"HAWKEYE" CLOSE-VISUAL OVERHEAD LINE INSPECTION SERVICE

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1. GENERAL DESCRIPTION

The Mace Technologies *"Hawkeye"* aerial close-visual inspection is a condition monitoring tool designed to establish the precise state of overhead transmission and distribution lines. The technique allows thorough examination of each component - even at midspan. Small but potentially catastrophic faults, such as displaced split pins, loose nuts and conductor strand damage, are readily detected.

The qualified inspector is seated on the skid of a helicopter and held at close proximity to the line. The helicopter follows a regular and well-defined flight path at each tower to facilitate a complete study of the structure from the earthwire attachment to the footing and then slowly proceeds down the span. The inspector's defect detection ability is greatly enhanced by the use of gyroscopically stabilised binoculars.

To assist the client in their own assessment of the nature and maintenance priority of the various faults, photographs of the defects are taken for reference.

All observations are directly recorded on a custom-developed *Hawkeye* database by the computer operator seated in the aircraft. The software is designed for the rapid entry of the nature of the fault, its precise location and the digital photograph reference. Operating on an intelligent prompt system, the programme demands entry of data absolutely relevant to the particular situation only. No important details can thus be missed and no time is wasted in the air.

The *Hawkeye* software utilises a pen-based computer tablet and is the most sophisticated aerial line inspection programme available. It eliminates the need for keyboard entry of information, thus further improving both the speed and accuracy of data capture.

2. THE INSPECTION TEAM

The Mace inspection team comprises:

- Roy Macey Pr.Eng., MSc(Eng)
  Aerial inspector, Computer Operator, data analysis and report preparation.
  (36 years experience in the overhead line field. Served as South Africa's representative on the Cigre Study Committee B2, "Overhead Lines")

- Dick Viles DipTech
  Aerial Inspector, Thermographer
  (25 years experience on overhead lines and their components)

- Nando Salvoldi DipTech
  Computer Operator, Thermographer
  (29 years experience with Eskom and Mace Technologies)

- Allan Muir Pr.Eng., BSc(Eng)
  Computer Operator, Software Support, Data Analyst.
  (Specialist in overhead line design and related software for 16 years)

The first three members of the team have been together since the *Hawkeye* service was established in 1989. A list of the lines which have been examined to date is attached.

The *Hawkeye* inspections are conducted in association with pilots well experienced in line inspection, maintenance and construction. Bell Jetranger III, Bell Longranger, Squirrel or Hughes 500 helicopters are used. The aircraft meet all statutory requirements and any other specifications laid down by the client in respect of insurance, certification and performance.

3. DOCUMENTATION

A comprehensive inspection document is provided. This comprises a written report on the general state of the line and its various components, a complete listing of all defects found, separate listings of each category of fault, fault statistics and photographs of the defects.

The standard report structure is as follows:

Section 1: Introduction

Section 2: Inspection Description

Section 3: Structures

Section 4: Insulator String Assemblies

Section 5: Conductors and Conductor Fittings

Section 6: Earthwire and Earthwire Fittings

Section 7: Servitude

Appendix A: Fault Listing
- all faults
- insulator faults
- conductor faults
- earthwire faults
- tower faults
- servitude faults

Appendix B: Fault Statistics
- faults listed in frequency of occurrence
- faults listed alphabetically
- faults listed in terms of category

Appendix C: Photographs

The fault listings can also be made available on disc and formatted to suit the client's existing database software and systems.

4. *"REDEYE"* THERMAL INSPECTION

The *Hawkeye* inspection is most comprehensive but an internal defect on, for example, an incorrectly applied or deteriorating midspan splice, compression deadend or other current-carrying joint may be invisible to the eye and thus go undetected. Such faults on overhead lines are rare but, if they exist, can cause dropping of the conductors and serious disruption of supply. An infrared examination of the line is thus offered as an optional service that can be coupled with the visual inspection while the helicopter and personnel are on site.

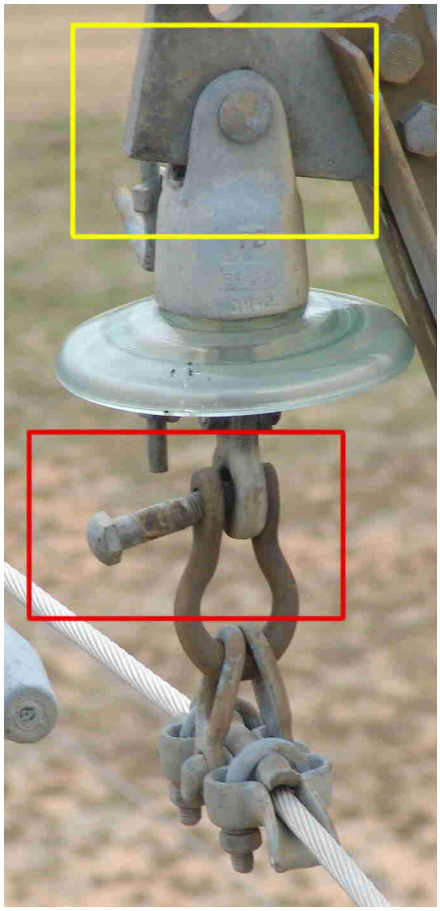
For the *Redeye* infrared inspections, the thermographer is seated on the side of the helicopter and examines all current-carrying components, such as compression deadends, jumper flag terminals, midspan splices and conductor repair sleeves, with an extra high resolution (1280 x 960 pixel) thermal imager. The instrument employed is a Jenoptik Variocam HiRes Research 1.2 Mega camera which is of the uncooled focal plane array (FPA) type operating in the 8 to 14 micron spectral range. The images are stored on an internal flash card. Additional storage and viewing by a second thermographer is facilitated by a firewire connection to the on-board computer. Where thermal elevations are detected, the recorded images can be studied in detail by means of the Jenoptik "VarioAnalyze" and "VarioCapture" thermal analysis software.

