

Khayakazi

Corporate Specialist – Transformers
and Reactors at **Eskom Holdings SOC**

Interview with **Khayakazi Dioka**

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Dioka





Transformer Technology hosted Khayakazi Dioka, Corporate Specialist – Transformers and Reactors at South Africa’s electricity utility Eskom Holdings SOC, [on a recent TechTalk anchored by Alan Ross](#), Editor in Chief. This interview is an edited excerpt from that.

Alan Ross: My guest, Khayakazi Dioki, is with Eskom, a company in charge of the transformer fleet for the national transmission and distribution grid in South Africa. As Eskom’s Corporate Specialist - Transformers and Reactors, she is responsible for more transformers than any woman that I know.

Congratulations on that Khaya and welcome!
It’s great to have you.

Khayakazi Dioka: Thank you so much, Alan. It’s a pleasure and honor to be interviewed by you.

AR People need to know that when you and I first met, the teddy bears were behind you and I couldn’t let go without asking about that. While you are a smart professional female engineer who has tremendous responsibility for transformers, and are heavily involved in CIGRE, the teddy bears are also part of another role that you play as the mother of two daughters. Tell us a little bit about your daughters.

KD Thank you, Alan. I have two daughters and I think they are very brilliant

young ladies. They take after the mother; the father agrees.

One is almost twelve now and the other turned eight. They want to do a lot of things, but engineering is not one of them. I took them to work one time when we were doing design reviews and one of my colleagues gave them a calculation to do. We wanted to calculate the stress between the windings. My daughter got the distance correct, and then she said, "I want to be a transformer!" I think she was five.

AR When I told my two sons when I first got involved with transformers some twenty years ago, the youngest one said, "Dad, I love transformers. I mean, Optimus Prime and all that!" When he learnt it wasn't that kind of transformers, he lost interest and became a movie producer.

Let's talk a little bit about your role at both Eskom and CIGRE. At Eskom, you have an enormous number of transformers that are your responsibility, both power and distribution transformers. Obviously, you have a team of people that support you, but how do you go about managing such an incredibly large fleet of transformers?

KD It's quite an interesting task. It is one of the things that make me stay in this field because I am not doing the same thing every day. I'm in the engineering environment, so we own the technology. We look after all these transformers, from specification to finding the transformer, ensuring that whatever we purchase as the organization is according to the need of our network. So, the specification is where it all begins.

We also specify according to the climate and the South African need - not just the need of the network, but also the environment that we are in as these transformers could be procured from anywhere in the country and they are of different sizes. We have power transformers ranging from 10 MVA, or even 2.5 MVA, to as high as 800 MVA. You can really appreciate the fleet size and the ranges that we have.

This also makes the fleet lifecycle management a little bit different because the specification needs to define what we need for all ranges, from the small power transformers to large power transformers. An example are the requirements for condition monitoring, where the implementation of some condition monitoring devices would not be cost-effective for smaller transformers.

Another interesting aspect of this role is that one minute there is a transformer that

has failed and we are involved in failure investigations, which requires a different approach. If the incident requires severe investigation and a specialist, this is when we get involved. It is this kind of feedback that we use to monitor the transformer throughout its lifecycle. We can take that information and feed it back into the revision of the specification if there is a need for that.

This is one of the advantages that we have, we get to see the whole lifespan of the transformer, i.e. what causes the transformer to fail, if that is in any way linked to the design, how it was specified some 10 or 15 years ago. This then helps in making improvements in the specification and ensures the reliability of the transformers procured going forward. Sometimes this involves the introduction of new technologies.

In our transmission network fleet, we have over 600 power transformers and over 100 reactors. Over and above that, we have over 5,000 power transformers in the distribution network, ranging from 1.25 MVA all the way to 160 MVA. We also have pole-mounted and ground-mounted transformers, which are known as distribution transformers. That fleet alone is over 400,000 units.

We are responsible for the specification of those transformers as well, selecting the suppliers and ensuring that the designs are in accordance with our requirements. We conduct design reviews and perform all factory acceptance tests. But the actual asset management and the maintenance of the operation belongs to the field staff and their management.

