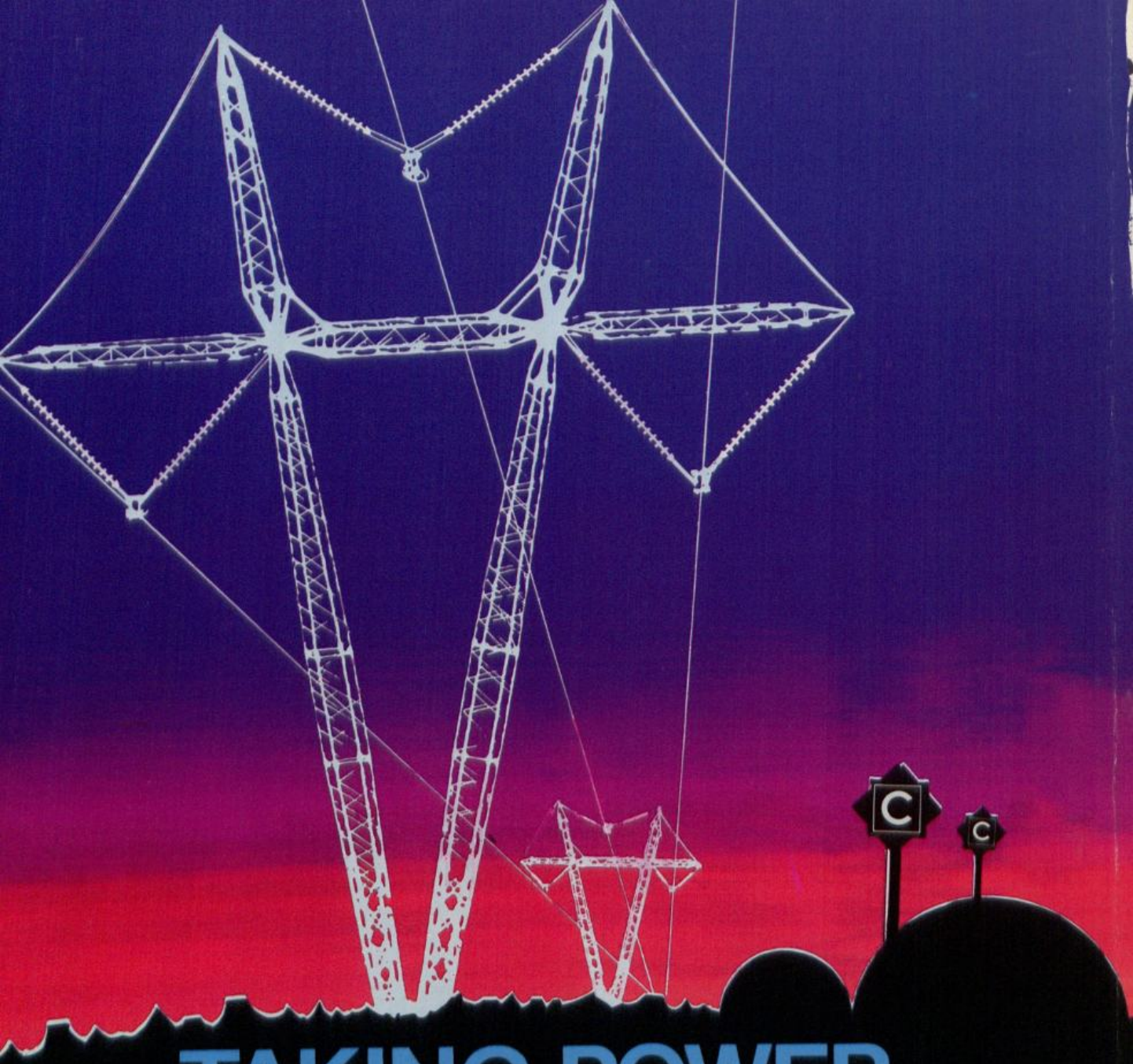
The Association of Municipal Electricity Undertakings of South Africa
Die Vereniging van Munisipale Elektrisiteitsondernemings van Suid-Afrika

11th TECHNICAL MEETING PROCEEDINGS
11e TEGNIESE VERGADERING VERRIGTINGE

PORT ELIZABETH

1-2 SEPTEMBER 1986



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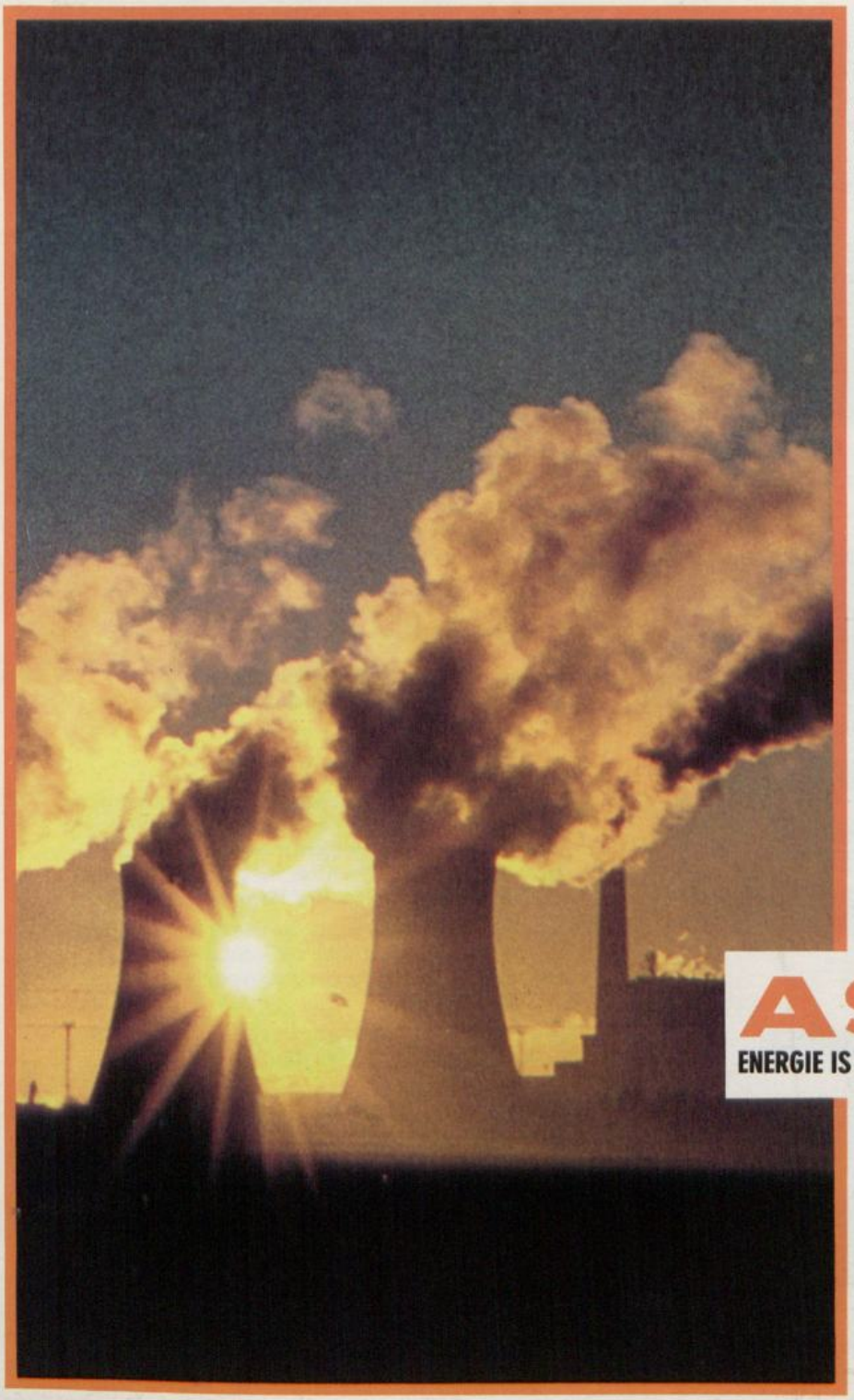

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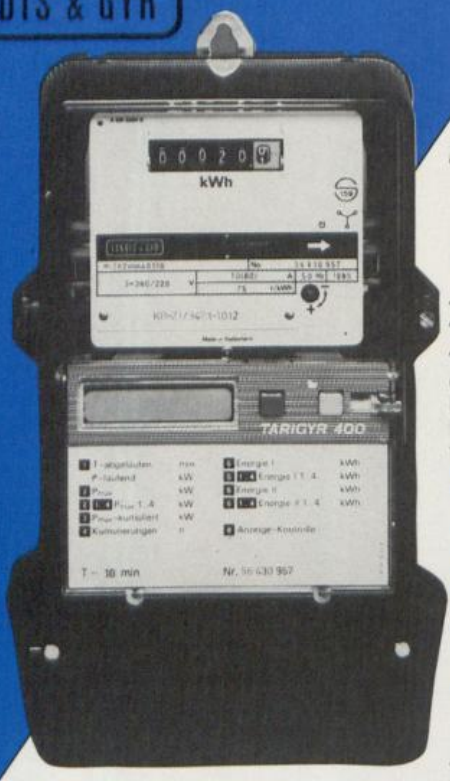

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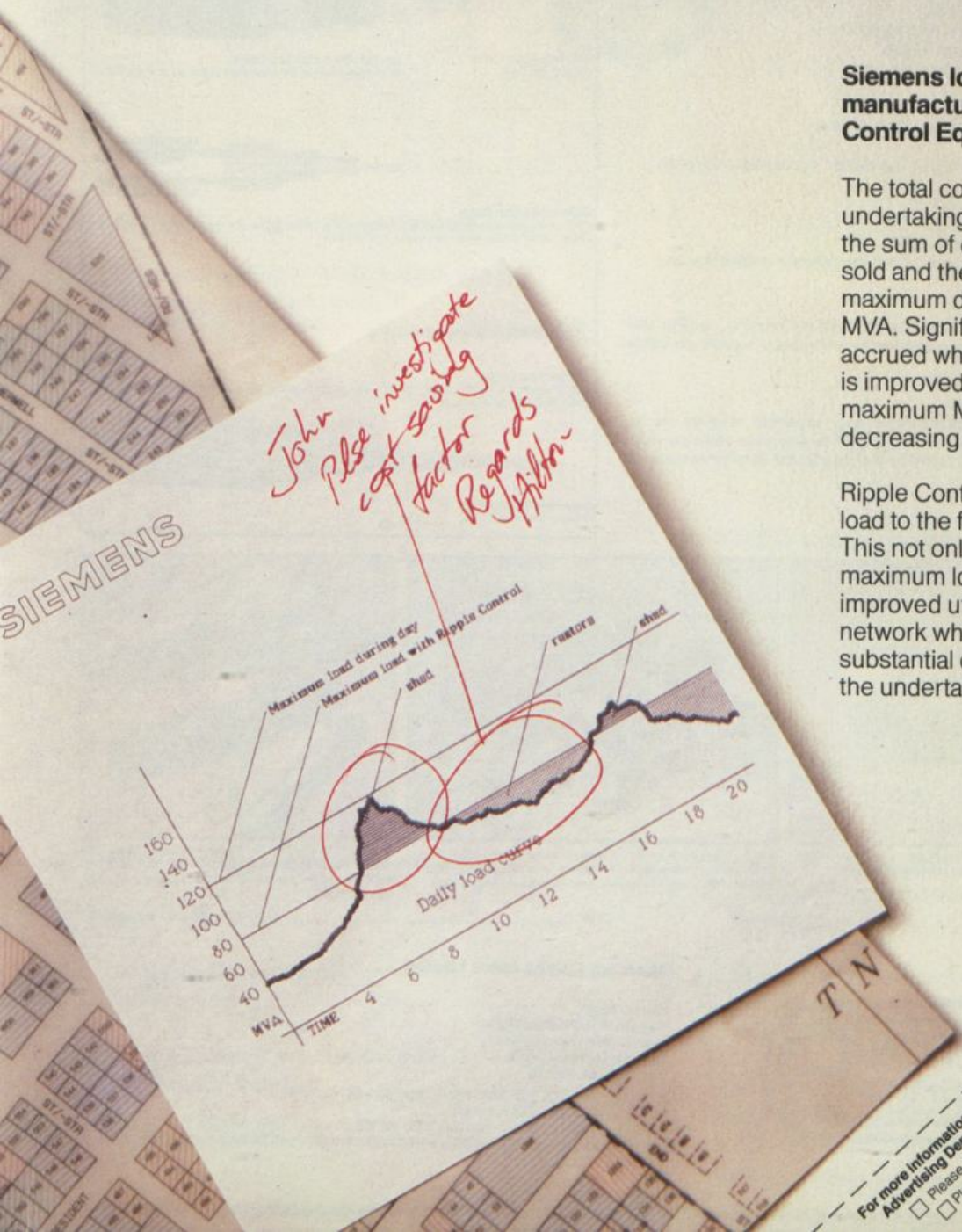

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- PVC insulated cable — up to 6,6 kV
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- Signalling, auto and airport lighting cable
- Housewire, domestic flexible cords
- Twin and earth wiring systems/Surfix
- Coaxial cable
- Instrumentation cable
- Communication cable and Telephone Cable
- Optical fibre
- Aluminium overhead stranded conductor (including aluminium alloy
- Aerial Bundled Conductor (ABC)
- Bare copper conductor
- Trailing cable — rubber and XLPE
- Cable accessories can be supplied for different insulations and voltages

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Paper-Insulated Cable
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Up to 3,8/6,6 kV.

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THE ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS OF SOUTH AFRICA

DIE VERENIGING VAN ELEKTRISITEITSONDERNEMINGS VAN SUID-AFRIKA

OFFICIAL PROCEEDINGS

11th TECHNICAL MEETING
1-2 SEPTEMBER 1986
PORT ELIZABETH

AMPTELIKE VERRIGTINGE

11e TEGNIESE VERGADERING
1-2 SEPTEMBER 1986
PORT ELIZABETH

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The AMEU is the body to bring together municipal councillors, electrical engineers and all persons interested in the advancement and the development of undertakings and to promote wider contact and the exchange of views.

Die VMEO is die organisasie om munisipale raadslede, elektrotegniese ingenieurs en alle persone met belang in die bevordering en ontwikkeling van ondernemings bymekaar te bring en om wyer kennismaking en die wisseling van sienswyses te bevorder.

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TECHNICAL MEETING PROCEEDINGS TEGNIESE VERGADERING VERRIGTINGE

Opinions expressed in papers or discussions does not necessarily represent the official views of the AMEU.

Menings uitgespreek in referate of besprekings verteenwoordig nie noodwendig die amptelike menings van die VMEO nie.

OFFICIAL PROCEEDINGS

11th TECHNICAL MEETING
1-2 SEPTEMBER 1986
PORT ELIZABETH

AMPTELIKE VERRIGTINGE

11e TEGNIESE VERGADERING
1-2 SEPTEMBER 1986
PORT ELIZABETH

TABLE OF ATTENDANCE/
TABEL VAN BYWONING

Honorary Members	8	Erelede
Guests	22	Gaste
Local Authorities	24	Plaaslike Besture
Engineers	110	Ingenieurs
Associates	8	Assosiaatlede
Affiliates	166	Geaffilieerdes
Ladies	144	Dames
Staff	14	Personeel
	496	
Apologies	7	Verskonings

OFFICIAL OPENING/AMPTELIKE OPENING

Ds O. J. Fourie het die verrigtinge geopen met skriflesing en gebed.

MNR J A LOUBSER : PRESIDENT

Baie dankie ds Fourie. U weet soos wat u self gesê het, dit is 'n groot vergadering en sonder the leiding van die Allerhoogste kan ons nie 'n sukses daarvan maak nie.

Dames en here, Raadsheer Ben Olivier is die Burgemeester van Port Elizabeth. Dit is nou vir my 'n groot voorreg om vir Raadsheer Olivier te vra om hierdie vergadering te open.

WELCOME BY THE MAYOR
VERWELKOMING DEUR DIE BURGEMEESTER

Die Burgemeester, Raadsheer Ben Olivier

Mr President, distinguished guests, ladies and gentlemen. Dit verskaf my groot genoee om u vanoggend in Port Eliabeth, "Die Vriendelike Stad," te verwelkom en die Elfde Tegniese vergadering van die VMEO amptelik te open.

Dit is 'n voorreg om as gasheer op te tree by so 'n groot byeenkoms van tegniese deskundiges uit die verskillende sentra van Suid-Afrika — nie alleen munisipale elektrotegniese ingenieurs nie, maar ander verteenwoordigers van Parastaatsliggame en die Handel en Nywerheid.

Now in its 81st year, and having grown in size from 2 x 400 kW DC generators in 1905 to a system with a load of almost 400 MW, we as a Council are justly proud of the undertaking as well as having been associated with your Association not only since its founding as a foundation member, but, with all humility, as the actual founder.

In substantiation I would like to quote from various extracts of your proceedings where it was stated that:

Raadsheer Ben Olivier, burgemeester van Port ELizabeth en Mev M. Olivier saam met Mnr J. A. Loubser, President van die VMEO en Mev Martie Loubser.

"Die Vereniging het tot stand gekom as gevolg van 'n brief wat deur John Roberts aan Dr J H Dobson geskryf is, maar die eer om stigter van die Vereniging te wees berus by Bernard Sankey."

Dit is duidelik onderstreep deur andere op die 8ste konferensie in Oos-London toe gesê is:

"Dit was deur sy poging, toe hy nog in Port Elizabeth was, dat die ideë van die Vereniging gebore is."

Well you obviously guessed by now that Bernard Sankey must have been Port Elizabeth's Municipal Electrical Engineer, and as a result of his and other municipal electrical engineers' efforts the Association was formed in 1915 and duly paid its first visit to Port Elizabeth in 1920.

As the importance of the Association grew, so invitations to hold conferences in other centres grew and Port Elizabeth accordingly had to wait util 1933 before it could host its second conference and until 1949 and 1965 for its third and fourth visits respectively.

Dit blyk nou dat Port Elizabeth mondig geword het deurdat 21 jaar intussen verstryk het en u nou in 1986-konferensie in Port Elizabeth hou, al is dit 'n tegniese ene.

Mnr die President, aangesien ons nie ons naam "Die Vriendelike Stad" wil verloor nie, versoek ek u om toe te sien dat daar nie weer 21 jaar verloop voordat ons as gasheer vir die Vereniging kan optree nie, veral — en daarvan is ek oortuig — nadat u twee wonderlike dae van gasvryheid in die "Vriendelike Stad" ondervind het.

Whilst appreciating your heavy programme will keep delegates hard at work with no spare time, we do hope that the programme we have prepared for the delegates' wives, which probably can be likened to a short travel tour of Port Elizabeth, will enable all to take note of some of its numerous attractions, and the Mayoress and I look forward to meeting you and your wives at the official reception being held tonight.

I trust your stay will be enjoyable and hope those of you who might not have known Port Elizabeth very well will now plan to return and spend a much longer time in the "Friendly City." You may make use of this opportunity to look for and buy your retirement house, flat or townhouse. Prices will not be as reasonable for a long time.

It now gives me great pleasure to declare the 11th Technical Conference of the Association of Municipal Electricity Undertakings duly open and may your deliberations be highly successful and your return home safe and pleasant.

MNR J A LOUBSER : PRESIDENT

Mnr die Burgemeester, ek het van daardie advertensie gehou wat u so tussen in geglip het maar ek glo nie u hoef dit te sê nie want ek kan vir u sê as ek kyk na die aantal mense wat hier verteenwoordig is, dan is dit 'n rekord aantal mense vir 'n tegniese vergadering en u hoef nie te adverteer nie — die mense hou van Port Elizabeth en dit is baie aangenaam om hier te wees.

Baie dankie vir u vriendelike uitnodiging en vir die mooi woorde wat u aan ons gerig het.

U weet een van die probleme wat 'n burgemeester het is — hy weet nie wat hy moet doen met al die mansjetknope wat hy het nie. Maar ons het tog gevoel ons moet vir hom ietsie gee wat hom kan herinner aan hierdie groot massa mense wat vandag hier bymekaar is.

Dames en here, laat ek nou begin deur dadelik vir u te sê baie welkom hier. Ek is besonders beindruk deur die mense wat hier is.

To me its a pleasure because all my friends are here. I know some of you may say "why do you need enemies with some of these friends" maar daar is tog 'n paar treurige oomblikke wat ons ook moet iets oor se en ek sal u nou net moet herinner dat ongeveer 'n week gelede het Jannie van der Walt, een van ons vorige Presidente, skielik heengegaan. Ek vra u om asseblief 'n paar minute op te staan en net aan hom dink. Baie dankie.

Hier is 'n paar spesiale mense vandag hier en een van hulle is mnr Stofberg van Evkom. I really appreciate his presence here today. He would not have been here but when I asked him to please be here, just for support for myself, he immediately agreed to it.

Mnr Stofberg tree een van die dae af. Ons ken hom almal baie goed en ek dink tog ek sal dit waardeer as hy net sal opstaan sodat almal hom kan sien.

Ek moet vir u sê hy was ook 'n Elektrotegniese Stadsingenieur, hy was lid van die VMEO, en toe het hy by die destydse "vyand," Evkom, gaan aansluit. Nou ek sê destydse vyand maar deesdae praat ons nie meer so nie. Deesdae gaan dit baie goed. Baie welkom, Mnr Stofberg, ek waardeer dit regtig dat u hier is.

Ek het verskoning van twee erelede ontvang: Ralph Anderson van die WNNR — hy het 'n mooi briefie geskryf omdat hy nie hier kan wees nie, en pas 'n telegram van Dr Straszacker — hy het vir ons "Regret unable to attend. Send greetings and good wishes for success of Technical Meeting." Ek wil net se ek waardeer al hierdie verskonings. Dit is goeie vriende van ons, daardie.

Dames en Here, nou kom ons by die eerste referaat wat gelewer word deur mnr Beaurain en mnr van der Walt gesamentlik. Mnr Beaurain is Distribusie Ingenieur van Pretoria Munisipaliteit en mnr van der Walt is 'n Privaat Konsultant. Ek stel hulle nou dadelik aan die woord.

Mnr Beaurain

'n Gedeelte van die groot getal afgevaardigdes.

PAPERS — REFERATE

Mr C. Beaurain

TOWNSHIP RETICULATION

C Beaurain Pr Eng **Chief Distrubution Engineer**
Electricity Department
City Council of Pretoria

S J van der Walt Pr Eng Nienaber & Van der Walt

1.0 INTRODUCTION

The 'Guidelines for the provision of engineering service in residential townships' was published in 1983 by the Department of Community Development. Section G of the Guidelines, which deals with the electrical network, was prepared by the National Building Research Institute (NBRI) of the CSIR, assisted by the AMEU.

This section was based on the British "Chief Engineers Conference Report on the Design of Medium Voltage Underground for New Housing Estates'.

The 'Guidelines' have been used by various organisations such as municipalities and consulting engineers for the past three years. This is therefore an opportune time at this technical meeting of the AMEU to exchange information on the problems and shortcomings of Section G of the 'Guidelines'.

We have thought it well to present this paper to initiate the process of information exchange.

DORPSBENETTING

C Beaurain Pr Ing **Hoofverspreidingsingenieur**
Elektrisiteitsdepartement
Stadsraad van Pretoria

S J van der Walt Pr Ing

1.0 INLEIDING

Die 'Riglyne vir die voorsiening van ingenieursdienste in residensiële dorpsgebiede' is in 1983 deur die Departement van Gemeenskapsontwikkeling gepubliseer. Afdeling G van die 'Riglyne' wat handel oor die elektriese netwerk is deur die Nasionale Bounavorsingsinstituut (NBNI) van die WNNR voorberei met bystand van die VMEO.

Hierdie afdeling is op die Britse 'Chief Engineers Conference Report on the Design of Medium Voltage Underground Networks for New Housing Estates' gebaseer.

Die 'Riglyne' is deur verskillende organisasies soos munisipaliteite en raadgewende ingenieurs vir die afgelope drie jaar gebruik. Dit is dus 'n goeie geleentheid om by hierdie tegniese vergadering van die VMEO inligting uit te ruil oor die probleme en tekortkominge van Afdeling G van die 'Riglyne'.

Ons het goedgedink om hierdie referaat aan te bied om die proses van inligtinguitruiling te begin.

2.0 COST OF COMPONENTS USED IN UNDERGROUND RETICULATION OF RESIDENTIAL TOWNSHIPS

In an attempt to establish the relative influence of the different components of a township reticulation system on the cost of the reticulation, the costs of reticulation in several towns in the PWV area were analysed by the consulting engineers concerned. In some of these towns the consulting engineers had been involved in the reticulation design, but in other cases the lay-outs had been kindly supplied by the Electricity Deparments of the Town Councils. The results obtained were as follows:

In all the township reticulation schemes the 11 kV high voltage had been done with ring feeders, and the low voltage with radial feeders.

	COMPONENT OF INSTALLATION	PERCENTAGE OF COST CONTRIBUTION BY COMPONENT
1.	Excavations	5 (mainly soft formation)
2.	High voltage cable	20-30
3.	Miniature substation (with on-load high voltage switchgear)	16-25
4.	Low voltage cable	16
5.	House connections	8
6.	Meter kiosks	9
7.	Street lights	12
8.	Earthing, contract preparation	4

It must be emphasized that these figures can vary for different township lay-outs and they should only be used to illustrate the relative costs of the components.

3.0 HIGH VOLTAGE CABLES (11 kV)

It is clear from the table that one of the largest cost factors is the 11 kV distribution, between miniature substations and between miniature substations and feeder substations. It is therefore appropriate to discuss this apsect first. The analysis of the township lay-outs showed clearly that, in a number of the township reticulation schemes, the 11 kV cable sizes were selected to match the fault level and not the load requirements of the 11 kV ring.

The reason for this must be sought in the interpretation of the data from some cable manufacturers. Manufacturers sometimes quote through-fault current rating for 1 s or a kA/mm^2 factor based on 1 s. Another reason why cables with a 1 s through-fault rating of 250 and 350 MVA are used can be found in Standard Specification SABS 1339-1981: 'Cross-linked polyethylene (XLPE) — insulated electric cables', in Table 35. This table is shown in Fig. 1.
The implication, particularly in the note below the table, is that one should not use cables smaller than 95 and 120 mm^2 on 250 and 350 MVA systems, respectively.

Cables can however withstand higher through-fault currents for shorter periods and, where ring feeders serve miniature substations, there is no reason why the higher values cannot be used, as

2.0 KOSTE VAN KOMPONENTE WAT GEBRUIK WORD IN ONDERGRONDSE RETIKULASIE VAN RESIDENSIËLE DORPSGEBIEDE

In 'n poging om die relatiewe invloed van die verskillende komponente van 'n dorpsbenettingstelsel op die benettingskoste te bepaal, is die benettingskostes van 'n paar dorpe in die PWV-gebied deur die betrokke raadgewende ingenieurs ontleed. By sommige van die dorpe was die raadgewende ingenieurs by die benettingsontwerp betrokke maar in ander gevalle is die uitlegte goedgunstiglik deur die elektrisiteitsdepartemente van stadsrade voorsien. Die volgende resultate is verkry:

In die dorpsgebiedretikulasieskemas was die 11 kV hoëspanning met ringvoerders, en die laespanning met radiaalvoerders gedoen.

	KOMPONENT VAN INSTALLASIE	PERSENTASIE VAN KOSTE BYGEDRA DEUR KOMPONENTE
1.	Uitgrawings	5 (hoofsaaklik sagte formasie)
2.	Hoëspanningkabel	20-30
3.	Miniatuursubstasie (met vollasho̲espanningskakeltuig	16-25
4.	Laespanningkabel	16
5.	Huisaansluitings	8
6.	Meterkaste	9
7.	Straatligte	12
8.	Aarding, kontrakvoorbereiding	4

Daar moet benadruk word dat hierdie syfers kan varieer vir verskillende dorpsuitlegte en hulle moet slegs gebruik word om die relatiewe koste van die komponente te illustreer

3.0 HOËSPANNINGKABELS (11 kV)

Dit is duidelik uit die tabel dat een van die grootste kostefaktore die 11 kV verspreiding tussen miniatuursubstasies en tussen miniatuursubstasies en voerdersubstasies is. Dit is dus paslik om hierdie aspek eerste te bespreek.
Dit het uit die ontleding van die dorpsuitlegte duidelik geblyk dat in 'n aantal van die dorpsbenettingskemas die 11 kV kabelgroottes gekies is om by die foutvlak en nie die lasvereister van die 11 kV ring te pas nie.

Die rede hiervoor moet gesoek word in die interpretasie van sommige kabelvervaardigers se data. Vervaardigers kwoteer somtyds deurfoutstroomaanslag vir 1 s of 'n kA/mm faktor wat op 1 s baseer is.
'n Ander rede waarom kabels met 'n 1 s deurfoutaanslag van 250 en 350 MVA gebruik word kan gevind word in Standaardspesifikasie SABS 1339-1981: 'Elektriese kabels met isolasie van kruisgebinde poliëtileen (XLPE), in Tabel 35. Hierdie tabel word in Fig. 1 getoon.
Veral die nota onderaan die tabel het die implikasie dat 'n mens nie kabels kleiner as 95 en 120 mm op 250 en 350 MVA stelsels respektiewelik moet gebruik nie.

Kabels kan egter ho̲er deurfoutstrome vir korter tydperke weerstaan en waar ringvoerders miniatuursubstasies bedien is daar geen rede waarom daar nie met die ho̲er waardes gewerk kan word

fuses are used in miniature substations for transformer fault protection in most cases. Discrimination between the fuse and the ring overload protection can therefore be easily obtained.

In Fig. 2 the through-fault capability of a 35 mm² cable is shown as a function of the duration of the fault.

From this figure one can see that the 35 mm² cable can be used on

3.1 a 250 MVA system, if the fault duration is limited to 0,15 s and

3.2 a 350 MVA system, if the fault duration is limited to 0,07 s.

The total interrupting time of 11 kV circuit breakers is typically 60-70 ms, with the result that through-fault times of 100-200 ms can be used for supply cables to miniature substations.

It is clear therefore that in almost all cases the size of cable feeders to miniature substations can be based on thermal rating.

4.0 REDUNDANCY IN CABLE FEEDERS

With 'redundancy' is meant cables performing a stand-by function. It is good practice to make provision for redundancy in cable feeders in a design, to enhance the reliability of the power supply. Redundancy is however provided at additional cost, and should be kept to a minimum. Fig. 3 shows the ring feeder systems, each with its redundancy. In all cases it was assumed that cable sizes are selected in accordance with thermal demand. It is therefore clear that the cost of miniature substation feeders can be reduced by using these half-ring systems.
The following cost advantage was achieved by replacing a ring feeder with a three half-ring feeder.

Ring feeder	
11 kV cable, 95²	
6 500 m	R331 500-00
	R331 500-00
Three half-ring feeder	
11 kV cable, 35 mm²	
7500 (R30/m)	R130 250-00
1 x T4 Switch	R14 000-00
	R244 250-00

As already pointed out, this can only be achieved in all cases if smaller cables and shorter through-fault capability ratings are used for systems with 250 and 350 MVA symmetrical fault ratings.
It must be noted however that where feeders supply other types of substations, with for example circuit breakers, co-ordination of the protection will necessitate selection of longer through-fault times.

nie aangesien daar in die meeste gevalle sekerings in miniatuursubstasies vir transformatorfoutbeskerming gebruik word. Diskriminasie tussen die sekering en ringoorstroombeveiliging kan dus maklik verkry word.

Ing Fig. 2 word die deurfoutvermoë van 'n 35 mm kabel getoon as 'n funksie van die duur van die fout.

Vanaf hierdie figuur kan 'n mens sien dat die 35 mm kabel gebruik kan word op

3.1 'n 250 MVA stelsel, indien die foutduur beperk word tot 0,15 s, en

3.2 'n 350 MVA stelsel, indien die foutduur beperk word tot 0,07 s.

Die totale breektyd van 11 kV stroombrekers is tipies 60-70 ms met die gevolg dat deurfouttye van 100-200 ms vir toevoerkabels na miniatuursubstasies gebruik kan word.

Dit is dus duidelik dat in bykans alle gevalle die grootte van kabelvoerders na miniatuursubstasies op termiese aanslag gebaseer kan word.

4.0 OORTOLLIGHEID IN KABELVOERDERS

Met oortolligheid word bedoel kabels verrig 'n bystandsfunksie. Dit is goeie praktyk om in die ontwerp vir oortolligheid in kabelvoerders voorsiening te maak om die betroubaarheid van kragvoorsiening te verhoog. Die oortolligheid word egter teen bykomende koste voorsien en moet tot die minimum beperk word.

Fig. 3 toon die ringvoerder-, die drie 'halfring'-voerder- en die vier 'halfring'-voerderstelsels, elk met sy oortolligheid, aan.

In alle gevalle is aanvaar dat die kabelgroottes in ooreenstemming met die termiese aanvraag gekies is. Dit is dus duidelik dat die koste van miniatuursubstasie-voerders verlaag kan word deur hierdie 'halfring'-stelsels te gebruik.

Die volgende kostevoordeel is verkry met die vervanging van 'n ringvoerder met 'n drie 'halfring'-voerder.

Ringvoerder	
11 kV Kabel 95 mm2 6 500 m	R331 500,00
	R331 500,00
Drie 'halfring'-voerder	
11 kV kabel 35 mmPT2PT	
7 500 m R30/m	R130 250,00
1 x T4 skakelaar	R 14 000,00
	R244 250,00

Soos reeds uitgewys kan dit alleenlik vir alle gevalle verkry word indien kleiner kabels en korter tydaanslae vir deurfoutvermoë gebruik word vir stelsels met 250 MVA en 350 MVA simmetriese foutaanslag.

Daar moet egter gelet word dat waar voerders ander tipe substasies met bv. stroombrekers invoer sal koördinasie van die beveiligting, veroorsaak dat langer deurfouttye gekies moet word.

5.0 FUTURE SYSTEMS AT HIGHER VOLTAGE e.g. 22 kV

Distribution at 22 kV can further reduce the cable costs of miniature substation feeders. The main reason for this is that 22 kV cable is only 20-30% more expensive than an 11 kV cable of the same cross-sectional area. But such a cable can carry approximately twice the power that an 11 kV cable of the same size can.

There would be a cost difference between 11 kV and 22 kV switchgear, but if 22 kV were to be more generally used, this difference would become less.

6.0 MINIATURE SUBSTATIONS

Miniature substations are in general use in electrical reticulation of residential townships. They are the second most costly item in such reticulation. If the costs of miniature substations, with on-load switches and fuses feeding the transformer, are broken down into components, they appear as follows:

COMPONENT	PERCENTAGE OF COST CONTRIBUTED BY COMPONENT
11 kV switchgear	40
Transformer	40
Enclosure and low Voltage switchgear	20

These figures may vary from one manufacturer to another, and they are dependent on the complexity of the low voltage switchgear and the type of street lighting controlgear.

Observation of the services of the high voltage switchgear in the miniature substation leads one to the conclusion that on-load switching is seldom used.

If use is made of 'half-ring' designs where switching is needed at the node of the half-rings, the requirement of switching at every miniature substation becomes even less.

Another proposal is to use on-load high voltage switching on every second miniature substation. Fig. 4 illustrates this proposal.

The goal of the on-load switching facility is firstly to obviate as far as possible unnecessary interruption of supply to consumers in case of faults or when work is required on the system, and this is therefore a factor in the continuity desired by the consumer and something that can only be commented on by electricity supply authorities.

If the consumers, particularly the residential consumer, were prepared to accept a lower standard of service, one of the two on-load switches at the miniature substation could be done away with, with direct connection of the cable to the busbars of the fuse switch or blade links in air. When a length of cable between two miniature substations has to be isolated for some or other reason, then

5.0 TOEKOMSTIGE STELSELS TEEN HOËR SPANNING BY 22 kV"

Verspreiding teen 22 kV kan verder sny aan die kabelkostes van miniatuursubstasie voerders.

Die hoofrede hiervoor is dat 22 kV kabel slegs 20-30% duurder is as 'n 11 kV kabel van dieselfde area grootte. So 'n kabel kan dan nagenoeg twee maal die drywing van 'n 11 kV kabel van dieselfde grootte versprei.

Daar sal 'n verskil in kostes tussen 11 kV- en 22kV-skakeltuig wees maar indien 22kV meer algemeen gebruik word sal die verskil kleiner word.

6.0 MINIATUURSUBSTASIES

Miniatuursubstasies word algemeen gebruik in die elektriese benetting van residensiële dorpsgebiede gebruik. Hulle is die tweede duurste item in benetting van dorpsgebiede.
Indien die koste van miniatuursubstasies met vollasskakelaars en sekerings, wat die transformator voer, in komponente opgebreek word lyk dit soos volg:

KOMPONENT	PERSENTASIE VAN KOSTE DEUR KOMPONENT BYGEDRA
11 kV Skakeltuig	40
Transformator	40
Omhulsel en skakeltuig vir laespanning	20

Hierdie syfers mag varieer van een vervaardiger na 'n ander en is ook afhanklik van die kompleksiteit van die laespanningskakeltuig en die tipe beheer van die straatverligting.

Indien 'n mens die diens van die hoëspanning skakeltuig in die miniatuursubstasie beskou kom 'n mens tot die gevolgtrekking dat vollasskakeling selde gebruik word.

Indien gebruik gemaak word van 'halfringe' ontwerpe waar skakeling by die node van die 'half ringe' benodig word, word die vereiste van skakeling by elke miniatuursubstasie selfs nog minder.

Nog 'n voorstel is om vollashoëspanningskakeling op elke tweede miniatuursubstasie te gebruik. Fig. 4 illustreer die voorstel.

Die doel van die vollasskakelfasiliteit is eerstens om sover moontlik onnodige onderbreking van toevoere na verbruikers te voorkom in geval van foute of wanneer aan die stelsel gewerk moet word en is dus 'n faktor van die bestendigheid wat die verbruiker verlang en iets waaroor slegs elektrisiteitsvoorsieningsowerhede kommentaar kan lewer. Indien die verbruikers en veral die residensiële verbruiker bereid sou wees om 'n laer standaard van diens te aanvaar, kan daar moontlik weggedoen word met een van die twee vollasskakelaars by die miniatuursubstasie met direkte verbinding van die kabel aan die geleistamme van die

only one miniature substation would have to be disconnected for the time it takes to uncouple the other end of the cable or to open the blade links. Such an arrangements can effect a 10% reduction in the cost of miniature substations.

Another option that manufacturers and users should consider is no-load switching at miniature substations. One would hope that with development this could be done within the transformer tank (with or without common oil). I think everyone will agree that such an assembly would make a neat compact unit.

A lowering of costs of high voltage switchgear in miniature substations will tend to reduce the optimum size of the miniature substation. By optimum size we mean the size that leads to the lowest cost for the reticulation of the township. In its turn this will lead to smaller supply areas for miniature substations and therefore to shorter low voltage cables.

7.0 MAIN LOW VOLTAGE DISTRIBUTION

There are two main approaches to the main low voltage distribution in townships, namely:

7.1 A radial system.

7.2 A ring system. (This is not covered in the Guidelines.)

These days townships are planned to have minimum street-length per erf so that township layouts have far fewer streets than townships planned 30 years ago.

Fig. 5 and 6 illustrate this.

This trend has created additional costs for the main low voltage distribution and makes the ring distribution system less attractive.

The method of calculating voltage drop in the main low voltage cables as given in the 'Guidelines' is the best available and originated in the 'Chief ENgineers Report'.

A test programme has been started, in co-operation with the City Council of Pretoria, to test the constants contained in Tables G2 and G3 of the 'Guidelines'.

It was also commenced to find a simple test method for evaluating the maximum demand after diversity and the maximum demand of different consumers in a specific township.

Initial measurements indicate the possibility that the maximum demand of a consumer, over the peak period, can be represented by a single statistical function with a maximum, a minimum, and an average value. Such a representation can greatly simplify the test method.

sekeringskakelaar of lemskakels in lug. Indien 'n lengte kabel tussen twee miniatuursubstasies om een of ander rede afgesonder moet word sal daar dan slegs een miniatuursubstasie uitgeskakel hoef te word vir die tyd wat dit neem om die kabel se ander ent te ontkoppel of die lemskakels oop te maak.

So 'n rangskikking kan 'n 10% vermindering in die koste van miniatuursubstasies meebring.

'n Ander opsie wat vervaardigers en gebruikers moet oorweeg is nullasskakeling by miniatuursubstasies. Met ontwikkeling kan 'n mens hoop dat so iets binne die transformatortenk gedoen kan word (met of sonder gemeenskaplike olie) Ek dink elkeen sal saamstem dat so 'n samestelling sal 'n netjiese kompakte eenheid sal maak.

'n Verlaging in kostes van hoëspanningskakeltuig in miniatuursubstasie sal neig om die optimum grootte van die miniatuursubstasie te verlaag. Met optimum grootte bedoel ons die grootte wat lei tot die minimum koste vir die benetting van die dorpsgebied.

Op sy beurt sal dit lei tot kleiner voorsieningsgebiede vir miniatuursubstasies en dus korter laespanningkabels.

7.0 HOOFLAESPANNINGVERSPREIDING

Daar is twee hoof benaderings tot die hooflaespanningverspreiding in dorpsgebiede naamlik:

7.1 'n Radiaalstelsel.

7.2 'n Ringstelsel (hierdie word nie in die riglyne gedek nie).

Dorpsgebiede word deesdae beplan vir minimum staatlengte per erf sodat dorpsgebieduitlegte heelwat minder strate het as dorpsgebiede wat 30 jaar gelede beplan is.

Fig. 5 en 6 illustreer hierdie.

Hierdie tendens het bykomende koste vir die hooflaespanningverspreiding veroorsaak en maak die ringverspreidingsisteem minder aantreklik.

Die metode om spanningsval in die hooflaespanningkabels te bereken wat in die 'riglyne' uiteengesit word is die beste beskikbaar en het sy oorsprong in die "Chief Engineers Report'.

In samewerking met die Stadsraad van Pretoria is 'n toetsprogram begin om die konstantes vervat in Tabel G2 en G3 van die 'Riglyne' te toets.

Die toetsprogram is ook begin om 'n eenvoudige toetsmetode te vind om die maksimumaanvraag na diversiteit en die maksimumaanvraag van verskillende verbruikers in 'n spesifieke dorpsgebied te evalueer.

Aanvanklike metings dui op die moontlikheid dat die maksimumaanvraag van 'n verbruiker, oor die

Further measurements during the winter peak load period will confirm whether the representation is usable or not. As these preliminary tests will only be completed during July 1986, the results will be handed out as an appendix to this paper.

8.0 STREET LIGHTING

At 12% of the costs of township reticulation, cheaper street lighting in residential townships can contribute to the lowering of reticulation costs.

The typical cost contribution of the three components of a street lighting lay-out is given here:

COMPONENT	PERCENTAGE OF COST CONTRIBUTED BY COMPONENT
Lamp	11
Pole	46
Cable	43

This division of costs is based on a street lighting design with 125 W mercury vapour lamps and a 4 mm^2, 3-phase cable from the miniature substation. From this cost structure, it can be seen that one has to look for cheaper alternatives for street light poles and cables.

At first glance it appears promising to feed street lighting from the meter kiosk and thereby save the separate cable between street lights.

If the peak demand period of the township occurs after sunset, there will be little to gain as the capacity of the main low voltage cable would have to be increased to carry the additional load. For townships where the maximum demand occurs during daylight it can be worth the trouble to feed street lighting from meter kiosks.

It should be interesting to compare costs of street lighting in group housing schemes with those of conventional street lighting as shorter poles and different light fittings are used.

9.0 COPPER LOSSES IN THE DISTRIBUTION NETWORK

It is part of the oprimization process to include electrical losses in the determination of cable sizes.

The minimum total costs occur where the interest on the extra amount spent on a cable is equal to the saving on copper losses as a result of the use of a larger cable.

Fig. 7 illustrates the principle.

The break-even point for high voltage cables is far below the thermal rating and is therefore not practical.

piek periode, deur 'n enkel statistiese funksie met 'n maksimum, 'n minimum en 'n gemiddelde waarde voorgestel kan word. So 'n voorstelling kan die toetsmetode aansienlik vergemaklik.

Verdere metings gedurende die winterpieklasperiode sal bevestig of die voorstelling bruikbaar is.

Aangesien hierdie voorlopige toetse eers in Julie 1986 voltooi kan word sal die resultate as 'n bylaag tot die referaat uitgedeel word.