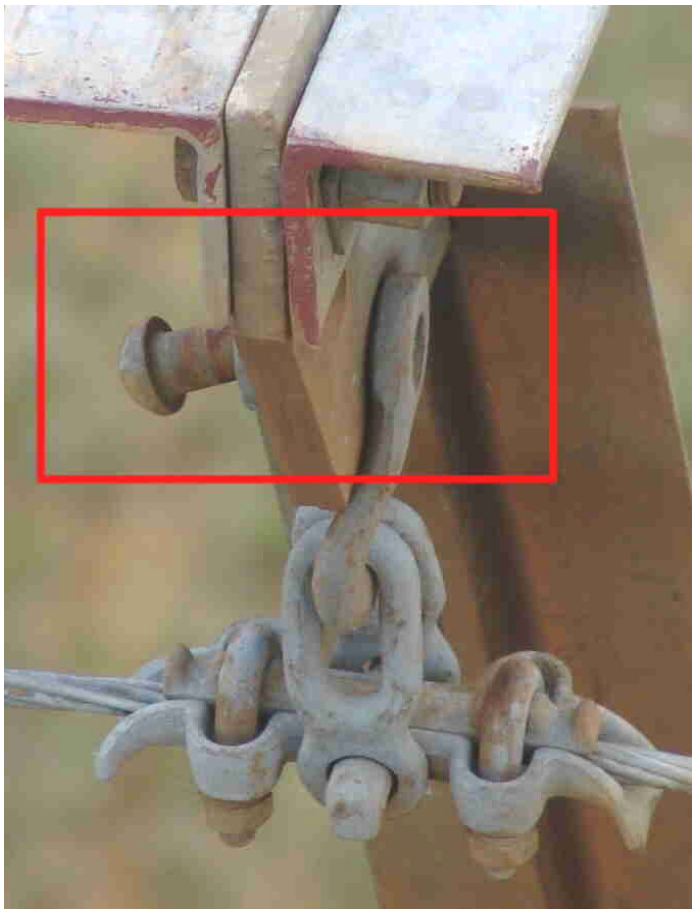
5. INSPECTION COSTS

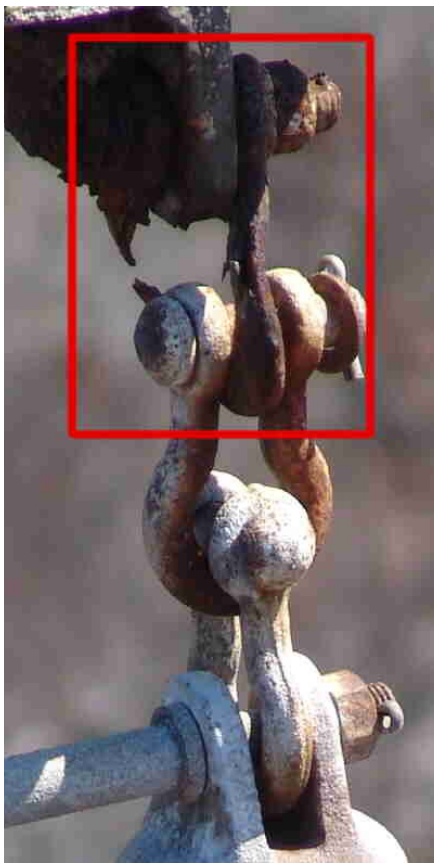
The price of a *Hawkeye* and/or *Redeye* inspection is largely determined by the local costs of helicopter operation. The configuration of the line, the number of circuits, the number of conductors per phase, the ratio of suspension to strain towers and the general condition all influence the time – and therefore the helicopter rotor hours - required for rigorous inspection. It can vary widely but the average inspection time is 15 structures per hour. The geographical location and the distance the helicopter has to be ferried to site also have a significant influence on costs. Each project is thus quoted on an individual basis. However, the quotations provided are fixed and include helicopter operation, fuel, the services of a pilot, inspector and computer operator, the preparation of the comprehensive report, complete instrumentation and all travelling and subsistence expenses.

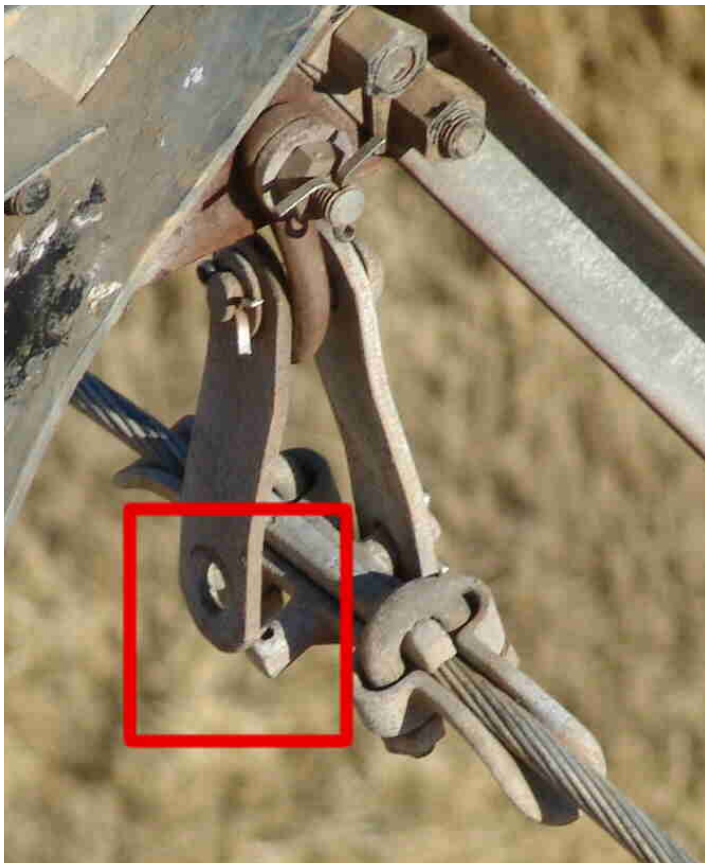
6. FAULT DETECTION

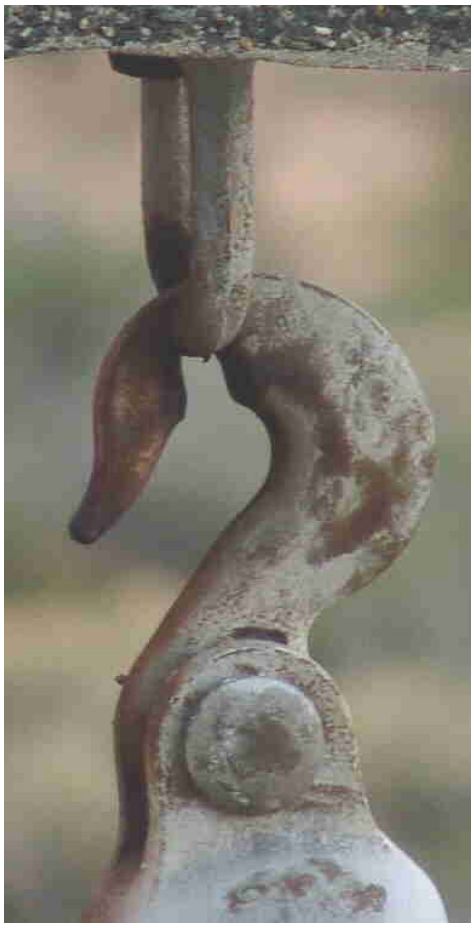
The high quality of the *Hawkeye* inspection can be largely attributed to the experience of the personnel involved. Comprehensive knowledge of overhead lines and their individual components is critically important. For example, being able to identify the various types of ceramic and non-ceramic insulators and being familiar with all the possible failure mechanisms associated with their particular construction and material is necessary for the detection of potential problems and degradation in the early stages. The following illustrations show a small selection of the types of defects that are typically identified.

