

Randy Williams

Development Manager with
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Interview with **Randy Williams**

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Photo: MASS

Randy Williams is Business Development Manager at North American Substation Services (NASS), the largest independent provider of substation services in the USA. His career includes 38 years with ABB where he gained extensive experience with bushings. In this interview, Randy talks to Transformer Technology's Editor in Chief Alan Ross about the history of bushings, current trends and innovations in bushing manufacturing and predictions for the future of this critical transformer component.



Alan Ross: I am delighted to talk to a marketing guru, Randy Williams, who spent 38 years with ABB, the last 25 of which he was part of the ABB plant in Alamo, Tennessee.

Randy, you are a bushings expert, and I would like to hear your take on their history, where they are now and where you think they are going.

Bushings are both one of the most important parts of a transformer and one of its weakest links as they age. You have seen all of the

problems with the way bushings were made and they are not made the same way that they used to be. If you were to describe the genesis of bushings from the very beginning, what would you say about the role they played and the common elements of manufacturing back when you started working for ABB?

Randy Williams: I was very fortunate to be at the Alamo plant when it was a start-up in 1981. It was primarily put there to build a new bushing technology. Westinghouse made their own bushings and sold them, but they had three

different bushing manufacturing facilities. GE was the leader with probably 60-70% of the market. That is the reason why there have been so many Type U bushings out there over the years. Most of those were mainly oil impregnated bushings, condenser bushings.

A standard bulk-type or stud-type bushing is normally just 15 kV, 25 kV. It is when you get to 25 kV and above that you want to grade the voltage as it is funneled in and out of your transformer or through that wall. The condenser itself hasn't changed much in design,



but the materials have changed from a plain paper or a metal foil used as the gradient to grade the bushing capacitance to a printed ink design. The printed ink design was not similar to GE because it was a herringbone. Westinghouse bought the license from the European company Micafil to do the ink printing type, which actually saved in manufacturing. If you take, for example, a 138 kV bushing which can have 30 sheets of aluminum foil to grade the bushing, and the sheets could wrinkle up or they could have gaps, that was very manufacturing-unfriendly. The printing type, on the other





hand, was done automatically with only one or two sheets, even in a 500 kV bushing of metal foil to get the contact from the ground into the test tap.

That has changed and everybody wants to get away from oil due to the risks to the environment. Porcelain has almost gone away because of manufacturing. Since there is no porcelain manufacturing in the U.S., all the porcelain has come in from overseas and a lot of it is not standard on nonstandard replacement bushings. Also, a porcelain delivery could be up to 26 weeks, so suddenly, time comes into play. Also, everybody wants to avoid leaks - gaskets deteriorate just like they do on a transformer, but nobody thinks about it on a bushing because of age and a permanent set over time.

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Photo: NASS

To get away from oil, manufacturers have gone to resin-impregnated paper or resin-impregnated synthetics. With resin-impregnated paper, the lower end of the bushing was exposed and, since this was a machine lower end, you couldn't store the bushing out in the yard anymore. So, a spare bushing had to be stored in oil, otherwise it would take on moisture. And we know how most utilities store their bushings, if they can find them: somewhere, here, there, everywhere (laughs). So, they tried to solve the moisture ingress into the condenser by going to the synthetics because that material will not take on the moisture and deteriorate the bushing.

The key concern is the longevity of the bushing insulating material in the field.

Condenser design hasn't changed that much. It never caused the problem, there was just oil on the top. Such bushings last 60 years, as long as you maintain them correctly and test them. I know there are 60-year-old condenser bushings in service that have oil in them.

The key concern is the longevity of the insulating material in the field. As porcelain goes away and polymers and other types of insulating materials are introduced, nobody really knows how long they will last, while we know porcelain will last 100 years. That is why utilities have not moved in that direction yet; they may be waiting to see what happens. But many of the new materials used in the upper end on the air side are self-cleaning because of the use of silicone, which reduces maintenance. A porcelain plant is the dirtiest place in the world. If your bushings are in a highly contaminated environment, alternative materials are much better than porcelain.

Manufacturing has changed. Being able to do resin, paper-impregnated or synthetic condenser bushings and then apply some type of silicone insulator at the upper end allows you to make a bushing in two days and not wait 26 weeks for a porcelain. I think that is the direction that bushings are going - alternative materials improve the lead time of manufacturing.

AR Are there any differences in the silicone materials being used in HV bushing insulators?

RW That is a great question, Alan. There are three types being used: RTV (Room Temperature Vulcanized), which is a low grade material used in smaller insulators; and for HV insulators there are two premium materials - LSR (Liquid Silicone Rubber) and HTV (High Temperature Vulcanized), with the main difference between the two being that LSR is molded during the manufacturing process and HTV is an extruded method allowing for better flexibility for fit and better performance due to the tear drop shape at the end of the shed.

AR You previously said something really interesting as well - the basic use of the bushing hasn't changed. When you think about transformers, they haven't changed very much. One of the things that is changing is that we have become an inverter-based system instead of the traditional step-down system. Do you think this new "step-everywhere" system is going to change how bushings operate?

RW I believe there have been a few papers focused on that in the industry, especially in renewables, about different utilities that had events because of those concerns.

AR Yes, we see that it is going to create change. FERC Order No. 2222 just came out, which basically said to utilities that if somebody creates power, they need to figure out



how to get it in the grid, irrespective of finances. It is going to create a lot of changes in all of the components, especially when it comes to transformers used for gas and wind farms.

I would like to ask you one last thing concerning bushings. When you look at a transformer and see three porcelain bushings - two of them clean and cream-colored and one as brown as it could possibly be, and not brown from dirt - the brown color can be an indicator of overheating. And when that happens, you have to replace that bushing. One of the things you just mentioned was lead time. When you would get a call from a utility, giving you the specs and saying they needed that one bushing for the Westinghouse transformer made in 1976 - how would you address that?

RW The number one problem is that when somebody wants a replacement, especially these days, they usually don't have the people who can modify something on the transformer or even braze on connectors for the draw lead; they lack expertise in the field. So, what they need is a one-for-one fit. I didn't try to sell and get that

What I did was sit down and ask questions - and it was a lot of work. I would sit down with the utility people and they gave me the list of their transformers. I would then put together a list so that we consolidate all of the bushings for critical transformers they had on their system. Sometimes it could be five hundred transformers. I would get all the data and put it in an Excel file. Then I would grade those bushings myself and determine - by design or by style - which are the high players, which ones may need to be tested more often, and which are good to go and can be tested normally. I would compile that list and then show which bushings are long lead time - 26 weeks. For the common ones, the lead time is two days from a manufacturing company. I would try to get the utility to buy spares for the critical transformers, so they don't have to wait 26 weeks for a new one.

I did that with most of the large utilities in the United States and they used that Excel spreadsheet to look at their minimum and maximum spare parting for critical bushings and which ones were off the shelf.

AR Randy, your reputation in the industry is that of diligence. You created the



business when I was with ABB, even though I believe we had 70% market share, especially on the replacement side for GE or Westinghouse.

Some bushings have a lead time of 26 weeks, so I would always recommend utilities to get spares for critical transformers.

system that people talk about. That is a brilliant way to do it, and I hope people are still doing that today. Part of a great reliability program is a great spares program. The best way to keep yourself from having shutdowns is to do an analysis of critical components, not just assets, and then determine what your spares program should be.

Randy, thank you so much for sharing your knowledge with our Transformer Technology community.

RW Thank you, Alan.
Always a pleasure.