8.0 STRAATVERLIGTING

Teen 12% van die koste van dorpsgebiedretikulasie kan goedkoper straatverligting in residensiële dorpsgebiede bydra tot die verlaging van retikulasiekostes.

Die tipiese kostebydrae van die drie komponente van 'n straatverpligtinguitleg word hieronder gegee:

KOMPONENT	PERSENTASIE VAN KOSTE BYDRA DEUR KOMPONENT
Lamp	11
Paal	46
Kabel	43

Hierdie verdeling van koste is gebaseer op 'n straatverligtingsontwerp met 125 W kwikdamplampe en 'n 4 mm^2, 3 fase kabel vanaf die miniatuursubstasie. Uit die kostestruktuur kan gesien word dat 'n mens na goedkoper alternatiewe vir. straatligpale en kabeltoevoere moet soek.

By die eerste oogopslag lyk dit belowend om straatverligting vanaf die meterkas te voer en sodoende die aparte kabel tussen straatligte te spaar.

Indien die piekaanvraagperiode van die dorpsgebied na sonsondergang voorkom sal daar min te wen wees aangesien die hooflaespanningkabel se vermoë verhoog sal moet word om die bykomstige las te dra.

Vir dorpsgebiede waar maksimumaanvraag gedurende daglig voorkom kan dit die moeite werd wees om straatverligting vanaf meterkaste te voer.

Dit behoort interessant te wees om kostes vir straatverligting van groepsbehuisingskemas te vergelyk met die van konvensionele straatverligting aangesien korter pale en ander ligtoebehore gebruik word.

9.0 KOPERVERLIESE IN DIE VERSPREIDINGSNETWERK

Dit is deel van die optimiseringsproses om elektriese verliese in te sluit by die bepaling van kabelgroottes.

Die minimum totale koste sal wees waar die rente op die ekstra bedrag gespandeer op 'n kabel gelyk is aan die besparing aan koperverliese as gevolg van die gebruik van die groter kabel.

Fig. 7 illustreer die beginsel.

For low voltage cables the break-even point is nearer, but still below the thermal rating.

Even in the case of single-phase house connection cables, the economical current rating is still below the thermal rating, mainly because the load factor in a house is so weak.

This type of house connection has the additional problem that it is difficult to reduce the fault level at the consumers distribution board to 5 kA (in the vicinity of the miniature substation). This problem is overcome if three-phase connections are made to houses.

In the case of street lighting three-phase distribution wins on both capital costs and losses.

10.0 CONCLUSION

It is possible to cut the cost of underground reticulation systems for townships. The most advantageous area lies in high voltage reticulation. To realise all the savings will require further research and development work.

We hope that this paper will not be seen as criticism of members of the AMEU or the 'Guidelines', but rather as an attempt to initiate a second phase where the 'Guidelines' can be expanded to include:

10.1 An 11 kV cable lay-out design procedure which spells out the advantages of three and four half-ring systems.

10.2 Sufficient data to enable the user to select a protection system for the through-fault rating of the high voltage cable he wishes to use.

10.3 Information about the selection of high voltage switchgear for miniature substations that links up with 10.1.

10.4 A method of measuring the maximum demand function of the consumer. Tables such as G1, which gives maximum demand after diversity as a function of income, should be done away with. In the RSA, with a rapidly changing community and a range of climatic conditions, such as classification has small chance of remaining suitable for long. A method of measuring should rather be used in which local municipalities can determine the maximum demand function of their consumers.

10.5 A calculation method for voltage drop in which the constants obtained in 10.4 can easily be incorporated.

With these additions the 'Guidelines' should make provision for all types of residential townships.

Die gelykbreekpunt vir hoëspanningkabels is ver onder die termiese aanslag en is dus nie prakties nie.

Vir laespanningkabels is die gelykbreekpunt nader, maar steeds onder die termiese aanslag.

Selfs die geval van enkelfase huisaansluitingskabels is die ekonomiese stroomaanslag nog onder die termiese aanslag hoofsaaklik omdat die lasfaktor van 'n huis so swak is.

Hierdie tipe huisaansluiting het die bykomstige probleem dat dit moeilik is om die foutvlak by die verbruiker se verdeelbord tot 5 kA te verlaag (in die nabyheid van die miniatuursubstasies). Hierdie probleem word te bowe gekom indien driefase aansluitings aan huise gegee word.

In die geval van straatverligting wen driefase verspreiding op beide kapitaalkoste en verliese.

10.0 GEVOLGTREKKING

Dit is moontlik om die koste van ondergrondse retikulasiestelsels vir dorpsgebiede te besnoei. Die mees vrugbare area lê in die hoëspanningsretikulasie. Om al die besparings te realiseer sal verdere navorsing en ontwikkelingswerk benodig wees.

Ons hoop dat die referaat nie gesien sal word as kritiek op lede van die VMEO of op die 'Riglyne' nie maar as 'n poging om 'n tweede fase te inisieer waar die 'Riglyne' uitgebrei kan word om die volgende in te sluit:

10.1 'n 11 kV kabeluitlegontwerpprosedure wat die voordele van drie- en vier- 'halfring' stelsels uitspel.

10.2 Voldoende data om die gebruiker in staat te stel om 'n beskermingstelsel vir die deurfoutaanslag van die hoëspanningkabel wat hy wil gebruik te kies.

10.3 Inligting aangaande die kies van hoëspanningsskakeltuig vir miniatuursubstasies wat aansluit by 10.1.

10.4 'n Meetmetode om die maksimumaanvraagfunksie van die verbruiker te bepaal. Daar moet liefs weggedoen word met tabelle soos bv. G1 wat maksimum aanvraag na diversiteit as 'n funksie van inkomste aangee. In die R.S.A. met 'n vinnig veranderde samelewing en 'n verskeidenheid van klimaattoestande het so 'n klassifikasie min kans om lank toepaslik te wees. Daar moet liefs van 'n meetmetode gebruik gemaak word sodat plaaslike munisipaliteite die maksimumaanvraagfunksie van hul verbruikers kan bepaal.

10.5 'n Berekeningsmetode vir spanningsval waar die konstantes in 10.4 verkry maklik geïnkorporeer kan word.
Met hierdie byvoegings behoort die 'Riglyne' voorsiening te maak vir alle tipes residensiële dorpsgebiede.

FIG. 1

TABLE 35 - MAXIMUM SYMMETRICAL FAULT CURRENT CARRYING CAPACITY OF CABLES MADE TO THIS SPECIFICATION

1	2	3	4	5	6	7
Conductor size	Copper conductor			Aluminium conductor		
	0,5 s	1 s	3 s	0,5 s	1 s	3 s
mm^2	kA	kA	kA	kA	kA	kA
16	3,3	2,3	1,4	-	-	-
25	5,2	3,7	2,1	3,4	2,4	1,4
35	7,2	5,1	2,9	4,8	3,4	1,9
50	10,4	7,2	4,2	6,8	4,8	2,8
70	14,5	10,1	5,9	9,5	6,7	3,9
95	19,7	13,8	8,0	12,9	9,1	5,3
120	24,8	17,4	10,0	16,3	11,5	6,7
150	31,0	21,8	12,6	20,4	14,4	8,3
185	38,3	26,8	15,5	25,2	17,8	10,3
240	49,7	34,8	20,1	32,6	23,0	13,3
300	62,1	43,5	25,1	40,8	28,8	16,6
400	82,8	58,0	33,5	54,4	38,4	22,2
500	103	72,5	41,9	68,0	48,0	27,7
630	130	91,3	52,7	85,7	60,5	34,9
800	166	116	67,0	109	76,8	44,3
1 000	207	145	83,7	136	96,0	55,4

NOTE: A symmetrical fault is carried by the cable conductors only and is independent of the method of earthing adopted. It is recommended that even where fast acting feeder protection is employed, a cable capable of carrying the prospective fault current for 1 s be installed.

TABEL 35 - MAKSIMUM VERMOË OM SIMMETRIESE FOUTSTROOM TE DRA VAN KABELS WAT VOLGENS HIERDIE SPESIFIKASIE VERVAARDIG IS

1	2	3	4	5	6	7
Geleier-grootte	Kopergeleier			Aluminiumgeleier		
	0,5 s	1 s	3 s	0,5 s	1 s	3 s
mm^2	kA	kA	kA	kA	kA	kA
16	3,3	2,3	1,4	-	-	-
25	5,2	3,7	2,1	3,4	2,4	1,4
35	7,2	5,1	2,9	4,8	3,4	1,9
50	10,4	7,2	4,2	6,8	4,8	2,8
70	14,5	10,1	5,9	9,5	6,7	3,9
95	19,7	13,8	8,0	12,9	9,1	5,3
120	24,8	17,4	10,0	16,3	11,5	6,7
150	31,0	21,8	12,6	20,4	14,4	8,3
185	38,3	26,8	15,5	25,2	17,8	10,3
240	49,7	34,8	20,1	32,6	23,0	13,3
300	62,1	43,5	25,1	40,8	28,8	16,6
400	82,8	58,0	33,5	54,4	38,4	22,2
500	103	72,5	41,9	68,0	48,0	27,7
630	130	91,3	52,7	85,7	60,5	34,9
800	166	116	67,0	109	76,8	44,3
1 000	207	145	83,7	136	96,0	55,4

OPM.: 'n Simmetriese fout word slegs deur die kabelgeleiers gedra, ongeag die aardingsmetode wat gevolg word. Daar word aanbeveel dat selfs waar snelwerkende toevoerbeveiliging gebruik word, 'n kabel wat die waarskynlike foutstroom 1 sekonde lank kan dra, geïnstalleer word.

FIG. 2

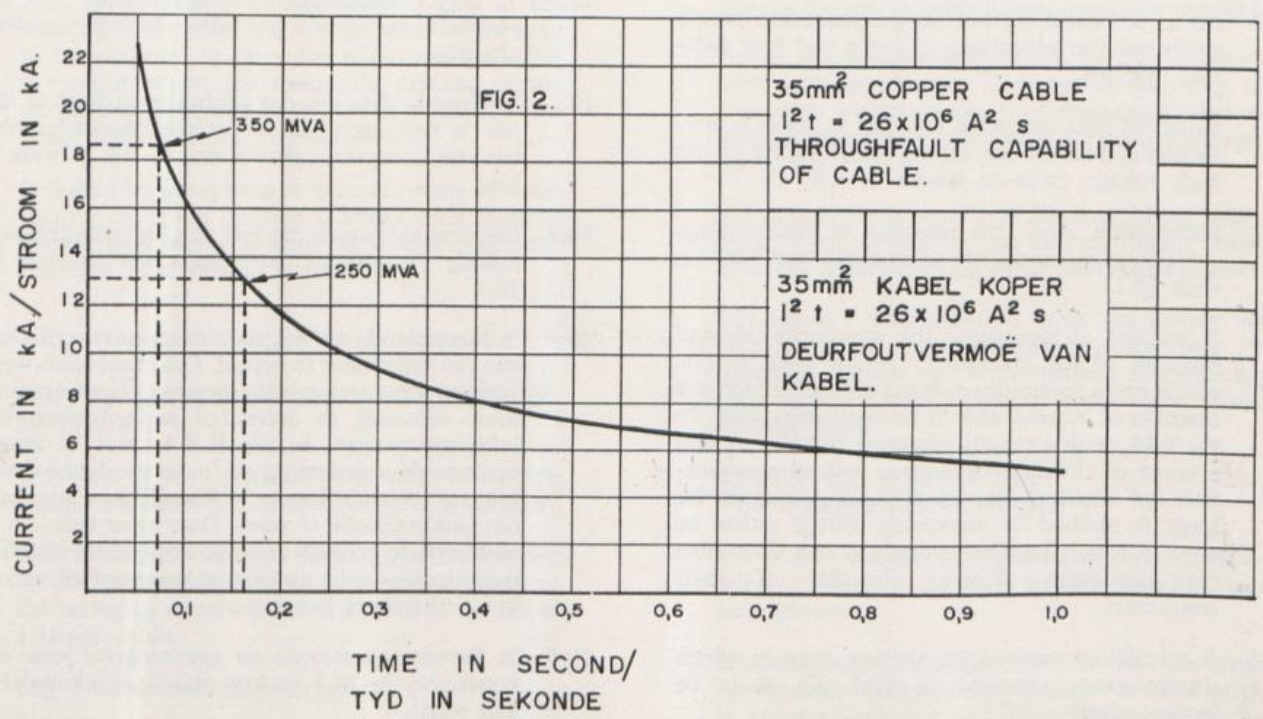


FIG. 3

TWO HALF RING FEEDER REDUNDANCY 100%

TWEE HALWE RINGE OORTOLLIGHEID 100%.

THREE HALF RING FEEDER REDUNDANCY 30%

DRIE HALWE RINGE OORTOLLIGHEID 30%

FOUR HALF RING FEEDER REDUNDANCY 25%

VIER HALWE RINGE OORTOLLIGHEID 25%

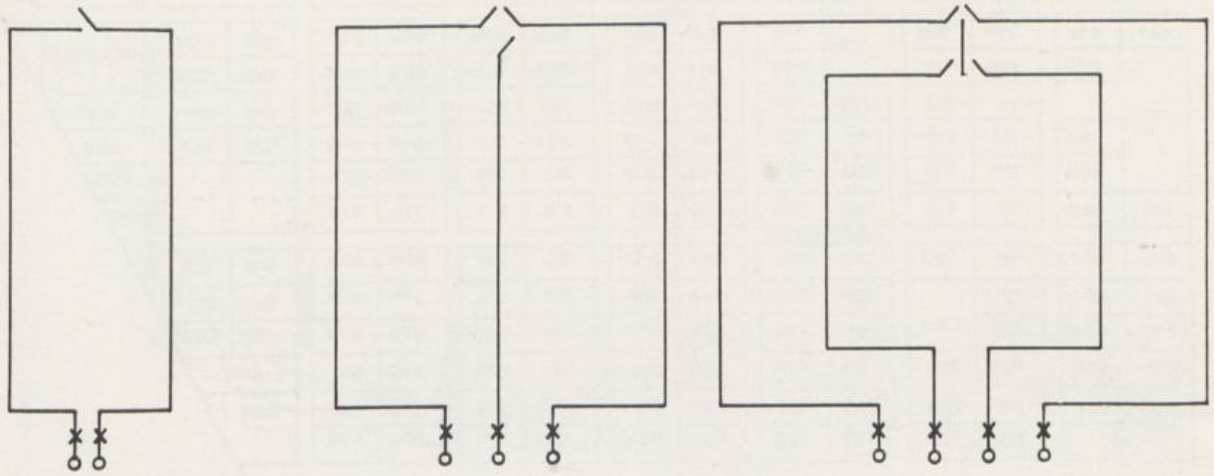
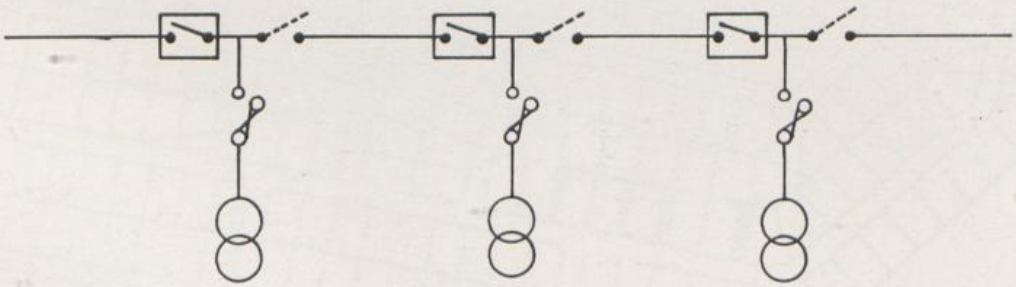


FIG. 4. LAYOUT WITH ON-LOAD SWITCHING AT EVERY SECOND MINIATURE

UITLEG MET VOLLASSKAKELFASILITEITE ELKE TWEEDE MINIATUURSUBSTASIE



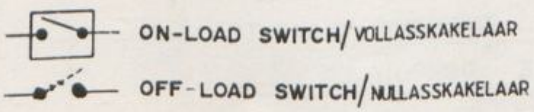
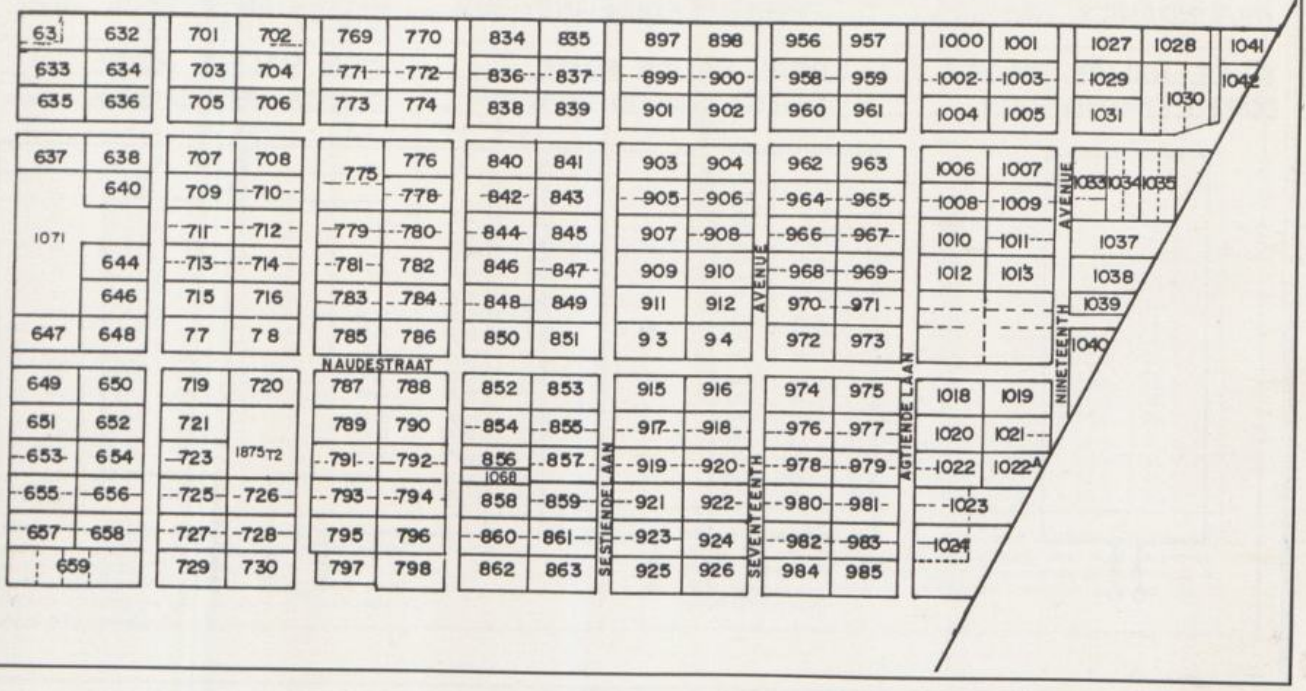


FIG. 5. OLD TOWNSHIP LAYOUT

OU DORPSUITLEG.



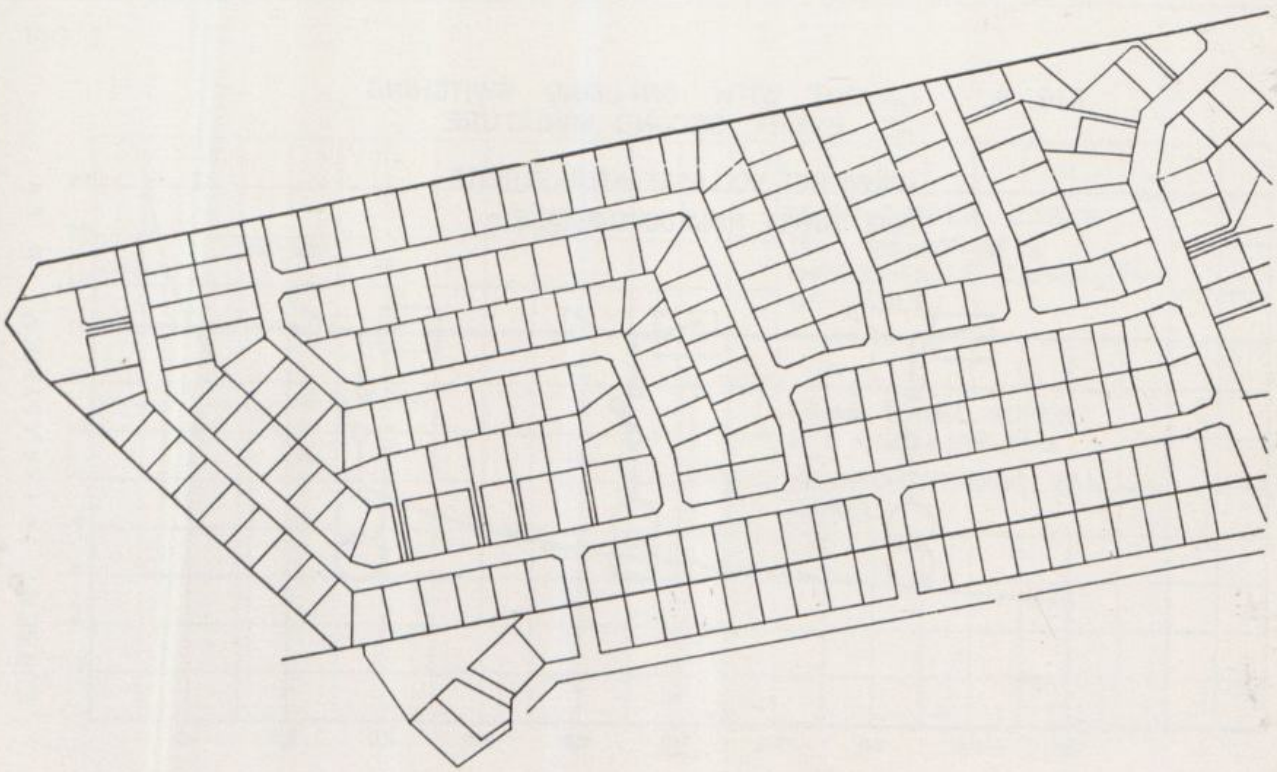


FIG. 6 NEW TOWNSHIP LAYOUT

NUWE DORPUITLEG.

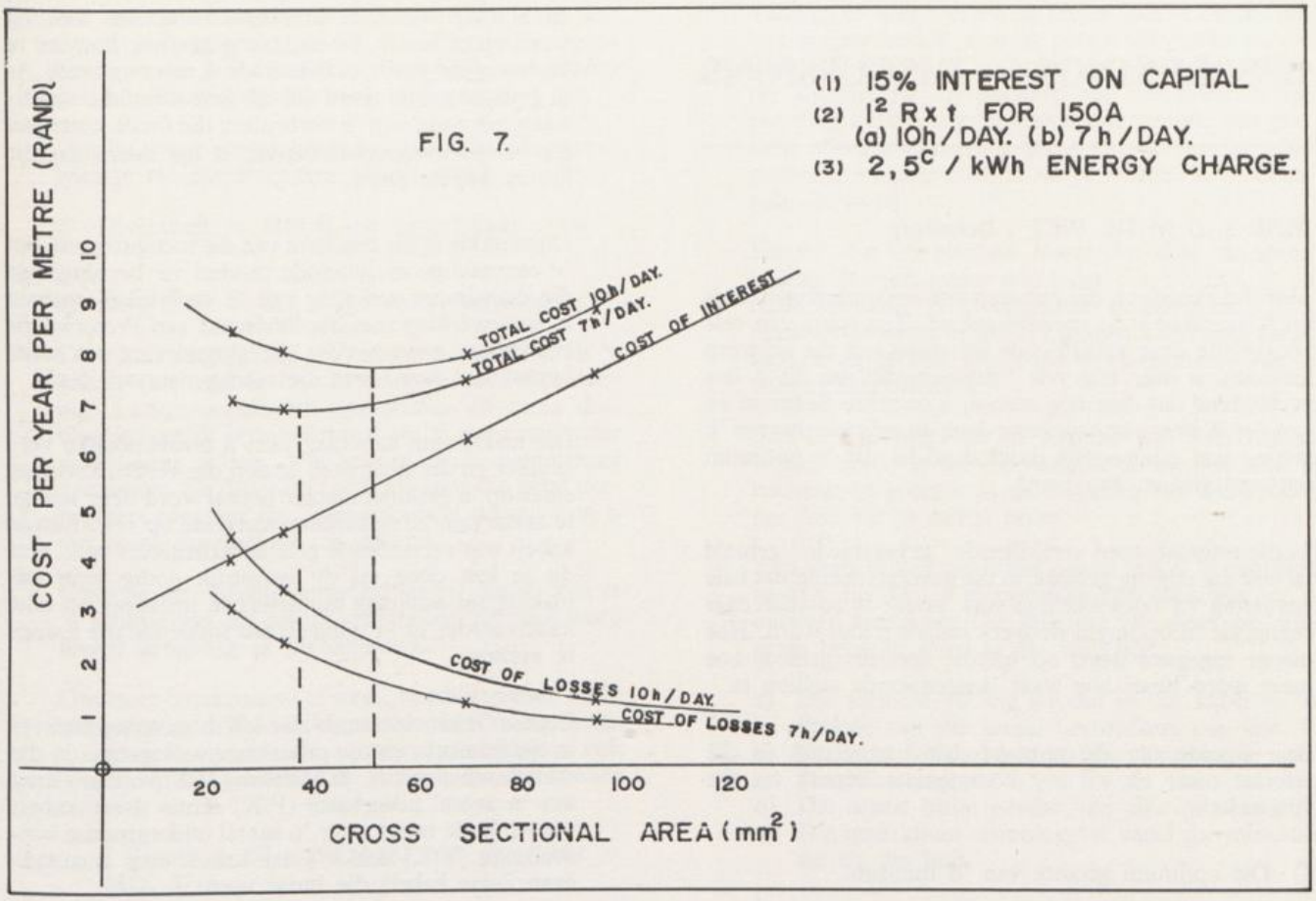


FIG. 7.
(1) 15% INTEREST ON CAPITAL
(2) $I^2 R x t$ FOR 150A
(a) 10h/DAY. (b) 7h/DAY.
(3) 2,5c / kWh ENERGY CHARGE.
COST PER YEAR PER METRE (RAND)
TOTAL COST 10h/DAY.
TOTAL COST 7h/DAY.
COST OF INTEREST
COST OF LOSSES 10h/DAY.
COST OF LOSSES 7h/DAY.
CROSS SECTIONAL AREA (mm^2)

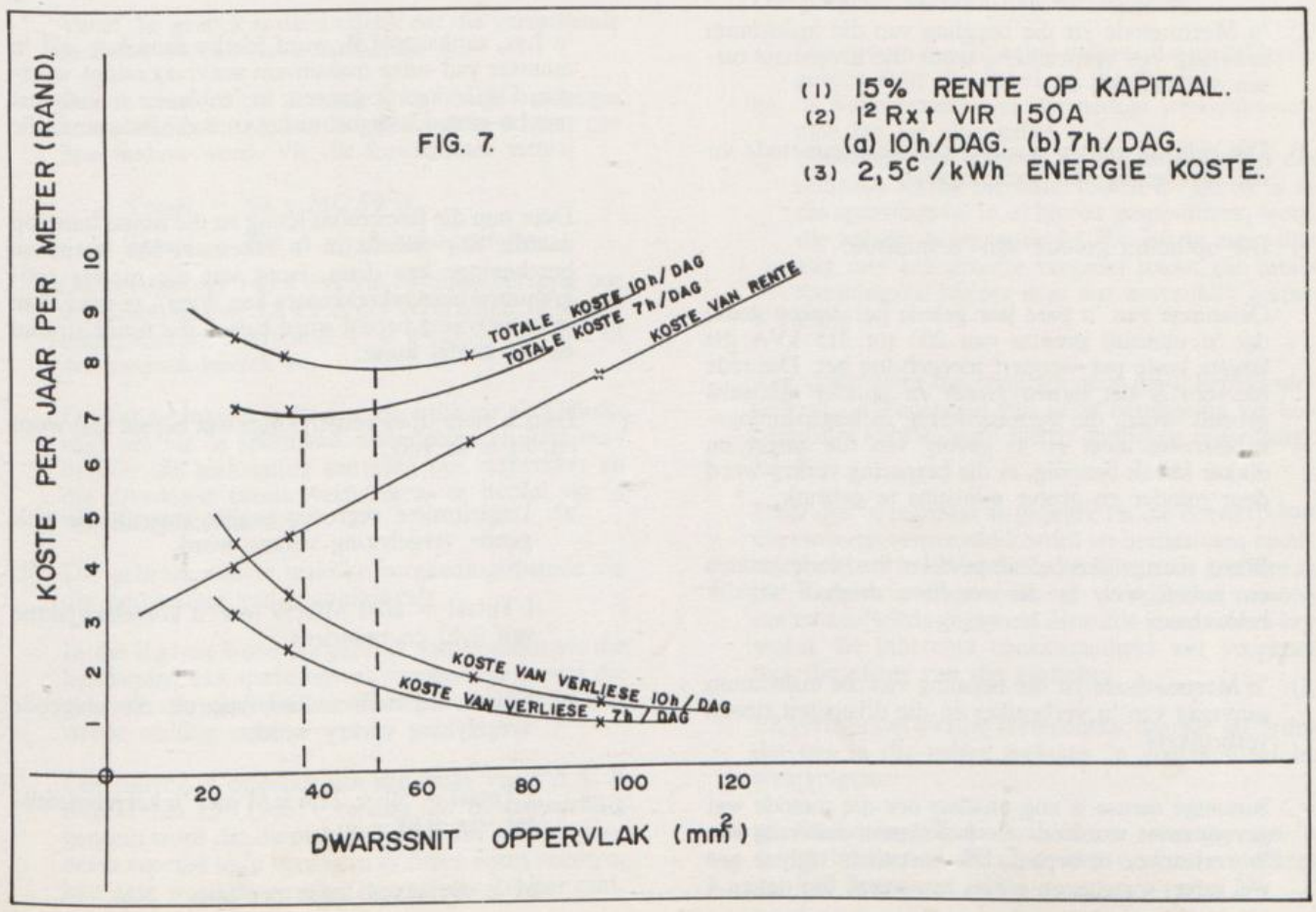


FIG. 7.
(1) 15% RENTE OP KAPITAAL.
(2) $I^2 R x t$ VIR 150A
(a) 10h/DAG. (b) 7h/DAG.
(3) 2,5c / kWh ENERGIE KOSTE.
KOSTE PER JAAR PER METER (RAND)
TOTALE KOSTE 10h/DAG
TOTALE KOSTE 7h/DAG
KOSTE VAN RENTE
KOSTE VAN VERLIESE 10h/DAG
KOSTE VAN VERLIESE 7h/DAG
DWARSSNIT OPPERVLAK (mm^2)

BESPREKINGS — DISCUSSIONS

MNR L D M DE WET : Boksburg

Mnr die President, die ontwerp van verspreidingsstelsels vir woondorpe is 'n spesialis gebied. Ten spyte van vele voorskrifte deur verskillende instansies oor die ontwerp metodes, is daar nog vele "grysgebiede" en dit is dus verblydend dat daar nog mense, soos mnre Beaurain en van der Walt is wat navorsing doen en referate skryf in 'n poging wat uiteiendelik daartoe sal lei dat 'n optimum ontwerp gedoen kan word.

In die referaat word verskillende "grysgebiede" gemeld en ook die stelling gemaak in die gevolgtrekking dat baie navorsing en ontwikkelingswerk nodig is voordat daar regtig vir 'n optimum netwerk ontwerp kan word. Hoe dieper ingegaan word op hierdie spesialis gebied, hoe meer word besef hoe waar laasgenoemde stelling is.

Baie aspekte oor die ontwerp word aangeraak in die referaat maar ek wil my kommentaar beperk tot die volgende:

1) Die optimum grootte van 'n minisub.

2) 'n Meetmetode vir die bepaling van die maksimum aanvraag van verbruikers, asook die diversiteit tussen verbruikers, en

3) Die gebruik van 'n manlike berekeningsmetode vir die berekening van spanningsval.

1) Die optimum grootte van 'n minisub:

Oefeninge van 'n paar jaar gelede het daarop gedui dat 'n minisub grootte van 200 tot 315 kVA die laagste koste per woonerf meegebring het. Die rede hiervoor is dat indien groter en minder minisubs gebruik word, die vermeerdering in laagspanningskabelkostes meer is, as gevolg van die langer en dikker kabels benodig, as die besparing verkry word deur minder en groter minisubs te gebruik.

Word soortgelyke oefeninge deur Stadsrade gedoen en indien wel, is die resultate daarvan vryelik beskikbaar?

2) 'n Meetmethode vir die bepaling van die maksimum aanvraag van 'n verbruiker en die diversiteit tussen verbruikers :

Sommige mense is nog onseker oor die metode wat gevolg moet word om die maksimum aanvraag van 'n verbruiker te bepaal. Die bestaande riglyne gee wel syfers waartussen gekies kan word, bv. tussen 4 en 8 kV.A vir hoër inkomste behuising. Leiding word egter nie in die riglyne gegee oor hoe om te besluit of dit 4 of 6, of dalk 8 kV.A moet wees nie. As in gedagte gehou word dat die keuse van die maksimum aanvraag van 'n verbruiker die finale koste van die verspreidingstelsel bepaal, is die nodig dat dit korrek bepaal word.

Ongelukkig is die resultate van die toetsprogram, om 'n eenvoudige toetsmetode te vind vir bepaling van die maksimum aanvraag van 'n verbruiker, gedoen in samewerking met die Stadsraad van Pretoria, nie beskikbaar gewees voor die vergadering nie sodat bepaal kon word wat die uitslag daarvan is nie.

Die maksimum aanvraag van 'n huishoudelike verbruiker en die diversiteit tussen die verbruikers kan egter op 'n maklike manier bepaal word deur lesings te neem van die maksimum aanvraag op verskillende kabels wat verskillende getalle verbruikers voer. Om dit te kan doen sal dit natuurlik nodig wees om maksimum aanvraag ammeters te installeer op elke kabelvoerder in 'n minisub om sodoende die lesings te verkry.

Beskou 'n kabelnetwerk met kW.h meters gehuisves in die minisubs en die pilaarkaste soos getoon in die skets, aanhangsel A. 'n Minisub (M/S) voorsien krag aan 'n aantal pilaarkaste (P/K) d.m.v 4-aar kabels wat op hulle beurt weer 'n aantal ondergrondse verdeelkaste (V/K) d.m.v 4-aar kabels voer waarvandaan 2-aar kabels die huise voer.

'n Lys, aanhangsel B, word hierby aangeheg wat 'n monster van sulke maksimum aanvraaglesings weergee. Die lesings is geneem in 'n blanke woonbuurt met bo-gemiddelde behuising en is die lesings vir die winter maande.

Deur nou die fasestroom lesing en die aantal huise op daardie fase telkens in 'n rekenaar, wat statistiese berekeninge kan doen, (soos wat die meeste programmeerbare sakrekenaars kan doen), te voer, kan 'n vergelyking bepaal word tussen die totale stroom en die aantal huise.

Daar is twee tipes vergelykings wat bepaal kan word en dit is as volg:

a) Logaritmiese regressie analise waaruit die volgende vergelyking verkry word:

I Totaal = 60 x MO,59 met 'n korrelasiefaktor van 0,40 en tweedens

b) Linêre regressie analise, waaruit die volgende vergelyking verkry word:

I Totaal = 50 + 21,6 x M met 'n korrelasiefaktor van 0,81.

M is die aantal huise per fase.

Die korrelasiefaktor vir die eerste vergelyking is matig wat dalk te onakkuraat is. Vir die tweede vergelyking is die korrelasiefaktor baie hoog wat daarop dui dat die vergelyking meer akkuraat is.

Van bg. twee vergelykings kan die volgende vergelykings vir die diversiteit afgelei word:

c) Diversiteit = MO,41 vir vergelyking a) en

d) Diversiteit = $\frac{3{,}3 \times M}{M + 2{,}3}$ vir vergelyking b).

Die eerste vergelyking gee 'n stroom van 60 A vir 'n enkele huis teenoor 71,6 A vir die tweede vergelyking. Laasgenoemde lyk onrealisties en meer data moet moontlik versamel word om 'n meer realistiese vergelyking te kry. Vir laasgenoemde vergelyking vermeeder die diversiteit ook nie soos die getal verbruikers toeneem nie. Eersgenoemde vergelyking is dus meer aanvaarbaar vir gebruik.

Grafieke van hierdie vergelykings vir die stroom as 'n funksie van die aantal verbruikers per fase word hierby aangeheg as aanhangsel C.

Om meer betekenisvol te wees, word 'n grafiek vir 'n ontwerpstroom van 60 A met diversiteit soos genoem in die referaat oor die ontwerp van Soweto ook getoon op die grafiek. Die formule vir die Soweto ontwerp is:

I Totaal = 60 x MO,6285 met diversiteit = MO, 3715

Vanaf die grafiek is dit duidelik dat die verskillende formules redelik naby aanmekaar is.

Om te toets of die formule in a) enige realistiese antwoorde oplewer, kan 'n geval van se 8 huise per fase beskou word. Vir die formule

I Totaal = 60 x MO,59 is

I Totaal = 205 A vir 8 huise per fase.

Dit is ongeveer 140 kV.A vir 24 huise versprei oor drie fases, m.a.w. 5,8 kV.A per verbruiker. In vergelyking met die Riglyne se 4 - 8 kV.A, lyk dit dus of die formule korrek is.

Op hierdie manier is dit dus moontlik vir elke Stadsraad om vir 'n spesifieke woongebied en klas verbruiker die maksimum aanvraag per verbruiker en die diversiteit tussen verbruikers te bepaal op 'n wetenskaplike manier.

3) Die gebruik van 'n maklike berekeningsmetode vir die berekening van spanningsval:

In die Riglyne word die gebruik van grafieke vir die berekening van spanningsval voorgeskryf en wat die gebruik van grafieke betref, wil ek 'n ietwat omstrede stelling maak.

Die riglyne is opgestel aan die hand van "A C E Report No 13 (1966)" verslag. As in aanmerking geneem word dat dit maklik 3 tot 4 jaar se navorsing neem voordat so 'n verslag in sy finale vorm verskyn, kan gesê word die verslag is ongeveer 24 jaar oud.

Vandag, in 'n tydperk waar feitlik elke Stadsraad oor 'n rekenaar beskik en waar persoonlike rekenaars al meer gebruik word, is dit vir my teleurstellend dat die Riglyne vir die ontwerp van woongebiedverspreidingsstelsels nog 'n onakkurate metode van grafieke aflees voorskryf in plaas daarvan om 'n meer moderne metode voor te skryf waarin 'n rekenaar gebruik word.

Ek wil dus 'n pleidooi lewer dat daar dringend aandag daaraan gegee word dat die VMEO, of 'n ondernemende Elektrotegniese Stadsingenieur, 'n rekenaar program opstel of laat opstel wat deur almal aanvaar en gebruik kan word vir die ontwerp van 'n verspreidingsnetwerk.

Met die gebruik van 'n formule wat soos hierbo bepaal word, is dit die aangewese metode om 'n rekenaar te gebruik in die bepaling van die stroom per fase vir 'n aantal huise.

Ten slotte wil ek net noem dat ek self al 'n program geskryf het vir 'n persoonlike rekenaar wat so 'n ontwerp kan doen. Die inligting van deur die program benodig word is die volgende:

a) Die formule vir die stroom in die kabel as 'n funksie van die aantal verbruikers per fase.
b) Die aantal pilaarkaste op die voerder.
c) Die kabellengtes.
d) Die aantal huise gevoer van elke pilaarkas.
e) Die maksimum spanningsval vanaf die minusub tot by die huis.

Die program bereken dan die volgende:

a) Die stroom in elke kabel volgens die aantal huise gevoer deur die kabel en die formule.
b) 'n Kabelgrootte wat die nodige stroomdravermoë het vir elke kabel.
c) Die totale spanningsval op die kabels vanaf die minusub tot by die huis. Indien dit groter is as die spanningsval in e) hierbo gespesifiseer, word die kabels, beginnende by die eerste een, elke slag met een grootte vergroot totdat die totale spanningsval kleiner is as wat aanvanklik gespesifeer is.

Ten slotte word die resultate deur die rekenaar uitgeskryf. 'n Voorbeeld van so 'n berekening vir kopergeleier kabels, word hierby aangeheg as aanhangsel A.

Deur dus 'n rekenaar te gebruik vir die ontwerp kan die ontwerp vergemaklik word en herhaalbare resultate verkry word. Met die gebruik van die grafieke in die Riglyne is dit moeilik vir verskillende persone om met dieselfde gegewens dieselfde antwoord te kry weens die inherente onakkuraatheid wat voorkom met die aflees van die grafieke.

Ek vertrou dat hierdie kommentaar daartoe sal bydra dat ons in die nabye toekoms 'n voorskrif sal hê waarvolgens:

a) Stadsrade self die maksimum aanvraag van 'n verbruiker en die diversiteit tussen verbruikers kan bepaal en

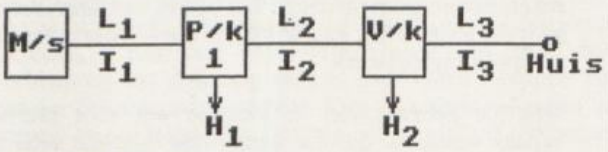
b) 'n Verspreidingstelsel op 'n maklike manier ontwerp kan word om tegnies en ekonomies aanvaarbaar te wees.

Dankie Mnr die president.

AANHANGSEL A

KABELGROOTTEBEREKENINGE 86-08-26

Jou netwerk lyk as volg:

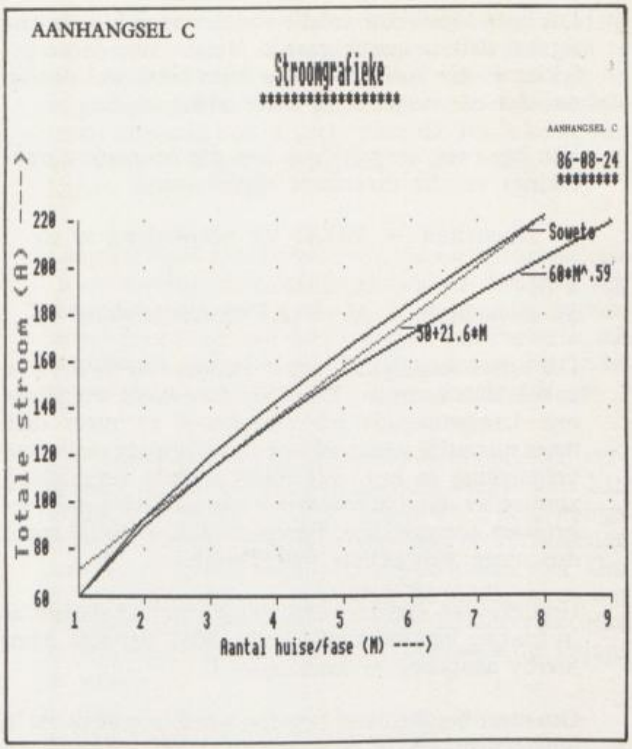


Plek: M/sub 8 na p/kas 8b
Diversiteit volgens: Soweto-kurwe
Die ontwerpstroom per huis = 60 A
Die kabelgroottes is as volg:

Kabel nr.	1	2	3
Lengte	120	80	40
Huise/kabel	9	3	1
Stroom (A)	120	60	60
Kabel (mm2)	120	50	50
dV (V)	4.18	4.27	2.14

Totale spanningsval = 10.58 V of 4.60%

AANHANGSEL C



STADSRAAD VAN BOKSBURG - DEPARTEMENT ELEKTRISITEIT

MAKSIMUM AANVRAAGLESING IN MINISUBS

AANHANGSEL B

1986-08-25

MINISUB	DATUM : 86-01-22 VOERDER	M.A. (A) ROOI	M.A. (A) GEEL	M.A. (A) BLOU	AANTAL HUISE ROOI	AANTAL HUISE GEEL	AANTAL HUISE BLOU	TOTALE AANTAL HUISE
1. Krigestraat, Parkrand (K 203) (630 kVA)	PLAASLIK	130	130	165	5	5	5	15
	PILAARKAS ERF 381	130	165	175	5	5	5	15
	PILAARKAS ERF 400 & 346	215	215	140	7	7	7	21
	PILAARKAS ERF 426	170	220	245	8	8	8	24
								75
								==
2. Websterstraat, Parkrand (K 202) (630 kVA)	PLAASLIK	150	165	170	5	5	5	15
	PILAARKAS ERF 509	190	160	160	7	6	6	19
	PILAARKAS ERF 493	250	255	310	10	10	10	30
								64
								==
3. Van der Post Noord, Parkrand (K 283) (300 kVA)	PLAASLIK	150	165	130	5	6	5	16
	PILAARKAS ERF 765	110	195	145	3	4	4	11
	PILAARKAS ERF 766	135	150	145	4	5	5	14
								41
								==
4. Van der Post Suid, Parkrand (K284) (300 kVA)	PLAASLIK	180	175	170	5	5	5	15
	PILAARKAS ERF 736	140	130	165	5	5	5	15
	PILAARKAS ERF 795	150	170	145	5	5	4	14
								44
								==
5. Millinstraat Noord, Parkrand (K288) (500 kVA)	PLAASLIK	185	145	150	5	5	5	15
	PILAARKAS ERF 1021	290	180	220	8	8	8	24
	PILAARKAS ERF 836	235	230	205	7	7	6	20
								59
								==

MR J R FATH — on behalf of T GAUNT, Affiliate

The cost of township distribution is influenced by two major factors:

- the demand and diversity for which it is designed, and
- the way in which the system is designed to meet the demand.