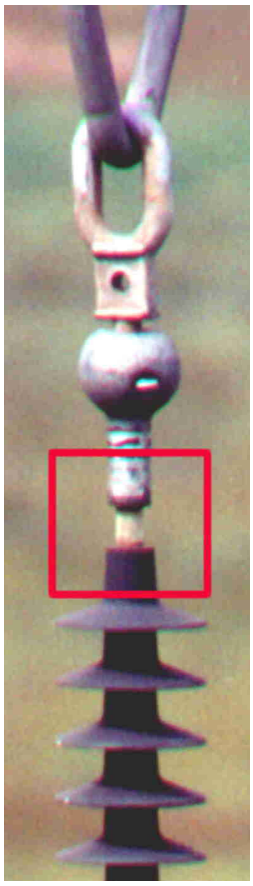


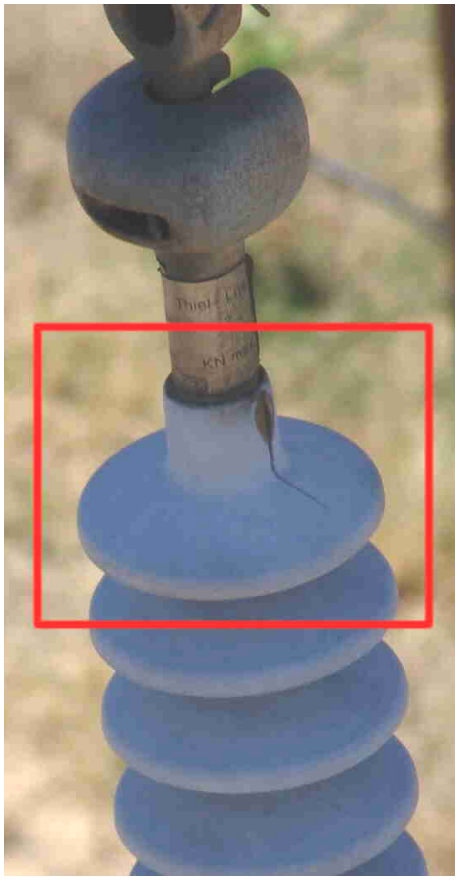


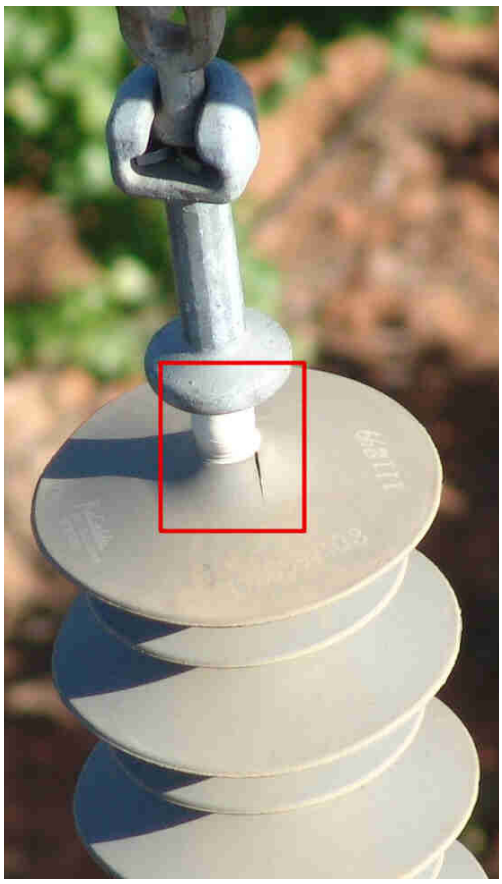


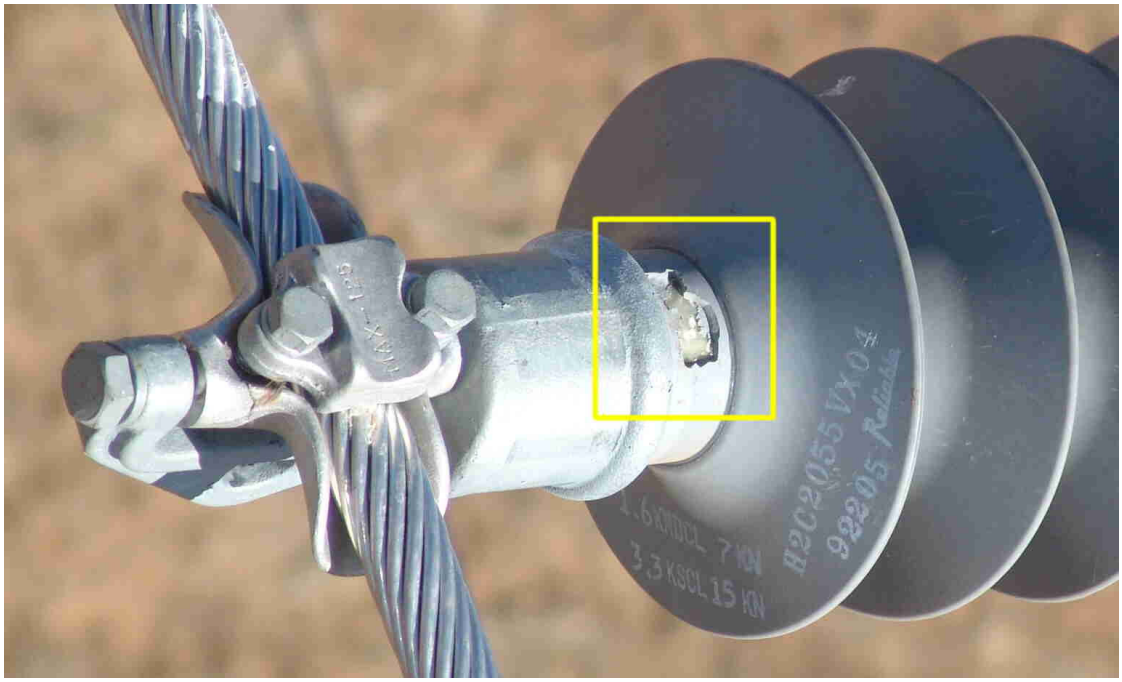








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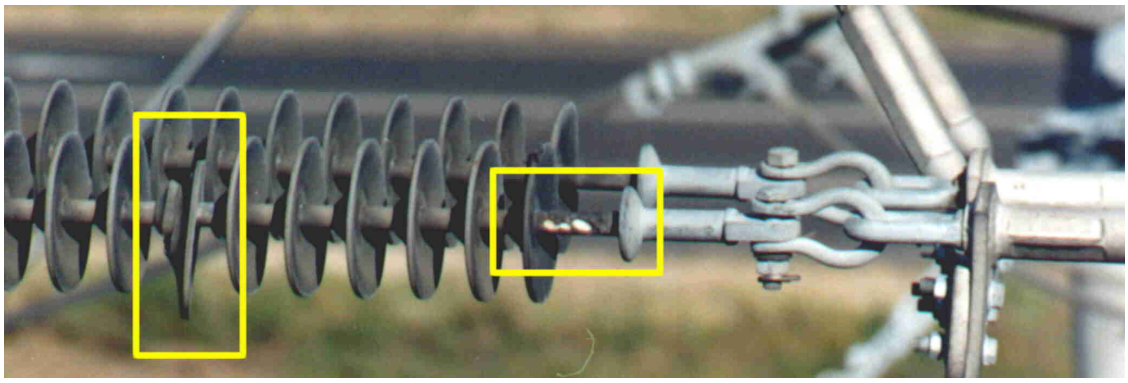
