the addition of a corona ring will reduce flash-over. To compensate for the lost dry arc distance from adding the corona ring, the insulator can be lengthened to gain back what was lost.

Ordering Corona Rings – the rings can be ordered separate of the insulators, but it is best to order them with the insulators, ideally as part of the insulator catalog number. The change in catalog number makes it easier to identify that the insulator must have a corona ring (Separates old applications without rings from new ones with rings). The new catalog number also dictates the need for a new insulator drawing that includes the corona ring along with the changes to the dry arc distance and flash-over values. Typically, corona rings are not interchangeable between suppliers, so it is best to use rings and insulators from the same supplier.

III. Corona Ring Attachment

The method by which the corona ring attaches to the composite insulator is a critical design characteristic. It is most common to attach the ring to the barrel or shank of the line end fitting; utilizing some form of a two piece clamp and bolt combo or a U-Bolt attachment. The clamping mechanism should be affixed tight enough to prevent the ring from moving post attachment, and the ring torus should be located near the rubber / end fitting interface to provide the required E-Field grading. (Proper location of the ring should be provided by the insulator supplier, along with installation instructions.)



Fig.2. Corona Ring Attachment to Composite Insulator

IV. Corona Ring Design Features & Benefits

Once it has been determined that a corona ring is required for a specific application and the appropriate ring design and size has been determined, there are some additional design features and benefits to be considered:

- **Ring Attachment** – ideally there should be a locating feature to guide installation of the corona ring in the correct position, quickly and with minimal instructions. If at all possible, avoid the need for special tools or measuring equipment to attach the corona ring to the insulator.
- **Mating Feature** – in service, the polymer insulator will be subjected to line vibration, which could cause the clamping mechanism of the corona ring to loosen and possibly slide down the end fitting or maybe even off of the assembly eliminating the effectiveness of the ring. A physical mating feature on the end fitting can prevent the ring from moving from its intended design position. By keeping the ring in the correct position, even when loose, the ring will still provide the required grading.

- **Hot Sticks** – it is desirable to be able to install a corona ring onto the insulator with a hot stick should the need arise to retrofit or replace the ring down the road.

V. Packaging

For most typical polymer insulator designs, it is common to bulk pack the insulators in a crate, and pack the corona rings separately within that same crate. This bulk pack concept should include installation instructions for easy and proper application of the ring at the job-site. Including the rings with the insulators inside the crate is an additional assurance that the insulators will be installed with the rings. This is the most economical packaging concept as well. If the corona rings are packaged separately from the insulators in their own crate or container, it opens the door to the possibility that the rings may get lost, overlooked, or skipped altogether during the construction phase.



Fig. 3. – Packaging of Corona Rings w/ Insulators

Whether packed in the insulator crate or separately, the corona rings need to be packed securely to protect the rings from scratches and surface damage during transit. Even the smallest imperfect on the ring can be an inception point for corona.

Another packaging option is to have the supplier assemble the ring onto the insulator prior to packaging at the factory. Though feasible, this option may not be the most economical packaging method. Aside from the cost to install the ring onto the insulator at the factory, the major cost driver is the number of additional crates required and shipping to the job-site. Insulators with rings attached at the plant will require greater spacing between units which results in fewer units per crate. Fewer insulators per crate drive up the cost per insulator and increase the total number of crates. This could potentially increase the total number of trucks needed to deliver the insulators to the job-site. The combined impact of more crates and more trucks is not ideal economically or environmentally, especially when there are more efforts being made to be “Green”.

The ideal packaging assures that the corona ring and insulators arrive to the job-site together, safe and secure, with appropriate instructions to assure that the installation is completed correctly each and every time.

VI. Conclusion

The corona ring is a vital part of the polymer insulator design. Historically they have been used at 230kV and higher applications, but today there are lower voltage applications where corona rings are beneficial to the long term performance of the polymer. Adding a corona ring to any polymer insulator will improve performance, but it is essential to understand why the ring is needed, and what potential effect not having the ring will have on the polymer. Once the decision has been made to add a corona ring to the polymer insulator, the battle is only half complete. Take steps to assure that for each application, the correct corona ring is used, installed properly in the correct location, and that the ring stays where it was supposed to be.

VII. Biographies

Edward Niedospial is the Senior Product Manager for Insulators at MacLean Power Systems. He is responsible for leading the support programs for the APEX™ Insulator Systems; including the Braced Post



product family, the Load Curve Generation System, and development of all Transmission Assembly projects to assist in finding the best fit in product performance, delivery, and lowest installed cost. Ed joined MacLean Power Systems in 1996 and has been instrumental in designing and developing new and improved manufacturing processes, quality control, new product development and testing.