HKS engineers have commented at other AMEU conferences on the parameters incorporated in the guidelines for the design of electricity distribution networks in residential townships. We believe that the application of the guidelines results in systems which are unnecessarily expensive. In this connection we have found some public authorities have adopted the SABS 0150 demands and diversities but relax the design voltage variation to figures exceeding the plus minus 5% laid down in the regulations, which is one way of reducing costs.

Today's paper takes a different approach to reducing the investment in distribution systems and we commend the authors for trying to address this large subject of system design. We have some questions relating to the proposals presented in the paper and would appreciate clarification from the authors.

1. The authors appear to propose that the overload protection on ring feeders could clear faults sufficiently quickly to permit the selection of cables with a fault current rating of only 100-200 ms. We are not sure what protection scheme is associated with the circuit breaker, but we believe that such short ratings are inadequate for most overload and back-up protection schemes on distribution cable rings. Further information on the protection system would be appreciated.

   We would mention that for Motherwell, just outside Port Elizabeth, the distribution system was designed so that thermal loadings and fault current ratings led to the selection of the same size of conductor. This enables maximum use to be made of the cables. This approach is very similar in effect to that described by the authors of today's paper but does not require such short fault clearance times.

2. We believe that the proposed omission of one on-load switch from the standard ring main HV switch of each mini-substation leads to complex operating procedures and will not allow significant cost savings. Could we have an indication of the cost savings achieved in practice?

   We believe that a much greater saving could be achieved by doing without HV switchgear on some of the transformers on a ring. The saving from adopting this approach is about 5% of the total cost of the electricity distribution system.

3. The Guidelines (SABS 0150) use the economic level of consumers as a categorisation of the demand functions of the average individual consumers. The authors propose that this categorisation be done away with in favour of using measured values. However, at the design stage assumptions have to be made regarding the electricity demand which may develop. Can the authors propose an alternative to the economic classification, for use in initial system design?

4. The authors have not mentioned other important ways of reducing the cost of an installation by adopting a design which takes into account the particulars circumstances of the project and makes use of adequate, but not over-rated equipment. Fault levels, protection schemes and even the voltage rating of the HV cables can be modified by changing the design. We mention these examples because a 'Guideline' will never entirely replace the skills and experience needed to solve engineering problems.

   One of the problems with guidelines is that they can be restrictive and also slow to adapt to changing circumstances. We are already concerned that the committee which was to have updated or amended the Guidelines after the one year trial period (after they were published in 1983) appears to have taken no action yet. Therefore we recommend strongly that the Guidelines should not be expanded as proposed by the authors to include some of the very many techniques used in system design. We believe that such a step would be a contradiction of the spirit of this paper - aimed at reducing costs by proposing new approaches to design. We would appreciate the author's comments on the role of guideline documents in engineering design.

Mr President, our questions touch on only four aspects of this paper. The authors have tackled a large subject of interest to a wide audience. We thank Mr Beaurain and Mr van der Walt for sharing their provocative ideas with us.

MR M P P CLARKE: Randburg

I would like to add my thanks to Messrs Beaurain and van der Walt for the trouble they have taken in preparing and presenting this very interesting paper today.

May I highlight a few points which struck me when I studied the paper, firstly by directing attention to a part of their "conclusions".

They have found that cutting the cost of township reticulation can most advantageously be done by further research in the high voltage part of the network.

This in turn flows from their comments inter alia on cable through-fault capability and the possibility of using faster clearance times for protective equipment. And my comment here is that designers must not lose sight of the fact that over the years field staff have tended to become less skilled and often less trained than in the past. By implication their understanding of the niceties of correct and accurate operation of protective equipment becomes less discerning and the consequences of poor or inadequate maintenance and operation procedures becomes more serious in the long term.

Maybe this is not quite the same as the old story of the housewife who solves the "blown fuse" problem by inserting a hair clip . . . but let it not be overlooked.

And let me remind those of you who attended last year's convention that Author J D van Niekerk, in his paper and later comments on the discussion in connection with "outdoor substations", clearly warned that all related aspects of innovative design concepts must be fully eval-

uated before a final decision is reached. It all boils down to the fact that we get nothing for nothing in this world; there is virtually always a price to be paid in the end.

Which brings me to my second point, namely, the price consumers may have to pay for other aspects of these and other savings possibilities. I refer to paragraph 6.0 Mini-Substation and in particular to the comment "If the consumers, particularly the residential consumer, were prepared to accept a lower standard of service, etc ..."

While this may be possible in some instances where less sophisticated people are using electricity for the first time, I have serious doubts about the introduction of some of the concepts described in the report in older established communities.

I have said it before and I believe it is worth repeating, electricity **is** the 20th century; uses are continually becoming more sophisticated and the need for **more** reliable not **less** reliable supplies is surely rising. Mr President, we ignore this at our peril and to the detriment of our profession.

By all means let us go forward with research, investigations, probing, trying, developing, but let us always keep in mind that there is a price to be paid sooner or later (and this price may not only be in money terms) and be sure that we have properly evaluated the full implications before making our final decision. Let **all** designers please take this to heart!

I thank the authors for stimulating our thinking in these matters; it can only be beneficial in charting the optimum course ahead.

MNR P J BOTES : Roodepoort

Wanneer die verspreidingsingenieur 'n kabel sien slang soos 'n Loch Ness Monster bo die grond, dan moet hy weet foutstrome het hom gehap.

Reeds sedert 1970 het Roodepoort sodanige punte wat onder bespreking was in die referaat aangespreek, beplannings gedoen en in werking gestel met verskillende mate van sukses. Dit is om die rede dat ek vir u hier wil inlig oor die praktiese ondervinding en instandhouding van sulke stelsels.

Sekering-skakelapparatuur is nie beskikbaar nie, wel apparatuur vir die beveiliging van transformatore, en meestal in kringformaat vorm met twee aflas-skakelare vir die kring en een sekering skakelaar vir die beheer van 'n transformator.

Die polimer-tipe paneelsekering skakelare van 'n oorsese fabrikaat het na 'n aantal jare aan die brand geslaan, wat 'n wonderlike rookskerm veroorsaak het soortgelyk aan 'n atoombom, wat my kollegas in die brandweerafdeling in vervoering gehad het. Hierdie tipe toerusting moes vervang word. Die staalomhulste skakelring, geskik net vir kring toepassing, moes aangepas word, en dit was juis hier waar heelwat probleme ondervind was en sekere van die probleme het ook gegrens aan onveiligheid en toestande met groot gevaar vir die operateur.

As 'n kabel geïnstalleer is met 'n kleiner foutstroomvermoë, wat eintlik net beveilig kan word deur 'n sekering, moet dit vervang word wanneer 'n ander vorm van beheerapparatuur gebruik word en dit jaag jou instandhoudingskoste op. Daar is feitlik niks anders te doen nie. Die gedagte is ook daar dat 'n sekering nie kan faal nie, dit moet dan afskakel onder foutstroom toestande, dit is 'n verkeerde afleiding en gevolglik is bystand beveiliging en beheer baie belangrik.

Onder "oortolligheid van kabelvoerders" word die idee van "halfring"-voerders aanbeveel, wat in Roodepoort in gebruik was, maar dit kan alleen in 'n nuwe gebied vooruit beplan word. Die ontwikkeling van dorpsgebiede wat betrokke is in die gebied wat beplan is, gebeur met rukke en stote, waar die eerste dorpe gewoonlik op die uiteinde van die gebied geproklameer word. Tussenin is daar groot gebiede waar nog nie eers beplanning gedoen is vir en selfs na tien jaar is daar nog gate in die prentjie en is die kringe nou nog nie voltooi nie. Gevolglik is daar nou 'n stelsel in gebruik wat net nie voltooi kan word nie, omdat sekere dorpsgebiede net nie wil of kan ontwikkel nie.

Daar moet kennis geneem word dat hoe kleiner die kapasiteit van die mini-sub, hoe minder diversiteit mee gespeel kan word.

"Offload" isolators are available on the market and have been extensively used in Roodepoort for quite a number of years. They are of the polymer-type, compact and specially designed for use in mini-subs.

The ultimate design on the low voltage cable and meter boxes is such that only radial cables are used, looping in and out of meter boxes designed to be directly connected to the two adjacent stands. This is economic and very practical and has numerous advances.

Diversiteit word beïnvloed deur "lasbeheer stelsels" waar dit in gebruik is en die gebruik van soortgelyke stelsels gee 'n mate van beheer wat die voorsiener het oor die diversiteit.

Om praktiese en veiligheidsrede is besluit dat weggedoen word in Roodepoort met die "halfkring" idee van kabelvoering.

Ons moet erken dat riglyne daar gestel is en dit is nie rigiede lyne waarvolgens beplanning gedoen word nie. In Roodepoort erken ons die riglyne en probeer om beter te doen, soos onsself voel op die mees ekonomiese prakties uitvoerbare en instandhouding goedkoopste manier van elektrisiteitsvoorsiening.

MR J D VAN NIEKERK : Affiliate

1. INTRODUCTION

Mr Beaurain and Mr van der Walt are to be congratulated on their paper which is very timeous as a review to the guidelines as everyone is presently engaged in efforts to reduce costs. The exchange of information is therefore very necessary.

2. COST OF COMPONENTS

The cost components in township reticulation depends however on the following factors i.e.

1. Layout of Township
2. Nearest point of supply
3. Ground conditions

The figures quoted are generally agreed with except for street lighting which we have found to be 4 to 5%.

It is assumed that cost components refer purely to first cost and that no lifetime costs have been included.

The design philosophy however should take into account the life cost of the reticulation. It is necessary in a system which could have a life of 40 or more years if for sake of relatively small savings, the cost of increased maintenance, outages, etc is considered.

3. HIGH VOLTAGE CABLE

3.1 The high voltage cable selection is always a concern as not to over design.
The design philosophy should include:

a) If primary supplies are included it should limit the fault level to 250 MVA or shall we say 12,5kA to the new standards, by transformer sizing and switching arrangements.

b) Use the 1 second fault rating but size the ring so that the connected load (all miniature substations) exceeed the cable rating up to fifty percent. The reasons for this is the normal load cycle expected in pure residential areas where peaks last normally not more than two hours and where the thermal rating of the cable will not be exceeded.

3.2 Consideration shall, however, be given to the cable impedance and distance to the protection circuit breaker, in establishing clearing times for occurences with lower fault values.

4. REDUNDANCY IN CABLE FEEDERS

The following remarks:

a) Making of half ring feeders complicates switching.

b) Additional switchgear in substation and or miniature substations is needed.

Mr Ron Slatem

Mr J. A. Venter

c) Co-ordination of protection times may necessitate selection of a longer through fault time and thus a possible upgrading of the cables.

5. FUTURE SYSTEMS AT 22 kV

This is a long term solution, but what about L.V. reticulation at 900V with small transformers to feed say up to six hours at 380/220V. The normal L.V. cable will then be better utilized.

6. MINIATURE SUBSTATION

a) Agreed that ON-Load Switching is seldom used.

b) A lower standard of service without a definition is very relative.

c) Using the figure of 10% as reduction on miniature substation means an overall reduction of 2%

d) Reducing optimum size of miniature substations result in small supply areas and saving in L.V. cables but more miniature substations would be required.

Again what about increasing the statutory voltage variation of plus minus 5% to plus minus 7½% and allowing for possible overloading of the miniature substation and L.V. cables during peak times?

7. MAIN L.V. CABLES

a) Agreed that the layout of townships is a cost factor but it can be reduced by having cable servitudes on stand boundaries.

c) The constants of table G2 of the guidelines should be tested as the figures have been taken from a report of ours written in 1977 for the reticulation of a black township. In this report we used coincidence factors which is the inverse of the diversity factors but this was for a 10% load factor, which also plays a role. This is shown in addendum 1.

The actual loads of all appliances should be taken into account when calculating the load.

For this reason a cheap thermal type relay rated at 5A connected between the stove and the geyser in each will reduce the connected load and so the ADMD. This may affect L.V. cable sizing.

It may be time that AMEU actively through their members and other bodies persue the clarification of this important aspect of the design on electricity reticulation so that scientifically determined factors can be used. Using the possible connected loads for the residential areas, the tables A B C in G2 becomes irrelevant. See Addendum II of method used.

We look forward to see the results of the tests being performed. However to help the information in Addendum III is relevant. This is a possible subject for a future separate paper.

8. STREET LIGHTING

a) Portion too high

b) Poles without an outreach not only save on first cost put possibly on maintenance.

c) Street lighting is more and more becoming a security aspect and cannot be compared with group housing area lighting.

9. COPPER LOSSES

We agree that this is a neglected area which needs more attention.

Lastly the paper has served as stimulant for future action but we must not allow the guidelines to restrict innovation.

ADDENDUM 1

AANTAL VERBRUIKERS	DIV. FAKTOR (Soos getoon in TABEL G2)	OMGEKEERDE	GELYKTYDIGHEIDS FAKTOR (Soos gebruik in die 1977 VERSLAG)
1	1,0	1	1
2	1,47	0,68	0,68
5	2,0	0,5	0,5
10	2,17	0,46	0,46
20	2,38	0,42	0,42
50	2,56	0,39	0,39
100 EN MEER	2,63	0,38	0,38

TABEL 1 ***ADDENDUM 2(a)***

BESKRYWING	**AANGESLOTE LAS (W)**
Stoof	7 000
Geyser (x2)	6 000
Ligte (14 x 7W)	1 050
STOPKONTAKTE: Wasmasjien	2 000
Poleerder	800
Stofsuier	800
Ketel	1 500
Verwarmer (2x)	2 000
Strykyster	700
Yskas	300
Televisie	600
Buitegeboue	1 250
TOTAAL	24 000

Die gemidelde aangeslote las vir dié klas verbruiker is dus 24 000 watt met 'n verwagte lasfaktor van 10%. Dit beteken 'n MWh (eenheid) verbruik van ongeveer 1-1,2MWh per maand. Daar is sekere erwe wat 'n hoër aangeslote las kan hê, maar aangesien die in die minderheid is, sal bogenoemde syfer as 'n gemiddelde gebruik word.

Indien by elke huishoudelike verbruiker 'n eenvoudige termiese laskontrole relê wat in Suid-Afrika vervaardig word installeer word om die warmwatersilinder (geiser) uit te skakel as die stoof aangeskakel word, kan die aangeslote las met tot 4 000 watt verminder word na 20 000 watt en die lasfaktor vermeerder na 16%.

Statisties is aangetoon dat die aanvraagfaktor van 'n huis ongeveer 0,6 bedra. Die gemiddelde maksimum aanvraag vir 'n individuele huis word dus 1 200 watt wat met 220V 'n stroom van 54,55 A beteken.

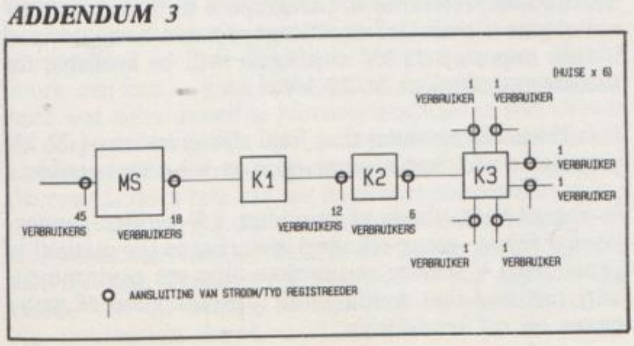
Die gelyktydigheidsfaktor vir huishoudelike verbruikers met 16% lasfaktor en berekende individuele maksimum aanvraag word in tabel I aangetoon. Die laaste kolom van tabel I toon die maksimum aanvraag per verbruiker na 'n 25% groei en voorsiening van 6% verspreidingsverliese.

TABEL 2 *ADDENDUM 2(b)*

Gelyktydigheidsfaktore volgens aantal verbruikers:

Aantal Verbruikers	Gelyktydigheidsfaktor 2*	Maksimum Aanvraag vir verbruiker 1*/ **met 25% groei Met Verliese 6% kW	Met Verliese 6% N kW
1	1	12,00 / 15	12,72 / 15,90
2	0,8	9,60 / 12	10,18 / 12,72
3	0,75	9,00 / 11,25	9,54 / 11,93
4	0,72	8,64 / 10,80	9,16 / 11,45
5	0,68	8,16 / 10,20	8,65 / 10,81
6	0,64	7,68 / 9,60	8,14 / 10,18
10	0,62	7,44 / 9,30	7,89 / 9,86
20	0,58	6,96 / 8,70	7,38 / 9,22
30 en Groter	0,57	6,84 / 8,55	7,25 / 9,06

ADDENDUM 3



MNR E. de C. PRETORIUS: Potchefstroom

1. Ek wil die outeurs gelukwens met 'n weldeurdagte, praktiese referaat.

2. HOËSPANNINGSKABELS

In Potchestroom maak ons die afgelope ingeveer 20 jaar met groot sukses gebruik van 16 mm² (koper) 11 kV kabels wat deur HBV-sekeringskakeltuig beskerm word. Slegs olie-geïsoleerde skakeltuig word gebruik.

Die aangeslote trasformatorkapasiteit op 'n ringvoerde word beperk tot 1 030 kVA. Die beskermende HBV-sekerings het 'n aanslag van 70 A. Ons het nog nooit probleme gehad met stuwingstrome ("in-rush currents") wat sekerings laat smelt nie.

Omdat 11 kV aardfoutstrome beperk word tot 400 A gebeur dit soms dat 'n aardfout op 'n ring die hoofring-OSB uitklink, maar dir gebeur **baie selde:** dit is 'n geval van die kool is die sous werd.

3. OORTOLLIGHEID VAN KABELVOERDERS

In Potchefstroom maak ons gebruik van die "drie halfring-voerder" metode. Dit hou beslis kostevoordele in.

4. TOEKOMSTIGE STELSELS TEEN HOËR SPANNINGS

Ek betwyfel dit of die besparing op die koste van kabel — as daar 'n besparing gaan wees — gaan opweeg teen die ekstra koste van skakeltuig en mini-substasies. Sal 22 kV mini-substasies nie uitermate groot wees nie?

5. MINI-SUBSTASIES

Indien van enkelpolige belaste ringskakeltuig, soos byvoorbeeld die wat plaaslik vervaardig word deur Interswitch, gebruik gemaak word, kan heelwat koste bespaar word. Ek is daarvan bewus dat sommige onder ons sidder by die aanhoor van enkelpolige skakeling op 11-kV-stelsels; waarom weet ek nie want dit is vry algemene praktyk in Europa.

Indien die ring deur HBV-sekerings beskerm word, hoef die mini-substasie nie eers afsonderlike beskerming te hê nie.

'n Verdere besparing is ook moontlik indien die oorbelastingvermoë van 'n transformator, wat so hoog is as 130% in residensiële gebiede met 'n relatief kortstondige kruinlas, uitgebuit word.

6. HOOF LAAGSPANNINGSVERSPREIDING

Een van die twee faktore wat die grootte van Hoof laagspanningskabels bepaal, is spanningsval. Staturer word dit neergelê dat nominale 220-V-verbruikersklemspannings nie laer as 209 V mag wees nie. Indien hierdie laer limiet in die geval van huishoudelike verbruikers verlaag kan word tot 200 V — en ek is seker dat dit geen buitensporige ongerief sal veroorsaak nie — kan daar heelwat op kabels bespaar word.

200 V is 9% onderkant die standaardspanning van 220 V. Dit is nie buitensporig nie gesien in die lig van die Internasionale Elektrotegniese Kommissie wat, al

is dit dan net 'n tussentydse maatreël, 'n toelaatbare spanningsvariasie van plus-minus 10% vir laagspanningstelsels neerlê.

'n Ander gedagte wat by my opkom, is of die bepaling dat die toelaatbare afwyking van plus-minus 5% van die standaardspanning oorskry mag word vir aaneenlopende tydperke tot 10 minute nie tot voordeel uitgebuit kan word nie. Weer eens moet ek daarop wys dat die kruinlas van huishoudelike verbruikers kortstondig is.

7. ALGEMEEN

(1) Ek stem volkome saam met die referente se stelling: "Daar moet liefs weggedoen word met tabelle soos byvoorbeeld G1 wat maksimum aanvraag na diversiteit **as 'n funksie van inkomste aangee."** (Ek onderstreep.) Wat word bedoel met hoë, middel en lae inkomste? Waar is die afsnypunte in R per jaar?
In 'n dorp kry 'n mens in alle geval selde homogene inkomstegroepe.

(2) 'n Probleem wat die jongste tyd sy kop in Potchefstroom en seker baie ander dorpe en stede uitsteek, is die (gemagtigde) oprigting van 'n tweede wooneenheid op 'n residensieel 1-perseel. Hoe moet 'n mens vir hierdie eventualiteit beplan?

8. Baie dankie aan die referente vir 'n baie interessante referaat.

MR A LAP: NBRI

The authors are to be congratulated on the clear and concise manner in which the subject was presented. The cost aspect of the various components of a reticulation system based on actual recent data is considered very important, and have been highlighted in the paper. High voltage cable is shown to be the highest cost component with a 20-30% of the total cost.

In the "Guidelines for the provision of engineering services" this cost implication of the various components has indeed been recognised but it was not appreciated that designers would base their cable selections solely on fault level as the authors have indicated. In fact, under section 8.2 "Selection of cables", it is stated that "that the size of cable may be determined from a knowledge of the maximum time required to clear the fault" (i.e. multiply the 13 kA fault mentioned in this paragraph by
1,41 for 0,5 sec duration
2,58 for 0,15 sec duration
3,77 for 0,07 sec duration

This directive was not perhaps clearly stipulated in the "Guidelines" and the authors should be thanked for pointing out this anomaly.

The authors also mention a test programme to test the constants contained in Tables G2 and G3 of the "Guidelines", namely Diversity and voltage drop correction constants for L.V. distributors respectively. Diversity was previously based on average actual data obtained from various sources, but the values of the other factors contained in Table G3 definitely require actual confirmation. It must be mentioned that various other municipalities have in the past indicated their disagreement with the "unbalanced" factors as shown.

The authors' practical contribution in this aspect should help to clarify the South African position.

It may be interesting to note that from questionnaires sent out to municipalities in 1980, that it was gleaned that the average life of PILC cables was indicated as 37,9 years and that cables appear to remain in better condition and last longer in ther larger towns. No reasons were forthcoming for the latter deduction.

MR V A RAYNAL: Affiliate

I congratulate Messrs Beaurain and van der Walt on their paper and the useful information provided therein.

As a member of the Steering Committee that formulated Section G (Electrical) of the Guidelines appear to have received general acceptance by AMEU members and are being implemented:

HV ring feeders
LV radial feeders
Use of mini-subs.

Personal choice in other matters, particularly the methods of providing low voltage service connections, is still the prerogative of the Town Electrical Enginees and at present there is a wide variety of choices in this matter.

In regard to shortcomings in the Guidelines, I do not agree with the authors that the voltage drop calculations are satisfactory as stated in their paragraph 7.

It has been confirmed that cable temperatures were omitted from volt drop calculations appearing in the Guidelines and a discrepancy of plus minus 20% exists, i.e. that volt drops calculated from the Guidelines are too low and could lead to an under-designed LV reticulation system.

I should like to comment what is probably the first 22 kV underground cable residential reticulation installation in the Republic, on behalf of Escom.

Our experience indicates that the HV switchgear component of the 22 000/400 volt mini-subs costs over 66% of the mini-sub and, furthermore, this switchgear is entirely imported.

Because reticulation at 22 kV eliminates one stage of transformation, it is in the national interest that it be adopted and there is every indication that it is rapidly gaining popularity in the Republic.

The authors' reference in paragraph 6 to the cost of HV switchgear is therefore significant and will be aggravated if only imported 22 kV switchgear will be available for fauture reticulations at 22 kV.

It is therefore essential that local manufacture of 22 kV ring main switchgear commence as soon as possible.

In regard to methods of providing LV service connections, I favour group (cluster) metering as the method of providing LV service connections that are environmentally tidy and that would avoid a proliferation of meter boxes on erf boundaries.

MNR S J VAN DER WALT — Geaffilieerde lid

Mnr die President, dames en here, ek is eintlik baie bly dat mnr Botes saam gesels het, veral omdat hy vertel daar is munisipale owerhede wat reeds die aflas-skakelaars gebruik. Ek reken die voorstel wat ons in die referaat gemaak het van een aflas of een nillasskakelaar of een vollasskakelaar is nog nie eers so optimum soos twee aflas-skakelaars nie en indien iemand twee aflas-skakelaars het, dan het hy in werklikheid seker 95% van die verbetering of kostevoordele wat ons voorgestel het met die substasies reeds gerealliseer. Ek moet hom eintlik gelukwens daarmee.

Dan die ander kommentaar — mnr Clarke het 'n punt daar met die verlaging van standaarde. Ek dink nie ons wil hier 'n beeld bring dat ons standaarde wil verlaag nie. Die beeld wat ek vir u graag wil voorhou is die van 'n ketting wat breek met die swakste skakelaar en ek wil graag die term gebruik projek-koordinasie of ontwerp-koordinasie dat ons nou al die dele ontwerp teen dieselfde ontwerpstandaard, of laat ons liewer se eweveel. Dit is eintlik moeilik om dit uit te druk maar ek wil nie graag die term "veiligheidsfaktor" gebruik, maar indien u dan so wil kies laat ons dan van 'n veiligheidsfaktor praat. Laat ons met dieselfde vertroue elke deel van die ontwerp doen dan optimiseer ons die ontwerp en om daarby terug te kom wil ek net graag die vriende van AKS hier noem, die kwessie van fout vermoë van skakelaars. Indien ons van skakeltuig praat, dan praat ons van 11 kV skakeltuig hoofsaaklik. 11 kV skakeltuig het die vermoë om by maksimum foutstroom waarvoor hy ontwerp is op die sogenaamde oombliklikheid klinking/klinktye van 50 tot 80 millisekondes te bereik. Dit is baie algemeen vandag om klinktye daar te gebruik en nou kan 'n mens wel sê goed maar daar is 'n oorstroom beveiliging aan hierdie ding gekoppel maar die punt waaroor ons gesels is die punt waar die maksimum fout vermoë van die stelsel vloei. Dit is die punt waarby jy die ontwerp, wanneer 'n maksimale stroom wat daardie stelsel voorsien, daar vloei indien ons ons beskerming so doen, dan sal die skakelaar of die stroombreker op daardie punt op die gebied van oombliklikke klinking funksioneer. Derhalwe kan ek nie 'n groot probleem sien nie om klinktye van in die omgewing van 100 millisekonde of selfs laer te kan gebruik.

Dan 'n volgende punt wat hulle gemaak het oor die klassifikasie van woongebiede. Ek wil net weereens die punt benadruk: wat ons voorstaan is nie 'n dokument met 'n klassifikasie van woongebiede. Ons staan voor 'n toetsmetode om elektrisiteitsvoorsienings owerhede en munisipaliteite in staat te stel om sy eie maksimum aanvraag syfer op 'n goedkoper eenvoudiger manier te bepaal en ons moet leer met die tyd. Indien 'n sekere tipe dorpsgebied in Port Elizabeth 'n eerste is van daardie soort, dan kan hy gaan kers opsteek by ander munisipaliteite wat naby dieselfde klimaatstoestande is wat alreeds 'n dorpsgebied gebou het en hy kan hulle maksimum aanvraag syfers gebruik. In die tweede ronde wanneer hy die tweede dorp bou dan het hy al data waarmee hy sy eie ontwerp kan verfyn. As u na Richardsbaai kyk dan sit sy maksimumaanvraag periode in die somer in die middel van die dag, Pretoria s'n is sewe-uur die aand in die middel van die winter, so daar is groot verskille tussen ons residensiële dorpe.

Mnr S. J. van der Walt aan die woord.

BYLAAG TOT REFERAAT

MNR S J VAN DER WALT :

PRAKTIESE TOETSE OM MAKSIMUM AANVRAAG EN DIVERSITEIT VAN VERBRUIKERS TE BEPAAL

1. INLEIDING

In 'n poging om meer inligting oor die laspatroon van verbruikers in 'n dorpsgebied te verkry is metings gemaak gedurende die wintermaande van 1986.

Die doel met die metings is nie om 'n nuwe stel waardes vir die "riglyne" te verkry nie maar eerder om die toepasbaarheid van die "riglyne" te toets.

2. METINGS

Die volgende lesings is geneem:

2.1 Registrasie van stroomaanvraag van 8 huise oor 2 weke periode met 'n stroomregistreerder.

2.2 Registrasie van maksimumvraag m.b.v. maksimumaanvraag ammeters by 16 huise asook die maksimumaanvraag van die kabel wat die 16 huise voer.

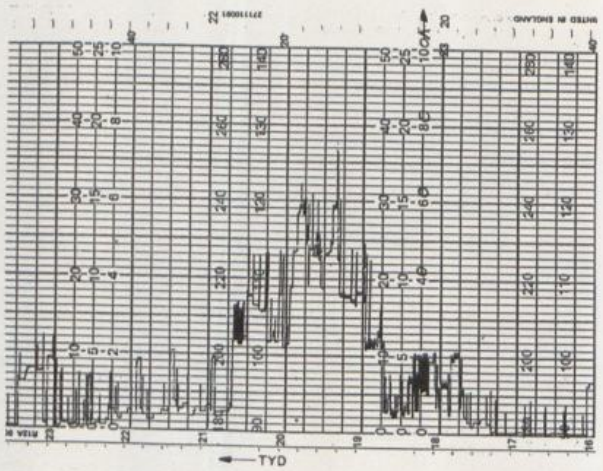
3.1 RESULTATE

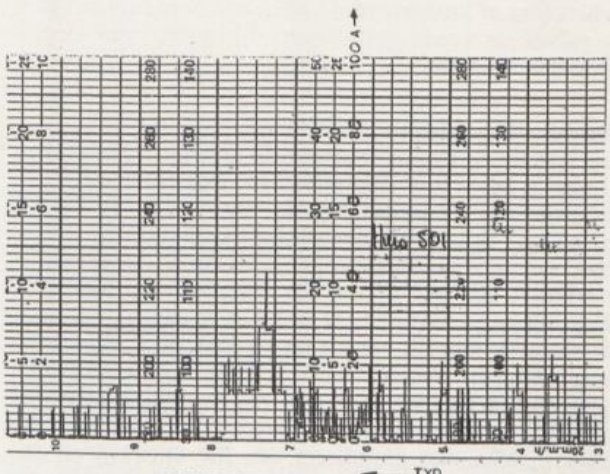
Die volgende resultate is verkry:

3.1 Fig. 3.1 toon tipiese laskurwes van die huise op verskillende dae. Maksimumaanvraag is oorwegend in die 17h30 tot 20h00.

3.2 Fig. 3.2 toon die maksimum aanvraag lesings wat verkry is op die 16 huise asook die maksimum-aanvraag van die toevoerkabel en die miniatuursubstasie.

FIG. 3.1 LASKURWES





OGGEND LASKURWE

FIG. 3.2.

OPNAME VAN LAESPANNING LESINGS IN FAERIE GLEN X 6

MINISUB: NEVADA / MINISOTA TYD VAN LESINGS: ONGEVEER 16h00 30 MINUTE MAKSIMUM AANVRAAGLESINGS IN A.

Erfnr.		Fasekleur	23/6/86 1	24/6/86 2	25/6/86 3	26/6/86 4	27/6/86 5	28/6/86 6	29/6/86 7	30/6/86 8	1/7/86 9	2/7/86 10	3/7/86 11	4/7/86 12	14/7/86 13	15/7/86 14	16/7/86 15
727		Blou	50.4	51.2	43.2	38.4	30.4	35.2	28.8	65.6	40	27.2	35.2	32	46.4	8	8
728		Rooi	69.6	60	64	60.8	54.4	49.6	56	51.2	57.6	56.8	64.8	64	57.6	38.4	24
729		Blou	49.6	41.6	41.6	36.8	40	24	28.8	43.2	45.6	44.8	45.6	37.6	46.4	44.8	36.8
730		Blou	46.6	48	42.4	35.2	46.4	48	46.4	41.6	47.2	44	35.2	43.2	44.8	40.8	38.4
731		Rooi	47.2	50.4	38.4	41.6	40	43.2	35.2	40	41.6	40	35.2	36.8	44.8	52.8	42.4
732		Blou	24	12	12	16	12	12	32	12	0	0	40.8	36	41.6	16	28
745		Geel	72	69.2	60	62.4	52.8	60.8	60.8	49.6	57.6	53.6	71.2	44.8	70.4	65.6	57.6
746	1.	Rooi	16	16	16	16	16	19.2	16	24	14	16	19.2	16	28.8	16	16
	2.	Geel	32	32	32	24	32	32	27.2	35.2	36	16	16	30.4	51.2	29.6	24.8
	3.	Blou	16	16	16	16	16	16	16	16	16	31.2	40.8	16	25.6	16	16
746/EF		——	64	64	64	56	64	67.2	59.2	75.2	66	63.2	76	62.4	97.6	61.6	56.8
747		Rooi	64	51.2	54.4	49.6	40	40	40	59.2	44	46.4	49.6	46.4	51.2	57.2	39.2
748		Geel	40	41.6	33.6	36.8	32	38.4	38.4	32	46.4	32.8	36.8	36.8	41.6	0	27.2
749		Blou	51.2	24	28.8	32	30.4	40	40	35.2	33.6	35.2	44	35.2	62.4	41.6	26.4
750		Rooi	57.6	46.4	48	52.8	54.4	48	56	38.4	56	51.2	40	42.4	58.4	56	71.2
751		Rooi	60	48	48	32	35.2	36.8	41.6	44.8	32	46.4	44.8	29.6	45.6	32	44.8
752	1.	Rooi	12	0	16	12.8	12.8	12	12	32	12	8	3.2	8	8	8	0
	2.	Geel	44	38.4	24	38.4	38.4	16	30.4	16	12	8	38.4	37.6	42.4	25.6	29.6
	3.	Blou	12.8	16	14	16	16	12	12	9	9	16	16	16	16	16	19.2
752/EF		——	68.8	54.4	54	67.2	67.2	40	54.4	57	33	32	57.6	61.6	66.4	49.6	48.8
753		Rooi	39.2	24	19.2	28.8	32	56	27.2	16	16	8	0	16	50.4	28.8	32
754		Geel	88	80	84.8	60.8	51.2	24	35.2	43.2	77.6	81.6	48	51.2	54.4	24	50.4
TOT. LAS																	
KAB	1.		171	180	156	174	204	204	192	180	222	162	168	192	207	132	135
	2.		288	318	243	222	216	210	180	162	162	222	238	201	222	135	195
	3.		192	168	162	192	180	162	168	168	171	168	175	210	201	183	165
MINS	1.		320		367.2	360	400	368	464	336	335	360	374	394.4	372	256	284
	2.		344		422.4	376	320	352	312	204	385	390	405	336.8	372	256	332
	3.		228		342.4	360	344	360	344	276	440	364	378	396	356	344	228

4. VERWERKING VAN RESULTATE

4.1 Vanaf die maksimumvraaglesings van die huise is 'n kumulatiewe distribusie kurwe geteken. Op dieselfde grafiek is die normaalverdeling ingeteken wat ooreenstem met die gemiddelde waarde en die standaardafwyking van die data. Sien Fig. 4.1.

4.2 Die kurwe van Fig. 4.1 is gebruik om maksimumaanvraag waardes vir verskillende verbruikers op 'n kabel toe te ken. Sien Fig. 4.2.

4.3 Berekenings van lasvloei is gedoen en daar is gevind dat die toedeling van Fig. 4.3 die spanningsval 'n maksimum maak.

Die spanningsval en kabellas is bereken met bostaande data asook met behulp van die "Riglyne." Die waardes word in Fig. 4.3 weergegee.

4.4. Waardes en diversiteit van 16 en 40 huise is bereken. Hierdie waardes word saam met die ooreenstemmende waardes van die "Riglyne" weergegee in Fig. 4.4.

5. BESPREKING VAN RESULTATE

5.1 Diversiteit tussen huise varieër tussen 0,72 en 0,89 met 'n gemiddelde waarde van 0,81 vir 16 huise en 'n gemiddelde waarde van 0,6 vir 40 huise. Hierdie resultate stem nie ooreen met die riglyne nie.

5.2 Die waardes van spanningsval bereken uit die resultate is effens hoër as die bereken volgens die riglyne.

5.3 Die konsep van 'n statistiese veranderlike maksimumaanvraag kan nie bevredigend saamgevoeg word onder die breë term diversiteit nie.

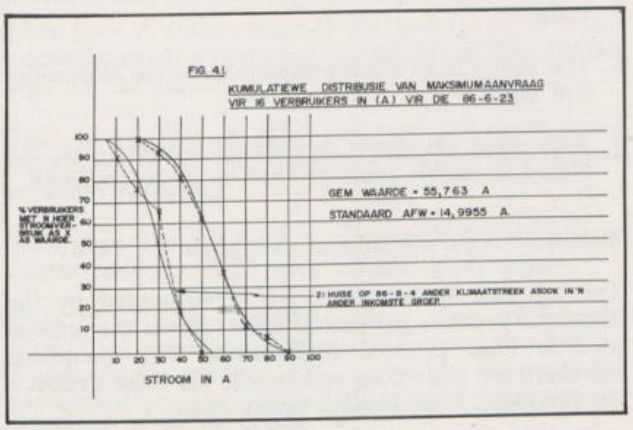
6. GEVOLGTREKKING

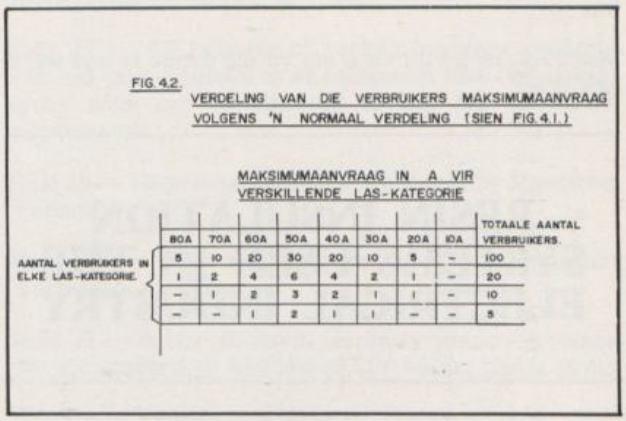
6.1 Dit blyk uit die beperkte voorlopige toetse dat 'n Suid-Afrikaanse metode ontwikkel moet word om die ontwerp van residensiële dorpsgebiede te doen.

6.2 Die metode om die maksimum spanningsval met die voorgestelde toedeling van die statistiese waardes van huislaste op 'n kabel te bereken is tegnies meer aanvaarbaar as die faktore van spanningsval van die riglyne.

6.3 Dit blyk verder dat die toetsmetode wat in dié bylaag gebruik is voorgelê kan word vir evaluasie deurdie V M E O.

6.4 Dié toetsmetode kan dan gebruik word om maksimumaanvraag (gemiddelde waarde, standaard afwyking en diversiteit) te bepaal vir alle inkomste- en bevolkingsgroepe.





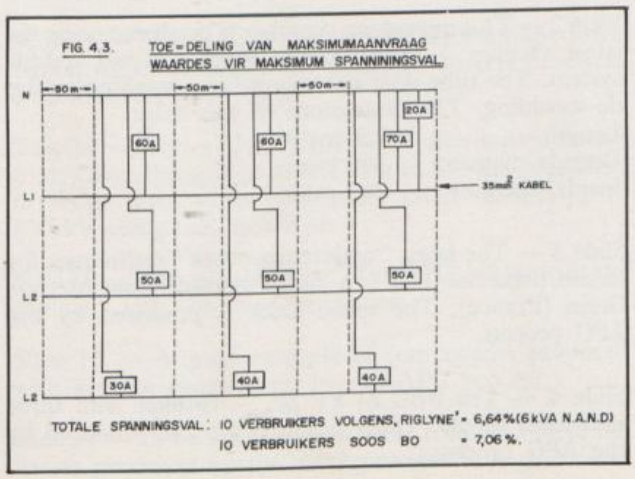


FIG. 4.4.

DIVERSITEITS FAKTORE

AANTAL VERBRUIKERS	GEMETE DIVERSITEIT			DIVERSITEIT VOLGENS, RIGLYNE'
	LAAG	GEM	HOOG	
16	0,72	0, 81	0, 89	0, 44
21	0,71	0, 73	0,83	0, 42
40	0,47	0, 6	0,67	0, 4

MNR C BEAURAIN: Pretoria

Meneer, ek dink dit is 'n punt wat mnr Fath gemaak het, dat 'n mens nie te eksklusief moet wees wanneer die riglyne oopgetrek word nie maar ek dink as 'n mens gaan kyk na die hele blou boek daar as 'n geheel, en jy kyk na die siviele dienste, dan sal jy agterkom dat die siviele dienste in groot detail gehanteer is en die hele gedagte, soos wat dit vir my lyk, is dat die boek uiteindelik in die hande gestop kan word van 'n jong ingenieur wat nou net uit 'n universiteit uitkom, of in elektrisiteits geval waar jy baie keer kry dat in 'n kleiner dorpie, waar hulle nie ingenieurs of mense met genoeg agtergrond kan bekostig nie, waar hulle daardie inligting kan gebruik wanneer hulle dorpe moet ontwikkel, en dan moet ons dink aan ons opkomende Swart plaaslike besture wat nie die kundigheid het nie en wat ook van hulle eie mense gaan gebruik maak en waar dit op die ou end dalk belangrik gaan wees om vir hulle 'n dokument te gee wat hulle basies kan neem en 'n soort van 'n handleiding van die begin tot end om vir hulle te lei deur die hele proses van ontwerp vir 'n dorpsuitleg.

MNR J LOUBSER: President

Ek kan vir u sê toe die firma Ciba-Ceigy by die VMEO aansoek gedoen het om geafilieer to wees, het ek dit so bietjie snaaks gevind want Ciba-Ceigy was by ons altyd bekend as 'n aptekersfirma. Hulle het my egter een dag genooi om bietjie te gaan kyk daar na hulle fabriek wat hulle besig was om te maak en ek was besonder beïndurk, en dit is presies hoekom mnr Thinus Fick vandag hier is.

Mnr Fick, ek los dit vir u om vir die mense te wys wat u kan doen.

RESIN INSULATION SYSTEMS USED IN THE ELECTRICAL INDUSTRY

MR L M FICK — Affiliate

Mr President, Ladies and Gentlemen

Epoxy is an organic material that is combined with inorganic fillers to produce rigid insulation structures for indoor and outdoor use. Cycloaliphatic epoxy is the acknowledged formulation for outdoor epoxy applicaton. Cycloaliphatic epoxy typically contains 60 to 65 weight percent inorganic fillers. These fillers are inexpensive dielectric materials that strengthen the epoxy and lower the cost per kilogram of the filled material as compared to the non-filled material. Typical fillers are silica, Sio_2(for indoor use), Sio, W12 EST (for outdoor use) and aluminatrihydrate $A1_20_33H_2$ (for SC6 (for SF_6application). The liquid resin, liquid hardener, liquid accelerator, colouring paste and filler are combined under vacuum to form the filled epoxy. The fillers, with or without surfactants such as silane on their surface, are mixed into the low viscosity liquid. Upon gelation and curing, this combination forms the composite solid insulation structure.