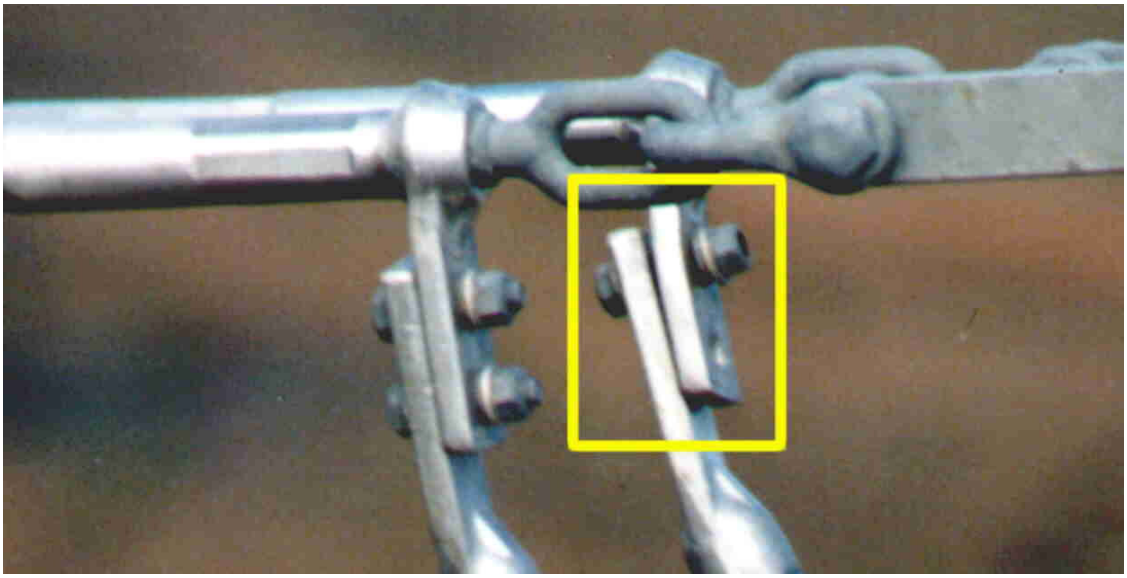
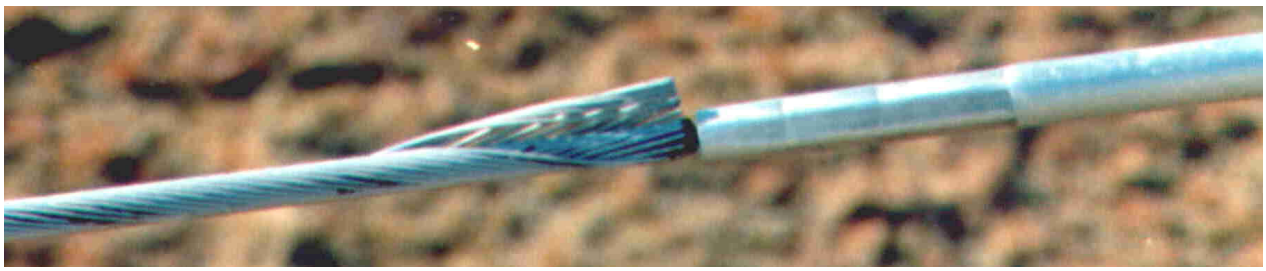
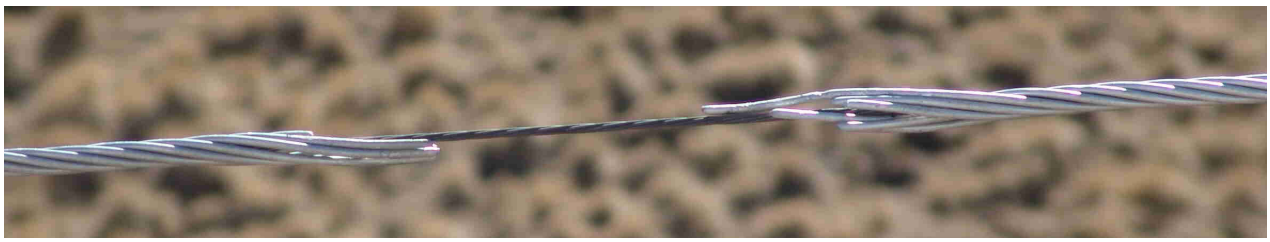
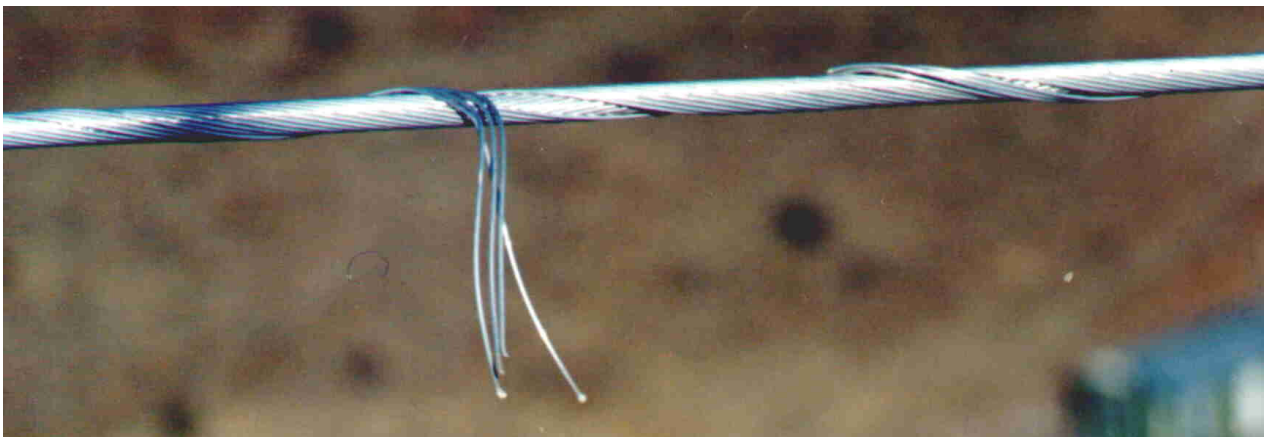
3.3 KSCL 15 KN
H2C2055 Vx 04
92205 Reliable

