CHAPTER 6 CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

6.1 CONCLUSION

Not all busbars of a complex network trace a classical swing locus.

The non-classical behaviour of the swing locus is due to the network shunts.

The non-classical behaviour of the swing locus makes the implementation of a “Trip-on-the-Way-Out” strategy difficult to achieve when the swing is observed from a position that is not the electrical centre.

The accuracy with which the classical two generator model traces the actual swing locus is greatly improved when the network shunts are included.

Simple network models (e.g. classical two generator model, improved two generator model) should only be used to understand the results obtained in more complex networks.

A representation of the network that includes synchronous generator dynamics, induction motors dynamics and SVC dynamics should be used when conducting the transient stability studies used to determine the network location and settings for out-of-step relays.

Relay manuals over-simplify the out-of-step phenomena.

At the time when the relays that protect the Eskom network against the case where the Mpumalanga-to-Western-Cape tie line lose angular stability were installed, the thinking was that the network behaves like an impedance connecting two
generators. This view of the network is not correct and resulted in relays being installed at locations (e.g. location C1 shown in Chapter 5, figure 5.1) that can not detect swings that have their electrical centre south of Hydra.

To clarify, we note that when the shunts are removed (current practice Eskom uses) the impedance locus at C1 is the locus shown in figure 5.3. For this case \( Z_s \) is fitted as is shown in figure 5.3. When the shunts are included the swing traces the impedance loci shown in figure 5.27. For this case the best fitting of \( Z_s \) is any of the fittings shown in figure 5.27. \( Z_s \) shown in figure 5.3 differs greatly from \( Z_s \) shown in figure 5.27. Hence, \( Z_s \) shown in figure 5.3 is not suited to protect the network from the swings shown in figure 5.27.

The swing behaves classically at C2. Therefore, \( Z_s \) at C2 can be fitted using the classical method illustrated in Chapter 2, figure 2.19.

6.2 RECOMMENDATIONS FOR FUTURE WORK

Future work should determine if it is possible to obtain a mathematical expression that can be used to construct the swing locus in the complex plane.

Future work should determine whether it is possible to compute the parameters of this mathematical expression while the network is pole slipping. This allows adapting the shape and complex plane location of the relay characteristic and hence the slipping of poles can be detected at any network location.