Araldite Epoxy Resin in the Electrical Industry

The use of araldite epoxy resin as insulation medium in the electrical industry in indoor and outdoor equipment has proved to be very successful. In indoor equipment of the last 39 years and outdoor in South Africa since 1977. The advantages that this insulation medium offers are as follows:

1. Outstanding dielectric strength, both in the short and long term, e.g. 20-30 kV/mm.
2. Very good tensile, flexural and impact properties, both short and long term.
3. Low water absorption that is readily released.
4. Excellent insert tolerance, e.g. copper, brass and steel.
5. Deflection temperatures that can be adjusted to be 10-15 °C higher than the service temperature of the equipment.
6. The addition of special fillers to suit the most demanding application, e.g. SF_6 and outdoor installations.
7. With new production techniques, components that are free from any defects (internal and external voids).
8. The ability to be readily moulded into the most difficult shapes.
9. With short gel cycles at elevated temperatures, the ability to enable mass production of components.

Slide 1 — Low oil volume switchgear for 24 kV.

The top and bottom parts are manufactured by the automatic pressure gelation process. This is the method used to mass produce components. The quenching chambers are glass-fibre reinforced. All these products are produced from araldite epoxy resin.

Slide 2 — This quenching chamber is produced using the latest vacuum — APG process using a liquid araldite system. The tube does not require any machining after de-moulding. The dimensions of this tube:

Length	2,3 metres
Outside diameter	300 mm
Inside diameter	260 mm.

Slide 3 — The latest "maintenance free" techniques for circuit breakers. This is a 24 kV breaker from Merlin-Gerin (France). The mono-block is produced by the APG process.

Slide 4 — The BBC 24 kV SF_6 — breaker with three individual spouts. These products are also produced by the APG process.

Slide 5 — 7,2 kV SF_6 — disconnector from Alsthom in France. The mono-block is also produced using the APG process.

Technical data:

Service voltage	— 3,2-6,6 kV
Rated current	— 200 A
Breaking capacity	— 2 MVA
Arc extinction time	— 25 milli-seconds
Endurance	— At least 100 000 movements
SF_6	— 1,5 bar.

Slide 6 — The most up to date and exclusive metal clad M.V. SF_6 distribution station up to 36 kV from Siemens (F.R.G.) with vacuum breakers. Ten years' maintenance free and operation under severe indoor and protected outdoor conditions are guaranteed.

Slide 7 — A 24 kV distribution station with individual insulated parts.

On top — busbar connection.

Middle — spout with an incorporated current transformer.

Bottom — spout with incorporated voltage transformer and cable connetors.

Slide 8 — A 3 phase 24 kV spout with direct connection possibility to the busbar system. This excellent design is also produced by the APG process.

Slide 9 — A single phase 24 kV spout with an incorporated current transformer. A simple but effective design for the future.

Slide 10 — This 10 MVA dry type cast resin power transformer is the geofol design and is installed offshore in South America.

Slide 11 — This 7,5 MVA transformer from Fuji Electric (Japan) also produced with araldite epoxy resins.

Slide 12 — This transformer from May and Christie (F.R.G.) is glass-fibre reinforced and impregnated with a liquid araldite system. This technique improves the mechanical performance and the capacity can thus be increased up to 15 MVA.

Slide 13 — This cross-section of a SF_6 high voltage distribution station indicates the numerous spacers produced with araldite epoxy resin.

Slide 14 — Here we have a 145 kV Sf_6 distribution station from Calor-Emag (F.R.G.). There is also the possibility to design distribution stations for rated voltages up to 800 kV using this technique.

Slide 15 — This is an example of an APG workship at the company GEC Power Distribution.

Slide 16 — A good example of components produced with araldite epoxy resin by the APG process.

Slide 17 — 12 kV vacuum switchgear from GE. Note the spouts produced by the APG process.

Slide 18 — 12 kV SF_6 switchgear from Reyrolle Parsons. The mono block is the largest component produced by the APG process in South Africa. This South African designed and developed product won the 1986 Telemechanique Design Award.

Slide 19 — Araldite epoxy resin is also used in the electronic industry in this particular instance to coat capacitors at S.T.C. in Boksburg.

For outdoor applications, we have the following:

Slide 20 — A 22 kV current transformer completely encapsulated with araldite epoxy resin.

Slide 21 — A 33 kV voltage transformer from the company ILSA. In this instance, the tank is metal and the two bushings are produced with epoxy.

Slide 22 — 22 kV insulator for drop out fuse. Developed and produced in South Africa.

Slide 23 — In this slide, we see the through wall bushings installed at the Witfield substation energised at 11 kV since 1977.

Slide 24 — Note the shed design of the insulators for this particular disconnector installation (Northern Europe). Since 1967 — 300 000 units — Stromberg.

Slide 25 — An example of a three phase disconnector produced by George Jordan (F.R.G.).

Slide 26 — Different shed design for insulators used in a disconnector in service in France.

Slide 27 — An example of various bushings available. The red post insulator is an indication that the araldite epoxy resin can be coloured to suit the customers' requirements.

Slide 28 — Suspension insulators produced by Stromberg (Finland).

Slide 29 — Post insulators produced by Stromberg (Finland).

Slide 30 — A test station in Germany where the insulators are exposed to accelerated UV testing under stress.

Slide 31 — Tension insulators on a concrete structure in Germany. Note the snow on the insulators.

Slide 32 — 22 kV - 1 600 amp through wall flange mounted bushing used on a 22 kV circuit breaker kiosk. Merlin and Gerin South Africa. Approximately 500 in use since 1983. Supplied to Escom.

Slide 33 — 33 kV tension/suspension insulator with end caps fitted from the company Electrical Moulded Components.

Slide 34 — 33 kV tension/suspension insulators installed at Mabopane outside Pretoria. This is a high vandalism area and since installation no breakdown has occurred. 250 installed — 1986.

Slide 35 — 33 kV post insulator produced in South Africa. Electrical Moulded Components.

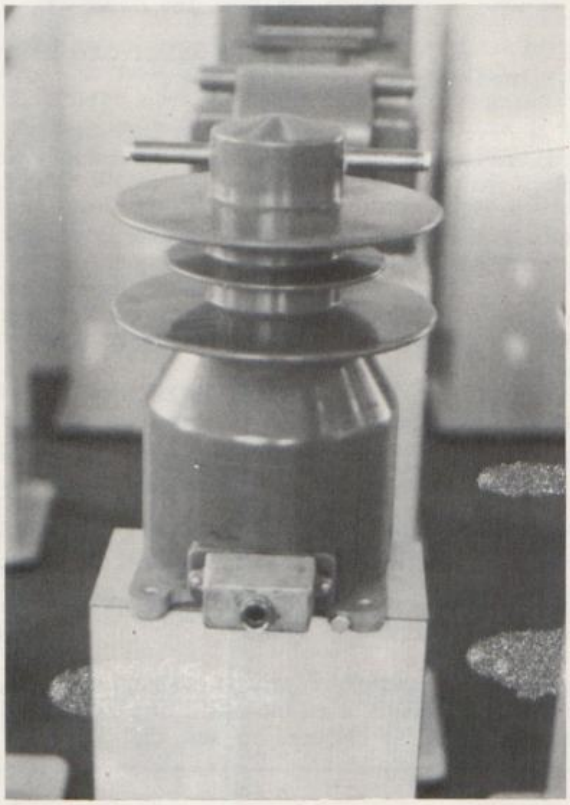
Slide 36 — 22 kV pin insulator produced in South Africa. Electrical Moulded Components.

Slide 37 — 22 kV post insulator produced in South Africa and 22 kV suspension insulator. Electrical Moulded Components.

Slide 38 — Due to the very good mechanical and chemical properties of araldite epoxy resin systems, it is now possible to utilise these properties in the production of chemical valves and pumps.

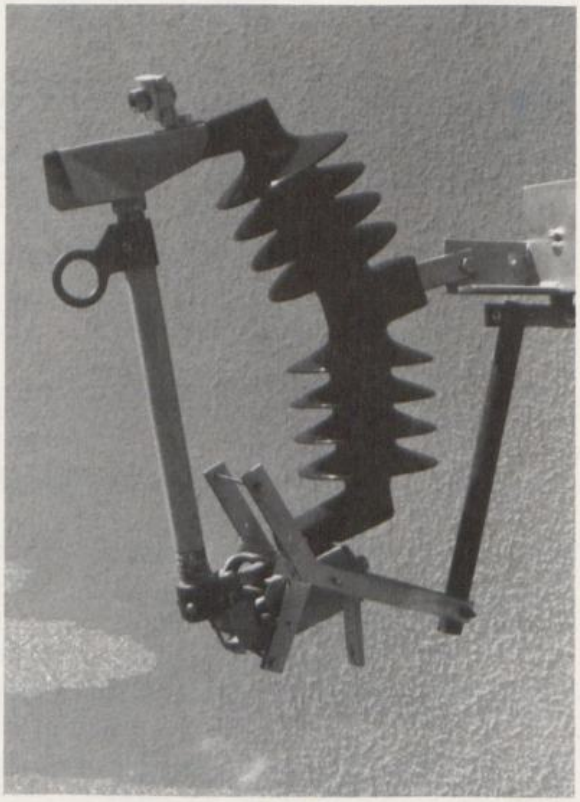
Slide 39 — It is also possible with araldite epoxy resin to produce products for your sporting activities.

In closing, Mr Loubser, ladies and gentlemen, thank you very much for this opportunity enabling me to give the presentation. I hope that the members present now have an insight into the application of araldite epoxy resin in their industry.



Slide 20

A 22 kV Current Transformer completely encapsulated with Araldite Epoxy Resin.

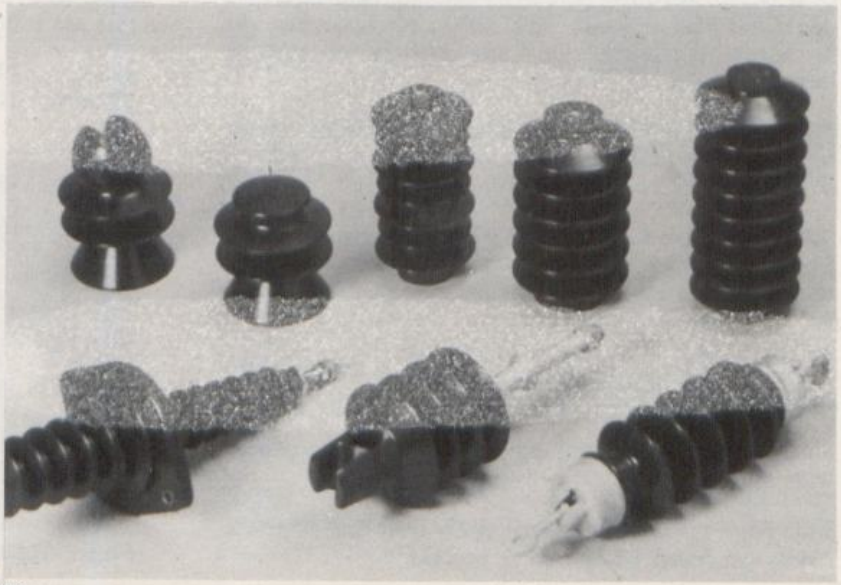


Slide 22

Cyclo-aliphatic Resin Insulator with built-in stress control used in new design of 22 kV fuse drop-out and 3 phase trip-all-phase automatic line spur sectionalizer (ABIMER (PTY) LTD).

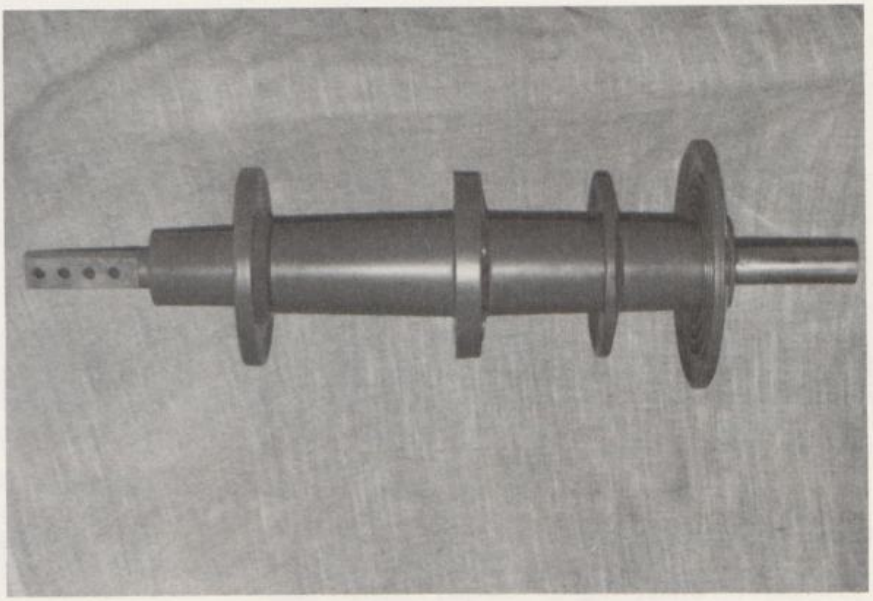
Slide 27

An example of various bushings and insulators available. Produced from Aralois B Epoxy Resin.



Slide 32

22 kV · 1600 Amp through wall flange mounted bushing. Supplied by: Electrical Moulded Components (Pty) Ltd.



DISCUSSIONS — BESPREKINGS

MR N VAN TONDER — Affiliate

The author has pointed out the many advantages to the manufacturer of epoxy resin insulation. It was impressive to note the roll call of names of famous companies using epoxy resin in electrical applications and it is obvious that the advantages have been recognised.

It comes as no surprise that my company's design engineers decided early on in the design process of our new circuit breaker to use cast epoxy resin in the monobloc housing the SF_6 gas and breaking parts. Breaking heavy currents on SF_6 gas in switchgear gives rise to degraded products of the gas.

Some of these, the acids in particular, are found to attack the silica filler traditionally used in the resin casting process. Perhaps the author could enlarge on methods to overcome this to assist any other designers bent on developing similar equipment.

As noted in the presentation, my company is a major user of araldite epoxy resin and it would be difficult to find a replacement for by way of example the mono-block used in our 11 kV LMS switchgear illustrated in one of the slides.

May I be the first to air the question which is no doubt exercising so many of the minds gathered here. In the event of sanctions reaching levels far more effective than now seems likely, how will supplies of resin be maintained?

MR G AUTON — Affiliate

Whereas I normally speak to you on the subject of vacuum switchgear, which has used enormous amounts of epoxy resins very successfully over three decades, my contribution today is to add to the presentation given by Mr Fick.

I have designed a new insulator for use in the fuse drop-out unit for overhead line applications up to 22 kV, in an application normally met by porcelain insulators, but now using the outdoor epoxy resin material known as cyclo-aliphatic resin. This, as Mr Fick stated, is a well-developed material resistant to ultra-violet light and electrical erosion.

The slide of the fuse drop-out assembly shows the extended creepage length of this insulator, which is 500 mm, of which a large part is weather-protected by the rain sheds.

Electrical stress on the surface is controlled by design using electrical field plots and consideration of the equipotention lines. Metal fittings are fully embedded into the resin during the moulding process, reducing the effect of corrosive weather, and giving an impulse level in excess of 150 kV.

This insulator is light in weight, resistant to impact and is expected to be available shortly.

The second slide shows an extension of the usage of the basic insulator which is now the base unit of a new product known as a line sectionaliser. It is not my intention to widen the scope of this session by discussing the detail features of the new product at this stage, the insulator assembly now carries a mechanical linkage which enables it to be used as a three phase tripping unit. A new automatic sectionaliser element is fitted in place of the conventional fuse and when used in co-ordination with an automatic circuit recloser, provides a new economic solution to the problem of three phase sectionalising.

In the meantime, it is sufficient to say that we have here, I believe, two good examples of the application of the outdoor epoxy resin system to a very old product which will now update it with new design concepts and possible applications. Thank you.

MR J E TOMS : SABS

In making this contribution, I do not want to detract from the excellent mechanical properties of epoxy resins, but to sound a word of caution regarding the service life of outdoor resin insulators, particularly at voltages of 33 kV and above.

Partial discharge on the insulator surfaces causes erosion of their surfaces, although, being cyclo-aliphatic, no carbon tracks are created. This erosion causes the insulator surface to lose its hydrophobicity and therefore, subject to filmwise rather than dropwise wetting. Also, the erosion tracks created by surface discharge present a residence medium for organic and other pollutants which form elecdtrolytes when moistened.

MR L M FICK: Affiliate

I shall start off by replying to Neil van Tonder's questions. Neil's first question was as to the formation of hydrofluoric acid, if I am correct, on the surface in the SF_6 application, he mentioned the use of silica flour, now we overcame that by using trihydrate of allumina where the acid formation is not coupled to the 0 molecule on the silica flour and we do not have a problem now in the formation of hydrofluoric acid using the trihydrate of allumina as a filler. We also have another system that has only lately been developed in the UK. It is the quick mix casting resin system where a slightly abrasive filler is used. Tests indicate in Europe and the UK that these components stand up very well to the arduous SF_6 application. As a very important question is the sanctions, may I read to you an extract from the Ciba-Ceigy Corporate and Social Report of 1986.

The recent corporate and social report, a copy of which Neil and many of the delegates will receive, reflects our present and future business policy. The Foreword by our General Manager confirms our commitment to continuing business as usual in these difficult times. Our normal stock policy of three to four months for Swiss origin products will continue as normal since we have no reason to suspect supplies being disrupted in the future.

This is a very nice corporate report and they state clearly that Switzerland will have nothing to do with sanctions against this country no matter how loud the people shout. They are not even in the United Nations so I think that says a lot.

We thank Mr Toms for the contribution and his support for the mechanical properties that the epoxy resin offers.

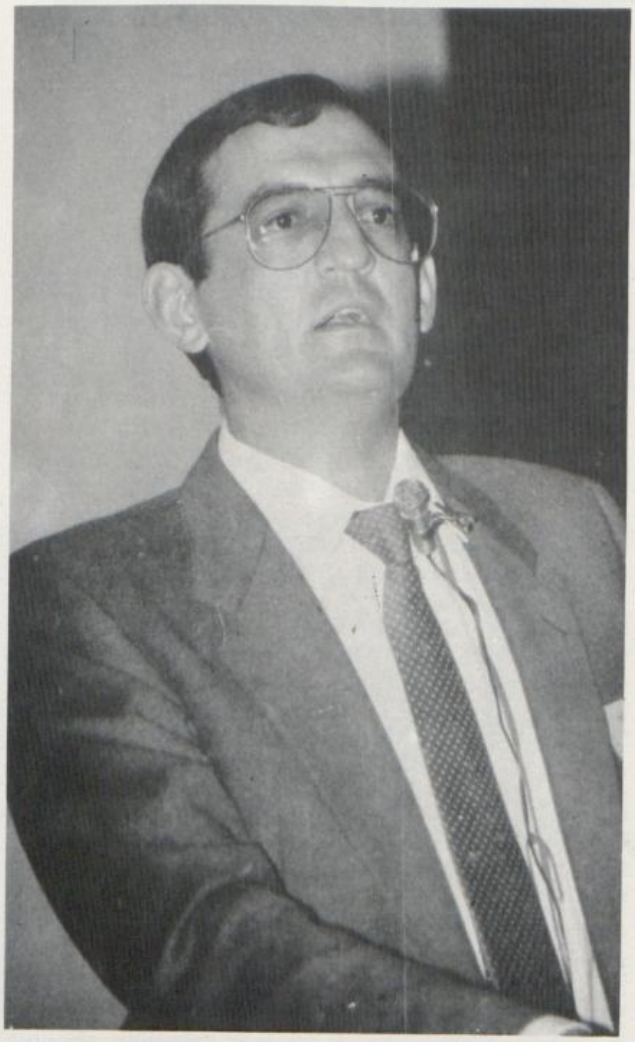
We concur with the view that there is no surface erosion below 33 kV and due consideration should be given to design of insulators above 33 kV. Any partial discharges that do take place on the surface of the insulators are usually a function of over-stress and varying degrees of pollution that could be minimised by good design.

It is true that experience with earlier produced insulators, both service and accelerated test programmes showed the type of degeneration that Mr Toms describes. During the early 1970's it was recognised that the surface of the insulator was more readily wettable after a time in service, due to weathering, and a new formulation of the epoxy resin was developed. The key to the success of this new material is, as described in the paper, the treatment of the filler material (silica Flour) prior to mixing it with the resin, has the effect of producing a much stronger moisture resistant bond between the resin and the grains of the filler, which is highly resistant to the effects of weathering and electrical stress. This now prevent the condition as described by Mr Toms.

Electron-Microscope photographs have confirmed the integrity of this bond even after prolonged accelarated weather cycle tests.

There remains the question of good design as applies to all products but we can have every confidence that surface contaminants will not significantly reduce the life or electrical performance of these insulators.

Just in closing, Mr Loubser, ladies and gentlemen, thank you very much for this opportunity enabling me to give the presentation. I hope that the members present now have an insight into the applications of araldite epoxy resin in their industry.



Mnr Fick aan die woord

You may be afraid of the dark. But it's the only time you can see the stars.

It takes only a small shift of vision to see beyond the darkness. Some people have it naturally. Others will shift when they are told of the bright stars in the sky. And some will continue to see only the darkness that surrounds them.

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Eastern Free State Branch
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EPPIC

MR J A LOUBSER : President

Ladies and Gentlemen, the next item is called EPPIC. Mr Marshall, one of our hosts for lunch this afternoon, will introduce his speakers. I can tell you there are quite a number of them but it is of such importance that it is well worth it.

MR G R MARSHALL : Affiliate

EPPIC stands for Environmental Planning Professions Interdisciplinary Committee and Figure 1 shows the constituent members who fund the committee's activities through capitation. The aims of EPPIC are the following:

1. Promote the availability of formal academic and practical training in resource management and environmental impact control for the planning professions.

2. Promote the availability of in-service continuing education in resource management and environmental impact control for practising planning professionals.

3. Promote the better and wider understanding of the philosophy of resource management and environmental impact control among planning professionals so that attitudes towards environmental impact can be positively influenced.

4. Promote the universal acceptance of resource management and environmental impact control as essential consideration in the planning and design process for all development projects.

A large amount of legislation has been promulgated by central government which impinges on environmental impact control and a list is included in Mr Hulley's paper.

Figure 2 shows the inter-relationships between the various bodies, departments and the Council for the Environment which was established on 7 July 1982 in terms of Conservation Act 100 of 1982. An element of line management through Parliament, Department of Environmental Affairs, Council for the Environment and outside bodies. However, the Habitat Council was formed as an ad hoc group by parliament and can communicate with it directly. In the same way, Council for the Environment reports directly to the Minister of Environment Affairs and Tourism.

EPPIC has a link with Council for the environment through common membership and officials of the Department of Environmental Affairs attend all EPPIC central executive meetings. EPPIC is further divided into regional groups which meet in Pretoria, Johannesburg, Southern Cape, Western Cape, East London, Durban/Pietermaritzburg.

Mr G. R. Marshall

EPPIC exhorts the officials and councillors here today to encourage their planners to undertake an environmental impact assessment for all their projects no matter how small. Such a study need involve no more than half a dozen pages under the headings and Figure 3 sets out the main elements in the design chain.

EPPIC

ENVIRONMENTAL PLANNING PROFESSIONS INTERDISCIPLINARY COMMITTEE

MEMBERS:

INSTITUTE OF SOUTH AFRICAN ARCHITECTS

INSTITUTE OF LANDSCAPE ARCHITECTS OF S.A.

S.A. INSTITUTION OF CIVIL ENGINEERS

S.A. INSTITUTE OF ECOLOGISTS

S.A. INSTITUTE OF ELECTRICAL ENGINEERS

S.A. INSTITUTE OF FORESTRY

INSTITUTE OF LANDSURVEYORS FOR TRANSVAAL

S.A. INSTITUTE OF MINING AND METALLURGY

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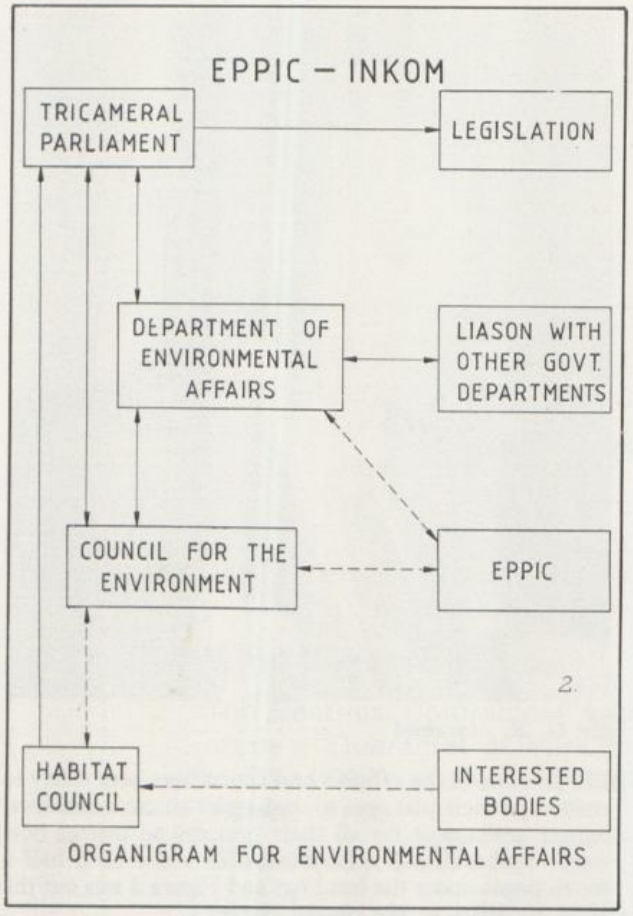

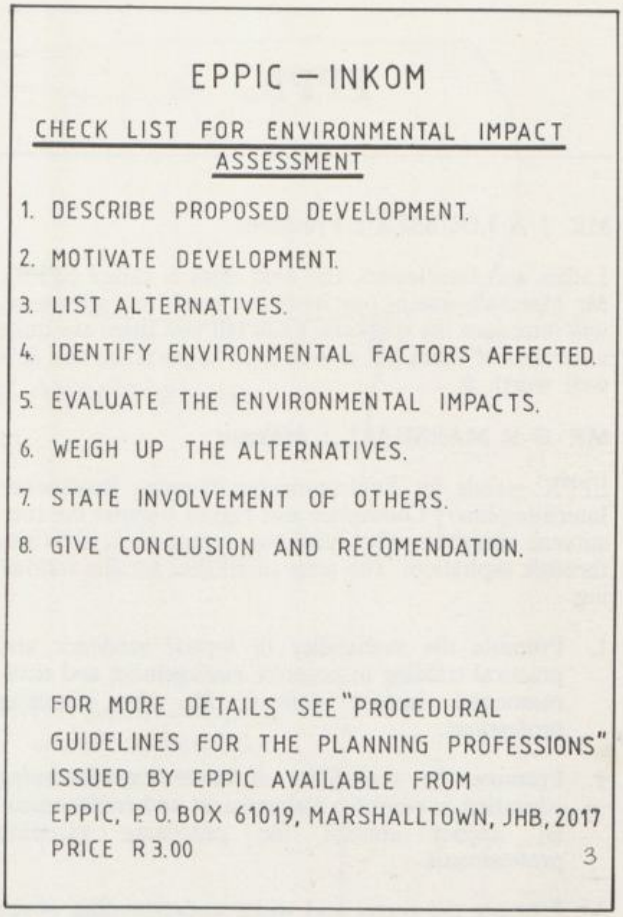

MESSRS MERZ AND McLELLAN

MR J. A. LOUBSER: President

Ladies and Gentlemen, it is my special privilege to congratulate Messrs Merz and McLellan on their 50th anniversary in the RSA. They will host us at lunch today and I wish to thank them for their kind gesture. I am sure you will all enjoy their hospitality.

Eugene Pretorius en Giel Odendaal geniet 'n grappie voor die gelukwensingsbanier van Merz en McLellan.

SOME ENVIRONMENTAL IMPACTS OF ELECTRICITY TRANSMISSION AND DISTRIBUTION LINES

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Mr J. C. A. Hobbs

ABSTRACT

By their nature Linear Developments impact a diverse array of environments. The diverse interactions between powerlines and birdlife represent examples of such impacts. Since 1977 these interactions have been investigated by a multi-disciplinary research co-ordinating committee of Escom. Recommendations of this committee demonstrate how ecological principles can be integrated into development decision-making. It further demonstrated the importance of incorporating environmental consideration alongside the economic and technological factors in decision-making. Experience gained by this committee provides a valuable source of information to all concerned with developing similar transmission and distribution systems.

INTRODUCTION

The evident trends in population growth, people's expectations, rural to urban migration, greater industrialization and mechanization suggest that the area of land currently used for generating and transporting electricity will increase dramatically. In the absence of economically viable alternatives, the supply of electricity (to at least the main load centres) will continue to be by overhead powerlines.

It is thus imperative that organisations that have gained experience in controlling the negative environmental consequences of such developments provide the opportunity to other engaged in developing similar programmes to avoid repetition of mistakes already made. Valuable experience has been gained by ESCOM and this information is freely available to planners and engineers developing systems and designing structures.

About 90% of the electricity sold in South Africa is generated by coalfired power stations situated at the coal fields in the north-eastern part of the country. This electricity is transported via a national grid of high voltaged transmission lines that total over 150 000 km. Linear developments of this nature impact many different habitats, ecosytems, and human communities in contract to geographically concentrated ones which usually perturb in an intensive but spatially compact fashion. One consequence of the transportation of electricity by overhead powerlines is an increased mortality and injury rate in avi-fauna. For the past decade a multi-disciplinary, inter-departmental committee of Escom, the Bird Research Committee (BRC), has investigated the interactions between avi-fauna and powerlines.

Such interactions can be both hazardous to avi-fauna and to the maintenance of an electricity supply to consumers or, indeed, both. Damage to conductors and insulators and resultant electrical faulting are caused by the activities of bird on towers and this has necessitated immediate attention. The 'raison d' etre' of this committee is therefore primarily economic.

There are four main interactions between electrical installations and birds. Certain tower designs pose an electrocution hazard to birds. Other towers provide safe nesting sites. The use of towers as roosts may result in excreta accumulating on insulators which may cause flashovers, and conductors and guardwires strung between towers may act as a collision hazard to birds in flight.

TABLE 1 — INTERACTIONS BETWEEN BIRDS AND POWERLINES

Interaction	Potential Nature of Impact	
	To Electrical Supply	To Birds
Electrocution Hazards	Adverse	Adverse
Nestling Activity	Adverse	Beneficial
Roosting	Adverse	Beneficial
Collision Hazards	Adverse	Adverse

ELECTROCUTION HAZARDS

Some species of bird are electrocuted when using towers as perches. This is not only a problem for birds but also to electrical systems reliability because of outages that may result. A secondary impact also reported is that of

bush fires resulting from birds falling in flames to the dry vegetation (including valuable grazing) characteristic of Southern African dry seasons.

Strictly speaking, the electrocution hazard is not limited to birdlife. Other powerlines (particularly woodpole distribution lines of 22kv) have been responsible for electrocuting bats (probably the larger fruit eating bats (Megachrioptera). African Elephants (loxodonta africana, Giraffe camelopardalis). Vervet Monkeys Cercopithecus aethiops) and Chacma Baboons (Papio ursinus) as well as various species of snakes. These observations were made principally at distribution lines either in or close to the Kruger National Park which has research stations and rest camps supplies by overhead powerlines. Cabling is now the preferred (but more costly) option in supplying electricity to more recent developments within the Park.

The problem of bird electrocutions was first highlighted in 1972 with a published account of 148 birds found dead beneath transmission lines over a period of 27 months (Markus, 1972). A subsequent study of ESCOM patrolmen's reports attributed the deaths of 169 birds to electrocution by powerlines (Ledger and Annegarn, 1981).

This latter paper highlighted two specific tower designs as problematic to birds of larger wing span — the "kite" construction accounting for 80,5% of birds electrocuted and the "H Pole" construction accounting for 16,1%. Figure 1 contrasts these designs of problematic dimensions with the safe lattice steel portal tower used regularly by many species without mishap.

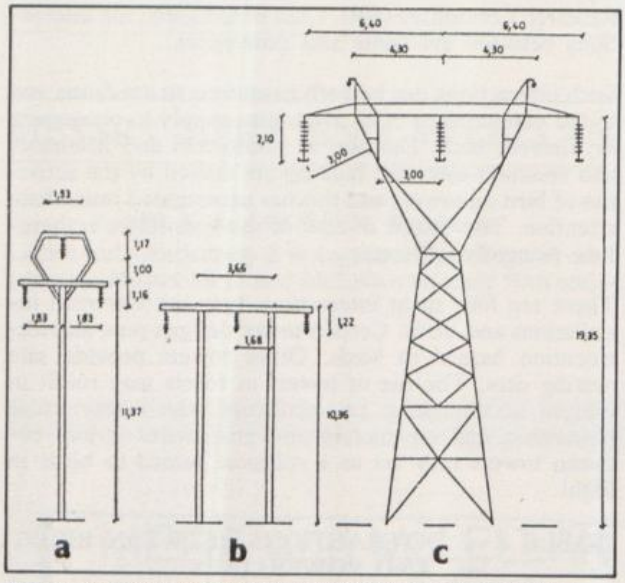


Fig. 1 Diagram to show dimensions and clearances of (a) 88 kV Kite construction, (b) 88 kV H construction and (c) 132 kV lattice tower.

Of great concern has been the principle victim of these electrocutions — the Cape vulture (Gyps coprotheres). This is an endemic species of Southern Africa with a large wing span (2,5 metres) and low reproductived rate. A colonial species, it nests on rocky ledges and cliffs. The Cape vulture is of "vulnerable" status (Brooke, 1984) and recorded as such in the Internationald Council ford Bird Preservation's Red Data Book (Coller & Stuart, 1985).

Young Cape Vultures have poor survival prospects. There is only a 17% probability of young birds reaching beyond their first year and a 10,6% chance of fledgling birds reaching their third year (Ledger, 1984). This situation has been attributed to, inter alia, disturbance at breeding colonies, poisoning and shooting, changes in both nature and extent of available food sources and electrocutions on certain types of electricity towers such as the "kite" and "H Pole" designs.

It has been suggested that younger birds are forced to forage away from breeding colonies due to competition with adults over limited food resources. In doing this they utilize electricity towers as roosts, especially in the principal livestock rearing regions of the northern Cape and western Transvaal provinces and these are regions where the "kite" tower has been frequently erected in the past (Ledger, 1984). This design is fortunately or unfortunately depending which way you look at it unique in South Africa.

This partnership is, however, of mutual benefit because to mitigate the electrocution hazard to this species also serves the purpose of reducing the threat to power system reliability. Electrocution incidents normally result in momentary faults which the system is designed to tolerate by auto reclosure. If, on the other hand, the incident is prolonged by, for example, a bird falling across conductors, then three unsuccessful attempts at auto reclosure results in the line "locking out" and a consequent supply outage together with the need for a visual inspection (often in difficult terrain) to establish the problem and restore supplies. One such vulture electrocution incident caused the loss of supply to a cement factory for 14 hours and caused damage to a conductor (Ledger, 1984).

In addressing possibly solutions to this problem international experiences were reviewed. Electricity companies in western USA had experienced similar problems with golden eagles (Aquila chrysaetos) on their pylons and measures carried out there provided initial ideas. Experiments with mock-up tower and a "tame" vulture were carried out whilst field observations were made of vulture behaviour at carcasses positioned near a "kite" 88kV tower. Data collection of dead birds and line faults provided further insights to the problem. This study carried out between June 1978 and July 1981 recorded 246 vulture electrocutions and attributed 90% to the "kite" tower design. The study further identified certain sections of lines as being of greater significance than others (Ledger, et al, in preparation).

Certain areas of the towers were identified as being safe for vulture use and so adaptions in the form of a wooden or steel perch were made to create greater space for birds in these areas. However, gregarious habits and competition for space still resulted in individuals being forced into the high hazard zones. A PVC spiral sleeve has therefore been fitted over the central phase conductor to afford greate insulation.

Some success therefore appears to have been achieved through this policy of retrofitting safety additions to "kite" towers but monitoring is continuing and additional adaptions are fitted when problem sections of line are idenfified. Nevertheless, the ultimate solution would appear to be the replacement of these towers of hazardous design with safer structures as and when oportunities arise. The "kite" tower is inherently incompatible with birds of larger wing span and electrical engineers responsible for designing structures for use elsewhere should

take cognizance of the required critical distances between phase to phase and phase to earth conductors in areas frequented by birds of larger wing span.

NESTING ACTIVITY

Certain tower designs, the lattice portal for example, provide safe nesting sites for several species. To date eleven species of larger bird are known to use towers for this purpose. These include the martial eagle (Polemaetus bellicosus) also classified as "vulnerable" (Brooke, 1984).

The presence of these nests on towers may damage conductors and insulators and may pose a threat to the critically co-ordinated manoeuvres of liveline maintenance crews that work on energised lines. Generally speaking, however, the presence of these nests cause only minor problems to the maintenance of electricity supplies. Historically, however, destruction of nests on towers was routine practice regardless of the occupants and their status.

African environments are changing rapidly with development and indigenous vegetation (and the nesting opportunities it presents) gradually being cleared for mechanised agriculture, commercial afforestation and other rural development initiatives. It is therefore possible that towers act a positive feature in a situation of nesting habitat reduction and even enable some species, such as Martial Eagles in the Karoo desert, to extend their range into relatively treeless environments where nest sites have never been plentiful (Hobbs and Strydom, 1982). Whether this is a good or bad thing, ecologically speaking, is worthy of further study.

On the recommendation of the BRC, Escom's approach is now to remove only those nests that can be demonstrated to be a hazard to electricity supplies or maintenance crews. Even in these instances trimming of sticks that protrude over insulators is preferred to total removal where feasible. The BRC is investigating the use of a locally manufactured nesting platform that can be positioned at safe locations on a tower and onto which nests of certain endangered species, that pose a threat, may be relocated and thereby tolerated.

To recommend a selective policy when it comes to bird interactions assumes anability amongst field personnel to identify specie and have a knowledge of their status. To facilitiate such skills, where they may be lacking, the BRC has produced an identification guide illustrating the diagnostic characteristics of birds known to interact with electrical installations. (Ledger, preparation). This will not only encourage a more discerning approach by field staff but also enhance the on-going data collection on interactions observed and recorded.

In November 1986, a routine helicopter patrol of a line north of Kimberley in the northern Cape province led to the discovery of the first record of African whitebacked vultures (Gyps africanus) (WBVs) nesting on artificial structures (Ledger and Hobbs, 1985). The WBV is the commonest vulture of Africa and, unlike the Cape vulture, nests on tree tops. Five nests containing chicks and four similarly constructed but empty nests were observed in the lower part of the box section cross-arm above the central phase insulator strings which were badly polluted and therefore making the nests likely candidates for removal if they had been encountered by patrolmen before the BRC recommendation.

Whilst suitable nesting sites were available there was evidence of human disturbance beneath the line. It is hypothesized that this was adequate disturbance - dwellings and agricultural activity - to encourage the birds to move up to the safer nesting location of the towers.

This belief is supported by the existence of WBV nests in trees on an adjacent Game Reserve with minimal human presence which is traversed by identical structures offering the same opportunities.

It is further suggested that the Escom approach is possible contributory factor that has allowed WBVs situated here, as they are, on the southern extremes of their breeding range to breed on towers undisturbed - a development of great interest in avian evolution and demonstrating their adaptability to an environment modified by human technology. These suggestions are further supported by the similar discovery of another first record of black eagles (Aquila verreauxii) nesting on a 275kv strain tower approximately 50 km north-east of Kimberley.

Two species of smaller birds build very large communal nests on Escom structures - the social weaver (Philetirus socius) and the redbilled buffalo weaver (Bublaornis niger). Other birds - the Cape sparrow (Passer melanurus) and crows (Corvus spp) - are known to make occasional use of pieces of wire in the construction of their nests in electrical installations. The nesting activities of the Cape Sparrow in capacitor banks at sub-stations has resulted in serious, costly damage to capacitors.

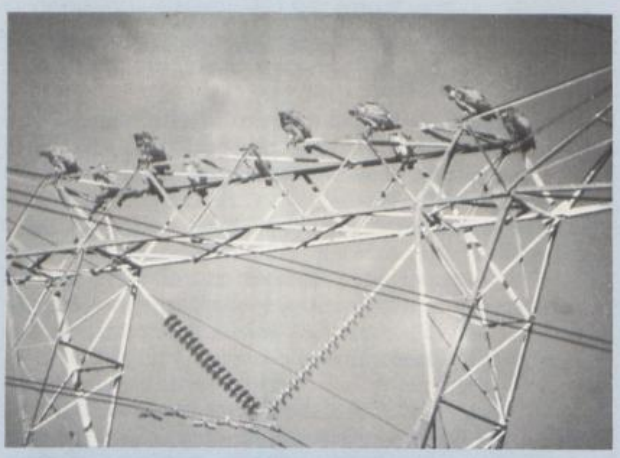
The aforementioned nests of social weavers can reach up to 4 metres deep and 7,2 metres long enclosing from 5 to 50 rounded nest chambers (Maclean, 1985). When nests of this scale smother the wood poles of distribution lines in the Kalahari desert thornveld, there appears to be no alternative to complete removal as nests of this nature have been known to ignite and destroy the support pole as well as initiate bush fires (Van Rensburg, pers. comm.). Nest destruction is, however, a temporary measure as birds of this species are industrious builders and the breeding season can be up to 9 months depending on rainfall (Maclean, 1985).

A "quality circle" of local Escom staff identified this as a problem worthy of their concerted attentions and ideas were generated for the solution of the problem. A decoy pole has been placed adjacent to poles favoured by the Social Weavers. In some instances, this has been successful in attracting the birds away from distribution lines.

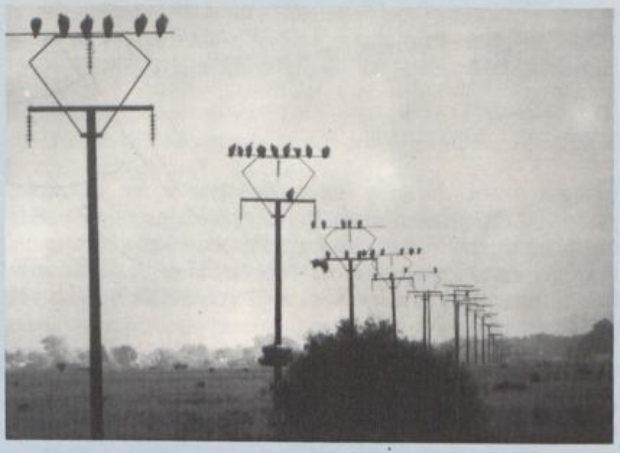
Birds are not limited to nesting on structures - in one instance they had excavated nesting chambers and sought food in a 132kv wood pole support. Barbets (Capitonidae) and Woodpeckers (Picidae) commonly nest by excavating holes in dead tree trunks or the underside of branches. When they adapt to wood poles of powerlines they act as "Biological indicators" that the useful life of the pole is at the end.

ROOSTING

By the simple act of using towers as roosts, birds may pollute the insulators beneath them with their excrement

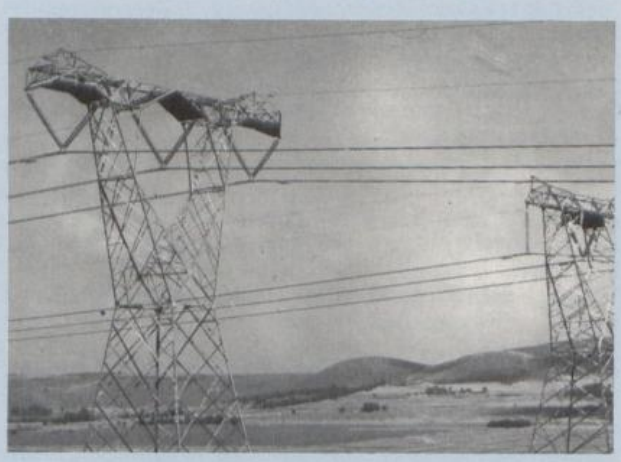


Cape vultures safely using a lattice portal tower in the Western Transvaal.
(Photo: J. C. A. Hobbs)



The "kite tower" (88 kV) — an electrocution hazard to birds of larger wingspan — with woodpole perches.
(Photo: J. A. Ledger)

Insulators polluted by bird excreta.
(Photo: J. A. Ledger)



Slatted board "V" string insulator shield, safeguard against bird initiated pollution.
(Photo: J. A. Ledger)

First recorded white-backed vulture nest and chick on an artificial structure (a transmission tower).
(Photo: Escom)

Capacitors damaged by birds using pieces of wire in nest building.
(Photo: J. C. A. Hobbs)

thereby reducing insulating properties of the discs which may, in turn, result in a "flashover" and a potential supply outage.