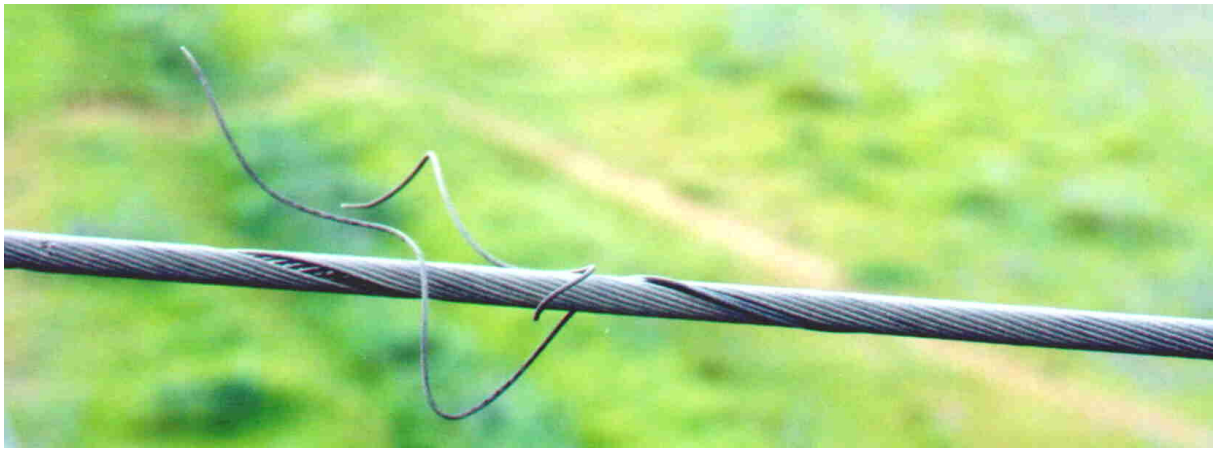


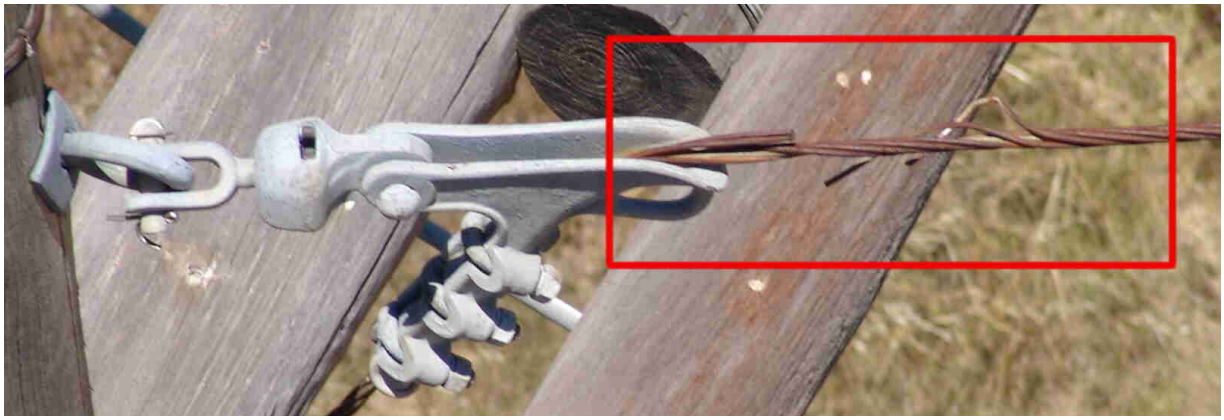


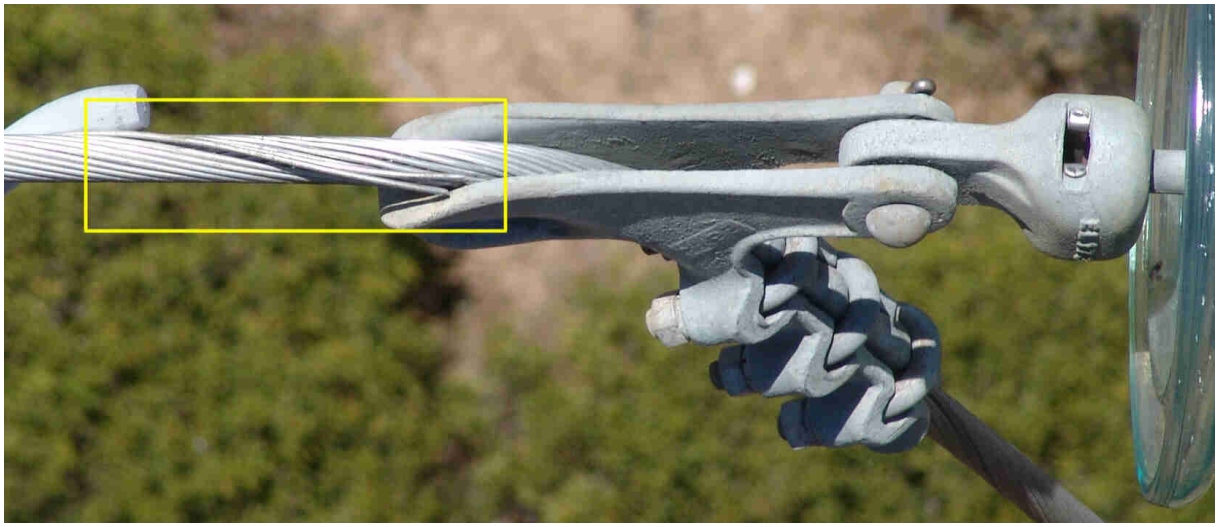


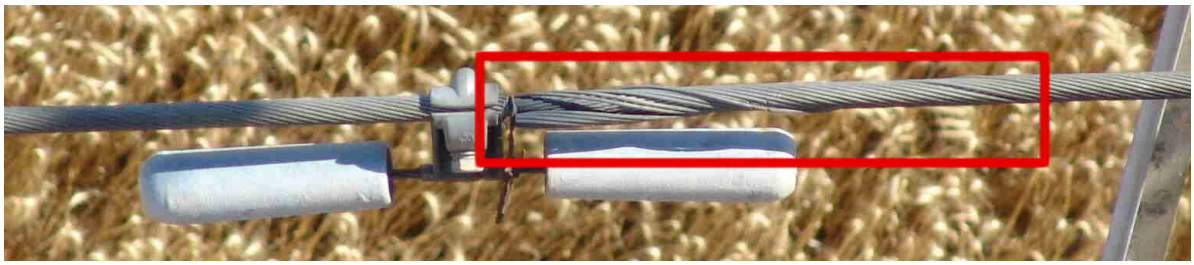


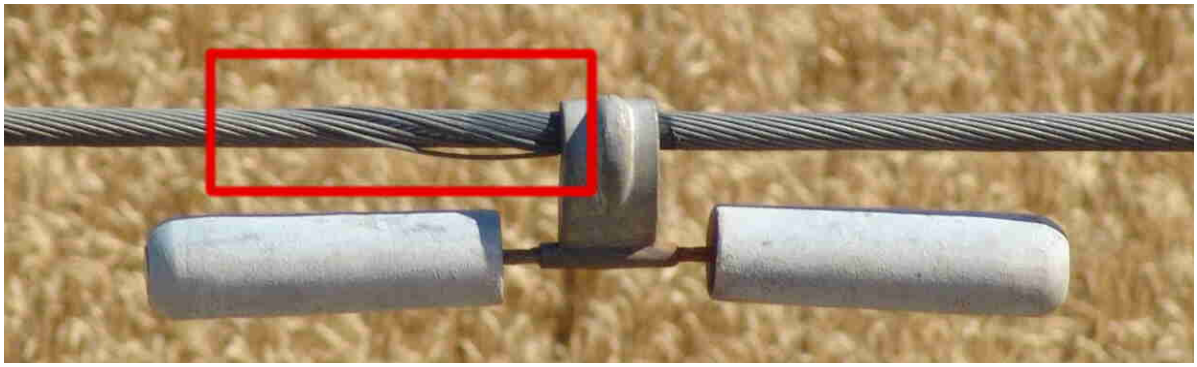


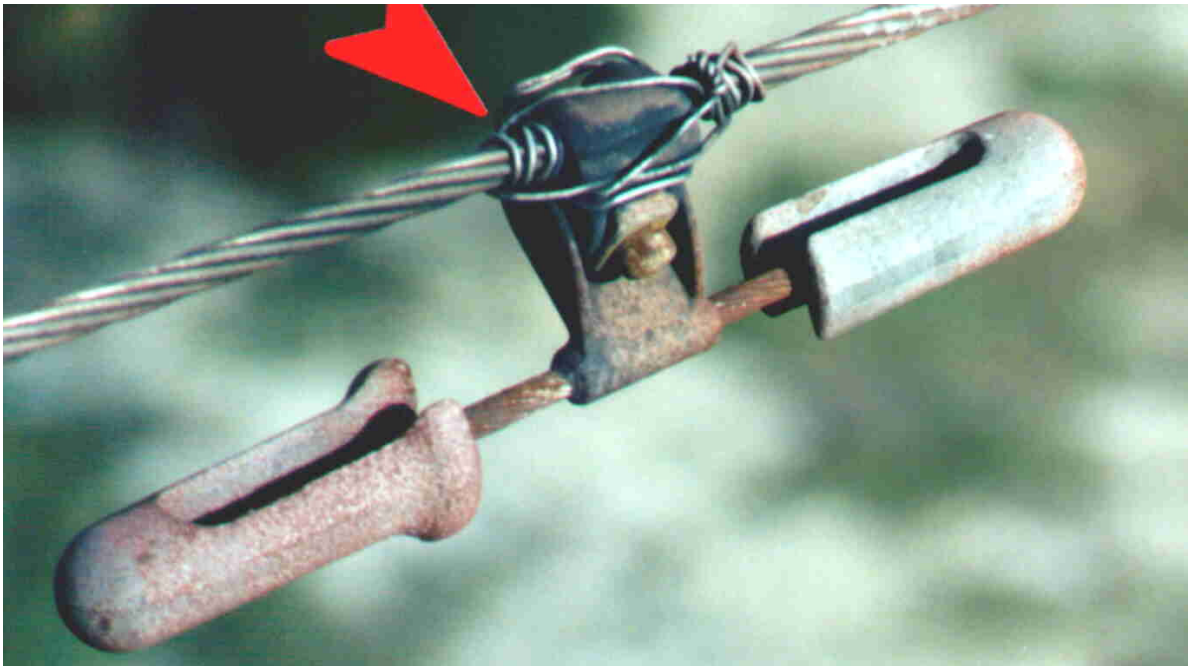


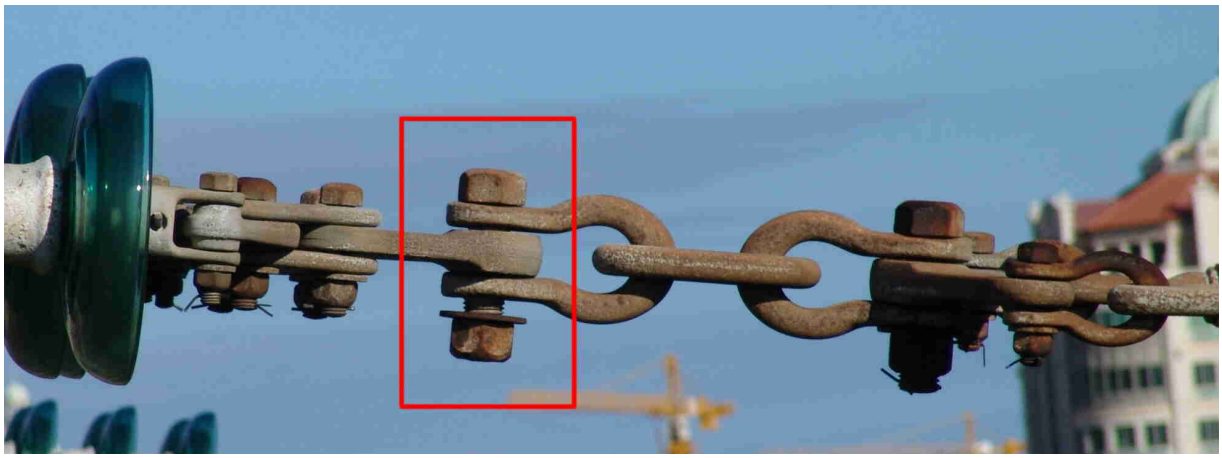


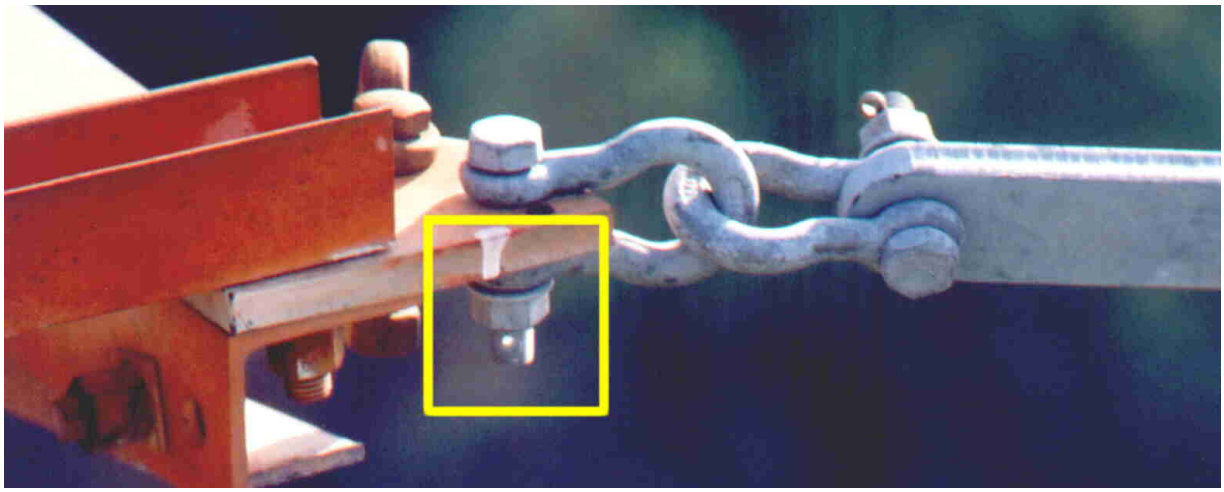


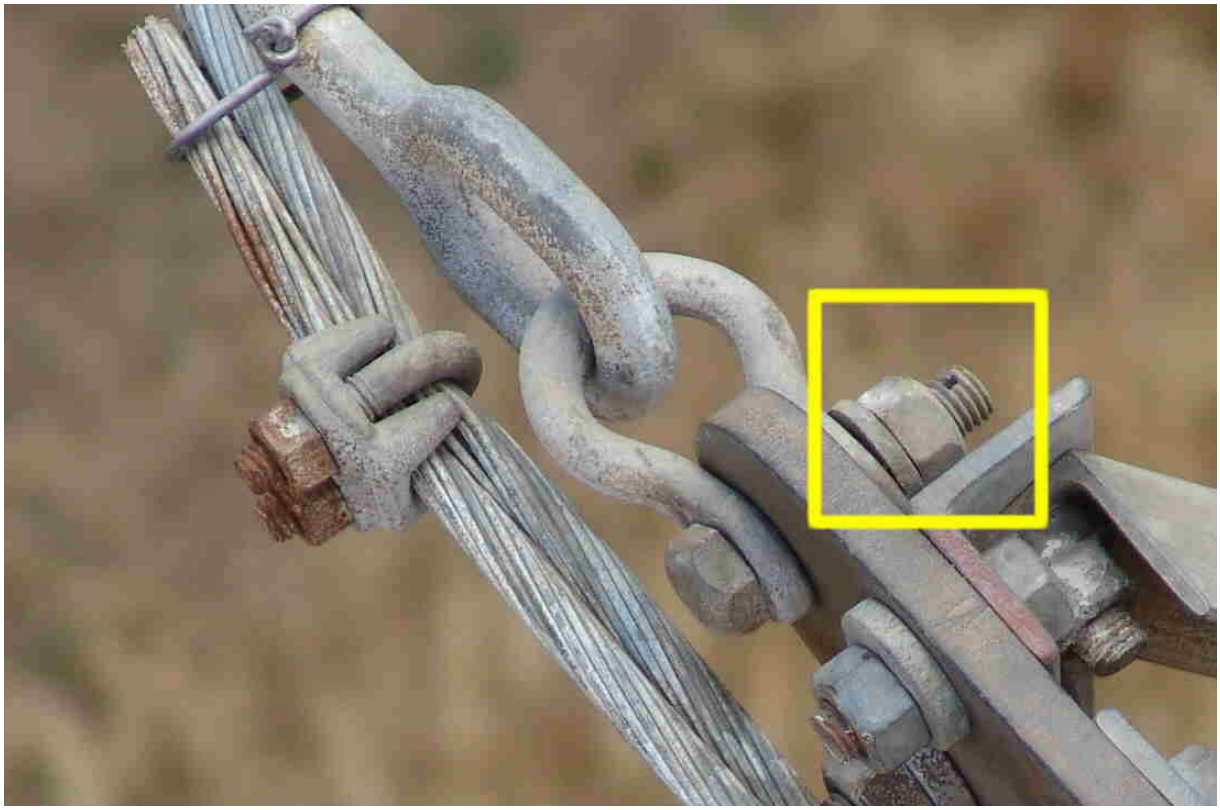


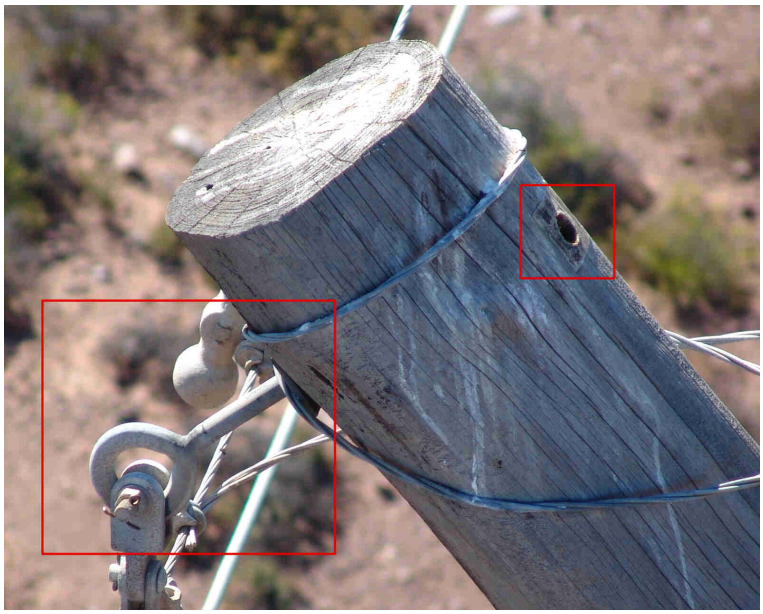












REFERENCE LIST