AR The scope of what you do is as broad as anything here in North America. You mentioned the difference between the things you would do to monitor and do the diagnostics on an 800 MVA unit as opposed to what you would do on a 4.5 MVA unit. Obviously, there is a growth of monitoring and that's something that is happening in South Africa and the Eskom network. But you will not use a monitor that costs \$10,000 or \$20,000 on a pole-mounted transformer, which, if it fails, it fails. So, from a reliability perspective, it is about an asset operating as it was designed to operate for as long as it was designed for, which means lifecycle cost-effectiveness is critical.

Most transformers in North America are way beyond their expected reliable life. I imagine that you have some over 50 year old transformers and some brand new ones in your fleet as well. How do you go about deciding a monitoring program, a program

as opposed to monitoring, for an individual transformer? Does age matter? What conditions do you take into account when you start looking at getting data from a transformer?

KD Monitoring for us is more related to the size of the transformer. What we use is what we call the Asset Health Appraisal (AHA). In the AHA, we know the condition of each and every transformer, and this is updated every two to three years. The input from the report gives us an indication of which transformers are healthy and which need attention. That attention could mean replacement, immediate maintenance or any repair work that needs to be done.

Based on the AHA report, we have recommendations for replacement and critical transformers are put on a replacement project. Our projects department then starts the procurement process for the transformers set for replacement. The rest of the transformers are categorized according to the maintenance that is required. For instance, for a transformer that is in a bad condition, but that condition resulted from gassing of the transformer, we know that this indicates that the unit has a developing fault. And from there, that can be rectified. We investigate the developing fault, rectify it, and the transformer is back in service. This is generally how we categorize the

transformers or how we prioritize replacement. We do not replace according to age; we replace according to condition, because then the condition will determine whether the transformer needs replacement or not.

AR This is brilliant because there are too many places where we see transformers being replaced because of age. They are actually replacing transformers that are good, but just old, and they are not replacing much newer ones that are not as good.

It must also be an enormous task to continuously get the data and update it. For example, DGA can happen instantaneously, it does not happen over two to three years unless the unit is overheating. You must have a very robust asset health program. Is that something that you have developed at Eskom or you use outside vendors? How do you manage that vast amount of data that is coming in?

KD Within Eskom we have a database for our maintenance activities.

When it comes to DGA, there are two ways we deal with that. Some of our transformers are fitted with online gas monitors and as soon as the gas value goes up, a message is sent to the asset owner indicating that there is something going on with the transformer, so an immediate action can be taken. But historically, we have



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been doing manual oil sampling for all our larger transmission transformers every six months. This information is then stored in our database, at our research laboratory.

All of that data, for each transformer that has been sampled, is readily available and I can access it from my computer. The data is then recorded in our AHA program that I mentioned, where we feed all extracted data, and this information gives us the trending data.

I think this is key to DGA - trending the data to see whether a failure is developing on a given unit.

Also, every two years we do life assessment for each transformer, looking at paper insulation. This is all recorded in the same database where we have records on every transformer at Eskom. So, by monitoring insulation, we can calculate the asset health, check the status, and determine whether it is in good or bad condition. The insulation, which is what the life expectancy of your transformer depends on, carries more weight than the rest of the data.

When we detect a transformer has a DP (degree of polarization) value of around 200, for example, meaning it is nearing the end of its life, do we replace it immediately? No! If everything else is fine with that transformer, it basically becomes

a critical unit that is awaiting replacement. We don't switch it out. If there is any work that needs to be done on that transformer, you don't want to switch it on and off and drain oil from it because you might not be able to get that insulation back. So, you handle the unit with care while it is in service. In most cases when there is no human intervention those transformers can still stay in service for a little longer.

We then look at major components such as bushing and tap changers. We then need to zoom into the condition of these components to ensure that their condition is also good. An example of an unfortunate case is when a very healthy transformer suddenly fails due to a bushing failure. Unfortunately, the old technology of bushings, oil-impregnated bushings, has resulted in many transformers catching fire. This is very heartbreaking, to see a transformer that is healthy suddenly fail due to a component that could have been replaced cost-effectively.

AR Khaya, it has been a delight talking to you. You are a wealth of knowledge, and that knowledge is something that we want to share with our community and our marketplace, so thank you very much.

Khayakazi Dioka: Thank you very much for having me.