This a particular problem where birds exhibit gregarious behaviour such as in wetland areas. Ibsies, Storks, Herons and Egrets all regularly use the same towers leading to a build-up of excreta on the insulators. A recent report of insulator pollution and regular "tripping out" of a 400kv transmission line resulted in the need to take the line out of service for 7 hours to enable the insulators to be cleaned. The pollution causing "flashovers" from phase conductors to cross-arm had been the result of roosting activity of the endemic bold ibis (Geronthicus calvus). Over 100 birds were observed to use these lattice towers on one night.

The solution in such cases is to attach "birdguards". These are designed to be a deterrent to birds roosting above critical parts of towers. Some appreciation of bird behaviour is necessary in designing and attaching "birdguards" to towers. To fit "birdguards" across the total available area would only serve to encourage birds onto adjacent towers, thereby necessitating similar measures there. To avoid having to attach "birdguards" to all towers, birds need only to be discouraged from critical part of a tower i.e. to move over rather than move off.

In an attempt to establish which of the many available designs of "birdguard" are cost-effective, a cross-arm of a tower has been floated into a wetland area near Johannesburg which is frequented by vast numbers of birds. A hide has been erected and observations are underway to monitor various species reactions to different designs of guards. In the field, data on faults is collected by operators who report incidents to a control centre for entry into a computerized fault recording system known as "Escom Distribution Availability and Reliability Monitoring System" (E-DARMS).

This date will provide statiscal information on the role of birds in causing electrical faults.

COLLISION HAZARDS

Whilst the mortality or injury of birds through colliding with powerlines is inherently undesirable the biological significance of such events is currently a matter of conjecture.

It is possible that birds striking conductors could cause phase to phase "flashovers" on lines where these distances can be bridged. A recent report has also been received of a black eagle (Aquila verreauxii) bringing a conductor down after colliding with it, this being despite this bird's great visual auity (Roelofse, pers. comm.). However, such events are considered to be infrequent and concerns here are primarily towards birds' welfare rather than the integrity of electricity supplies. Doubtless avian mortality due to collisions with obstacles, man-made or otherwise, is not a new event.

Interest in the study of this impact is more recent. American power companies have conducted a great deal of research into this phenomenon because of the conflicts encountered with powerful wildfowl hunting lobbyists - waterfowl being consistent powerline collision victims. Power companies have been subjected to powerline construction delays, litigation proceedings over routing decisions and ruled to pay compensation for reduced recreational opportunities due to destruction of waterfowl, their available habitat and influencing their flight behaviour in areas used for wildfowl hunting (Hobbs, 1984).

Whilst Africa does not have the equivalent of such powerful pressure groups nor the major "flyways" of North America, Escom is addressing the collision hazard that powerlines pose to birds in flight.

An 18 month study of a 1 km stretch of 88kv lines (comprising a total of 24 wires) in suburban Johannesburg resulted in the collection cf 92 birds of 18 species under the lines (Lockwood and Ledger, in press).

The conductors are not considered to be the usual hazard but rather the "guardwires" - a much thinner and less easily visible wire, necessary to intercept lightning strikes. It is suspected that birds can usually see conductors in their way and take evasive action, usually gaining altitude, where they encounter the "guardwires".

As an immediate measure to address this problem, various powerline markers have been developed and fitted to lines where regular collisions have been observed. These include an orange aluminium sphere, a polyethylene adhesive strip that acts as a "flag" on lines and a fluorescent tube that is energised by the electrical field around conductors. The latter addresses the problem of collisions occuring at night or during periods of inclement weather. Collisions at these times are thought to be a frequent event.

A further line marker type that is used is the plastic floatation ball more commonly used in the cisterns of toilets. These have been adapted effectively, if a little inelegantly, to mark lines supplying fish factories and salt works on the Berg River estuary north of Cape Town where flamingoes (phoenicopterus spp) have been regular casualties.

The collision hazard posed by powerlines to birds is difficult to quantify and the consequence to total or locational bird populations difficult (but important) to evaluate. An important distinction is drawn in environmental planning parlance between the magnitude and the importance (or significance) of an impact. Clearly the discovery of 1 000 cadavers of an abundant species is of disturbing magnitude but may not reflect great biological significance in terms of species survival prospects. However, a recent report of one Wattled Crane (Grus carunculata) mortality resulting from gangrene sustained as a result of a powerline collision injury (Johnson and Sinclair, 1984) is of potential importance if indicative of a frequent cause of mortality to this, one of the most threatened breeding birds of Southern Africa with approximately pars remaining.

To reduce speculative and frequently emotive comment on this interaction, the BRC (together with the Anglo Amlerican Corporation and the Transvaal Provincial Nature Conservation Division) have funded a research project into this topic. The Blesbokspruit wetland near Johannesburg serves as a convenient study area because of its diverse birdlife and the numerous powerlines that cross it. Collisions have been noted on an ad hoc basis for many years in this area. Early results are indicating that those species exhibiting poor flight manoeuverability, unfamiliarity, certain types of formation flying and fra-

gile anatomies are most susceptible. Poor visibility during inclement weather conditions or disturbance at night serve to compound the problem. Collisions may not be a regular occurrence but, on the other hand, one fly past may result in numerous collision injuries and mortalities (Longridge, in preparation).

It is anticipated that the Blesbokspruit research project, will improve the quality of the biological input into the impact analyses of powerline routing altenatives whenever these unavoidably have to cross wetlands.

CONCLUSION

Prevention is, of course, better (and more enconomic) than cure in environmental management. To the authors' knowledge, there have been two studies that explicitly addressed bird and powerline interactions at the planning stage of routing and tower design choice. One study compared the anticipated impacts of a proposed 66kv line across a gorge near the South Africa - Lesotho border which is a breeding site of Cape Vultures. The route considered to be less a hazard to vultures in flight was selected and precautionary "guardwire" markers were attached (Sievewright, 1983).

The second study was not concerned with alternative routes but with already determined routes planned through Natal province where wetland crossings suggested the need for mitigatory measures such as "bird-guards" before construction (Ledger, 1980).

The activities of the BRC have been "post facto" with retrofitting being carried out once a problem can be demonstrated. A need exists to establish predictive models that can identify problems and required measures before they arise. The experience being gained by the Committee is leading to this possibility.

These experiences have been documented in the form of "technical guidelines" (Ledger, 1983).

The work of the BBC is an example of the implementation of this policy designed to minimize negative environmental impacts. Diverse disciplines are brought together to offer consultancy services and to support decision-making that is based on well informed and balanced assessments of the technical, economic and biological consequences of various alternatives - the objective being to reduce, if not eliminate entirely, powerline faults and bird injuries and mortalities.

*(The guidelines are available from the authors at their indicated addresses)

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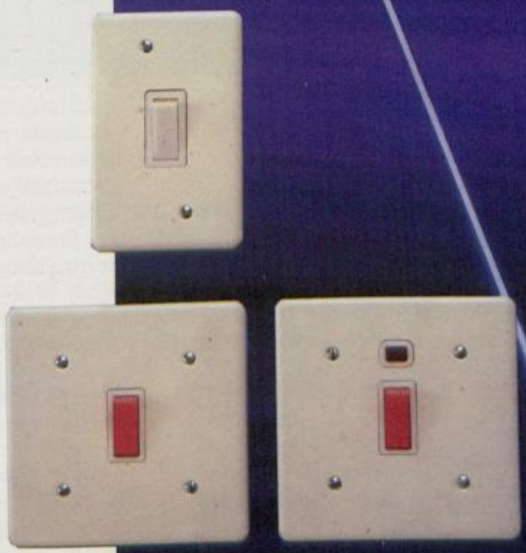

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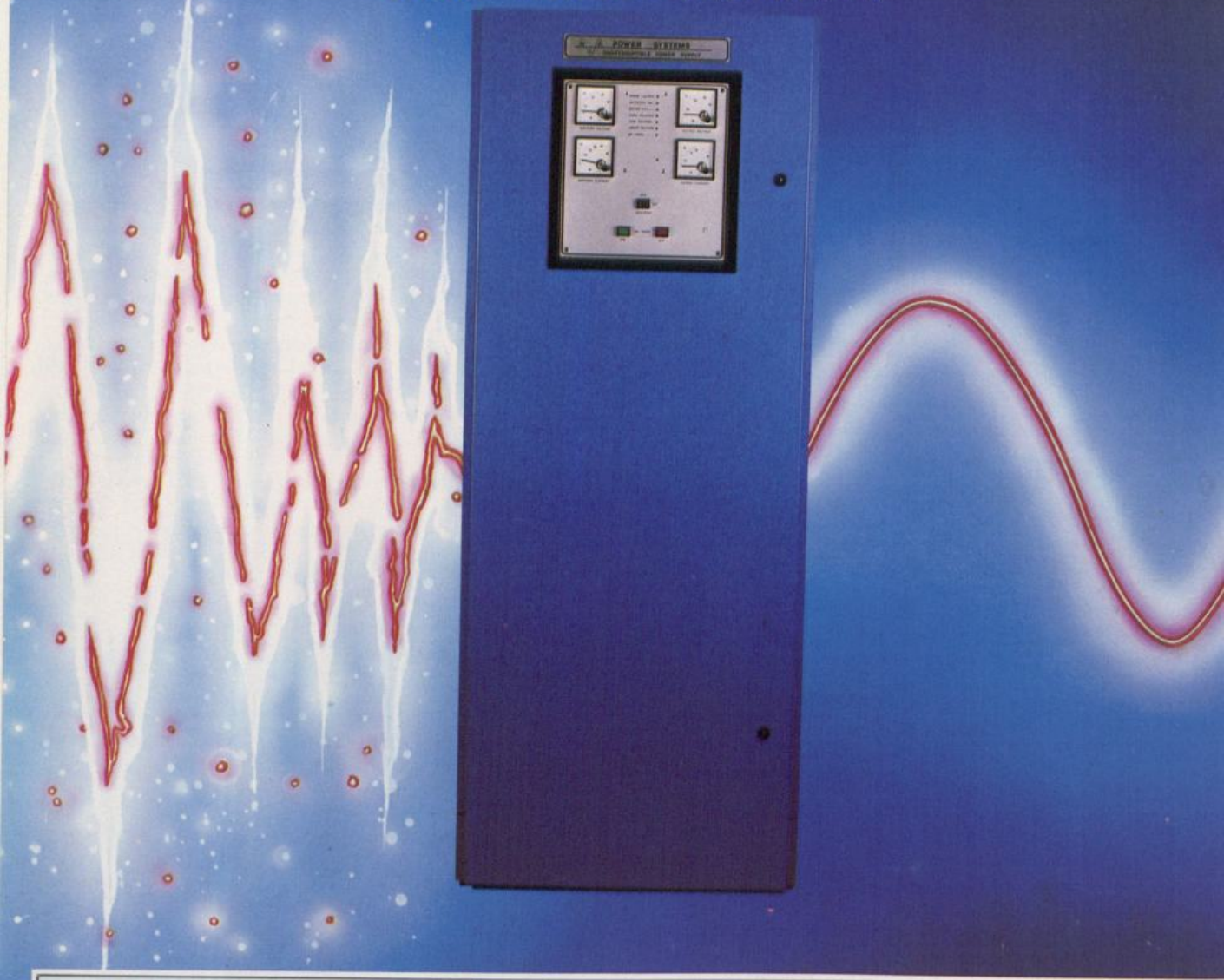

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HOLISTIC PLANNING INCORPORATING ENVIRONMENTAL FACTORS IN MUNICIPAL ELECTRICITY UNDERTAKINGS

BY MR D J HULLEY: Affiliate

ABSTRACT : The paper presents a short historical background to the development of an understanding of the need for holistic planning, the influence of NEPA in the process of development of the concepts of EIA's & EIC.

It presents the philosophy as seen by EPPIC for adoption by the physical plannings professions in South Africa, with particular reference to Electrical Engineers engaged in the planning and execution of municipal electricity undertakings.

The paper discusses the implications of the various SABS codes relating to co-ordinating position of engineering services in the road reserve and the lighting thereof followed by case studies in South Africa with an example of a successful holistic planning and execution approach in Naboomspruit, Northern Transvaal and a less successful planning and execution of a township project in Kinross, Eastern Transvaal. The paper also highlights the conflict which occurs in many South African towns and cities between trees and street lighting.

1. INTRODUCTION

A truism worth repeating is that man is part of the environment and cannot neatly be separated from it[1]. Human nature however, compels us to alter the natural environment for our benefit and seems to allow us to discount the future harmful effects of our actions. No-one, who reflects on the our increase in life span, in personal comfort and material well-being can doubt that such alterations have created a better life for many. Less fortunate people have come to expect this progress. But these improvements come with a serious cost in environmental problems that affect all people and we are beginning to pay that cost now without realising how great it is[2].

An increasing awareness of the probability of these costs in the USA and Western Europe led progressively to legislation in attempts to preserve the environment and minimise the costs. The National Environmental Policy Act (NEPA) passed by the United States Congress in December 1969 was a watershed act with far reaching consequences for the entire industrialised world. Though this act was passed after one day's hearing, a voice vote in the senate and a few hours' meager discussion in the House, as its actual impacts became apparent it give rise to much

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discussion, referals to courts and research, resulting in a vigorous and ongoing analysis during the succeeding implementation phase of the act[3].

2. SOUTH AFRICAN SITUATION

South Africa has no equivalent of NEPA, but a multiplicity of acts, ordinances and by-laws have a bearing on environmental matters and conservation. A list of some of these acts is appended to this paper. There exists a strong ongoing debate and lobby for the implementation of compulsory Environmental Impact Statements (EIS), Environmental Impact Assessments (EIA) and Environmental Impact Control (EIC). During the period 1970 to 1986 the concept and definition of the environment has varied considerably.

3. DEFINITIONS OF ENVIRONMENT

In the California Environmental Quality Act (2), for example, environment is defined rather narrowly as "THE PHYSICAL CONDITIONS WHICH EXIST WITHIN THE AREA WHICH WILL BE AFFECTED BY A PROPOSED PROJECT, INCLUDING LAND, AIR, WATER, MINERALS, FLORA, FAUNA, AND OBJECTS OF HISTORIC AND AESTHETIC SIGNIFICANCE". This definition includes reference to the man-made environment, but makes no mention of its social, political, and economic dimensions.

In the report of the Planning Committee of the President's Council on priorities between conservation and development, the word environment is used

"ONLY WITH REFERENCE TO MAN'S PHYSICAL AND CULTURAL ENVIRONMENT". In this report the man-environment relationship is investigated in an effort to determine the relative importance for the country as a whole in regard to conservation on the one hand and physical development on the other. From the evidence submitted to the Planning Committee of the President's Council, the following adverse impacts of development on the environment were identified: Visual impacts resulting from mines and roads, impacts on vegetation and wildlife, impacts on air quality resulting from the increasing use of fossil fuels and mining activities, impacts on water quality with reference to mining, acid rain and siltation, the destruction of the soil resulting from man's abuse of the environment, the decline of marine resources resulting from man's exploitation, and the negative effects arising from the purchasing of game farms and undeveloped areas for property development purposes. The above clearly show that the evidence submitted to the Planning Committee of the President's Council did not include any reference to man's social and political environment, and that the implicit definition of the environment as established by this evidence was therefore very similar to that contained in the California Environmental Quality Act.

In the White Paper on a National Policy regarding environmental conservation of 1980 the overall Government policy is stated as follows : "BROADLY, THE GOVERNMENT'S POLICY IS THAT A GOLDEN MEAN BETWEEN DYNAMIC DEVELOPMENT AND THE VITAL DEMANDS OF ENVIRONMENTAL CONSERVATION SHOULD CONSTANTLY BE SOUGHT". The aim is, therefore, that man and nature should co-exist in productive harmony to come up to the social, economic and other expectations of present and future populations. The White Paper then deals with the national policy with regard to the following aspects of conservation : Air pollution, cultural-historical aspects, marine pollution, nature conservation, noise pollution, radiation pollution, soil conservation, solid waste and littering, water pollution, and other environmental aspects which may be identified from time to time. In a discussion of cultural-historic aspects, the White Paper states that: "IN MODERN SOCIETY MOST PEOPLE ALREADY LIVE IN URBAN ENVIRONMENTS AND IT IS IMPORTANT TO ENHANCE THE QUALITY OF LIFE IN TOWNS AND CITIES. THE PRESERVATION OF THE PREHISTORIC, HISTORIC AND CONTEMPORARY CULTURAL COMPONENTS CONTRIBUTES TO THE QUALITY OF LIFE CREATED IN THE URBAN AND RURAL ENVIRONMENT". Although the White Paper recognizes the importance of the quality of life in urban areas, the national policy is spelt out only with reference to man's physical and cultural environment as well as nature conservation.

The South African Council for the Environment, in summing up the conclusions of their Midmar Workshop held in September 1985, states that the aim of an environmental impact assessment is "TO IDENTIFY AND PREDICT IMPACTS ON THE BIOGEOPHYSICAL ENVIRONMENT AND ON PEOPLES' HEALTH AND WELL-BEING, OF ALTERNATIVE LEGISLATIVE PROPOSALS, POLICIES, PLANS; PROGRAMMES AND PROJECTS: TO CANVASS ORGANISATIONAL AND PUBLIC ATTITUDES TO ALTERNATIVES; TO PROPOSE MITIGATING MEASURES TO REDUCE IMPACTS, AND TO COMMUNICATE ALL OF THIS INFORMATION TO THE DECISION-MAKERS". The definition implied by this very recent statement by the Council for the Environment is obviously much wider than the previously mentioned definitions. Whereas the California Environmental Quality Act talks about impacts of a **proposed project,** the Council of the Environment talks about impacts of **legislative proposals, policies, plans, programmes and projects,** and also brings in the extremely important references to **people's well-being, communication, and mitigating measures.**

The Environmental Planning Professions Interdisciplinary Committee (EPPIC) uses the following definition in the 1985 edition of their philosophical and procedural guidelines for the planning professions of Environmental Impact Control: "THE ENVIRONMENT CONSISTS OF THE ENTIRE COMPLEX OF INTERACTING PHYSICAL, BIOLOGICAL, ECONOMIC, AND CULTURAL FACTORS WHICH ROUTINELY INFLUENCE THE LIVES OF INDIVIDUALS AND COMMUNITIES. IN PARTICULAR THE ENVIRONMENT INCLUDES: ...". EPPIC then introduces the following extremely important concept as part of their definition: "THE QUALITY OF LIFE PERCEIVED BY MAN DEPENDS ON THE QUALITY OF **ALL** ASPECTS OF HIS ENVIRONMENT TO A GREATER OR LESSER EXTENT DEPENDING ON HIS DEGREE OF DEVELOPMENT. IT IS ESSENTIAL, THEREFORE, THAT THE EFFECTS OF A PROPOSED DEVELOPMENT ON ALL ASPECTS OF THE ENVIRONMENT ARE ASSESSED BEFORE THE DECISION TO PROCEED IS TAKEN".

The National Transport Policy Study, in a document on the environmental aspects of transport puts forward the following definition of the environment : "THE HOLISTIC SYNTHESIS OF THE PHYSICAL, BIOTIC, SOCIAL, POLITICAL AND ECONOMIC SYSTEMS WITHIN WHICH MAN MAINTAINS HIS EXISTENCE AND LIFE STYLES". This powerful definition put forward in 1984 was derived after an in-depth literature study of this topic had been made, and is considered to be best reflecting the broader approach to the environment.

From the above definitions it is clear that there is a wide spectrum of definitions of **environment.** These definitions can be classified into two broad groups, as follows : The first group excludes direct reference to man's quality of life, while it concentrates mainly on the physical and non-human living aspects. The second group of definitions includes the concept of quality of life with all the factors that may affect it. It is also clear that the most recent authoritative statements on the environment in South Africa adopt the latter holistic approach[4].

4. THE ROLL OF THE ENGINEER

All engineers, as with all other environmental planning professions, carry a great responsibility in the planning, execution and operation of projects which inevitably have an effect on the environment. It therefore behoves each and every Engineer to be conscious of this responsibility and to adopt an holistic approach to planning which in terms of the National Transport Policy Study will lead to "THE HOLISTIC SYNTHESIS OF THE PHYSICAL, BIOTIC, SOCIAL, POLITICAL AND ECONOMIC SYSTEMS WITHIN WHICH MAN MAINTAIN HIS EXISTANCE".

5. THE ELECTRICAL ENGINEER

The Institute of Electrical Engineers has been a constituent member of EPPIC since shortly after the inception of EPPIC and has constantly through its representatives on EPPIC played an active roll in promoting the basic Philosophy and aims of EPPIC which are: "EPPIC RECOGNISES THAT IT IS THE FUNCTION OF THE PROFESSIONAL PLANNING DISCIPLINES TO PROVIDE FACILITIES DESIGNED TO SERVE THE NEEDS OF SOCIETY AND THAT THESE NEEDS ARE REQUIRED TO MODIFY THE ENVIRONMENT. IT CONTENDS, HOWEVER, THAT THEY SHOULD ALWAYS CONSIDER ALL THE EFFECTS OF SUCH FACILITIES ON THE ENVIRONMENT, TAKE ALL REASONABLE STEPS TO MINIMISE HARMFUL EFFECTS AND ACHIEVE AN OPTIMUM BALANCE BETWEEN DESIRABLE AND UNDESRIABLE EFFECTS ON THE ENVIRONMENT BEFORE DECISIONS ARE TAKEN". Within this basic philosophy the aims of EPPIC are :

(1) To define the functions and responsibilities of members of professional planning disciplines.

(2) To draw up a set of guidelines to assist them in taking environmental aspects into account in an effective manner.

(3) To focus continually the attention of planners, decision-makers and the public in general on the environmental objectives and procedures of the professional planning disciplines.

6. SCOPE OF ELECTRICAL ENGINEER PROJECTS

The scope of the Electrical Engineers work and therefore the projects effect on the environment can vary from the macro projects and effects such as the development of a 3600 MW power station to the relatively minor project of provision of power and lighting in a suburban street. This part of this paper will attempt to study the environmental impacts that occur in the provision of power and lighting in the urban street.

7. THE NATURE AND ROLL OF AN URBAN STREET

The urban street or road is a narrow linear strip of land which provides for a multiplicity of purposes such as :

(1) Separating and providing access to the adjacent land uses, which may be of a variable nature.

(2) Providing a corridor for movement of people and goods by means of buses, lorries, cars, motor-cycles, mopeds, bicycles, tricycles, prams and pedestrians.

(3) This movement of people and goods may be through movement, movement between adjacent properties and land uses, between non-contiguous properties, or across the linear strip to opposite properties.

(4) The provision of corridor space for all services such as water, sewers, street lighting power, telephone and gas.

(5) Recreation, communication and work area.

(6) Enhancing or decreasing security and danger aspects.

(7) Aesthetic fulfillment or degradation of the adjacent community.

(8) A source of pollution impacts in the form of noise, fumes and particulate matter.

(9) Space for trees, gardens and landscaping.

The provision of street lighting and power must not only be designed to comply with the appropriate SABS Codes, but must be planned and designed to fit in with and augment all this multiplicity of functions of the street and its users.

8. SOUTH AFRICAN GUIDELINES AND SABS CODES

The guidelines for the provision of engineering services for residential townships compiled and issued by the Department of Community Development in 1983 is a commonly used guideline.

These guidelines in the chapter on Overall Planning Considerations state: "One of the most significant of the problems identified was that engineering services cost more than necessary, when the special layout needs of each service have not been co-ordinated in the overall layout from the beginning", and that their — i.e. various engineers, planners, surveyors and other professions — primary function is "to provide a township layout and services which recognise human needs for SECURITY OF PERSON AND PROPERTY, SAFETY (including road safety), PRIVACY and GOOD ENVIRONMENTAL QUALITY".

Under the heading of Goals and Objectives it stated that it is essential that the designer be guided to-

wards the target of an acceptable living environment by the positive influences which relate to the quality of the environment and which should form the goals. Seven goals which have been derived from the target statement are ECONOMY, FUNCTIONAL EFFICIENCY, SAFETY, CONVENIENCE, ENVIRONMENTAL QUALITY, PRIVACY AND SECURITY OF PERSON AND PROPERTY.

In part G of the guidelines it is stated that "the main objective is the design and subsequent construction of an economical electricity distribution system capable of meeting probable demands of safety and reliability, whilst maintaining the voltage within the statutory permissible limits.

With reference to street lighting the guidelines refer to SABS code of Practice for Public Lighting : SABS 098 Part 1 — the Lighting of Streets and Highways, which states : "Public lighting should permit users of the road to drive or walk about at night with the greatest possible safety and comfort".

"The lighting has to satisfy both drivers and pedestrians but in practice it is mainly the more demanding requirements of the drivers which dictate the standard of lighting'.

"For the pedestrian, distinct visibility of footways, vehicles and obstacles and the absence of dark patches are essential".

As part of the planning three figures showing planning of services are given as follows :

20 metre reserve with eight metre carriageway, two cycleways and two footways

16 metre reserve, 7,4 metre carriageway and two footways

13,5 metre reserve, 6 metre carriageway and one footway

Copies of these figures are attached as Appendices X Y Z.

In each case the electric light pole is shown at the reserve boundary behind the tree line, which gives rise to the following questions :

(1) In view of the fact that light intensity at any surface is inversely proportional to the distance squared, will this arrangement lead to the most economical usage of electricity?

(2) With trees forming a barrier to passage of light, will the cycleway and footway on either side of the road be adequately lit fulfilling the requirement of distinct visibility of footway, vehicles and obstacles and absence of dark patches as required by the code?

(3) Will the source of light shielded by the trees be able to fulfil the requirements for lighting the carriageway, viz. public lighting should permit users of the road — i.e. carriageway — to drive or walk around at night with the greatest possible safety and comfort?

These guidelines and questions give rise to the more general but more important question which is :

"Are we as Engineers fully studying, understanding these guidelines enabling implementation of our design skills in fulfilling the aims and objectives as set out in various guidelines and codes of practice?"

SABS 098 Pt 1-1976 provides the following criteria of quality :

(a) The level of luminance

(b) The uniformity of luminance

(c) The limitation of glare

stating that "a high level of luminance, good uniformity and a minimum of glare are equally important for the provision of maximum visibility and visual comfort of the driver".

In considering these criteria and the various types of urban streets, with the multiplicity of various uses, the following question arises: Should the level of the criteria be the same for each of the following categories of roads? (classifications given are Permanent International Association of Road Congresses with the proposed S.A. Road class no. in brackets)

Major Road (class 2)
Primary Distributor (class 3)
Local Distributor (class 4)
Estate — or Residential (class 5 with further subclauses 5a to 5)

The volumes of vehicular traffic on these roads will vary from high volumes on the major road to a very low volume on minor estate or residential roads. Arising from this, the level of criteria will alter in terms of the user which could vary from high vehicular volume to low vehicular volume with perhaps pedestrian traffic being the dominant traffic.

In addition with the strong South African estate tree tradition a co-ordination of estate street lighting types and position is of paramount importance.

Consideration should be given to :

(1) Type and volume of traffic
(2) Height of luminaire
(3) Position of luminaire
(4) Type of luminaire
(5) Type of trees
(6) Position of trees
(7) Power supply — overhead or underground

Consideration of these interlocking factors could lead to a reassessment of street lighting, resulting in an aesthetically more satisfying street at a lesser cost, fulfilling all the requirements of ECONOMY FUNCTIONAL EFFICIENCY, SAFETY CONVENIENCE, ENVIRONMENTAL QUALITY, PRIVACY and SECURITY OF PERSON AND PROPERTY.

9. CASE STUDIES

Naboomspruit

Naboomspruit, a Northern Transvaal country town, was planned on the traditional grid iron pattern of most South African small towns, with 60 Cape ft — i.e. 18,89 m — road reserves with 4 m sidewalks on either side, the resulting carriageway was 10,89 metres wide. The riding surface was gravel. Power and street lighting was the standard gumpole, overhead wire power and street lighting. Due to the wide carriageway and long straight streets with long blocks, high speeds with the resulting danger and dust were common practice.

During 1978 Naboomspruit instructed its consultants to investigate and report on a street tarring programme. This investigation resulted in the following basic recommendation :

The aims of the road improvement scheme must be to :

(1) Provide an adequate riding surface
(2) Increase safety
(3) Increase amenity
(4) Provide adequate drainage
(5) Reduce speed
(6) Increase general and aesthetic quality of life

(the above not necessarily in order of importance).

To achieve these aims it would be necessary to :

(1) Reduce the width of the riding surface
(2) Adjust the vertical alignment of the riding surface to allow for drainage
(3) Redesign the street lighting
(4) Scrap and rebuild all existing kerbing
(5) Encourage landscaping of sidewalks
(6) Reconsider longitudinal alignment to introduce a visual restriction to speeding
(7) Introduce public participation

A test section of two blocks was undertaken with full participation of the affected residents in the two block test section.

Notwithstanding the labeling by townsfolk of the test section streets with gently curving longitudinal alignment as "dronk strate" a subsequent poll of citizens when it was planned to extend the street tarring programme an overwhelming majority voted in favour of the "dronk strate".

The 3 m height liminaire at lower lighting intensity with reduced glare have proved adequate, have enhanced the general amenity and aesthetic appeal of the street, and will not in future be in conflict with tree growth. Monitoring over a two year test period showed that :—

(1) Speed through the area had been reduced
(2) Dust and noise levels reduced
(3) Safety especially at dusk and early evening when children met and played around the attractive low level lighting — had increased
(4) Residents had extended their gardens into the sidewalks, thus resulting in improved visual appearance both day and night
(5) The mid block circular island was only partially successful and that an elongated island would be more successful
(6) That the cul-de-sac especially without a turning circle was unsuccessful
(7) The overall quality of life in the area had improved
(8) That the cost was less than if conventional road widths had been built
(9) People believed that their property value appreciated

Kinross Ext. 17

Kinross Ext. 17 is a township built by Kinross Municipality as a residential area for coloured and Indians working at Sasol II & III.

In terms of the Group Areas Act the two groups had to be separated and a buffer strip had to be provided between the two communities. This condition was fulfilled by providing a wide main collector road reserve between the two communities. An Escom servitude along the western half of the road on the north side of the road strengthened the barrier strip.

At the time of development a four lane double carriageway was planned in the buffer road reserve, but as an economy measure it was decided to build the 2 lane northern carriageway only.

The electrical consultant designed the street lighting for this main collector with lighting standards along the south boundary of the reserve well away from the north carriageway. This factor was not noticed by the civil engineers in charge of the overall project, the civil site engineer, the electrical contractor or anyone else before the whole electrical system was activated, by which time cost to install the system had been incurred and no money was available to rectify the error. With better co-ordination and holistic planning these luminaires could have been placed in the future centre island between the future carriageways.

10. CONCLUSIONS

There is much that all engineers, be they electrical, civil, mining, agricultural or any other, can achieve in maintaining and enhancing existing environments and in the creation of new urban environments by adopting an holistic approach to planning.

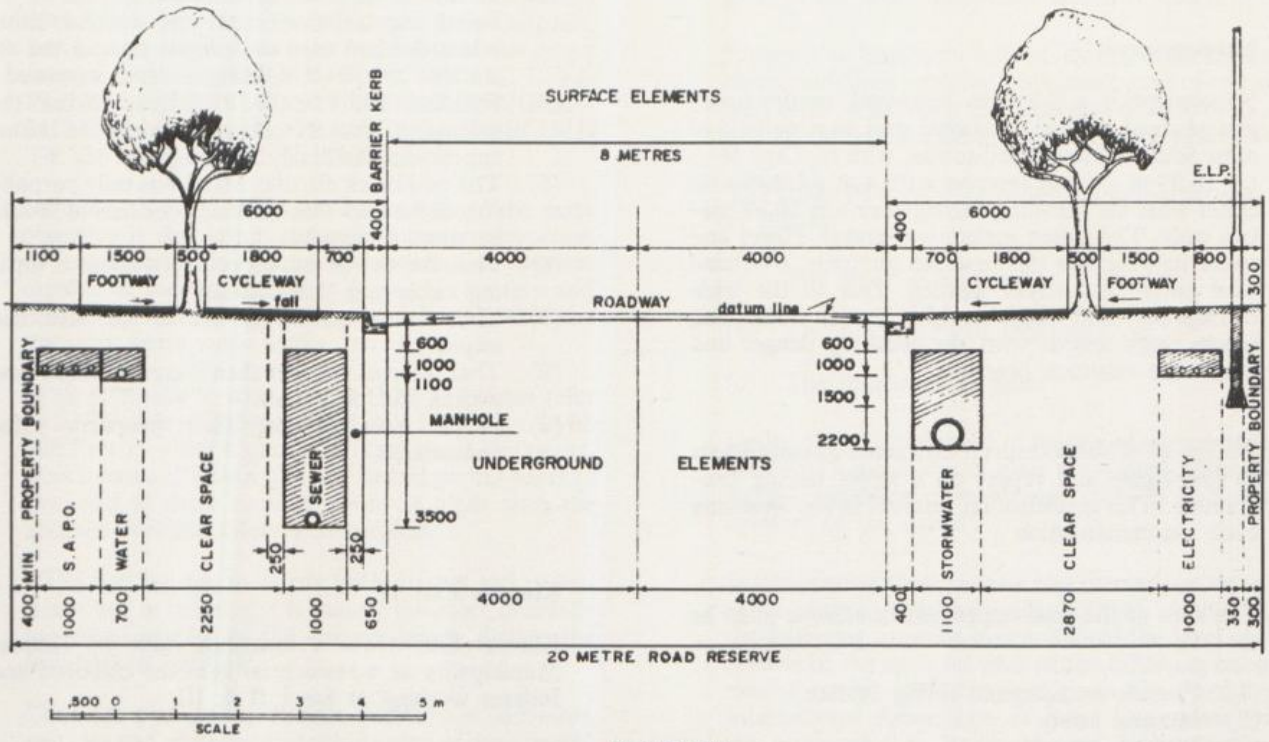

FIGURE A4

SAMPLE CROSS-SECTION SHOWING SERVICES IN A CLASS 4 LOCAL DISTRIBUTOR ROAD (MAJOR BUS ROUTE)

ANNEXURE X

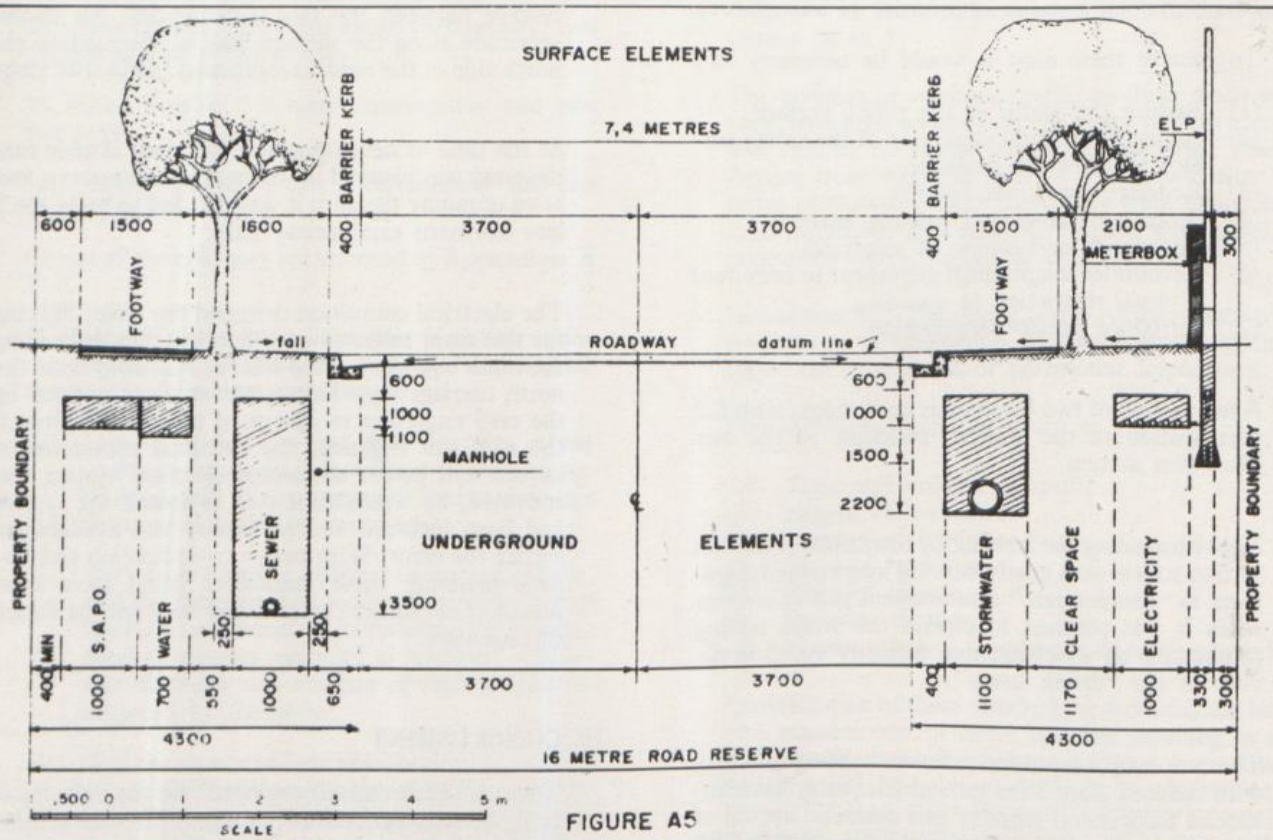

FIGURE A5

SAMPLE CROSS-SECTION SHOWING SERVICES IN A CLASS 4 LOCAL DISTRIBUTOR ROAD (LOCAL BUS ROUTE)

ANNEXURE Y

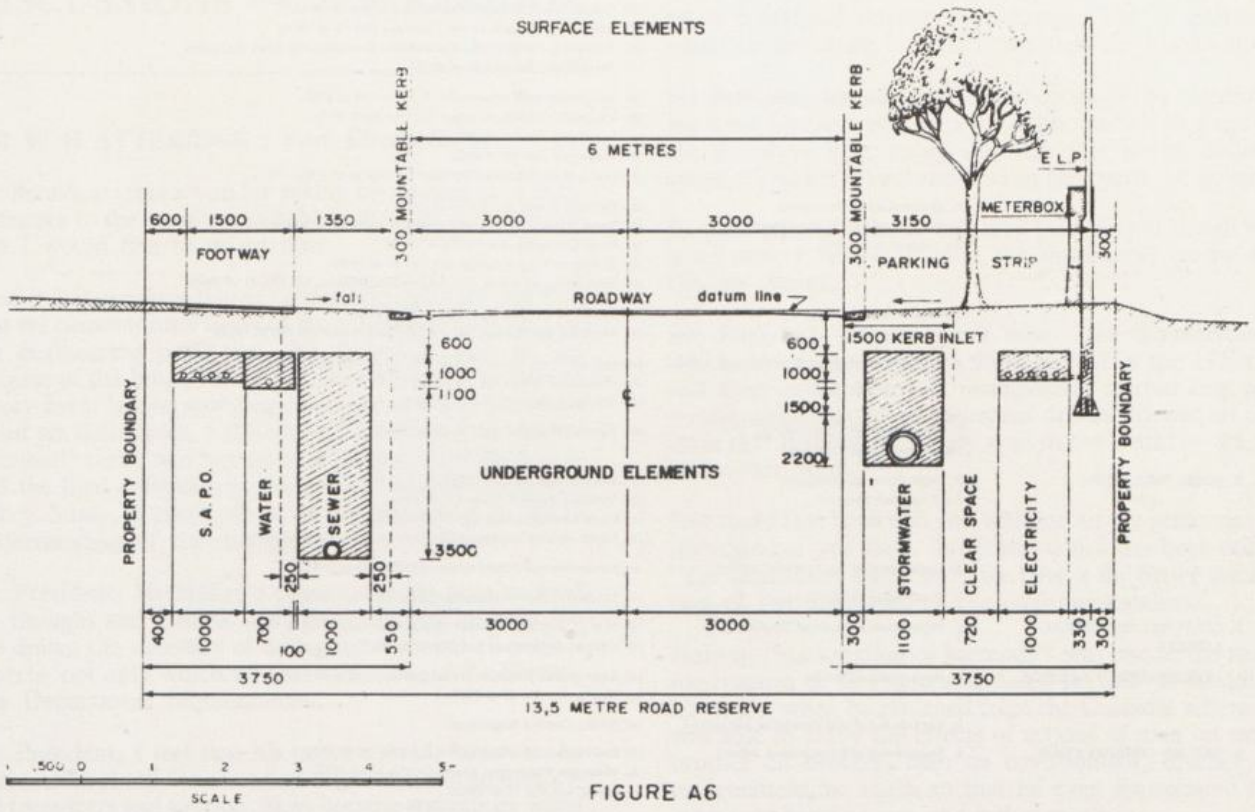

FIGURE A6

SAMPLE CROSS-SECTION SHOWING SERVICES IN A CLASS 5a ACCESS COLLECTOR ROAD

ANNEXURE Z

NOTES

(1) McEvoy 111 et al (1977) : Handbook for Environmental Planning. The Social Consequences of Environmental Change : John Wiley & Sons New York PP XII

(2) Corwil Ruth : Impact Assessment, Origin. Operation and Outlook : Environmental Impact Assessment, Hefferman et al 1975, Freeman Cooper & Company, San Francisco

(3) Renny Michael : The Law of Environmental Impact Assessment, Hefferman et al 1975

(4) Celliers MP : The Engineer and the Man-made Environment : Symposium to commemorate World Environment Day, June 1986

REFERENCES

(1) Guidelines for the Provision of Engineering services in Residential Townships

(2) SABS 098 Part 1 — 1976 Code of Practice for The Lighting of Streets and Highways

(3) SABS 098 Part 2 — 1976 Code of Practice for the Lighting of certain specific areas of streets and highways

(4) SABS 1500 — 1983 Standardized Specification for Electrical Engineering works

(5) SABS 1277 — 1980 Street Lighting Luminaires

(6) Hulley DJ : Urban Road Design — Social Impact and Public Participation, Symposium Engineering and the Environment, South African Institution of Civil Engineers, Pietermaritzburg 1984

Table 1: Legislation relating to Environmental Conservation*

ENVIRONMENTAL ASPECT	INSTITUTION	ACT/ORDINANCE
1. SOIL PROTECTION	1. Department of Agriculture	(a) Conservation of Agricultural Resources Act (No 43 of 1983) (b) Unbeneficial Occupation of farms Act (No 29 of 1937) (c) Subdivision of Agricultural Land Act (No 70 of 1970) (d) Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Amendment Act (No 24 of 1977)
	2. Department of Environment Affairs	(a) Environmental Conservation Act (No 100 of 1982) (b) Mountain Catchment Areas Act (No 63 of 1970) (c) Forest Act (No 72 of 1968) (d) Water Act (No 54 of 1956) (e) Sect 4 of the Physical Planning Act (No 88 of 1967)
	3. Department of Transport/ National Transport Commission/ SA Transport Services	(a) National Roads Act (no 54 of 1971) (b) South African Transport Services Act (No 65 of 1981) (c) Road Transport Act (No 74 of 1977) (d) Transport Co-ordination Act (No 44 of 1948) (e) Advertising on Roads and Ribbon Development Act (No 21 of 1949)
	4. Department of Health	(a) Hazardous Substances Act (No 15 of 1973) (b) Medicine and Related Substances Control Act (No 101 of 1965)
	5. Department of Minaral and Energy Affairs	(a) Sect 6B of the Physical Planning Act (No 88 of 1967) (b) Mines and Works Act (No 27 of 1956) (c) Mining Rights Act (No 20 of 1976)
	6. Department of Constitutional Development and Planning	(a) Physical Planning Act (No 88 of 1967)
2. NOISE POLLUTION	1. Department of Transport/ SA Transport Services	(a) Aviation Act (no 74 of 1962) (b) National Roads Act (No 54 of 1971) (c) Road Transportation Act (No 74 of 1977) (d) South African Transportation Services Act (No 65 of 1981)
	2. Department of Environment Affairs	(a) Environmental Conservation Act (No 100 of 1982)
	3. Department of Manpower	(a) Machinery and Occupation Safety Act (No 6 of 1983)
3. CULTURAL-HISTORICAL ASPECTS	1. Department of national Education	(a) War Graves and National Monuments Act (No 28 of 1969) (b) Cultural Institutions Act (No 29 of 1969)
4. ATMOSPHERIC POLLUTION	1. Department of Health	(a) Atmospheric Pollution Prevention Act (No 45 of 1965) (b) Health Act (No 63 of 1977)
	2. Various Local and Provincial Authorities	(a) Smoke Control Regulations
5. NATURE CONSERVATION	1. Department of Environment Affairs	(a) Environmental Conservation Act (No 100 of 1982) (b) Mountain Catchment Areas Act (No 63 of 1970) (c) Forest Act (No 72 of 1968)
	2. National Parks Board	(a) National parks Act (No 57 of 1976)
	3. Transvaal Nature Conservation Division	(a) Ordinance 17 of 1967
	4. Cape Provincial Department of Nature and Environmental Conservation	(a) Ordinance 19 of 1974
	5. OFS Division of Nature Conservation	(a) Ordinance 8 of 1969
	6. Natal Parks, Game and Fish Preservation Board	(a) Ordinance 15 of 1974
6. MARINE POLLUTION	1. Department of Environment Affairs	(a) Sea Birds and Seals Protection Act (No 46 of 1973) (b) Territorial Waters Act (No 87 of 1963) (c) Sea Fisheries Act (No 58 of 1973) (d) Fishing Industry Development Act (No 86 of 1978)
	2. Department of Transport	(a) Territorial Waters Act (No 87 of 1963) (b) Prevention and Combating of Pollution of the Sea by Oil Act (No 67 of 1971) (c) Merchant Shipping Act (No 57 of 1951) (d) Marine Traffic Act (No 2 of 1981) (e) Dumping at Sea Control Act (No 73 of 1980)
	3. Fisheries Development Corporation of South Africa Limited	(a) Fishing Industry Development Act (No 86 of 1978)
7. RADIANT POLLUTION	1. Department of Mineral and Energy Affairs/Nucor	(a) Nuclear Energy Act (No 92 of 1982) (a) Nuclear Installations Act (No 43 of 1963)
	2. Department of Health	(a) Hazardous Substances Act (No 15 of 1973)
8. SOLID WASTE AND LITTERING	1. Department of Health	(a) Health Act (No 63 of 1977)
	2. Provincial Authorities	(a) Sea-shore Act (No 21 of 1935)
9. WATER POLLUTION	1. Department of Environment Affairs	(a) Water Act (No 54 of 1956) (b) Dumping at Sea Control Act (No 73 of 1980) (c) Sea Fisheries Act (No 58 of 1973)
	2. Department of Health	(a) Health Act (No 63 of 1977) (b) Foodstuffs, Cosmetics and Disinfectants Act (No 54 of 1972)
	3. Department of Mineral and Energy Affairs	(a) Sect 6B of the Physical Planning Act (No 88 of 1967) (b) Mines and Works Act (No 27 of 1856) (c) Mining Rights Act (No 20 of 1967) (d) Precious Stones Act (No 73 of 1964)
	4. Nucor	(a) Nuclear Energy Act (No 92 of 1982)
	5. Department of Community Development	(a) Sea-shore Act (No 21 of 1935)
	6. Water Research Commission	(a) Water Research Act (No 34 of 1971)
	7. Cape Provincial Deaprtment of Nature and Environmental Conservation	(a) Ordinance 19 of 1974
	8. Natal Parks, Game and Fish Preservation Board	(a) Ordinance 15 of 1974

DISCUSSIONS — BESPREKINGS

MR W H ATTERIDGE : Port Elizabeth

Mr President, thank you for asking me to propose a vote of thanks to the speakers and the authors of these papers and I would like to do so now.