"HAWKEYE", "REDEYE" AND GROUND-BASED LINE INSPECTIONS UNDERTAKEN BY MACE ELECTRICAL TECHNOLOGIES

ESKOM TRANSMISSION GROUP

Leander/Perseus 400kV
Blanco/Droerivier 400kV
Avon/Impala No.1 275kV
Avon/Mersey No.2 275kV
Mersey/Georgedale No.2 275kV
Ingagane/Bloukrans 275kV
Witkop/Tabor 275kV
Hydra/Roodekuil 220kV
Marathon/Komatipoort 275kV
Mersey/Chivelston 400kV
Acacia/Philippi 400kV
Bighorn/Turfshaft 132kV

LESOTHO ELECTRICITY CORPORATION

Pitseng/Ha Lejone 132kV
Ha Lejone/Katse Dam 66kV
Maseru/Maputsoe 132kV
Maputsoe/Pitseng 132kV
Mazenod/Bushman's Pass 132kV
Bushman's Pass/Mohale 132kV
Katse/Tunnel Outlet 132kV
Khukhune/Letseng 88kV
Maseru/Muela 132kV
Khukhune/Clarens 88kV
Mohales Hoek/Mafeteng 132kV
Mazenod/Roma 33kV
Roma/Thaba Tseka 33kV
Mazenod/Mabote 132kV
Mazenod/Mohale 132kV
Mohales Hoek/Quthing 33kV
Mafeteng/Mohales Hoek 33kV
Mazenod/Mafeteng 132kV
Mohales Hoek/Litsoeneng 33kV
Litsoeneng/Tee-off 33Kv