I feel it is imperative that at conferences we have like this that we communicate some of these lesser known facts of the engineering profession. Mr President, due to the lateness of the hour, I shall cut short all that I was going to say here, but in studying the papers, I felt that after about six definitions, I was not too sure what the "environment" really was but with the holistic approach to it and the final definition given in the National Transport Policy Study, I think all of us do now have a better understanding of the message.

Mr President, Mr Hulley's paper certainly gave us food for thought and I think with the examples he gave, he has drawn the necessity of taking into account all project aspects, not only which we sometimes do, of the Electricity Department requirements.

Mr President, I feel that his paper should, however, be presented not only to electrical engineers, but to municipal treasurers and to councillors because sometimes when electrical engineers make a statement that they would like to increase the cost of a project because they would like to care for a near extinct species, they do not always get the money.

Mr President, regarding Messrs Hobbs and Ledger's paper, we can say here in Port Elizabeth, that we certainly suffered in the late seventies from linear interaction with birds. It became quite serious at one time, and I am sure our Escom friends remember. I would like to recommend recognition of all the facts in the paper because it is a very good one, especially for those engineers who have to deal with these problems.

I have not read the guidelines, but as an environmentalist as well, I think we could indicate on a diagram where this various bird activity is in South Africa. Perhaps they are in the guidelines, if so, when we design overhead lines, we can then refer back to these guidelines and see if precautions should be taken.

Mr President, as we know from our training as engineers that change, used in the wider sense of the word is one of the basic principles of the engineering profession, and we must always be in a position to accommodate and assimilate change — it is part of our function whether it be retarring a dusty street in Naboomspruit or building a power station. Not change for change's sake, but ultimately for the betterment of our fellow beings and the environment on this planet.

Furthermore, Mr President, I do not wish to enter into discussions with the other professions, they may be here today, but I personally feel that the engineer has been responsible for the majority of changes over time with the others following after us. The engineer scientist has therefore, by that very statement, a great responsibility to see that the work undertaken by him is perhaps never an unintentional retrogressive change. Let us examine what we are doing — put it through the microscope.

Mr President, I would like to now conclude, by mentioning what I believe may be a lesser known fact to some of the members here today and this fact is the holistic approach which was mentioned in the paper, or holism.

Its principles have been with us a long time although the word was, I believe it is in the dictionary, coined by General Smuts.

Mr President, holism is not new. Like management, which everybody seems to think started in the 1950s, I just want to mention that management started long ago — the principles of management are mentioned in the book that is the most widely read in the world — we all know that book.

Just study that book and you will find all the principles of management you need. In holism, which has been called "the creation of harmony", we have a far better definition of the objectives of the environmentalists.

Holism, "the creation of harmony" was one of the main motivations of St Frances of Assisi in 1228 in founding his order, when he returned from the Crusades where he was able to study the effects of actions of man on man, brother on brother, man on environment, brother on environment, so much so that he even appreciated the extent of brother sun and sister moon.

Mr Chairman, I now wish to propose a vote of thanks to the authors and ask you all to show your appreciation in the usual manner.

MR J R FATH : Affiliate

Mr Hulley has told us about environmental policy and quality, has given examples of good and not-so-good engineering in South Africa and has introduced the subject of EPPIC.

We, as members of various institutes, are contributing, through these institutes each year to the running expenses of EPPIC.

EPPIC has prepared carefully phrased philosophies and aims, but as Mr Hulley has described, these phrases do not prevent the poor execution of projects. EPPIC has no power to enforce consideration of environmental aspects, nor to assess projects itself. For example, Escom carries out most of its own environmental impact assessments and other authorities use consulting engineers. Our own experiences (most of it is in the environmental field) show that these studies invariably end up as local political issues.

One question is typical of those environmentally-related issues facing municipal engineers :

Under what conditions is the additional cost of underground electricity distribution justified instead of cheaper overhead systems?

If we want answers to such questions, can EPPIC help to find them? Is there a need for EPPIC and do engineers benefit from their contributions to EPPIC?

We would like to hear the views of Mr Hulley and of other members on these questions.

MNR T BUYS : Germiston

Dit is inderdaad verblydend om so 'n referaat by die Tegniese Vergadering van die VMEO aan te hoor. Dit gebeur min dat die Gaswetenskappe en die Natuurwetenskappe op so 'n wyse bymekaar kom en samewerking soek. Die holistiese benadering gee natuurlik uitdrukking aan die mens se opdrag wat ons vanoggend weer by vernuwing by die opening met Genesis I verneem het.

So 'n samewerking is sterk aan te beveel, miskien is dit onontbeerlik. Ek wil dus aanbeveel dat hierdie samewerking vir besluitneming deur die VMEO nagestreef sal word. Ons is dit aan ons nageslag verskuldig.

MR E de C PRETORIUS : Potchefstroom

1. On page 8 of this paper Mr Hulley states: ".... light intensity at any surface is inversely proportional to the distance squared ...." The picture is actually darker than this. The statement should have read: ".... light intensity on any **horizontal** surface is inversely proportional to the **cube** of the distance from the light source ...." (due to the cosine factor). I realize that other factors also come into the picture.

2. Our approach in Potchefstroom is to erect street lighting poles as close to the kerb as is practicable, commensurate with vehicular traffic parameters (speed, volume) i.e. normally one metre behind the kerb in streets in residential areas and streets where the speed limit is 60 km/h or less.

3. Potchefstroom can boast with the longest continuous oak-lined street route in the RSA — possibly the southern hemisphere; it was recently proclaimed a national monument. To preserve and enhance the beauty of these oaks **and** to illuminate the carriageway we have resorted to low level (3 m mounting height) street lighting like done in Naboomspruit — (did they get the idea from Potchefstroom?) There is only one very serious problem with this type of installation from the motorist's point of view : discomfort glare, which is very difficult to overcome satisfactorily, i.e. without sacrificing light falling on the carriageway.

MR J A LOUBSER : President

Ladies and Gentlemen, before we start, may I just make a few corrections on the attendance register. Amongst the ordinary members, four very important Honorary Members have been left out, i.e. Mr Eugene Pretorius, Mr Jules von Ahlften, Mr Wessel Barnard and Bill Beesley. Please accept my apologies for these names being left out and also amongst the speakers Mr R Phillips, Group Technical Adviser — Electronics and Telecommunications of Aberdare Cables.

Then I would like to make the announcement that Mr Charles Adams has been co-opted by the Executive Council in place of Mr Dennis Palser who resigned.

Mr C. E. Adams, City Electricity Engineer of Port Elizabeth.

Whilst I'm on my feet, can I also congratulate a few persons :

Ronnie Lee, on your appointment as City Electrical Engineer of the largest city in the RSA, viz Johannesburg.

Ronnie het die plek oorgeneem van Wessel. Ons het gedink dis die laaste sien van die blikkantien maar dis nie so nie. Wessel Barnard is op die Elektrisiteitsbeheerraad aangestel. Ons wens hom ook daar geluk.

Mr Wessel Barnard

Fred Daniels, who unfortunately couldn't make it to be present here. He has been appointed as City Electrical Engineer of Cape Town — second largest.

We are now coming to Paper No 4 which will be delivered by Mr Ron Wedderburn — you know that's one thing about me — I know my friends. He is one of those. I had to contact him at the very last minute — you people who received that first official programme would notice it that I contacted Mr Wedderburn and he, without any objection, agreed to give us this paper on "Protection of Overhead and Underground Cable."

THE PROTECTION OF UNDERGROUND CABLE AND OVERHEAD BUNDLED CONDUCTOR RETICULATION SYSTEMS

By R. J. Wedderburn

1. SUMMARY

The overload and shortcircuit protection of underground cable reticulation systems has become very standardised over the years. A review of the protection requirements of these cable systems could be in order, especially with the possible inclusion of aerial cable systems in the form of overhead bundled conductors either supplementing or replacing underground cable systems. This paper will describe the protection requirements for both types of reticulation systems. The advantages and disadvantages of existing protection systems will be discussed together with possible future trends in protection and the commonality of the protection requirements for both underground and aerial cable sysems.

2. INTRODUCTION

Underground cable systems for electric lighting were first introduced in the 1880's by Edison in the United States of America and Ferranti in London. The modern paper-taped cable was introduced by Ferranti when he subsequently changed the insulation of the solid copper rods from jute wrapping to paper impregnated with Ozokerite wax.

By the turn of the century the copper rods has been superseded by a flexible stranded copper conductor and the insulation level of the single phase 11kV cable was of the order of 2kV/mm.

Overhead open wire lines were relative cheap to build, but in densely populated, urban and suburban, areas they were obviously undesirable, therefore, underground distribution systems became widely used. These cables were either laid in ducts or buried directly in trenches in the ground.

The Introduction of underground cables eliminated the problems associated with the effects of the weather and lightning, however, underground cable faults, when they occur, are more difficult to locate and repair.

Mr Ron Wedderburn

In the early years of electrical power distribution, a protective device was intended to protect only the circuit directly associated with it, but today the protection systems is concerned more with guarding the power system as a whole and with maintaining continuity of supply than with protecting individual circuits or apparatus. Modern protection systems tend towards an acceptable compromise between the complex technical requirements for the continuity of supply and the practical considerations of cost and availability. If continuity of supply is the prime concern, then the protection system must be highly discriminative, so that it will only isolate the faulty component and leave the remainder of the systems undisturbed.

3. PROTECTION REQUIREMENTS

Before a protection system can be chosen or specified, the nature and causes of possible cable failure should be analysed and the requirements of the protective device or system will then be easier to define. Cable networks may be subjected to a number of different types of stress where abnormal conditions cause a reduction in the basic insulation or dielectric between phase conductors or between phase conductor and earth. The nature and causes of possible udnerground cable failure will be discussed under two broad sub-headings.

3.1 Thermal

Heat in a cable is usually associated with either cyclic or prolonged overloads. However, there

are other causes of heat build up in cable networks and these will be dealt with separately.

A cable undergoes a differential expansion when it carries a current as the coefficient of linear expansion of the sheath is different to that of the conductor. If the current rating of the cable conductor is exceeded heating will result and movement of the dielectric could take place with gaseous voids forming between the sheath and the insulation. In the case of a paper insulated cable, breakdown of the dielectric will then occur, as the electric stress across the void is high and local discharge occurs, creating heat which chars the paper. Treeing occurs in extruded insulation when discharges take place in any void existant in the dielectric.

Each type of insulation has a maximum approved conductor temperature at rated cable voltage and these temperatures are critical as some types of insulations deteriorate more rapidly than others if subjected to temperatures in excess of their rated levels.

When a cable is subjected to a short circuit an extremely large inrush of current occurs at the inception of the fault. However, the protection, associated with the fault, will generally limited the fault duration to a very short period. Under these conditions almost all of the energy must appear as heat in the conductor or the sheath, depending upon the nature of the fault, and for the limited period associated with fast fault clearance. It will be evident, therefore, that the thermal effect on the dielectric will be miminal.

Cable sheaths with either steel wire or tape armouring are usually bonded to common steelwork at both ends of a cable run and this steelwork is usually earthed. In the case of single core cable networks the bonding of the cable sheats networks the bonding of the cabled sheaths tends to eliminate the high voltages which could occur due to the presence of induced eddy currents in the cable sheaths induced by the interaction of the invidual fluxes produced by each cable and the mutual inductance of all three cables. However, even with the cable sheaths bonded, eddy currents will still be produced and these currents will also contribute to the heating of the cable network. In three core cable networks the resultant magnetic field is almost zero and, therefore, with the very small eddy currents no heating is evolved.

The high losses occurring in some networks where long cable runs occur, has led to a system of crossbonding or transposing the cable sheaths at the end of each run and after three lengths have been traversed, the sheaths are bonded to earth. Charging currents, when cable networks are energised, if very high, due to the capacitance of the cable, can also add to the overall heating of the cable. In the extreme case where the current on no-load at the sending end is equal to the rated current then there will be no possibility of any load current being passed through the cable without an excessive temperature rise.

This problem could also be associated with a cable fed transformer where the isolating circuit breaker is upstream of a long cable run, with the cable solidly connected to the transformer winding. In this case there is the problem of the charging current including both the cable and the transformer in-rush currents.

TYPICAL CABLE WORKING TEMPERATURES

	MAXIMUM CONTINUOUS			EMERGENCY	AFTER SHORT CIRCUIT	
	Conductor	Ground	Ambient Air		Conductor	Screen
PILC:						
Belted	65 deg C	25 deg C	30deg C		160deg C	175 deg C *
Screened	70 deg C	25 deg C	30 deg C		160 deg C	175 deg C
XLPE	d90 deg C	25 deg C	30 deg C	130 deg C	250 deg C	250 deg C

★

This is the absolute sheath temperature. Temperatures in excess of this level could cause melting of the jointing metal.

3.2 Mechanical Breakdown

There are a number of possible causes for the electrical breakdown of solid dielectrics.

When a short circuit occurs, the large inrush current will set up magnetic forces. These magnetic forces, acting on the conductors or conductor and sheath, usually take the form of a repulsive force between the conductors carrying a current in opposite directions with the result that there is a tendency for the magnetic force to burst the cable.

The multicore paper cables, this tendency for the cable to burst has to be taken into account when cable protection settings are calculated, assuming that the cable will be able to withstand the magnitude of the fault current for at least one second.

Also inherent with the repulsive force during short circuit conditions is the heating of the conductor. The conductor will attempt to expand at each end as the centred of the cable tends to be the point of equilibrium. The sheath may, in the case of a lead sheath, also become permanently distorted.

TYPICAL FACTORS FOR DETERMINING 1 SECOND SHORT CIRCUIT RATING OF CABLES

	Maximum continuous temperature of the Conductor	Conductor Material	
		Copper	Aluminium
PILC:			
Belted	65 deg C	0.116	0.078
Screened	70 deg C	0.113	0.075
XLPE	90 deg C	0.145	0.0958

Rating (kA) = conductor size x factor

Included in the area of mechanical breakdown are the faults brought about by damage caused by external sources such as manual or mechanical digging operations.

3.3. Aerial Bundled Conductor

This type of cable is usually lightweight overhead cable using cross-linked polyethylene insulation with an earthed metal screen surrounding the insulation and covered with a weather resistant plastic sheath. The three phase conductors are twisted in trefoil around a stranded wire support cable. This support cable is used as the earth return as well as supporting the three cables at each pole mounting support hook.

The cables require the same protection as single core underground cables. However, the thermal heating of the dielectric will be increased due to the ambient air conditions as the conductors may not necessarily be in a protected or shaded environment. Convection and radiation of heat in free air should counteract this additional heating and manufacturers maximum loading currents will allow for any additional heating.

In addition to these requirements, there is the possibility of weather and lightning creating problems with the exposed suspended cables.

Another possible problem area is the location of high resistance faults between conductor and screen, as this type of fault may not be easily located or visible from the ground.

4. PROTECTION SYSTEMS

The choice of the protection system depends on two broad methods of discrimination. It can either be qualitative, in which the currents entering and leaving the protected section are compared or quantitives, in which the relays actually measure quantities such as current, time, fault-loop impedance, etc. The two systems are more commonly referred to as restricted or unit protection and unrestricted protection.

Intrinsically coupled to the choice off protection system is the type of reticulation system used. There are three distinctly different types.

Radial

Ring Mains

Parallel or Split-conductor

Ring mains can either have a normally open point or be operated as a normally closed ring. This type of system offers two alternatives supplied to any point of supply within the ring if the ring is closed and is sometimes the most favoured of the three system.

The protection system chosen should match the requirements of the reticulation system and the two main protection requirements for cable reticulation systems. The systems will be discussed under two specific sub-headings.

To clarify these discussions, the cable network terminal points will be called sending end, upstream side, receiving end, downstream side. Where sending end or upstream side, will be the end closest to the generating point and receiving end or downstream side of the network furtherest from the generating point.

4.1 Restricted or Unit Protection

This protection systems requires an auxiliary cable with two or more cores specifically intended for comparing the currents entering and leaving the protected section. The auxiliary cable will, therefore, have to be the same length as the main power cable and can in certain instances, where long cable runs occur, be fairly costly. The cores intended for current comparison are called pilots and this protection is sometimes called Pilot Wire Protection.

Unit protection systems, whether the bases of the protection is circulating current or balanced voltage, will only respond to faults that occur within the protected section and as such their operation is independent of any other protection system. However, they do not provide back-up protection for an section downstream and the sending end protection system tends to be a combination of pilot wire and some type of unrestricted protection. The unrestricted protection will act as backup protection for any faults not cleared by the pilto wire protection whether the fault occurs within the protected section or downstream of it.

However, there are a number of problems associated with the application of this type protection to cable networks and these problem areas will be discussed together with possible solutions.

The pilot cable is normally laid in the same trench as the power cable and protection from interference by twisting the pair of pilots and in some cases providing additional screening for any pilot cores within a multicore cable. Should the fault be caused by some external force on the power cables, there is every probability that the auxillary cable will be damaged as well and this could cause maloperation of the pilot wire protection. Should the pilot cores be damaged without damage to the power cable there is also a probability of the protection maloperation as indicated by the following table:

Pilot Fault Voltage	Circulating System	Balanced Current System
Short Circuit	Fails to trip on internal fault	Trips on full load
Open Circuit	Trips on full load	Fails to trip on on internal fault

Pilot wire supervision can eliminate possible maloperation by providing an early warming of any damage to the pilots.

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Unit protection will not operate for thermal heating caused by either cycling or prolonged overcurrent. This problem could be taken care of by the back-up overcurrent relay, but this will be dealt with separately.

Summarising, Unit protection will remain stabled for any through fault. Normal cable runs are relatively short and, therefore, the provision of a pilot cable is not unduly expensive if it is laid in the same trench as the power cables. Fault clearance is fast and where fault currents are high, speed of fault clearance is very important. Faults due to insulation breakdown and mechanical damage are providedd for, however, abnormal loading and thermal heating require additional protection. Most frequently used on ring mains and parallel or split-conductor feeders. Has limited use on a system with tee-off loads unless specifically designed for this type of application.

4.2 Unrestricted Protection

4.2.1 Time graded overcurrent

This type of protection is the simplest of cheapest, but the most difficult type of protection to apply because of the time grading required to obtain discrimination. The system suffers from inflexibility when used in growing or changing power network and requires adjustments or even replacement as system parameters change.

The maximum overcurrent setting normally used on cable networks is 150% of the standard rating for the type of cable and conductor size being used. From the cable life point of view, it is desirable to keep the overcurrent relay setting fairly low as these settings will limit the overcurrent for a set time and so limit the heating of the cable, thereby protecting it from thermal damage.

However, these low overcurrent setting have been found to be completely impractical in any power system where co-ordination is the most important factor. The rapidly increasing demand for power required for distribution purposes has made it essential that careful considerations be given to short circuit loadings and mechanical forces set up in a cable network under fault conditions. There is, therefore, a tendency to set the overcurrent protection relay settings for fault level instead of overload. The actual fault level is normally used unless this exceeds the short circuit rating of the cable. In this case an acceptable compromise can be reached by setting the relay such that the circuit breaker will trip within the recommended short circuit time rating of the cable.

From this it will be apparent that the overcurrent relay when used in isolation no longer performs the task of monitoring the thermal condition of the cable, as the setting will be too high to monitor cycling or prolonged overloads. However, when used in conjunction with pilot wire protection the lower setting of the overcurrent relay could be tolerated if the operating time is delayed so that unco-ordinated tripping does not occur downstream of the receiving end current transformers of the pilot wire protection, this delayed tripping of the overcurrent relay may jeopardize the integrity of the overall protection system.
Summarising. Time Graded Overcurrent protection is normally used either on its own or as a back-up to the sending end pilot wire protection. Fault clearance is determined by the time delay necessary to provide discrimination with similar protection either upstream or downstream. Faults due to insulation breakdown and mechanical damage are provided for, however, abnormal loading may or may not be provided for as this is dependant on the setting of the relay. Most frequently used on its own on radial feeders and as back-up on parallel or split-conductor feeders. Can be used on ring mains, but may have to be directionalised to allow for complete discrimination.

4.2.2. Distance Impendance

Distance impedance relays have been widely used on overhead lines for many years and due to problems with pilot wires and incapability of cable differential schemes for back-up protection, distance relays are now being used on high voltage underground cables.

There is a basic difference in the nature and performance of underground cables compared with overhead lines and when conventional distance relays are used on underground cable networks the zero sequence impedance of the cable causes an error in measurement.

The current return path for an earth fault in the underground cable depends upon the way in which the cable sheath is bonded and also where it is earthed. Cross bonding of the cable sheaths will also create parallel conducting paths and the only positive way in which the zero sequence impedance of the cable can be determined is by actual measurement after the cable is laid.

Summarizing, Distance Impedance protection will provide fast clearance for any fault occurring within the zone 1 reach of the relay. Faults which occur beyond the reach of zone 1, which is usually set at 70 to 80 percent of the cable impedance, will be cleared after a slight delay, but will be cleared far quicker than those which have to rely on time delayed overcurrent. Thermal breakdown is not covered completely in that the impedance of the cable

will not vary with overload conditions and as the impedance relay only measures and voltages at the sending end, low overcurrent settings tend to be impractical.

5. DEVELOPMENTS

The provision of protection systems which provide specifically for underground cables are being developed and one such system incorporates the remote location of a faulted 11kV cable section within a ring from the main sub-station. The location of the faulted section is available on a display panel 20 seconds after the main breaker has been tripped.

Thermal response can be obtained from resistance temperature detectors located on the cable sheath. However, they will only indicate the temperature of the sheath and not the temperature of the conductor. Therefore, any response from such a device would have to be related to the cable situation and the manner in which it is laid and the dissipation of heat into the surrounding medium. There is tendency for the selection of cables with a dielectric which can tolerate far higher operating temperatures without losing its electrical properties.
Pilot wire protection systems are now being developed using a fibre optic link instead of the metallic pilot circuit connecting the two relays. These fibre optic links also allow for communication channels between the two points of protection.

ACKNOWLEDGEMENTS

The Author wishes to thank GEC Measurements Company for the opportunity given him to present this paper. In addition the Author wishes to thank GEC Measurements, U.K. for permission to include some of the new developments in the protection of cable networks.

DISCUSSIONS — BESPREKINGS

MR E G DAVIES : Pietermaritburg

We must thank Mr Wedderburn for presenting his information in such a manner that he has been able to cover the subject with an interesting overview of the topic but still provide sufficient detail to let us know that he knows his topic. There are, however, a few comments I would like to make, starting with the subject of cable systems.

One of the consequences of thermal abuse which Mr Wedderburn has not mentioned is the risk of buckling at the joints caused by the longitudinal expansion forces. In 11 kV paper cables it is not considered safe to exceed a conductor temperature of 160 °C which is equivalent to a temperature rise of 120 °C above the stress free temperature of 40 °C. Good modern joints, however, have a greater mechanical strength under compression than those of older design and should be better able to withstand buckling.

In lead sheathed cables, a maximum temperature of 250 °C must not be exceeded in the lead sheath otherwise fracture or cracking may occur. With a steel tape armoured cable, it is considered that all of the return fault current flows down the lead sheath, whereas with a steel wire armoured cable the fault current divides according to the relative impedance of each component. For this reason, Pietermaritburg Electricity Department has for several years been purchasing steel wire armoured 11 kV cable in preference to steel tape armoured cable.

One small point which I would like to draw attention to :

With reference to the repulsive forces which cause bursting of a cable. These forces are usually considered to occur under symmetrical short circuit conditions when the current is flowing in all three conductors in the same (not opposite) direction.

With reference to the aerial bundled conductor, Mr Wedderburn has mentioned the heating of the dielectric caused by ambient air conditions. One consideration which the importers of this type of cable may have overlooked is the solar radiation absorption into the black polythene dielectric which could be of considerable magnitude in South Africa where the solar radiation constant is high. This may derate the capacity of the aerial bundled conductor severally when compared with the same cross-section of bare aluminium conductor.

We are all aware, I am sure, about the problems relating to broken conductors falling to the ground, earth cradles, sensitive earth fault protection and the like, but I wonder whether sufficient consideration has been given to the problems that may arise with broken ABC conductors.

Getting on to the subject of protection, I would make the following observations.

The manufacturers of protection equipment have obviously not allowed progress to hamper development of this equipment despite the fact that we power engineers are traditionally conservative and usually very sceptical when it comes to electronics, computers and microprocessors expanding their presence into our power electro-mechanical domains. There has in recent times been a lot of work done on static relays, particularly in providing the same functions as were previously provided electromechanically but, in addition to this there are new innovations which surely are going to make protection, and the part that we, the power engineers, play in protection, much easier.

Mention was made by Mr Wedderburn of the use of fibre optics as an alternative to pilot wires in restricted or unit protection and I would endorse this development totally as it must surely lead to more dependable and reliable protection by eliminating externally influenced maloperations. One area of concern is the earthing of pilot cable armouring at both ends thus permitting circulating and earth fault currents in the armouring. We commonly insulate the armouring at one end but the use of fibre optics could well solve this problem provided it can be done cost effectively. There is, however, in my mind, a major problem yet to be overcome and that is the separation of the pilot/fibre optic link from the power carrying conductors so as to prevent damage to this link in the event of faults.

Whilst on the subject of unit protection, and we all know the advantages that unit protection gives in terms of grading protection on a distribution system, I would like to revive the subject of cut-ins on unit protected feeders and the limitations imposed on the loads of these cut-ins without resorting to circuit breaker installations and the re-establishment of unit protection on the two shorter legs.

Distance protection has always had an appeal but application to short feeders is questionable and its price prohibitive — perhaps this is an area for R & D to investigate now that the computer manufacturers are producing their equipment cheaper.

At an earlier meeting such as this, George 1982, I tackled the subject with, and I quote :

"I would envisage the ideal form of protection or the municipal network as having three fundamental elements. The first element would be a traditional IDMT relay. The second would be a differential type circuit which will sense the amount of load being taken off within the protected zone. Should this current exceed the rated current, it will then bring an extremely inverse minimum time relay into play. This will then trip, but in such a manner as to permit co-ordination with the fuses protecting transformers on ring main units."

I wonder whether any progress has been made in this direction or whether in fact better alternatives have been produced by manufacturers.

Lastly, I would like to briefly comment that it appears as though not too much has changed regarding the philosophy of settings for the over-current IDMT relays in respect of overload versus fault and the saturation of CTs. I look forward to the day when there is irrefutable argument either way which is convincing.

MR M P P CLARKE: Randburg

Mr President, I would like to thank Mr Wedderburn for presenting us with a very interesting resumé of the method in use for the protection of high voltage underground cable networks and overhead bundled conductor systems, and for giving us a hint of the things to come.

Not having any personal experience of high voltage bundled conductor systems and taking note of the possibility of the increasing use of this type of cable, I, and I believe our members too, would appreciate more information on the protection systems actually in use on these systems. Does he see any merit in the incorporation of sensitive earth fault devices in such protective schemes, particularly as they offer some additional safeguard against single phasing — bearing in mind his comments on the vulnerability of these cables to weather, lightning and other hazards?

While I accept the bona fides of his comments in 4.2.1 on the difficulty of grading the traditional over-current time-graded protective system, I believe this should not frighten us off from this well-proven method.

Nothwithstanding the difficulties which may be encountered in some instances, these systems can be made to work successfully to give acceptable levels of discrimination at reasonable cost, even in growing or changing networks, and deserve to be thoroughly investigated when decisions on protective schemes are being taken.

Could we have the author's comments on the use of "high sets" and other devices to improve the discrimination capability of the traditional IDMT systems?

At the same time I am critical of the author's failure to highlight the changing needs of consumers, in terms of reliability of supply, and the demands which this places on the protection scheme. We live in an age of increasingly sophisticated electrical usage and the effect of unnecessary supply breaks on some of this equipment must not be under-estimated.

Supply industry engineers must make every effort to provide reliability and integrity of supply and, bearing in mind that the protective system is a relatively small part of the total cost of any system, it behoves us to look at all the options before finalising of choice of equipment.

My thanks again for having presented this interesting paper.

MR E de C PRETORIUS : Potchefstroom

Unit Protection

Mr Wedderburn states that unit protection "has limited use on a system with tee-off loads unless specifically designed for this type of application."

My experience, forced by necessity, is that tee-off loads can be tolerated on Translay-protected feeders — (Translay is a circulating current system) — provided the sum total of these loads do not exceed 50%, theoretically, but in practice I would advise not more than 30%, of the sending end current transformer rating, and HRC fuse protection is employed on the tee-off feeder. Low magnitude fault currents on the tee-off feeders or loads may, however, cause main feeder tripping problems. Such faults, however, are very rare.

Time Graded Overcurrent (And, I Presume Earth Fault) Protection

If the relay settings are set for fault level instead of overload, some means of overload protection should be provided : a simple, effective and fairly cheap method is a contact-making thermal ammeter (but make sure to have a saturating current transformer in circuit).

Distance Protection

Loss of potential on a distance protection relay can cause unexpected and embarrassing trips!

MR R J WEDDERBURN : Affiliate

Mr President

Mr Davies, the buckled joint was as such considered but not specifically mentioned in the paper — what I was looking at there was this being part and parcel of the mechanical breakdown. The problem is how do you actually determine whether the joint is buckled. It's a case of you have got to wait until the fault occurs before you can actually take action. With the case of thermal

protection, you may be able to measure the temperature, but with the buckled joint, you have a problem. I don't know if this is what you are after.

Buckling of joints does occur as such but it's a case of finding out what has happened. The only way you can find out is when the fault occurs and this is a problem — it is to actually find out prior to this whether the joint has buckled. I take it you were considering the joints buckling under the in-rush current situation.

The problem is that a joint could buckle under an in-rush current and the problem is to measure that in-rush current related to the buckling of the joint. The only time you would find out about this is when a fault develops due to the buckled joint and you would then take out your protection but you would not know what it was until you examined the fault condition.

Cable bursting — if I could just quickly draw something on the overhead. If we look at our log I log T characteristic, we have a situation where we have a fault level for the one and three second areas of the cable and generally it is a characteristic looking something like that. What was portrayed this morning, I think, was that you did not have to worry about that area because you were working right back in this area of the cable with the idea being that you are working on instantaneous values of tripping time and you are looking at about 120 milli-seconds and 70 milli-seconds and bearing in mind that your breaker, if it is a bulk oil or a minimum oil, it is going to be 100 milli-seconds away, you are relying on instantaneous protection in 20 milli-seconds to operate, the problem being that if you are using instantaneous protection, you've got no grading with your fuses on the transformers so it's a case of an over-kill situation. But should a fault occur on a transformer, a fuse won't be allowed to trip in time, or let's say fuse in time, and you'll be taking out the supply breaker for a fault that could be catered for by the fuse. So I attempt to look at this area which is your three and your one second times and ensure that the protection is graded in such a way that it fits in underneath the one and three second limits of the cable. If you were to allow your protection to sit up there, for instance, you would quite forseeably burst the cable under in-rush current. The only problem is that with an in-rush current as such it's of a very short duration so you've got to be able to analyse this and take action and it's the speed of the break coupled to the protection — it's quite a problem. Does that answer that question?

With regard to aerial bundled conductors and solar radiation, I did cover to a certain extent today that with solar heating, you would get increased temperatures in the bundled conductor but because the bundled conductors are in free air, convection currents should get rid of that heating but I take your point, they do tend to be covered with the black polythene or let's say a black PVC coating and this is going to increase the temperature of your conductor. Maybe the cable specialists could answer that one. The T rating as such is part and parcel of that.

With regard to aerial bundled conductors coming down, the problem is they have got an insulating sleeve around them and it would be very difficult to actually measure any current, it would be a capacitive current change as such because you would get the one capacitive situation where you've got the capacitive current due to the conductor hanging up on the pole and once it gets down to earth you've got a change in that capacitive current but you'd have to use very sensitive protection to measure that change in the capacitive currents.

Maybe with the sophisticated protection that might be possible in future, but we have looked at this recently and we cannot see anything at the present moment in the way of protecting that bundled conductor coming down to earth. Does that answer that question?

With regard to fibre-optics being cost effective, I think possible, very briefly, when my son first started at university, the calculators which we didn't have in our day, were about R120. That was a very simple calculator, I think, which are around about R15 now because they became cost effective. Fibre-optics at the moment tends to be a little expensive because it is a novelty. It tends to be coupled to a cable. There are various ways in which you can get your fibre-optic communication from one end to the other. You can actually wrap it around the phase conductor, you can sling it clothes-line fashion underneath the line, you can actually put it inside the earth wire or you can bury it. At the present moment the most cost effective way of doing this is to wrap it around one of the phase conductors.

With regard to tee-off of unit protection, I think that was Mr Eugene Pretorius, who raised a very valid point. You can get a certain amount of unbalance and you can tolerate this but you can't allow your tee-off load to be a lot higher than 50% of your send end current. Does that answer yours, Eugene?

With regard to the tee-off on a circulating current, it tends to be a little less intolerant, so you've got the difference between the balance voltage and the voltage of the circulating current. I think you've found that in practice.

IDMT protection using the differential load sensing — if I remember rightly you were talking about extremely inverse times. You can change the characteristics of the modern static relays to compensate for the various times that you require.

Mr Clarke, Mr President, you were saying the bundled conductor, I'm afraid there's very little experience been gained in South Africa on bundled conductor. Very few people have actually tried it out. When I've spoken about this overseas, it's been a sort of a situation where nobody has really come to grips with it. I did try to get some basic facts from the cable manufacturers, but to date I have not received much but there is a problem with (a) the protection of a bundled conductor because the earth wire is actually inside the wire, it's not a shield around the outside. There is a static shield around the conductor but it generally is not connected to earth so you have a problem of measuring that earth fault current.

I think I mentioned in the paper the problem also associated was finding the fault because there is no definite earth fault return.

The older type of protection, I wasn't trying to say that it was a thing of the past. I was advocating that you could use what your old-fashioned protectionists called the bread and butter IDMT over-current and earth fault, as

long as you allowed it to be set for a fault level, in other words we are looking at that rather than setting it down to load. Because if we're setting it on load, the problem is that somehow or other your consumer is going to take a higher load than you've allowed him to, let's say allowed in that way tariff-wise, and then you're going to trip him spuriously, so one of the ideas is to set your protection for fault current and eliminate the spurious tripping of your supply which can be annoying. I did mention that the reasoning behind this new sensing of the cable problems was to try to eliminate long durations of outage to the consumer so we have got the consumer in mind when we look at these systems.

Mr President, I did ask Eugene Pretorius if he would like to reply formally because at this stage I think it is his last technical meeting that he will be attending. I was hoping that as his valedictory address he would sort of address this paper but he did admit to me that he would rather just respond informally.

Unit protection with tee-offs I think we have considered.

With regard to HRC fuses on tee-offs, you have the problem of the characteristic of an HRC fuse and the characteristics, say, of the normal type of protection, which is the 10/3 curve. So you've got to consider possibly putting in extremly inverse with a high set cut-off to allow for future characteristics. The only problem is that our high set, which we used to call instantaneous, is not really instantaneous, you've got 20 milli-seconds of gap there so you've got a problem where you could get your fuse still operating during that 20 milli-seconds for high fault levels. So there is a problem with HRC fuses coupled with protection. Does that cover that point? I think I've covered everything, Mr President.

EVOLUTION AND STATUS OF THE SOLID STATE ELECTRICITY METER

BY MR D. SINCLAIR

The move from electromechanical to solid state electricity meters is a very major challenge that Sangamo Metering has met and conquered in the most difficult area of all, the single phase domestic meter.

The electromechanical Ferraris disc meter is a product which is, in product terms, of a very mature technology which is both highly accurate and highly stable. Literally millions of electromechanical meters have been manufactured since before the end of the last century and I submit that there are very few products (if any) that can be purchased for less than £20; are accurate to better than plus-minus 2.0% over full range; and have a service life in excess of 20 years.

So why take on the challenge of cramming so much expertise into a new electronic product?

Why start at the difficult end of high volume, low cost meters, when all the other manufacturers of electronic meters have only succeeded with very expensive, high accuracy, polyphase meters?

There are a number of reasons for moving the way in which we did.

As may be expected, the answer is complex, being a combination of reasons, some technical, some commercial and some for reasons of manufacturing. I will go into these in some detail in a few moments, but first I would like to outline who Sangamo Metering is and give you some idea of the kind of technical and financial resource that makes fundamental technology changes of this nature possible.

Mr D. Sinclair

Sangamo Metering is situated in the East of England at the Port of Felixstowe in Suffolk. Sangamo moved there from Enfield in 1964. Sangamo has been manufacturing meters at Felixstowe, Enfield and originally Ponders End, since the early 1920's. As you can imagine, a considerable number of Electricity Meters have been manufactured in over 60 years!

In 1975 a controlling interest in Sangamo was acquired when its parent company in the U.S, Sangamo Electric, was taken over by Schlumberger. Schlumberger is a multi-national company with primary interests in oil exploration and well head logging. The Company oper-

ates in some 115 countries, employs 75,000 people, and has a turn over of approximately $7 billion.

In the early 1970's, Schlumberger decided to broaden its interests into the user end of the energy market and acquired companies throughout the world manufacturing not only electricity meters, but also gas and water meters, which along with other instrumentation products and technology form Schlumberger Measurement and Control grouping.

Today those companies combine under the Schlumberger banner to form one of the largest utility metering Companies in the world.

In addition to utility metering, Schlumberger also acquired Fairchild in the late 1970's. This unusual mix of instrumentation, measurement in hostile environments, utility metering and semi-conductor technology, have combined in a unique technology blend.

Working at the company's research laboratories, first in France and later in England, the world's first single chip electricity meter was conceived. This occurred back in 1978 where, working within the background of high resolution instrumentation and the electrically hazardous environment of "down-hole" measurement in oil wells, a team of engineers developed a large scale integrated circuit which, when combined with a shunt to provide the input and using the output to drive a stepping motor driven register, resulted in an integrating electricity meter.

We will come back later and look at the detail of the meter and the technology involved.

In Sangamo, it was clear that a major level of reinvestment was necessary to fully automate the plant in Felixstowe to manufacture the next generation of electromechanical meters. However, it was the view of the management team in Felixstowe that with the possibility of an electronic meter on the horizon, it would be likely that the electromechanical meter would have been overtaken by developments in electronics before the enormous investment on the electromechanical meter had achieved a payback.

However, as stated earlier, to simply replace an electromechanical meter for an electronic equivalent seemed a daunting task unless the electronic meter could give significant advantages over the electromechanical unit.

As we were entering a new era, it was decided that rather than just repeat the electromechanical products, we should start with a blank sheet of paper and, with our long experience of dealing with Utilities throughout the world, take a fresh look at what our customers were trying to achieve and base our new product range around these parameters.

The first assumption was that we were not really looking at an electricity meter, but more at the end of a chain in which the name of the utility customer all the way back to the utility mainframe computer.

This assumption is extremely important as it conditions the view of an electricity meter not as a simple standalone unit but as the primary transducer in a revenue collection cycle.

This view is important, particularly when linked with the fact that electricity meters, particularly in developed countries, are changed on a random basis.

We must, therefore, design a product which carries out the functions of its electromechanical equivalent, but is also capable of being use din an upgraded system in the future without change.

It was also clear that capital is a scarce resource in most utilities and that our customers would not suddenly change from one technology to the next, but that it would be a gradual change over a period of 10 to 15 years.

This last assumption is extremely important in that this calls for a modular approach to the development of a product range such that changes and improvements brought about by the rapid change in technology can be absorbed and not be cause for abandoning one route in favour of another.

What then did we see as our customers' major objectives. Simply stated, these are seem to be

* Maximise return on capital investment
* Improve cash flow and reduce fraud

How can metering assist in these areas?

Taking these in turn:

* Maximise return on capital investment.

This is related to maximising the effectiveness of load management in terms of multiple tariffs. At present in the UK this is being achieved by using time switches to provide a fixed two rate tariff in an attempt to arrive at a two plateau load curve.

This is already running into some problems with creation of minor peaks at 01.00 hrs in the morning and consequently flexible load management using long wave phase modulated radio signals is being installed to overcome this problem.

Looking further ahead, it is clear that multi rate tariffs having possibly 4 or 5 rates will be required in order to maximise the generation capital resources.

The use of microprocessor based technology and custom designed integrated circuits means that multi tariff metering can be achieved at a relatively economic level and can be cost competitive with the current two rate meter and tariff time switch. The result of this will be the ability to cost effectively instal electronic meters, whilst not utilising their full potential immediately.

* Improve cash flow and reduce fraud.

There are two major problems currently being faced by the UK Utilities and these relate to a high incidence of meter fraud and to the problems primarily of cash flow in relation to coin prepayment meters and secondly to the whole subject of cash flow related to the three months credit customer.

The second area, that of prepayment, is a very detailed subject and worthy of more time than we have in this

paper. However, it should be recognised that with the extremely rapid decline in coin-operated units and the very rapid increase in intelligent tokens, the true prepayment, i.e. "payment before use" meter, is now with us and is likely to make a significant impact, particularly with the added features electronics can contribute.

Of even greater importance to a far wider number of Utilities is interference with electromechanical meters and the resultant loss in revenue.

The major cause of meter fraud in the electromechanical meter is interference with the disc. The solid state meter has no disc and as a consequence

— has been designed so as not to run in reverse.
— cannot be slowed by interference.

A further design feature is that the shunt is in the line and not the neutral to prevent electricity consumption by connecting between the line and ground and hence bypassing the meter.

More sophisticated means of fraud such as electromagnetic and radio frequency fields have also been taken into account in making the solid state meter proof against all but the most complex and difficult means of fraud.

Assisting our customers in making their objectives in the main direction of our product development, but does not necessarily explain the reason for starting with the domestic customer rather than the commercial/industrial sector.

The answer to this question lies in the area of revenue collection with respect of the capital involved to collect that revenue.

Within the UK ESI, there are some 22 million customers and it is interesting to note that of that total number, 90.2% are domestic customers and 9.8% are industrial-/commercial type customers.

If we consider this in terms of the revenue generated by these two groups then we find that 45% of the revenue is collected from the domestic sector, whilst 55% of the revenue is collected from the industrial group which is only 10% by volume of the total.

These factors emphasise the point that a far larger amount of money can be spent on collecting revenue in the industrial sector.

As a result, our conclusion was that product development was cyclic, moving first to the domestic area to quickly satisfy the market in terms of longer term developments and to provide products for the next 10 to 15 years.

Having established this as Phase 1 of the development plan, we would then move into the industrial and commercial area where, along with establishing the polyphase solid state meter, we would embark on two way communications and data acquisition in an area where, due to the high level of the revenue collected, a higher level of investment by Utilities could be envisaged.

The next stage would be to swing the techniques learnt in this Phase 2 back into the domestic area.

Having looked closely at the reasons for the change in technology based on a fundamental marketing approach, we will now look more closely at the fundamentals of the Sangamo Solid State Meter before looking at the reaction of the UK market to the meter, the method of introduction and the meter's future potential.

As with all integrating electricity meters, the electronic meter measures energy by multiplying together voltage and current and integrating the product with respect to time.

The functional block diagram of the meter is shown in Figure 2. Input to the large scale integrated circuit (LSI) is provided by means of a Manganin shunt and a voltage divider network which connects to the live and neutral mains inputs.

The basis of the multiplier is a transconductance multiplier which is fundamentally a pair of transistors connected in differential mode that can be shown to combine the low level output from the shunt and from the potential divider, and to feed the resultant voltage into the V-F converter. The linearity of this circuitry is extremely good. (Figure 1).

From the multiplier, the signal is then fed through a voltage to frequency converter which in association with an integrator and synchronised clock pulse from the crystal oscillator, provides an output that is a sequence of pulses which in turn drive a counter/divider logic circuit.

It should be noted that the voltage to frequency converter is biased such that for zero power there are no pulses to drive the counter/divider logic circuit.

Within the counter/divider logic (Figure 3) circuit, the pulses are used in an up-down counter. On reaching its maximum count, the counter provides 1 output pulse. The output pulses are divided down and presented via a buffer to the output/measurement light emitting diode (LED)

The LED pulse train is further divided by 8 to provide a bi-directional pulse to a stepper motor which drives in turn the meter register. In a multiple rate meter, these motor pulses are sent via a logical gate array to the correct register.

Also included in the circuitry is a logical creep inhibit device that inhibits the counter when no power is flowing through the shunt, thus preventing meter creep.

The output from the meter is shown by the LED which is pulsed from the LSI at a rate of 800 pulses/kWh. Each pulse is an 8kHz modulated light pulse which is used to facilitate pulse detection for testing purposes. In the same package, there is also a green LED which lights and remains lit if any attempt is made to fraudulently drive the meter in reverse.

As an optional output, a simple opto coupler circuit is available giving an output rate of 50 pulses/kWh.

The excellent performance of the meter is fully illustrated by the curves shown in Figure 4. It should be noted that the curve accuracy is highly repeatable and the meter's performance is linear throughout its range.

Before describing the mechanical arrangement of the meter, we should briefly consider the evolution of the meter from its original inception.

It should be emphasised that the fundamental electronic design of the meter has not changed throughout its evolution, except to improve its test-ability in making every pulse a metrological pulse and to provide the logical creep inhibit facility.

In 1981, 100 original meters were built with the fundamental object of proving the measurement capability of the meter. These meters were, under the control of the UK Electricity Council, installed on a trial basis throughout the UK. In measurement terms, the meters were excellent, but problems were foreseen with regard to electromagnetic and radio frequency interference.

The problem here was not in meeting the requirements of British Standard, which is designed to guard against accidental application of radio fields, but more to prevent the deliberate attempt to defraud the meter.

These problems were fully overcome and in 1983/1984, a further 3,000 meters were built, solid to customers, and installed. This meter was fully approved by the Department of Energy and was built to show that the meter was capable of being made in volume and that the results were repeatable. This was achieved, but, due to the methods of light load test and certification of the meter in the UK, this meter took some 20 hours to test, rather than the 4 hours of the conventional Ferraris meter.

This meter, although produced in volume, was not designed for full automation and so a subsequent meter was introduced in 1984 that was mechanically designed for a high level of automation.

This meter, known as the Mark IIa was produced in volumes of up to 6,000 units — still with the test problem and still not fully cost competitive with the electromechanical meter.

We had, however, by this time proved beyond doubt that the meter was highly accurate, repeatable and reliable — the only remaining problem being that of manufacturing cost.

The breakthrough that has now resulted in our current production unit came in early 1985 when the decision was made to move to the technology of very small surface mounted components. This move allowed us to reduce the PCB size to 30% of its original size, dispense with the original hybrid circuit and replace this with a thick film resistor. The resistor network is trimmed by a laser as part of the production process in matching the meter chip to the shunt characteristics.

In moving to the new technology of surface mounting and laser trimming, Sangamo has invested very heavily in capital equipment in manufacturing the PCB together with a final automated assembly link, complete with robotic assembly. All this equipment has been housed in a purpose-built factory adjacent to the current facilities in Felixstowe.

The final meter (illustrated here: Figure 5) is now being produced in volume and some 60,000 units alone will be produced this year.

The level of acceptance of the meter has been greatly enhanced by the improvement in its ability to be tested which has been reduced from the original 20 hours to 6 minutes!

Tests, both by Sangamo and independent laboratories, have shown that the S.P.A. Meter out-performs its electromechanical counterpart.

The SPA Meter (Single Phase Model A) is now fully approved by the UK Department of Energy and the majority of Boards in the UK are installing the meter with some, notably South of Scotland, London, South Eastern, North Eastern and others, making a policy decision to generally change from electromechanical to solid state meters.

The solid state meter is now firmly established in manufacture and Sangamo is again looking to the future.

In parallel with the meter development, work has been going on to establish a National Radio Load Control system within the UK. This is now starting to gather momentum and Sangamo now has a radio receiver (known as a Radio Teleswitch) which receives and decodes a coded signal contained in a sub-audio carrier on the 200kHz BBC Radio 4 Network. The basis of the Sangamo Radio Teleswitch is a further custom-designed LSI and a microprocessor to interpret and act upon the signal originating from the Area Boards via the CEGB Central Control.

This parallel development puts Sangamo in the unique position of being able to deal with both measurement and communication in custom-built LSI. By combining these units together with software into one integrated unit, Sangamo has the ability to provide the full requirements of a fully integrated domestic metering system.

This unit, which will include a multi-rate tariff component, will also be provided with a data output port. At the present moment, this data output port will be accessed by means of a hand-held unit which will be carried by the Meter Reader. This hand-held unit stores data from up to 250 meters and, at the end of the day, the data is downloaded, via modems, from the meter reading office, to the mainframe computer.

This is the last link in the chain between mainframe computer and the meter. The use of data output ports and meter readers at this stage is necessary until the cost of two way communications between Utility and Consumer becomes a cost effective reality.

When that day arrives, the data output port in the combined metering and control unit can be directly linked by whatever communication path is seen to be cost effective at that time. By taking the route that Sangamo Metering has embarked upon, some very distinct advantages accrue, namely:

* the ability to change from electromechanical to electronic technology on a random basis;

* by initially using radio as the outbound load control path and hand-held units/data concentrators for revenue data, there is no clash in priority between the System Control/commercial requirements of the Utility and the revenue collection aspects.

* the need to provide data concentrator and programming units connected by telephone to the Utility mainframe will create a computing infrastructure necessary to deal with the longer term automatic meter reading — whatever the means of communication.

* the cost effective means of communicating with every consumer is a long way off, but this should not preclude the investment in new technology now. Sangamo Metering's strategy allows this to happen.

In summary, therefore, we can confidently state that the Sangamo Solid State Meter is in volume production and is being installed in large numbers in the U.K. and has already generated considerable interest overseas. The meter provides a basic measuring element to act as the fundamental transducer for all future revenue collection systems for the Electricity Utility.

Taking the fundamental measurement L.S.I. and the recently developed communications L.S.I. and combining this with software, we have the start of a modular system to take the domestic electricity meter consumer forward for the next 15 years.

If we add to this the very significant investment in manufacturing by means of the latest automated technology and years of application experience in Utilities world wide, we believe that Solid State Domestic Electricity Metering is now firmly part of the future.

In conclusion, I should like to thank you for allowing me to report to you on the evolution and status of the Solid State Single Phase Energy Meter and trust that I have demonstrated why we have made the change and, having made the change, opened up the potential application for the meter.

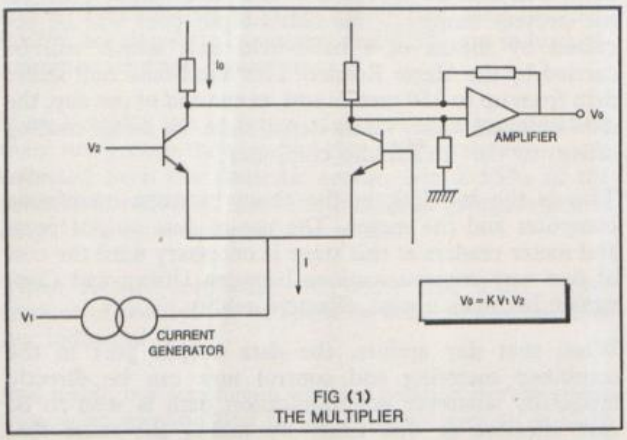


FIG (1)
THE MULTIPLIER

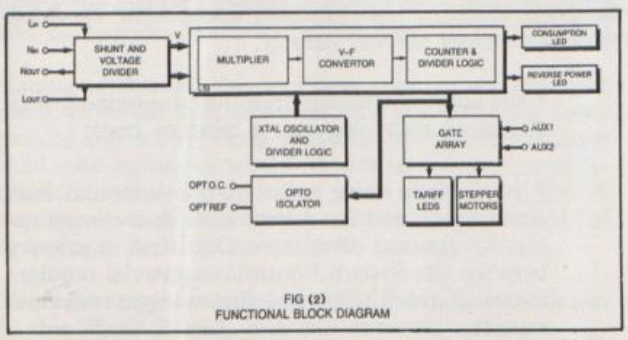


FIG (2)
FUNCTIONAL BLOCK DIAGRAM

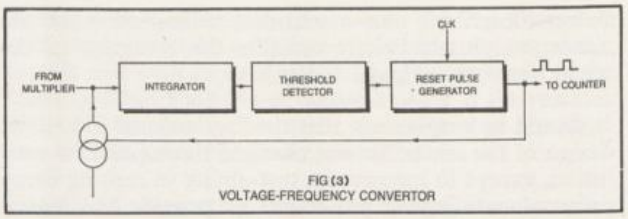


FIG (3)
VOLTAGE-FREQUENCY CONVERTOR

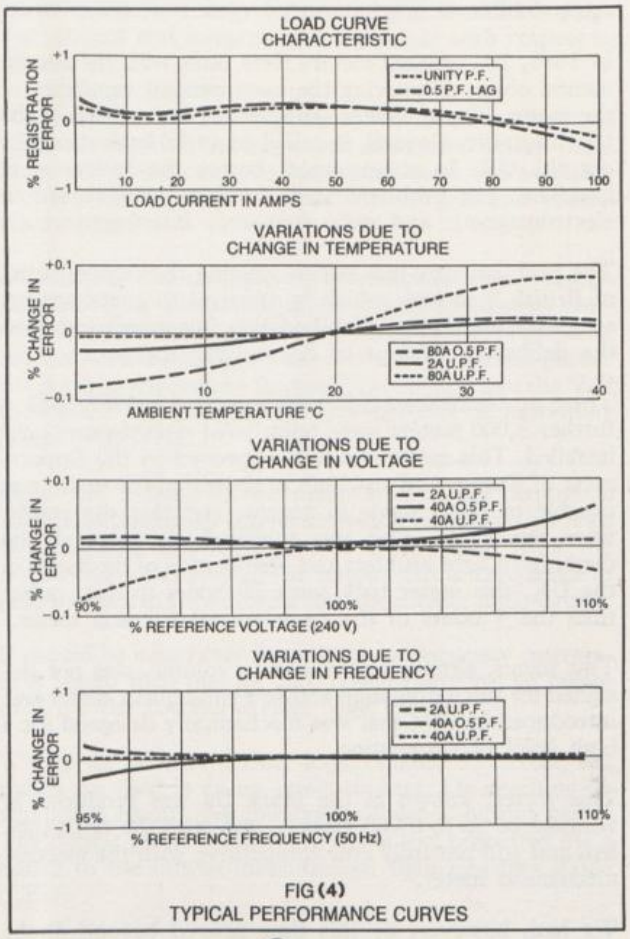


FIG (4)
TYPICAL PERFORMANCE CURVES

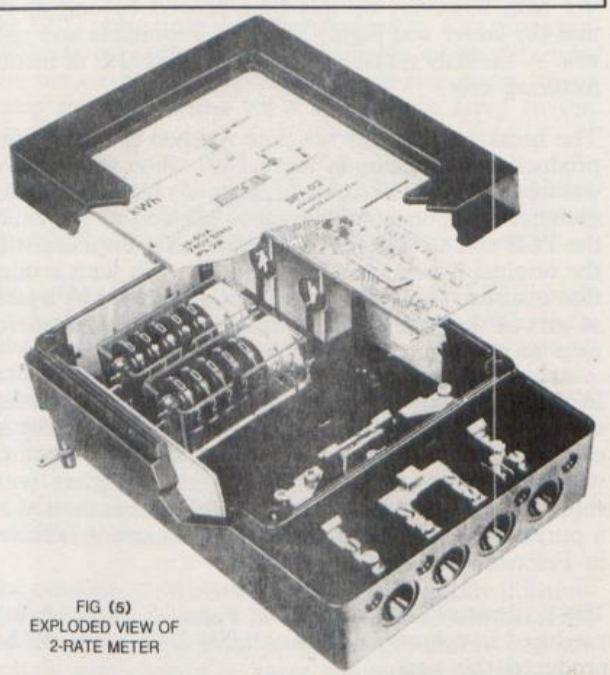


FIG (5)
EXPLODED VIEW OF 2-RATE METER

DISCUSSIONS — BESPREKINGS

MR K ROBSON: East London

Mr President, Delegates

Mr Sinclair has presented to this Technical Meeting a forward-looking paper which, I have no doubt, has stimulated the thinking of all who have studied or listened to it.

The electromechanical Ferraris disc meter and the transformer are two remarkable pieces of electrical apparatus with high standards of operating performance over long periods of service and varying loads.

The electromechanical energy meter has consistently been low-priced and the obvious first question to Mr Sinclair must be — what projections have been made for the short, medium and long term selling prices of the new solid state electricity meter and, for purposes of comparison — the electromechanical meter? Is the anticipated selling price competitive as of now and if not, when is it expected to be competitive?

The evolution of the Sangamo Meter — "the electronic equivalent" — not only as a new technology measuring device but also as a revenue assessing and collection instrument, is a story, told briefly in the paper, of a manufacturer's commitment to the future. This has necessitated a courageous decision to invest heavily in research and manufacturing plant and equipment.

The fundamental electronic circuitry of the new solid state meter, incorporating a shunt and voltage divider, multiplier V-F converter, counter/divider logic circuit and ultimately the LED pulse train to the stepper motor to drive the meter register, is of special interest. Perhaps Mr Sinclair is able to tell us if problems were experienced during the development with electromagnetic and radio frequency interference, voltage and lightning spikes?

With the increasing incidence of electromagnetic interference associated with electronic equipment connected to electricity supply systems, can Mr Sinclair give the assurance that the solid state meter will not be affected in service?

It would be helpful also to be given some details of the methods of defrauding the meter which were simulated during the research and development phase. Although defrauding of disc meters is on the increase, it would seem not to be a serious problem in South Africa at this stage. The East London Undertaking dealt with twelve such instances in the 1985/1986 year of a total of almost 25 000 consumer installations. Unfortunately such fraudulent actions cause damage to bearings, discs, registers and magnets. Thus a meter without discs and adjustable magnets is to be welcomed.

The important aspect of meter testing is given some attention in the paper and I refer to the statement of Mr Sinclair that the meter is capable of being tested in six minutes. A number of questions arise:

1. Is this time achieved with bulk or mass testing?
2. Would the full range of tests as laid down in the SABS Code of Practice for the Testing of Electricity Meters be completed in that time?
3. It is the practice in the East London Undertaking and probably in other Undertakings, to test fully all new meters before installation. With the solid state meter, could supply authorities dispense with pre-installation testing?

The accuracy maintained by the electromechanical meter over long periods (frequently operating at excessive overloads), — between 25 to 40 years, is well proven. As a matter of interest, in the 1985/1986 year the East London Undertaking was required to test, in terms of its Electricity Supply By-Law at the request of consumers, 15 meters which had been in service for between two and thirty years. The average service life and average error of these 15 meters were 15 and 1,79% respectively. Not one meter was found to exceed the plus-minus 2,5% error. There are 26 000 meters installed in the East London area of supply. Could Mr Sinclair provide projected anticipated comparative statistics?

The section of the paper dealing with future possibilities for meter reading, revenue collection, portable computer accounting via main frame computers as well as prepayment intelligent token meters, would provide the content for a future paper.

Coin-operated meters for supply authorities consumer installations are not favoured or justified. East London has 614 such meters, almost all of which had been in service for many years. The capital cost is high and maintenance problems are significant, e.g. with only 614 meters in service, the Undertaking in 1985/1986 carried out 190 repairs to and subsequent test of such meters — a costly exercise.

With the massive development foreseen for the Black electricity consumer market in South Africa, will the token pre-payment meter take over from the credit meter? I have my doubts.

In considering faults in or failure of the solid state meter, the following questions are posed:

1. Is expensive testing equipment required?
2. Can components be easily replaced?
3. Can the future availability of spare components which are not obsolete be guaranteed?

In many instances it has been found that the costs of individual replacement components are out of all proportion to the cost of the equipment itself.

A sample meter was connected temporarily by the Undertaking to an air-conditioning unit and operated for some weeks. Compared to the disc meter which is silent in operation, the solid state meter was found to be noisy — can Mr Sinclair say if this is an operating characteristic?

It is recommended that manufacturers fit covers made from high impact resistance materials as a safeguard against vandalism.

It is suggested also that conductor entries to the terminal block be improved to foil attempts to by-pass the meter by using a wire loop between the line and load connectors.

Mr President, this can be described as a topical paper which has brought municipal electrical engineers up to date with domestic metering technology and for this we are grateful to Mr Sinclair.

MR M P P CLARKE: Randburg

Mr President, allow me to congratulate Mr Sinclair on his very interesting and timely presentation and to thank him for lifting a small part of the veil of mystery which, for most of us, surrounds "solid state" matters as applied to electricity kilowatt hour meters. I am sure that I am not alone in having been fascinated by the company's reasoning, the analysis of the future requirements of the supply industry, and the prediction of the way ahead in this matter.

The question for most of us here today is likely to be ". . . when do we start, and how fast should we go along the new route?" And to this end perhaps we should know what the implications in practical and money terms are, for our traditional meter testing facilities? Are the new meters likely to turn our thinking in this regard upside down? . . . is the company likely to set up special facilities for testing the very occasional "bad egg" in the batch? . . . and will we run out the useful life of our "old" meter test facilities on our existing electro-mechanical "left overs"?

Special care and emphasis has been placed on the security of the circuitry from electromagnetic and other radiation interference; does this mean that tests have been conducted on distribution networks in areas with severe lightning levels of the same order of magnitude as on the South African Highveld?

Interference with electromechanical meters is relatively simple to trade because, as the author says, it is generally someone "fiddling with the disc": my mind boggles when I try to think of how we will ever catch out a "boffin" who has found his way into the electronic meter's microprocessor or integrated circuits! And for those who would immediately say "impossible", I would gently remind you that almost weekly we are fed stories of "whiz kids" somewhere "cracking" one or other of the "safe" electronic/microprocessor controlled marvels of our present age. Some of you may well have spotted a story from London in the evening papers on Friday, 22nd last, in which it was reported that a bank in Whitehall had lost R1,5 million to a gang of high-tech crooks . . . and the Scotland Yard computer crime unit formed only two years ago is said to be investigating some 25 reported cases!

Mr Sinclair has given us a peep into a crystal ball and I confess I become distinctly uncomfortable when I try to visualise the world of tomorrow with consumer meter readings buzzing through the ether, to some centralised meter room at the Treasurer's offices; maybe by that time Escom electricity will be so cheap anyway that a few megawatt hours lost in transmission will not be too serious a matter!

Mr President, I am sure we will all be trying out these new meters before we are very much older . . . that is the way things happen. For giving us an insight into one of the ways ahead, I thank Mr Sinclair and his company, and wish them well with the new development.

MR D A MARÉ: Affiliate

Mr President, Sangamo Metering is indeed to be congratulated on the development work done on the solid state, Class 2, kWh meter.

1. In the paper it is stated that initial problems with radio frequency interference were overcome. It would be interesting to know more about tests conducted to establish the immunity to RFI and the level of immunity attained.

2. What effect does harmonics have on the solid state meters' performance.

3. It is noted that test time for the solid state meter has been reduced from 20 hours to 6 minutes.

   What was the reason for the time of 20 hours originally required for test and how is it now possible to do this in 6 minutes?

   The 6 minutes test time presumably does not include a dial test as a dial test of 3 kWh at 220 volt, 80 amp, unity power factor alone would take more than 10 minutes.

   What type of test equipment is required for testing the solid state meter and what will the cost of it be?

   The test time of 4 hours stated in the paper for a conventional Ferraris disc meter is, in my view, excessive. A test time of 20 to 30 minutes, including a dial test, would be reasonable.

4. How many solid state meters of the latest design are actually in service and what is their reliability record?

5. How does the life expectancy of the solid state meter compare with the 40 years of a Ferraris disc meter, particularly in view of the high incidence of lightning in certain areas?

MR D SINCLAIR — Affiliate

Thank you, gentlemen, for those questions, and I think we're going to need another hour or so to clear them all.

To start off with, price competitiveness. At the moment, this meter will be totally imported and depending on what the pound to rand exchange rate will be towards the end of this year will determine the price of the meter. It is our company's intention to, as we have in the past, do as much local production of this meter eventually as possible. We estimate that we could probably reach a figure of 70% local manufacture but this will take time. So I'm sorry Mr Robson, I can't give you a price at this moment but it's not going to be uncompetitive with the electro-mechanical meter when you compare the facilities that you are purchasing and the advantages.

With the question of interference, the radio frequency bombardment of the meter initially did give us an awful lot of problems and we overcame this basically by building a Faraday cage around the meter. If you have the time, I would like you to see one of these meters inside and you'll find that there are case-hardened metal shields built into the plastic sides which captures this interference completely so that that interference problem has now been solved as far as we are concerned.

With regard to the SABS recommendations, this meter meets fully with the BS Specifications and as such I don't think that there is any problem at all, it meets all the requirements of a number of British Specifications. I'll just read something that I've written down here — there's no BSS for electronic meters but these have been built and approved to the relevant part of BSS 685 of 1979 and the Organisation International metrologici, that a French company, Lagar, you know that's a part of the IEC's Specification. Generally all the requirements have been met for these meters. These meters have met all those requirements and are proved under Sections 49, 50 and 59 of the Sequence of Electricity Lightning Clauses, Act 1899 as incorporated with the Electricity Act, 1947, the Secretary of State of energy.

Now that brings me to another point. Surges and spikes and lightning. We comply with the BSS test of 6 kV on a 1,2 micro-second rise time and 50 micro-second fall. Although no harm came to the meters at 12 kV so they have extended the test beyond the 6 kV, they went up to 12 kV and we still had no problems.

There is also a voltage dependent resistor in the circuitry, the VDR, which breaks down to protect the meter under surge conditions. We also comply with the pulse test of 1 500 V for 30 nanoseconds and 500 nanoseconds superimposed on the mains between 30 kHz and 150 Hz.

A little bit about the adjustment on this meter. There is no adjustment. When you build the shunt you have to take the thick resistor and you cut it with a lazar beam to match that shunt exactly. Once that's done and those two components are assembled, the meter either works or it doesn't work. You don't adjust it at all. So, you know, the meter is either accurate or it doesn't work. I know that's a very short explanation but we could go into that in more detail at some stage in the future.

Regarding pre-payment meters, I'm sorry to hear that there's no future in East London for pre-payment meters because that is the new product that will be launched at the beginning of next year. This is a very private preview. The size of that is exactly the same size as the meter that we have up here. As well as being a token operated unit, you can also put a data key into the thing which loads it up and it reads information so you can take it back to your mainframe and uncup the information there.

With regard to testing, because there is no disc that you can look at, the LED over here needs a special adaptor. You have to have a multi-voltage tap so that you don't have to separate your voltage from your current with the IP link, so that might be an adjustment that a lot of you people have to make if you go for this meter, and secondly, this eye fits over the pulsing LED and picks up every eighth pulse and then it is computed by a very simple computer to give you the accuracy of the meter. As I say, you do this basically to initially test our selling you the meter under certain conditions, you know, it's a Class 2 meter.

With regard to the meter being noisy, this is a complaint that I have had but noisiness is relevant. What is actually happening is every time the stepper motor is pulsed, the stepper motor turns the dials and this is the noise that you are hearing. It's just a brush every now and again and it doesn't rattle like some Ferraris meters so I would say that noise should be — you can tolerate it — I can.

I think I've covered the point about lightning.

Interference with the meters. I agree with Mr Clarke that, I believe a lot of banks have been robbed because they are now fully computerised and I don't know the answer to that problem. How we are going to catch them is beyond me but somehow or other somebody will come up with a device that will detect these frauds eventually. I'm not too sure how it's going to be done but I'm sorry I can't give you a complete answer there.

I think the test equiment, as I say, you would need a bench where you can connect the voltage supply and the current supply. These meters have got no link in them at all and that's one of the things, I think, evolution will catch up with everybody and that's the way it's going to be in the future.

The test time — I apologise that I can't defend Mr Wheeler completely there because I'm a little bit puzzled as well but as I mentioned earlier, once the resistor is cut, the meter either works or it doesn't, and it can quickly be tested by checking the pulse rate. With regard to life, and any other electro-mechanical relay, there's no reason for it not to last longer and maintain its accuracy. I hope I've answered all your questions.

USING OPTICAL FIBRE AS THE COMMUNICATION MEDIUM IN A HIGH VOLTAGE ENVIRONMENT

R.N. PHILLIPS
and S.GUN

INTRODUCTION

No-one active in the field of electrical engineering can fail to be aware of the fast moving technology of optical communications. The technical press, technical journals, and even the daily press regularly features articles on some aspect of optical communications. Optical fibre is currently being used in such diverse disciplines as power generation, network control, process plant instrumentation, medical equipment, broad-band telephony, video, and data communications - to name but a representative selection.

This paper will discuss the technology of optical fibre communications. We shall discuss the basic principles very briefly, before describing the features and benefits of the technology and its applications specifically in the power generation ad distribution industries. Optical fibre is not limited to high voltage protection systems, but this important area of concern to so many practising power engineers has become one of the more important applications for optically based communications systems.

Some years ago, our exposure to optical fibre technology was limited to information received from overseas, particularly Japan, USA and Europe. Because of their massive Research and Development funding, most new innovations are still emanating from these sources, but local interest in the development of designs and systems aimed specifically at local conditions, particularly the very high lightning incidence of our inland regions, has resulted in specific South African products, designed and manufactured in South Africa. As an example, our company, Aberdare Cables, has an optical fibre cable manufacturing plant in this city of Port Elizabeth manufacturing locally designed cable for a variety of local customers.

Optical fibre has been used mainly by the South African Post Office for the provision of high capacity telephony links both within urban areas and to link our main cities. However, a number of organisations within the power generation and distribution industries which have already installed fibre include Escom and the cities of Cape Town and Johannesburg.

APPLICATIONS

One of the earliest applications was to use a fused fibre bundle to transmit an image ie. to use each individual fibre as a light pipe. Medical instruents, component inspection in inaccessible places, and photo-copying machines all use this characteristic of guiding light along the fibre.

Mr Rob Phillips

An important use of fibre is to carry multiple channel telephone conversations not only within the public telephone network (SAPO), but also within private telephone networks ie. Escom, SATS, municipalities, mining houses, etc.

Data communications is another important application. Fibre is used to link computer terminals to a host computer or to support a local area network by linking a number of components, printers, etc. The form of the data bit stream does not affect the fibre's transmission characteristics at all. Consequently a HV power line protection system carrying out-of-balance current information from the sensor to the switch gear can be regarded as a low speed data link.

Closed circuit TV systems for perimeter security, access control, or for the monitoring of inaccessible or hazardous processes can be achieved easily and cost effectively on fibre. Alarms, either in the form of transistor logic states, or contact closures, or the outputs of process instruments can be combined or multiplexed together, using inexpensive equipment to provide a distant control point with a complete indication of the status of a power station, a substation or any process plant or mine, for example.

Optical sensors are an exciting development, where the sensors measure some aspect of a process by that processes' direct interaction with the fibre. Detectors some way from the sensors, detect the change in the sensor's fibre characteristics. This application is used in intrinsi-

cally safe areas, where electrical power or electronic componentry is not desirable and can also be used in low cost automation systems for component detection and positioning or fault location.

FEATURES AND BENEFITS

1. Cable prices are now very competitive with conventional copper cable and the only added cost is the electronic/optical converters on both ends.

2. Long distance transmission possibilities without repeaters.

   Reliability is improved because of less equipment in the field and there are no difficulties with remote power feeding of repeaters.

3. Large transmission capacity

   - it is entirely feasible to combine a large number of inputs and send all this information through a single fibre. Fewer fibres are necessary so savind costs.

4. No shielding from electro-magnetic interference is required.
   Since the fibre is non-conductive, it is immune to any form of electro-magnetic interference. Lightning, power surges, fault conditions, electric traction systems etc have no effect on optical fibre systems.

5. Electrical isolation between transmitter and receiver results in no spurious signals introduced through ground loops and different ground potentials.

6. High security information transmission because the light signal is completely contained within the optical fibre. Cross talk does not exist.

7. No damage to sensitive electronic equipment due to voltage surge caused by fault conditions or lightning.

8. Flexible, light, and easy to install makes for convenient and quick installation using fewer people and less equipment than a conventional cable.

9. Optical transmission also gives added advantages in explosive environments where intrinsic safety is of prime importance. Even although the fibre may be cut, no spark can be produced.

FIRST PRINCIPLES OF OPTICS

Through a vacuum, light will travel in a straight line at a speed of 3 c 10^8 metres/second. Light is bent, refracted, and slowed down when it strikes a transparent material at any angle not perpendicular to the surface of the material.

Light can be regarded as being part of the electromagnetic spectrum in exactly the same way as x-rays and radio waves. The wavelength of visible light lies within the approximate range of 400 nano-metres (violet) to 750 nanometres (red). Optical fibre systems work best at either 850 or 1300 nanometres, both of which wavelengths lie in the infra-red band of the spectrum. (See Fig. 1)

Similarly a ray of light travelling in glass will be both refracted and reflected at the glass boundary with air. Over a certain critical angle of incidence, all the light will be reflected and none will be refracted out into the air. None of the light power will be lost since it is all trapped within the glass. It is this physical principle which makes possible the concept of optical communications.

OPTICAL FIBRE

a typical fibre consists of 3 clearly definable areas.

- The core is manufactured from extremely low-loss glass which has to be made from high purity materials. Its sole purpose is to transmit light with as little loss as possible.

- The cladding is manufactured from glass of a lower refractive index than the core. Its sole purpose is to trap the light withina the core region.

- The primary coat is a layer of either silicone rubber or acrylate. Its function is to increase the tensile strength of the fibre and to protect it from mechnical damage.

FIBRE TYPES

There are three important fibre types:

a) Step index multimode
b) Step index single mode
c) Graded index multimode

a) Step index multimode fibre consists of a core region of glass with a consistent refractive index surrounded by a cladding region of glass with a lower refractive index. This type of fibre is suitable for low capacity, slow speed information transfer over limited distances. As such, this type of fibre is not suitable for most applications found in municipal environments.

b) Step index single mode fibre is designed to overcome some of the disadvantages of the multimode step index fibre mentioned above. The distortions inherent in the multimode fibre have been virtually eliminated by making a fibre with a very smail core diameter (typically 9 microns) which can only propagate a single light ray. Information carrying capacity is improved dramatically and this type of fibre is suited to very high capacity, long distance information links. The South African Post Office is currently installing significant quantities of this type of fibre and other organizations are investigating using this single mode fibre in their networks.

   Single mode fibre is not suitble for all applications, however, mainly because of difficulties with coupling sufficient light power into the fibre, and difficulties associated with fusion splicing the fibres with an acceptably low loss.

c) Graded index multimode fibre has been designed to overcome the disadvantages of both previously mentioned types ie. the step index multimode and step index single mode fibres. The refractive index of the core is not consistent, but varies in a parabolic relationship through the core, with the highest refractive index at the centre of the core and the lowest refractive index on the outside of the core at the core/cladding interface.

Advantages of this design are ease of welding, connectorising, and coupling light into the fibre, along with the advantages of low loss and high information carrying capacity.

These advantages make this type of fibre particularly suitable for optical systems used in the power generation and municipal environments.

FIBRE MANUFACTURING TECHNIQUES

There are four important alternative manufacturing processes:

MCVD — Modified chemical vapour deposition
PCVD — Plasma-activated chemical vapour deposition
OVPO — Outside vapour phase oxidation
VAD — Vapour-phase axial deposition

This paper is not the occasion for a detailed discussion of the various processes for manufacturing the solid glass rod from which the fribre is drawn.

During the drawing process a layer of either acrylate or silicone rubber is applied to the fibre surface to protect the fibre from mechanical damage and to improve the tensile strength of the buffered fibre.

After drawing, the fibre is rewound under a specified tension, the proof stress, to eliminate any incipient microscopic imperfections in the fibre's surface which could, if undetected, cause problems during cable manufacturing, installation or the subsequent lifetime of the cable system.

USEFUL WAVELENGHTS

The attenuation or loss of light power in a fibre is not constant across the light spectrum but varies markedly with he wavelength (or colour of light) chosen.

Windows of low attenuation exist at the following wavelengths: 850nm, 1300nm and 1550nm where typical attenuations are respectively 2,5db/km; 0,7db/km; and 0,2db/km.

Although the 1550nm window appears ideal from a fibre point of view, the cost, availability and reliability of sources and detectors operating at each window, govern the wavelength chosen for any particular system.

CABLE DESIGN AND MANUFACTURE

In a practical cable, the primary coated fibre is further protected with an extruded layer of nylon or alternatively a loose fitting tube is extruded over the fibre. This secondary buffered fibre is stranded around a central strength member, after which additional strength elements, a moisture barrier and overall sheath are applied.

The technology of optical communications gives users the freedom to specify a completely metal free cable with sufficient strength, if required, to be completely self supporting over span lengths of up to 500 metres. Other designs are suitable for direct burial in the same cable trench as a high voltage cable, or can be directly ploughed in, where ground conditions are suitable.

In a power generation and distribution environment, the most important property of fibre trasmission is its freedom from interference and crosstalk. Fibre can be used in close proximity to power conductors, even inside an overhead phase conductor. Composite power and fibre cables are also possible and a number of composite undersea cables have been manufactured and installed. Remote power feeding of repeaters can be achieved by manufacturing a composite cable, containing both the fibre and the power feed conductors.

Lightning is a major problem in most of our inland areas and metal free cable is an ideal solution to the problems of spurious signals and operator safety.

Where a metal free cable is not required and steel wire or steel tape armour is required, a metallic strength element is used for cost reasons. One advantage of this design is that the central strength element and the armour wires may be used as an engineering order wire during installation of the system.

FAULT LOCATION

In the event of a broken fibre, caused almost invariably by mechanical damage to the cable, the location of the break can be determined by sending short pulses down the fibre from the break. Since the transmission speed of the pulse in the fibre is known, the distance to the break can be determined within an accuracy of 2 metres in 20km (0,01%).

CABLE REPAIR

A damaged cable can be repaired by splicing in a short length of cable. The fibres are joined together using an arc fusion process to butt-weld the fibres with an overall loss per weld of typically 0,1 to 0,2dB.

SPECIFIC APPLICATIONS IN A POWER GENERATION AND DISTRIBUTION ENVIRONMENT

Fibre can be used for virtually the complete spread of communications applications, by choosing suitable electrical/optical interface modules.

These modules are available for the following range of systems.

- TV, both CATV (community antenna) and CCTV (closed circuit) for the monitoring of industrial plants, security, and perimeter access control.
- Data links for the interconnection of computers, terminals and printers. All the common software rotocol standards, including RS 232 and RS 422 can be interfaced onto a fibre system either as a single channel or multiplexed together to feed a number of signals onto a single pair of fibres.
- Telephone or any combination of signals which can be converted into tones to simulate a conventinal telephone channel, can be multiplexed together to any of the standard transmission speeds recommended by the CCITT, the European body concerned with telephony standards. Standard capacities are 30, 120, 480, 1920 and 7680 channels, but the larger capacities are only likely to be of interest to the Post Office and possibly organisations such as SATS etc.

- Analogue signals typically found in the process control industry. All the standards eg 4-20mA, 0-5VDC etc can be converted either as a single channel or multiplexed together to feed many such analogue outputs onto a single fibre. Using this form of optical transmissin technique, an electrical substation or a pumping station, say, can be completely monitored and controlled from a remote control room.

- Logic states and contact closures. The logic states associated with electronic equipment as well as contact closures can also be multiplexed onto a single fibre. The contact closures can be derived from any spare pair of contacts on any relay in the system. Door alarms, the status of contact breakers, teperature and pressure alarms can all be transmitted in this way.

DISTRIBUTION SYSTEM PROTECTION

A number of manufacturers are now offering protection relays using fibres as the communication medium mainly because of the problems experienced with interference on the pilot cables linking the devices. In a paper read before the Minnesota Power Systems Conference in Minneapolis during 1982, two engineers from Westinghouse Corporation described a current differential relay using fibre as the communications medium.

Experience in the USA is that fully 90% of the causes of false operations or failures to trip are in one way or another related to the pilot wire. The channels are susceptible to extraneous voltages, such as longitudinally induced voltage and station ground mat rise.

In many parts of South Africa, high groud resistance is a proble, presumably increasing the local figure to a figure above 90%.

The Westinghouse engineers state the advantages as follows "The new relay system" should be more reliable because the optics channel is not effected by outside voltage influences caused by the fault. The sequence network used is simpler and more accurate than any previously known designs using either passive or active components. Therefore, the system should be more secure for faults, external to its zone of protection, and more dependable for internal faults. Another factor which will help increase the overall performance is that the relay system design considered the total problem of relaying as well as communications. For applications where fibre optic channels are not considered practical, the basic relay function can be performed over conventional communication channels by using the audiotone interface option.

Westinghouse is by no means the only company offering protection systems using fibre. Asea Electric is also able to offer a protection sytem using fibre as the communication medium.

APPLICATION NOTES FOR A METAL FREE OVERHEAD CABLE

A number of organisations have investigated the various options for a overhead cable suspended from existing power system support towers. Some of the alternatives are:

- Fibres in the earth wire or phase conductors
- Fibre cable lashed to the earth wire or phase conductor
- Metal free self supporting cable

This last solution was chosen for a trial link recently installed in Holland by NKF with whom we have a technical agreement, for the following reasons:

- Complete separation of the safety and control functions in the network which is critical during fault conditions then accurate error-free communications is essential.

- Complete separation of the power transmission and communications circuits.

- No interference in the power transmission system during installation or repair of the communications network

- Easy installation in both new and existing networks

A loose tube construction of cable using 6 graded index fibres was manufactued to meet the following specifications.

MECHANICAL CABLE CHARACTERISTICS

Overall diameter	15mm
Cable mass	175kg/km
Breaking load	60kN
UTS	1725 N/mm
Coefficient of thermal expansion	2,10-6/°C
Maximum allowable tension	17kN

The extreme weather conditions experienced by the cable were as follows:

CONDITIONS	CABLE TENSION	SAG	CABLE STRAIN	%UTS
-20°C : own weight	2,24	6,1	0,072	4
-5°C : +7N/m ice	7,83	8,6	0,43	13
10°C : +700N/m wind	9,72	9,3	0,48	16
20°C : installation	2,28	6,0	0,065	4
50°C : own weight	2,29	5,9	0,059	4

The optical transmission characteristics were as follows:

System transmission rate	2,048 Mbit/sec
Operational wavelength	1300nm
Fibre attenuation at 850nm	3,0dB/km
1300nm	0,7dB/km
Fibre bandwidth at 850nm	300 MHz.km
1300nm	800 MHz.km
Splice attenuation	O,1dB/splice

Installation of the 2000m lengths of cable was accomplished by a crew of 8 men entirely by hand. Because of the light mass of the cable no special winches were required. A tension device was used at fixing points to set the nominal tension as specified. The installation hardware used was the commonly used preformed spiral devices for the suspension points and a double contrahelically applied spiral for the dead-end tension fixing points.

The ends of the cable were brought down to ground level where the fusion splicing of the fibres was accomplished while the power system was operational.

Two of the fibres were connected through for use by the power authority whereas the other 4 fibres were looped back for a long term trial under operational conditions. The object of this trial was to investigate the systems performance under various weather conditions and the following variables are being continuously monitored.

- Attenuation
- Cable tension
- Cable vibration
- Temperature
- Wind speed and direction

Initial results are most encouraging and all the design criteria of the system are being met.

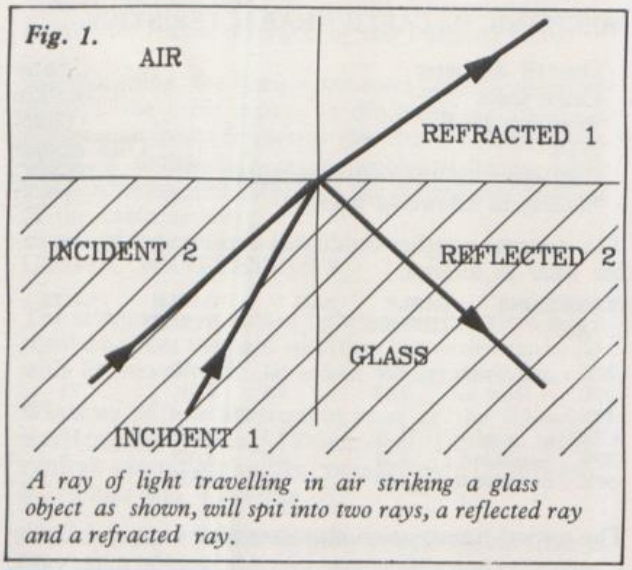
FUTURE TRENDS

Optical communications is one of the fastest moving technologies at present. Technological break-throughs occur virtually daily and fibre and cable performance are improving continously. In a number of countries, mainly in USA, Europe and Japan extremely large quantities of fibre are being installed. Longer and longer lengths of cable can be supplied and installation is becoming easier still. Prices are dropping and the economic break-point between a copper cable and an optical fibre cable favours an optical solution even for short links.