ESKOM KWA-ZULU NATAL DISTRIBUTOR

Illovo/Nkonke 132kV
Nkonke/Saiccor 132kV
Saiccor/Illovo 132kV
Illovo/Rayon 132kV
Rayon/Nkonke 132kV
Bendigo/Nkonke 132kV
Nkonke/Oribi No.3 88kV
Uvongo/Montreux 88kV
Illovo/Nkonke No.3 88kV
Idwala/Oribi 132kV
Idwala/Nkonke 132kV
Eros/Oribi 132kV
Bendigo/Oribi 132kV
Kokstad/Maluti 132kV
Bloukrans/Gowrie 132kV
Ingagane/Utrecht 88kV
Normandie/Vergenoeg 132kV
Normandie/Pongola 132kV
Colenso/Groenkop 88kV
Georgedale/Northdene 88kV
Georgedale/Lotus Park 88kV
Oribi/Port Edward 88kV
Avon/Glendale 132kV
Ingagane/Craigside No.1 88kV
Majuba/Bergvliet 88kV
Bergvliet/Volksrus 88kV
Majuba/Volksrust No.2 88kV
Colenso/Gowrie No.1 88kV
Impala/Nseleni 132kV
Mtubatuba/Nseleni 132kV
Hluhluwe/Mtubatuba 132kV
Hluhluwe/Mkuze 132kV
Mkuze/Pongola 132kV
Empangeni/Eshowe 88kV
Empangeni/Mandini 88kV
Empangeni/Umfolozi 88kV
Bloedrivier/Umfolozi 88kV
Umfolozi/Mtonjaneni 88kV
Impal/Zircon 132kV
Pongola/Pontus/Vergenoeg 132kV

ESKOM CAPE DISTRIBUTOR

Muldersvlei/Malmesbury 132kV
Malmesbury/Moorreesburg 132kV
Moorreesburg/Aurora 132kV
Aurora/Aurora Traction 50kV
Aurora/Blouwater 132kV
Blouwater/Iscor 1&2 66kV
Blouwater Farmers 1&2 11kV
Tee-Off/Blouwater 66kV
Tee-Off/Amcor 66kV
Fisheries/Koperfontein 66kV
Grassridge/Chatty 132kV
Juno/Koekenaap 132kV
Koekenaap/Brand-se-Baai 132kV
Plattekloof/Muldersvlei 132kV
Plattekloof/Springfield 132kV
Springfield/Muldersvlei 132kV
Stikland/Sarepta 132kV
Sarepta/Belhar 132kV
Sarepta/Cisco 132kV
Acacia/Montague Gardens 1&2 132kV
Acacia/Ascot 1&2 66kV
Acacia/Plattekloof 1&2 132kV
Hex/Chavonnes 66kV
Chavonnes/Breerivier 66kV
Breerivier/Wolseley 66kV
Wolseley/Gouda 66kV
Prospecthill/Malmesbury 132kV
Malmesbury/Moorreesburg 132kV
Aurora/Moorreesburg 132kV
Moorreesburg/Ongegund 66kV
Moorreesburg/Withoogte 66kV
Gouda/Ongegund 66kV
Moorreesburg/Misverstand 66kV
Moorreesburg/Gouda 66kV
Hex/Hugo 1 66kV
Hex/Hugo 2 66kV
Hex/Windmill 132kV
Boskloof/Ashton 132kV
Bredasdorp/Vryheid 66kV
Bredasdorp/Klipdale 66kV

CAPE TOWN CITY COUNCIL

Athlone/Philippi 132kV
Philippi/Mitchells Plain 132kV

ESKOM BLOEMFONTEIN DISTRIBUTOR

Grootkop/Kimberley 132kV
Harvard/Eastern Switchyard 132kV
Mangaung 132kV
Harvard/Park West 132kV

TSHWANE ELECTRICITY

Njala/Scientia 132kV
Tee-Off/Claudius 132kV
Swartkops132kV
Scientia/Rooiwal 132kV
Kwagga/Rooiwal 132kV
Rietvlei/Waterkloof 132kV
Tee-Off/Olievenhout 132kV
Kosmosdal/Olievenhout 132kV
Eldoraigne/De Hoewes 132kV
Brakfontein/Eldoraigne 132kV
Tee-Off/Kentron 132kV
Rietvlei/Brakfontein 132kV
Kwagga/De Hoewes/Njala 132kV
Eland/Villieria 132kV
Eland/Scientia 132kV
Rooiwal/Waltloo/Eland 132kV
Scientia/Willows 132kV
Kwagga/Bellom 1&2 132kV
Kwagga/Bellom 3&4 132kV
Kwagga/Pretoria West 1&2 132kV
Kwagga/Pretoria West 3&4 132kV
Kwagga/Saulsville 132kV
Kwagga/Iscor 275kV
Kwagga/Rosslyn 132kV
Njala/Waltloo 132kV
Waltloo/Mamelodi 132kV
Bellom/Park Town 132kV
Park Town/Rooiwal 132kV
Rooiwal/Rosslyn 132kV
Buffel/Rosslyn 132kV
Buffel/Soshanguve

ETHEKWINI ELECTRICITY

Durban South/Illovo 275kV
Durban South/Umbogintwini 132kV
Tee/Mount Edgecombe 275kV

BOROUGH OF RICHARDS BAY

Impala/Polaris 132kV
Polaris/Triomf 132kV
Polaris/Hercules 132kV
Carina Tee-Off 132kV
eSikhawini 132kV

KWA-ZULU NATAL GOVERNMENT

Sundumbilli/Isethebe 132kV

KEMPTON PARK MUNICIPALITY

Kempton Munic/Airport Super Sub 132kV
Winnie Mandela Park 33kV

PIETERMARITZBURG MUNICIPALITY

Mason/Pentrich 132kV
Riverside/Tee-Off 132kV
Tee-Off/Northdale 132kV
Riverside/Retief 132kV
Riverside/Mkondeni 132kV
Riverside/Woodburn 132kV
Woodburn/Mason 132kV

MIDRAND MUNICIPALITY

Grand Central 132kV

NELSON MANDELA MUNICIPALITY

Chatty/Summerstrand 132kV

MONDI KRAFT LTD.

Mondi Plant 132kV

TRANS-AFRICA PROJECTS

Avon/Mandini 132kV Lines 1 & 2
Avon/Driefontein 132kV Lines 1 & 2
Avon/Stanger 132kV Lines 1 & 2
Georgedale/Abattoir 132kV Lines 1 & 2