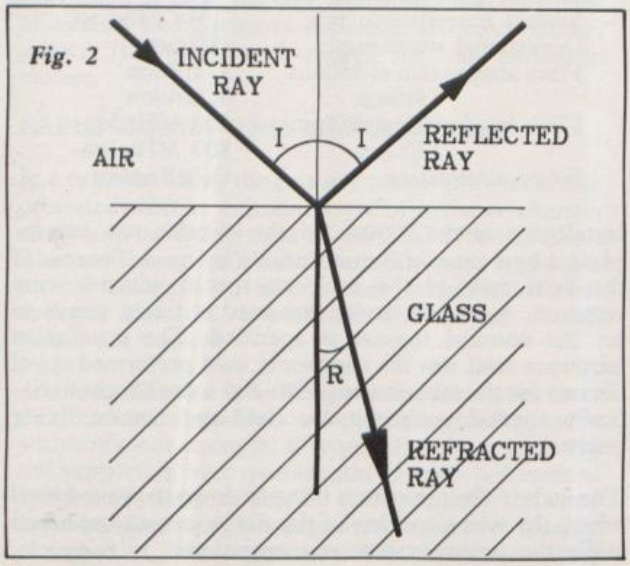
More and more information is being transmitted over fibres which have already been installed. Upgrading of existing systems is entirely feasible, merely by upgrading the interfaces installed on the ends of the cable. Optical communcations is virtually future-proof and engineers need have no fear that systems currently being offered will have to be replaced in the near-term. There is no reason at all to believe that the design life of 30 years will not be exceeded comfortably in exactly the same way that a large number of copper cables installed in the 1920's and before are still carrying traffic.

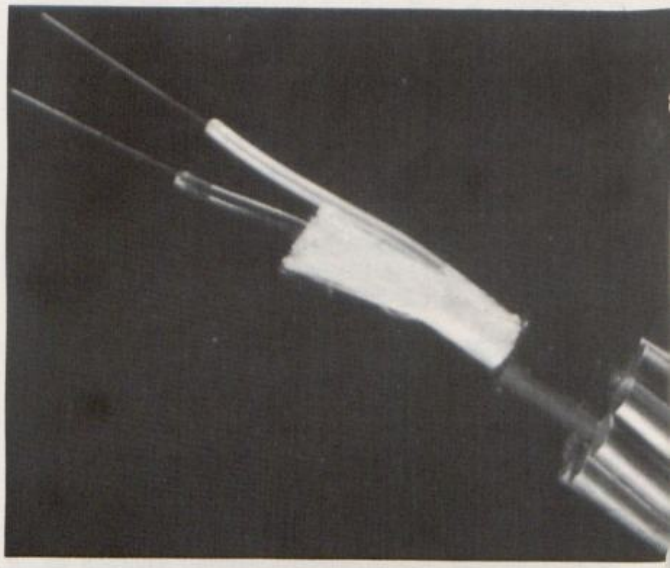
CONCLUSION

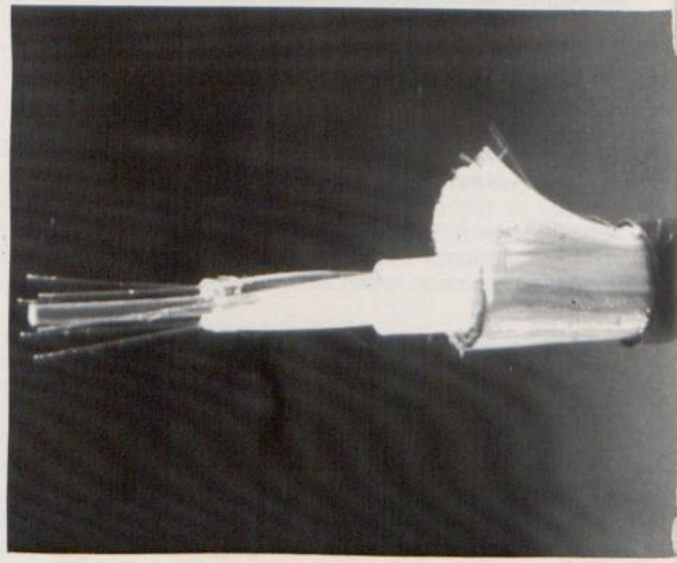
This paper has been written to give practicing engineers in the power generation and distribution industries an insight into the applications for fibre in those industries. We have not gone into specific technical details of how the fibre transmits light and we have steered away from a mathematical treatment, since we felt that at this technical meeting there would be more interest in practical applications than in the theory of this exciting technological development.



A ray of light travelling in air striking a glass object as shown, will spit into two rays, a reflected ray and a refracted ray.







DISCUSSIONS — BESPREKINGS

MR W BARNARD : Johannesburg

This is a manufacturer's review paper and as such is nothing new.

1. **Distribution System Protection (Paragraph 2)**

   We accept that it is probably true to say 90% of failure of protection systems utilising pilots is due to the pilots. However, one cannot say that these are pilot failures per se. The cause is almost invariably external such as mechanical damage and an optical underground cable will certainly not produce any solution to that problem.

2. **Metal-Free Overhead Cable**

   The use of a metal-free overhead cable is certainly interesting and we believe Escom has installed, on the Highveld, a length of about 50 km of Japanese manufacture. The communication characteristics of this and the NKF cable mentioned in the paper can be accepted but the well-known problem in RSA is the effect of ultra violet light on the support system. It is an unfortunate fact that non-metallic components tested and proved all over the world do not often survive the Highveld climate. Long term aging tests are required for this.

The Johannesburg Electricity Department has an optical fibre system in service designed to overcome both of these problems.

When the new Delta 275/88 kV Substation was designed, it was necessary to make provision for the vital control, protection and communication circuits. Because of their importance, it is normal practice to have two independent routes. The cost of the necessary cables, whether optical or conventional, and the actual laying in developed areas is extremely high, not to mention the inconvenience experienced by residents when excavation work takes place in their areas.

In 1982, it was learnt that a Japanese company of high repute had developed a means of enclosing optical fibres inside the earth wire used at the top of high voltage overhead power lines for lightning protection. At that time such an earth wire was undergoing field trials with Japanese supply authorities. The Electricity Department decided that this would be the communication medium for the future for whilst the use of optical fibres in underground cables for communiation has been available for some years, this was a new application.

The necessary specification was prepared departmentally and tenders were invited. When placed in September 1983, the order was one of the first for installation outside Japan. Together with the special terminal equipment, the optical fibre earth wire was some 25% lower in cost than for a coventional underground cable connection with all its attendant disadvantages.

The optical fibre earth wire link from Delta extends for 16 km to join up with the existing underground network at both Parkhurst and Sans Souci 88/11 kV Substations. Since September 1985 when the first 88 kV circuits were connected to Delta, all control, protection and communication has been over the optical fibre link. It has been unaffected by the lightning and the technical quality of communication is of the highest order. The earth wire contains five graded index multimode fibres, one pair for each of the terminal stations with one spare. It is interesting to note that whilst the Electricity Department is only using a very basic 30 channels per pair at 2M bits per second and 1 300 nm, the terminal equipment could be readily upgraded to provide over 2 000 channels per pair. This compares with a maximum of 12 channels over a conventional pair of copper wired and even then sophisticated terminal equipment is needed.

MR R SLATEM : Affiliate

I am going to concentrate on a particular protection aspect using fibre optics and I would like to start off by just making a remark in connection with Mr van Alphen's remark about the dentist in Russia. Now I would say that if you had your teeth done by that method you'd certainly find that he's wrecked them.

Gentlemen, talking about fibre optics protection, I mentioned that there was a Westinghouse relay available. Well, Westinghouse is not the only people who have made such a relay and in fact the relay has been made by a number of other companies, amongst which is the company Asea, and they have made a relay which is called the riot-hole relay. It's a development of the existing pilot wire protection relay which is really well known and is well known and to convert it from the use of a conventional copper pilot wire connection to a fibre optics length so it has been specially adapted to use fibre optics but it retains all the features of the ordinary pilot wire protection.

I'll only mention a few of the features that it has, for example, double-ended tripping, in other words if you have a weak in-feed from one end and you want to get both ends of your line out, this will get both ends of the line out. You get tripping signal within one of two cycles if a fault occurs on the line. You get a tripping signal within one or two cycles which is relatively fast and as fast as one needs in this modern day and age.

Other things that are important to any differential type of protection are CTs. These are never the same at the two ends, and one end is likely to go into saturation under a true fault condition and if that happens then normal differential protections are very often prone to give you instability problems and these protections can tolerate a certain amount of CR saturation without going unstable. And we don't have to have quite such massive CTs you might have to have otherwise.

Another thing that we quite commonly get on overhead lines particularly, and particularly in this country, with our high resistivities and so on, is high resistance faults and the protection can see resistance faults.

You can also tolerate on this relatively small transformer taps. In other words, if you wanted to apply this protection to a system where you had mini-subs teed off, you

can actually apply and have transformer taps on it as well.

Very, very briefly its application is essentially to two terminal lines. At either end of the line you have a set of current transformers and the current transformers detect that the current is either flowing through the circuit or that the current is flowing into a fault in the circuit. It has typical ground fault senstivities, phase fault sensitivities and, as I said before, the operating time is a maximum of 40 seconds. It can be applied over lines or cables up to a length of about 5 km if we use the 820 or 850 nm wavelength and if you go to the 1 300 nm you can get lengths of up to 25 km. Now 25 km is really something which is generally beyond the capability of a normal conventional pilot wire system because of pilot loop resistance, pilot capabilities and things like that.

Another thing that is important on many pilot wire systems you have to buy additional apparatus in order to give you supervision of your pilot link.

As Mr Barnard pointed out, bulldozers and so forth are very likely to pull out the cable and your pilort wire if it's a cable system. Now this has the continuous supervision of the fibre link and unlike normal conventional protection, this supervised the link within 2 milliseconds and you don't need any special apparatus in it — it's built in and within 2 milliseconds it will have blocked both ends of your protection so that if this protection operates, it will not give you a false trip and you don't need additional supervision equipment and additional starting equipment which is what you do require with a conventional pilot wire system. So there is a saving that one gets from the use of it.

I want to just briefly illustrate the principle of the conventional system in order to illustrate how the fibre optic has been adapted to this. The conventional system really compares the currents entering and leaving a circuit. If there's a difference between the neutral fault, a current will flow through this mid-pilot wire here, through the relays here, the operating relays at the two ends and that current which flows through the operating relays will cause the protection to trip and that current will flow whether the fault is fed from a single end or from both ends. Now what one has to do is to simulate that performance but instead of having a conventional link of conductors, to have a fibre optics link and the way that they have done it is very simple. They have taken exactly the same circuit, you see we have three phase circuit here, the three currents can then, converted by the usual summation transformer method, to a single output and that single output will represent all types of voltage again on the network and the mid-point of the outward transformer there is connected to the mid-point of a pair of resistors. Now, these resistors here are in effect connected across this transformer so you've got a mid-point here and you've got a mid-point in two equal resistors. So when there's a current which is equal in this resistor and in that resistor, your voltage across that point and that point will be zero and no current flows through your protection relay. We then take the current which is coming from this end through this resistor, convert it into a frequency signal, into a light signal, transmit it over a fibre optic lead to the other end, may bring back the current from the other end the same way through a frequency signal. The frequency signal is then converted into a voltage signal and then into a current signal. So what's happening at the other end is brought back as if it is the actual raw current from the other end being brought back to this end for comparison in exactly the same way as one did it with the conventional protection system. So therefore we are comparing apples with apples, we are comparing a current here and a current here. The fact that it's gone through a fibre optic link makes no difference because even the harmonics which are generated at the other end are transmitted through the fibre optics link.

The fibre optics link then brings you this current and these currents are equal so that the current flows through that circuit and the protection relay will operate.

Now very briefly, what are the advantages of fibre optics.

In protection, this has been hammered so many times I'm going to labour it. It's not sensitive to the voltage difference and mutual coupling. Actually this is not such an important point today because most of us on our lower voltage systems are using resistance earthing. It is the earth fault currents which cause you the problems so by having low resistance earthing, you get small currents and generally these over-voltage problems are not so serious today. They are on the higher voltage systems with solid earthing but not in resistance earth systems. The possible length is only limited by the capacity of the optical components and the belief is that 100 km will be possible at some time in the future.

Fast pilot wire supervision — that was already mentioned.

Now another thing which is important, if there's built-in logic for direct inter-trip, it's a very important thing which I'll deal with a little later.

Now nothing that we get in this world happens with only advantages. Is that right? Everything is a compromise and whatever advantage you get, you've got to have some disadvantage is that you must have an auxiliary power supply to power the fibre optics.

The second one is that if you don't combine your services, if you just want to put in a fibre optic protection link, you'll find that the protection system would possibly, although the link of the actual fibre optic cable will be equal in cost to the conventional pilot wire system, at the moment your terminal equipment, if you use it for a single purpose, is a little, or quite a lot more expensive.

So that's the disadvantage.

Now, are we talking about systems which have been new or are they in service at all. And the operation experience so far has been, first of all, this was given a very extensive simulated test. We don't do that much in this country but the Americans are great on this. The Americans, before they will buy a single protection system, have got to have it put onto a simulator and they put it through the most onerous conditions you can imagine. They think of all the possible things that could go wrong. Every damn condition that can occur on a network and they want it simulated to see that the protection will operate correctly for all these things so that a very stringent test has to be put onto this protection to prove that there are no conditions that can arise on the network which will cause the protection to mal-operate.

Then there are three applications. One is in Sweden on a 110 kV cable that went in in June 1985 over a 33 km length and a 1,6 km length. In America, Rochester Gas Electricity 127 kV line, 7 km, New York Electricity Gas USA, 127 kV line and 10 km. So the application so far appeared to be largely on overhead lines.

Now one of the things I mentioned was that you get an additional feature automatically in this. You don't have to buy extra equipment and that is inter-tripping. And why do I talk about inter-tripping? The FO doesn't stand for flash-over. The FO stands for fibre optics. And in your fibre optics inter-tripping there are certan advantages. And one of the advantages is that you get an automatic two-way inter-trip. And that two-way inter-trip is damn fast and I don't know if ever you've tried to apply inter-tripping over your pilot systems, and the usual problems is that if you try to do a DC inter-trip, you get AC interference. If you get an AC injector signal, it will give you a differential mode voltage and that voltage can actually, the AC voltage can cause your DC inter-trip receive relay to operate. And so you get a false trip. In order to overcome this, you have to filter out the AC signal. And if you say filter, filter to me means time delay. And if you're talking about an inter-trip signal, you're usually talking about 150, 200, up to 300 milliseconds you've got to wait for the inter-trip signal.

Now why do you put on an inter-trip signal? You put it out to get the other end out as fast as you can. So you put in an inter-trip signal and it takes you 300 milliseconds to get the other end out. You might as well wait for the back-up protection. You gain very little by it.

But here you get your inter-trip signal in 2 milliseconds. You've got an inter-trip signal. Maximum of about 5 milliseconds. Its AC surge, this is a point that I've mentioned before, and often when you're doing an inter-trip over pilots, you're connecting your battery to the pilot, you put in a 5 kV insulation on your pilot or a 15 kV insulation on the pilot between the pilot and the relay. Why? Because the pilot voltage can go up to 15 kV. Now you want to do a DC inter-trip over it. So you've got a battery at your station, you connect your battery to the pilot to send an inter-trip signal to the other end. And an over-voltage occurs and up goes your battery. The voltage of your battery is lifted. Unless you take special earthing precautions there, your battery can actually be lifted up and you get flash-overs, your battery or your battery charger or your wiring there.

With fibre optics you get no battery lift because it's all contained within the fibre optics channel.

Typical applications — there are two that I'm just going to mention, although there are many others.

One is for SF_6 switchgear. It's coming into vogue very frequently. I'm sure many of you in the larger municipalities with 132, 66 and even 33 are considering SF_6 switchgear. One of the things which is a problem with SF_6 switchgear is that if a fault occurs, you've got to get it off damn fast because if you don't get it off fast, and you wait for back-up time, you are liable to have the housing of the switchgear burnt through by the arc. So you must have fast protection for SF_6 switchgear.

Another one is a typical feeder transformer where you don't have a breaker on the HV side. And I have produced two slides to show this and gentlemen I'm not going to be long on this, it'll only take me a short while. The one is the SF_6 inter-trip. If you have a circuit breaker here on an SF_6 installations and that's the end of the SF_6, then if you have your circuit protection and your busbar protection there, if a fault occurs at this point, it's within the busbar protection outside the circuit protection but it is actually because that breaker clears the fault as if it was a busbar fault, but the fault is still in this circuit and you have to get this fault cleared out and so you need an inter-trip signal to get to this end and the inter-trip signal is very useful. You use this fibre optics for your circuit protection and from your busbar protection you send a fast inter-trip signal to get the other end out.

The last one then is the fast inter-trip or transformer protection. If you have a circuit without a high voltage breaker and you get a transformer protection operation, you use the circuit protection fibre optics link to send a fast inter-trip signal to take the breaker out at the other end.

MR J A VENTER : Cape Town

Mr Phillips makes mention in his paper that Cape Town has installed fibre optics cable and perhaps members would be interested in some details of the installation.

The fibre optic cable network has been planned to reinforce the existing private telephone cable network, which provides telephone, supervisory, telemetering and other telecommunications circuits for the control of electricity.

The total length of the planned network is 25,5 km of which 9,5 km of fibre optic cable has been laid. The network will connect Athlone Power Station, System Control, major switching stations and complexes accommodating engineering personnel.

The introduction of the fibre optic network will allow for the future replacement of four electro-mechanical PAX exchanges by one electronic exchange should this be necessary when the economic and service life of the electro-mechanical equipment is reached.

The fibre optic cable becomes economical, compared to 50 pair telephone cable (1,2 mm copper conductors and heavy insulation) at the following cable route lenghts:

2 Fibre optical cable : 10,6 km
4 Fibre optical cable : 11,6 km
8 Fibre optical cable : 14,2 km.

We have not commissioned any of the cable as yet. Terminal equipment for the first stage of the project has been received and installed and portion of the terminal equipment for the second stage has been received.

Council staff have laid fibre optic cable and made joints using a Siemens fibre optic fusion splicer. A Siemens time domain reflectometer is used to measure the attenuation of the fusion splices and the quality of the cable.

To make a joint with low loss (0,1 dB) between two fibres using a fusion splicer is quite an achievement and Council staff regularly obtain these results.

With the installation and commissioning of the terminal equipment, Council staff are gaining experience in optical line terminal equipment which is used to transmit and receive the optical signals over the fibre optic cable and in the 34 Mbit/s Pulse Code Modulation (PCM) system which is used to miltiplex a total of 480 channels over one fibre of a fibre optic cable.

MR B ALLAN : Affiliate

I have already complimented Mr Phillips on his paper. I was most interested because being a power engineer I'm just getting involved in this somewhat nebulous transmission of power by light. However, I have got a couple of questions I have to ask and I hope Mr Phillips will not think me impertinent in asking them.

Would you like to comment on the suitability of your aerial cables specially on your two Mbytes working at the 50 m and 100 km lengths. What would you reckon would be your maximum length for 30 Mbytes without having to use a repeater?

Have you any comments to make about the splicing and the housing for the splicings? Do you bring them down onto the ground? I know you showed one there but I'm talking now if you have to put a repeater in.

Also, is it possible for you to comment on what you reckon your span would be with a 12 mm ice and an 80 km/hr wind.

MR R N PHILLIPS : Affiliate

I would like to thank, very sincerely, the commentators who posed, in a couple of cases, some very searching and interesting questions.

In order — Mr Wessel Barnard with regard to the underground cable and mechanical damage. Obviously the fact that one is using optical fibre cable in no way eliminates pick axes, front-end loaders, various people digging holes, through the cable. Obviously it is a problem with any system and it's an equal problem with optical fibre as it is with a conventional cable and this is one of the reasons why so many people are looking at an overhead solution, especially when you've got a power route leading into a major urban area such as you have.

The second point with regard to UV resistance, I shall accept your comment that certainly some products which are designed and manufactured in Europe do not have the UV resistance capabilities that are required, especially on the Highveld. In our particular case, though, we have been manufacturing overhead cable for the Post Office. Admittedly it's not power cable, but conventional telephone cable and there are techniques and there are compounds which are available for the sheath which will give you a perfectly satisfactory UV resistance, even on the highveld, and 30 year life spans are typically expected.

Mr Slatem's comments with regard to the cost of interface systems. Interface systems are becoming cheaper and cheaper. As the volumes pick up, the costs certainly are dropping and although five years ago I would have to have admitted that the cost of interface systems is the significant cost element of the total, it is no longer the case these days.

Mr Jan Venter's contribution — I would like to congratulate him and the Council's staff on achieving 0,1 decibels per splice as a typical average. That's a very good figure and it just goes to show really that the splicing problem, which is a butt fusion welding technique, originally some years back was a problem, it is now no longer a problem and can be done under field conditions. We're out of the laboratory, we're out of people with ties and smart suits on actually having to do this. It's very much a field technique these days.

Mr Allan of Pirelli, I'm afraid, Sir, I did not bring my PC along to be able to pump those figures through. With regard to 12 mm of ice and 80 km of wind, I would really have to do the calculation. I'm sorry, I wouldn't like to give you an answer straight off the top of my head, but that's a rather unusual combination, especially in this part of the world and maybe afterwards we could discuss where precisely that was.

With regard to the distances, at 2 Mbits per second and graded index fibre, I should think, somewhere in the region of 35 km would give you a very good link length without repeaters. It depends also, of course, on what sort of environment you're going through and how many cable damages you expect over the 30 year life span of the cable. You know, is it going to be dug up ten times per kilometre over the life, or is it only going to be dug up once and obviously the allowance for future splice losses has to be brought into the system as well as 34 Mbit with graded index fibres, one can achieve somewhere in the region of 30 km these days quite satisfactorily.

That's on a telephone system, if we're talking about other systems then we obviously have to redo the sum.

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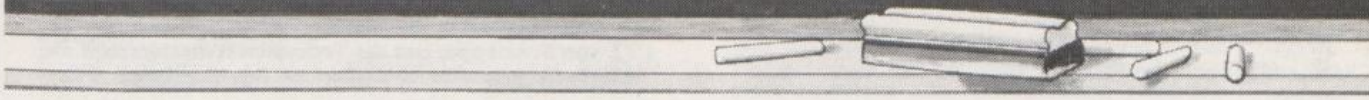

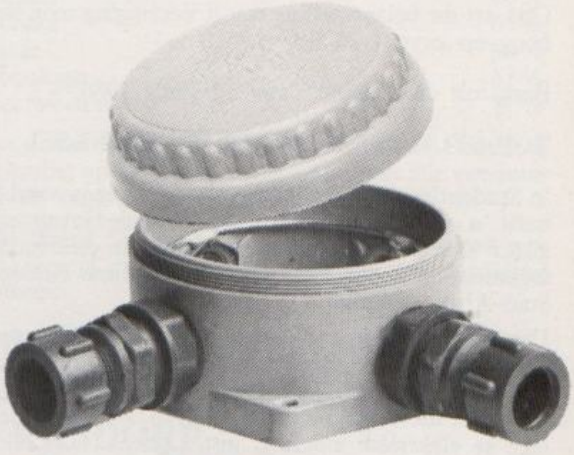

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AMEU BURSARIES AND AWARDS
VMEO BEURSE EN TOEKENNINGS

VMEO TEGNIESE TOEKENNING: TEGNIESE KOLLEGE VAN SUID-AFRIKA

Ons wil graag die uitslag en verloop van die toekenning van u merieteprys rapporteer.

Na oorweging van al ons studente in die elektrotegniese ingenieursrigting, is besluit dat ons mees verdienstelike student 'n persoon is wat by Sentraal Gevangenis aangehou word.

Hy was besonder entoesiasties oor sy werk en het baie goeie vordering gemaak.

Ongelukkig mag ons nie sy naam bekendstel nie. Dit prysuitdeling het op 11 Junie 1986 plaasgevind by Sentrale Gevangenis en is bygewoon deur mnr. Beaurain van Pretoria Munisipaliteit se Ingenieursafdeling, mnr. A.J. van der Lith (prinsipaal), mr. J.A. Botha (adjunk-prinsipaal) en mnr. G. van der Westhuizen (lektor) van Technisa, asook die personeel van Gevangenis Dienste se Opvoedkundige Dienste. Ons kon ongelukkig nie foto's neem nie, maar sluit 'n afskrif in van 'n berig wat in "Beeld" verskyn het. Daar het glo ook berigte oor die oorhandiging in die "Cape Times" en "Pretoria News" verskyn.

Ons stel die belangstelling wat u Vereniging toon werklik hoog op prys.

Berig uit die "Beeld" van 12 Junie 1986:—

TOP-STUDENT STUDEER IN TRONKSEL

'n Student met 'n sel as studeerkamer mag vreemd klink, maar 'n gevangene in Pretoria se Sentrale Gevangenis het gister 'n meriete-prys as beste student in elektrotegniese ingenieurswese vir 1985 van die Tegniese Kollege van Suid-Afrika ontvang.

Dié student, 'n gekwalifiseerde elektrisiën, het meer as honderd studente in die korrespondensiekursus van 'n jaar uitgestof. Hy is ook reeds besig om verder te studeer, het mev. Marietta van Rooyen, hoof van die Kollege se elektriese afdeling, gister gese.

Sowat 5 000 studente, meestal vakleerlinge, is by die kollege ingeskryf.

MCJ VAN SCHALKWYK: TECHNIKON WITWATERSRAND

AKADEMIESE REKORD: Junie 1985
(Vierde semester)

Aanbieding	Uitslag %
Elektriese Ingenieurswese H/CT4	80x
Elektriese Masjiene T4	87x
Ingenieurswiskunde T4	92x
Outomatiese Beheer T4	81x
Sterkteleer T4	76H
Industriële Elektronika T3	77H
Gemiddelde vir semester 82%	

Kode: x-Onderskeiding
H-Geslaag

Mnr Wessel Barnard, Hoof Stadselektrotegniese Ingenieur van Johannesburg oorhandig die VMEO-prys aan Mnr M. C. J. van Schalkwyk, van die Technikon Witwatersrand vir die beste prestasie in Elektriese Ingenieurswese T4.

CAPE TOWN TECHNICAL TRAINING CENTRE, AMEU AWARD

Mr Dennis Palser, City Electrical Engineer presenting Mr C. E. Marshall with the AMEU prize. Mr Marshall qualified on 21st May 1985 by passing a trade test with a B+ symbol.

AMEU AWARD: ML SULTAN TECHNICON

Please accept our sincere appreciation and thanks for your most generous gesture in donating the above award. In these troubled times it is comforting to see organizations like yours offering these sort of incentives for our young students.

The successful candidate is Mr Dhavan Nair. He has been a consistently good student since T1, and his T4 results were the highest in his class, with him obtaining distinctions in 3 subjects.

Mr Denis Fraser, the City Electrical Engineer of Durban, officiated at the prize-giving ceremony. On behalf of the A M E U and the Durban Electricity Department, he congratulated Mr Nair on his achievement, and also spent a short time explaining what the aims of the ideals of the AMEU are.

From left to right: Mr Denis Fraser, Mr Dhavan Nair and Mr D. J. Grieve, Acting Director — School of Electrical Engineering.

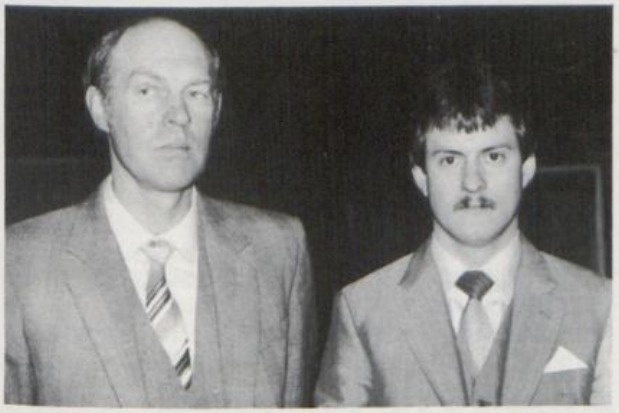
LETTER FROM MR NAIR:

Re: AMEU AWARDS

I was a student at M.L. Sultan Technikon during 1985 and was studying for the N.H. Diploma: Electrical Engineering. I wrote my examinations in November 1985.

I was pleasantly surprised to hear that I was selected to receive your organisation's award. I truly appreciate this gesture and my sincere thanks goes to your association for making this award possible. I will be using it towards furthering my studies.

VMEO TOEKENNING: TECHNIKON OVS



Mnr. P. J. van Rooyen, Adjunk-Elektrotegniese Stadsingenieur, Bloemfontein Munisipaliteit het die VMEO-toekenning oorhandig aan mnr. R. Barnard. Mnr. Barnard is 'n student in Elektriese Ingenieurswese (Sterkstroom) en het baie goed gevaar in die T4-eksamens in 1985 by die TECHNIKON OVS.

AMEU AWARD FOR 1985: EAST LONDON TECHNICAL COLLEGE

The AMEU Award for 1985 to the most deserving electrical engineering student, Mr C. B. Britz, an Apprentice Electrician in the employ of the East London Municipal Electricity Undertaking, by Mrs Temple wife of the Deputy Principal (Technical). On the right is Mr R. P. Howe, Head of Department: Technical Department.

VMEO TEGNIESE TOEKENNING: WESTLAKE TEGNIESE KOLLEGE

Die toekennig was gemaak aan mnr N J S van der Merwe afkomstig van De Aar. Hy is reeds 'n getroude man met twee kinders en het nadat hy sy St X eksamen geslaag het, die intensiewe opleidingskursus aan hierdie Kollege as 'n elektrisiën vir 1985 deurloop. Hy het dan ook in een jaar wat hy aan die Kollege opleiding ontvang het, in die volgende vakke in die N3 graad van die Nasionale Tegniese eksamens met onderskeiding geslaag.

Elektrisiëns	60%
Elektronika	69%
Wiskunde	99%
Elektronologie	61%
Ingenieurswetenskap	77%

Mnr van der Merwe is tans by 'n privaat elektriese onderneming op De Aar in diens en ons het alle vertroue dat hy dit nog ver sal bring.

Mnr Mickeleit, 'n Hoof Elektrotegniese Ingenieur *van die Stadsraad* van Kaapstad, het die prysuitdeling waargeneem.

BRIEF VAN DIE PRINSIPAAL, TEGNIESE KOLLEGE, KLERKSDORP

Meneer,

Die Prinsipaal en personeel waardeer die bydrae wat die VMEO aan die Kollege geskenk het. Dit is vanjaar toegeken aan mnr A. J. Strydom.

Ons kan u verseker dat u welwillendheid en persoonlike belangstelling in die jeug deur ons studente baie hoog waardeer word. Ons weet dat u bydrae jaarliks ons studente sterk sal motiveer tot lewering van goeie prestasie. Sodoende lewer die VMEO 'n mooi aandeel om die jeug van Klerksdorp en omgewing aan te moedig om die opleidingsfasiliteite van die Tegniese Kollege te benut tot voordeel van hulle eie toekoms.

Seënwense op u daaglikse arbeid.

TOPICS FOR DISCUSSION — ONDERWERPE VIR BESPREKING

PREVENTATIVE MAINTENANCE TESTS / VOORKOMENDE ONDERHOUDSTOETSE

MR A D W WOLMARANS: Affiliate

A. Inleiding

Meneer die President, dames en here, die onderwerp wat ons vandag moet bespreek is glad nie 'n nuwe onderwerp nie. Dit is veel eerder die doel om u aandag te bepaal by 'n aantal praktiese toetsmetodes wat met min moeite in die praktyk gebruik word. Hierdie toetsmetodes help die gebruiker om meer inligting te bekom aangaande die huidige elektriese toestand van 'n groot verskeidenheid elektriese toerusting wat gebruik word wanneer elektrisiteit opgewek en versprei word. Die metodes sluit in die meet van elektriese weerstand in die teenwoordigheid van induktansie, die meet van kapasitansie en verlieshoek van elektriese isolasie asook die meet van gedeeltelike ontlading in elektriese isolasie. In elke geval is die klem op toetsmetodes vir gebruik in 'n bedryfsomgewing in teenstelling met laboratorium of werkwinkeltoestande.

B. Bad Connections or Open Circuit Windings in a Power Transformer

Knowledge of the DC resistance of power transformer windings, but more so, any change in the resistance with time, would point to a tap-changer with high contact resistance requiring attention, or an open-circuit in the delta winding of a star/delta connected power transformer.

Winding resistances vary from as little as 100 micro-ohm for the low voltage winding to 100 ohm for a high voltage winding for a large and small power transformer respectively. This represents a six decade range in resistance to be measured. A typical measuring set-up would comprise a Kelvin four terminal bridge with suitable galvonometer and a source of DC voltage, example storage type batteries. This procedure, with further refinements including current limiting resistors and many precautions, is still in widespread use today.

The accuracy of measurement is limited by the accuracy of the bridge on condition that a steady direct current is observed. Steady current will be achieved from a steady DC source and where the magnitude of the current is limited by the resistance only without any back EMF due to the build-up of magnetic flux in the transformer winding and core. In practice, the time to reach steady state could be one hour and longer. Once the measuring current has stabilised to permit measurements, the energy stored within the transformer's magnetic circuit could range up to 100 kW-seconds in larger transformers. At the end of the test, this energy must be safely dissipated.

Mnr Dries Wolmarans

A practical system for measuring transformer winding resistance has been developed. The unit is transportable and is powered from the mains. The heart of the measuring system is a digital micro-ohm-meter with a resolution of 0,1 micro-ohm. Normally both primary and secondary windings on the same magnetic limb of the transformer are connected in series to the current source of the measuring system. In this way a relatively small current, maximum 50 ampere, will saturate the magnetic core of any power transformer via the many turns of the high voltage winding. Using a high initial supply voltage with suitable current limiting, saturation of the core and hence steady current in the transformer windings can be reached in less than 30 seconds after switch-on. By multi-plexing the measuring voltage input to the micro-ohm-meter, both winding resistances are measured in sequence. At the end of the measurement the energy stored in the magnetic core of the transformer is safely dissipated in a suitably rated resistor network through an ammeter.

Literature:

ANSI 857,12,90 - 1973
NEMA TR 27, 1965 - 1971
IEC Publication 76 - 1971
Tettex Information 15
Tettex Application 506-e

C. Collapse of Transformer Windings

Power transformer windings should withstand the mechanical forces resulting from a short circuit on the secondary with full voltage on the primary winding. During type testing of power transformers, the collapse of a winding is detected by measuring the change in inductance or the change in inducitve reactance before

and after the test. The method to measure inductance uses a classical Schering Bridge with a sinusoidal power supply. This method can be used in the field but due to the cost is seldom used.

An alternative and more practical test to check for the collapse of a winding comprises the measurement of the inter-winding capacitance at mains frequency. Again the change in capacitance before and after a short circuit test or heavy through fault would warrant further action. By performing capacitance measurements at intervals, the cumulative capacitance change since new can be determined.

Before we proceed in further detail on the practical aspects of capacitance measurements, I would like to introduce Dissipation Factor also called loss angle or loss factor and even sometimes referred to as insulation power factor.

D. Dissipation Factor

In a simplified equivalent electrical circuit, all insulation systems can be represented by a leakage resistor in parallel with a capacitor. The dissipation factor, usually referred to by its mathematical origin, as tangent delta, is equal to the capacitive reactance divided by the leakage resistance of our equivalent electrical circuit. Tangent delta factors range from below 0,00001 for sulpha hexafluoride gas insulated systems to 0,2 and higher for badly deteriorated transformer oil. Because tangent delta is dimensionless, it allows easy comparison between large and small test objects.

On newly manufactured electrical equipment, the dissipation factor of the insulation is a quick indication of the presence of free ions in the form of moisture. In particular we may refer to paper insulated oil-filled transformers, paper insulated oil or compound-filled high voltage cables, paper insulated oil-filled condenser type transformer bushings and oil-filled foil type power capacitors. Invariably a poor initial tangent delta value can be improved by boiling off the excess moisture at high vacuum.

Due to the combined effects of high operating temperature, temperature cycling, absorption of gases, absorption of water and high electrical stress, the insulating oil and paper gradually lose their insulating properties to the point where electrical breakdown may occur.

The deterioration of the insulation system can be monitored by means of oil samples and having the oil samples analysed. However, in some cases the taking of oil samples is impossible, i.e. hermetically sealed power transformers and power capacitors. In the case of high voltage capacitor type transformer bushings and high voltage instrument transformers, the taking of an oil sample is possible but seldom done in the field.

At the same time, electrical breakdown in an insulation system is normally preceded by a gradual, and followed by a rapid increase of tangent delta.

The practical solution requires periodic measurement of the tangent delta of the total insulation system of electrical equipment in use. If the measurement results are plotted on a time scale, the onset of accelerated deterioration can be monitored.

E. Capacitance and Dissipation Factor Measurements

In the previous two sections we have indicated the importance of monitoring any changes in capacitance and dissipation factor in an insulation system. Portable differential type capacitance and tangent delta bridges are commercially available and excellent results can be obtained under laboratory or workship conditions. Under conditions of mild electromagnetic and/or electrostatic interference, such as in a medium voltage electrical substation, adequate results can still be obtained by taking a second set of readings, without moving the connections to the test object but only reversing the incoming mains connection and averaging.

Measurements in close proximity to a high voltage busbar passing a high current are subject to severe interference due to magnetic and capacitive coupling to the test circuit. When severe interference is experienced, interference suppression techniques have to be applied. An example would be to build a wire mesh Faraday cage to include the test object, the measuring equipment and all interconnecting leads. Alternatively, if the interference is constant, the effect of the external interference could be suppressed electronically within the measuring equipment.

Suitable measuring equipment for field measurements exist. This self-contained measuring system is portable and is mains driven from a standard 15 A plug point. The power transformer can deliver 0-12 kV infinitely variable with a continuous 100 mA output and including a limited overload rating. The capacitance and tangent delta bridge is a differential derived Schering bridge and is available in two basic forms:

Firstly, an easy to use hand balance type using a sensitive electronic zero indicator.

Secondly, a fully automatic self-balancing type with digital read-out of all measured parameters. In either case, provision is made to counter the effects of external interference in an electronic interference suppression circuit.

Change in capacitance and change in tangent delta with time is a very practical means of assessing the aging of many insulation systems. With knowledge of the aging process, preventative maintenance can be performed timeously.

A short list of possible applications can include but is not limited to the following:

Individual cans in a bank of power capacitors
Oil-filled condenser type transformer bushings
Oil-filled condenser type wall through bushings
Oil-filled power transformers
Oil-filled voltage and current instrument transformers
High voltage switchgear
Oil or compound-filled high voltage power cable

In general it is recommended that the test voltage for capacitance and tangent delta measurement be the lesser of one half of normal rated voltage or 10 kilovolt. The

actual test voltage must be noted so that future testing can be done at the same and constant test voltage.

Change in capacitance and change in tangent delta with increase in the applied test voltage is also a useful measure of the status of the insulation system of a high voltage electric motor or generator. Again by repeating the measurements of capacitance and tangent delta with increase in the applied test voltage at intervals of time, the deterioration of the insulation can be monitored and preventative maintenance or replacement programmes planned accordingly.

F. Gedeeltelike Ontlading

In die laaste plek moet ook verwys word na 'n meet tegniek wat gedurende die vervaardiging van elektriese toerusting vir kwaliteitsbeheer aangewend word. Hierdie tegniek behels die meting van die intensiteit van gedeeltelike ontlading of ionisasie in die isolasie van 'n toetsvoorwerp. Die metings word dikwels by een-en-'n-half maal tot twee-en-'n-half maal bedryf spanning uitgevoer. Hierdie tegnieke word deurgaans gebruik by die finale aanvaarding van hoogspanning en superspanning elektriesekragkabel. Waar aanvaarbaarheidsgrense van hoogstens 5 pico coulomb, of te wel, 5 micro ampere per micro-sekonde geld as gevolg van die benodigde sensitiwiteit van die benodigde toerusting, is dit nodig dat die meting van gedeeltelike ontlading op kragkabels binne 'n Faraday hok gedoen word. Voorwaar baie klein seine wat die gebruik van uiters gevoelige meettoerusting benodig.

Gedeeltelike ontlading word ook aangewend as 'n aanvaardingstoets vir hoogspanning instrument transformators en wel vir stroomtransformators en alle elektromagnetiese spanningstransformators. Wanneer 'n Kruegerbrug tesame met die gedeeltelike ontladings detektor gebruik word, is dit soms moontlik om instrument transformators se gedeeltelike ontlading sonder die gebruik van 'n Faraday hok te bepaal.

Nadat hoog- en superspanning kragkabel geïnstalleer is, is dit besonder moeilik om die gedeeltelike ontladings van die kabel te bepaal. Twee redes is voor-die-handliggend, naamlik die hoë spanning en daarmee gepaardgaande baie groot blindstroom wat benodig word om 'n lang kabel te bekragtig, asook die beslommernis om Faraday hokke by elke kabel ent aan te bring. Meting op kragkabels in die veld word dus slegs in uitsonderlike gevalle uitgevoer.

Tegnieke om gedeeltelike ontlading van buitemuurse spanning transformators en ook gekombineerde stroom en spanning transformators binne in 'n werkende hoogspanning elektriese substasie te meet is ontwikkel en word reeds in Europa aangewend. In die praktyk word twee spannings transformators vanaf hul laagspanning windings gelyktydig bekragtig terwyl die hoogspanning terminale van die eenhede aanmekaar gekoppel word. Die Kruegerbrug metode word deurgaans gebruik om die teenwoordigheid van agtergrond steurnis te onderdruk waar meetsensiwiteit van 5 pC in 250 kilovolt substasies reeds bereik is. Tot die beste van my wete word gedeeltelike ontlading metings op hoogspanning toerusting in 'n werkende elektriese substasie nog nie in Suid-Afrika gedoen nie.

5. Afsluiting

In die voorafgaande is drie praktiese toetse wat gebruik kan word in 'n voorkomende onderhoudsprogram geidentifiseer.

Ek wil graag hiermee my dank betuig vir die geleentheid om ook 'n bydrae te maak by hierdie Elfde Tegniese Vergadering van die VMEO.

A THREE PHASE LINE SECTIONALISER

MR G AUTON: Affiliate

Yesterday, in my capacity as Design Consultant to Electrical Moulded Components, I showed you a slide of a new epoxy moulded insulator for use in fuse drop-out assemblies and I spoke of the possible use in a three phase sectionaliser unit.

All reticulation engineers have to live with the problem of transient fault damage causing permanent outages and this problem has been eased by the use of sectionalisers in co-ordination with automatic reclosers.

It is well known that the benefits of this solution are limited by the cost/benefit relationship, principally because of the high initial cost of the sectionalisers of the conventional type, which restrict their usage to main feeder circuits.

The new development which makes it possible to rethink the economics of sectionaliser application stems from a new concept of sectionaliser element in the form of a link which can be fitted to a fuse drop-out unit on every reasonable sized spur.

The element, shown on the slide now, is in the form of a conducting tube which fits into a drop-out assembly, and which also incorporates a toggle linkage somewhat like the fuse tube unit.

On the outside of the tube is a current transformer which senses the level of the current in the sectionaliser link and feeds this to a printed circuit intelligence unit mounted inside the tube. It also provides power to the built-in capacitor trip device.

The operating procedure is as follows when a fault develops on a protected spur:

The sectionaliser notes the passage of fault current and records this in the memory. The recloser opens and closes, and if the fault persists, the memory will again note this fact, and when it recognises that the recloser has cleared the fault for the second time, the sectionaliser will automatically open during the 'dead-time' — that is, it is an offload device.

Many hundreds of these sectionalisers have been installed in the UK, where the design was originated by the

Research Department of the Electricity Council. However, their application is essentially for 11 kV single phase reticulation and this is not of great advantage to us because of the predominance of our three phase reticulation.

The product for the local market must therefore have a three phase opening capability and a price to permit it to be used on all significant spur line connections. To make this possible, the new design has been based upon the fuse drop-out unit as a low cost base and to this has been added a tripping linkage to co-ordinate the opening of all three phases.

The slide shows a diagram of the linkage, which incorporates an insulated operating link to connect each phase to the trip-all-phase shaft. The result of one phase being activated as a result of a single phase fault is to collapse the toggle of the sectionaliser element of the phase concerned, which falls on a radius and impacts the tripping crank, from which it can be seen that the other two phases will be pushed out of contact to give three phase isolation.

It is expected that this approach to cost of sectionalising will result in much wider application possibilities on spur connections with an attendant improvement in the quality of the supply.

I hope that you find this to be of interest — a sectionaliser element is available for your inspection.

STANDAARDELEKTRISITEITSVERORDENINGE: TARIEF

MR A H L FORTMANN : Boksburg

Om hierdie bespreking in te lei is dit nodig om eers die vraag te stel wat hiertoe aanleiding gegee het.

Aanvanklik het die Vereniging van Stadstesouriers, Streeksgebiede Transvaal, 'n skrywe aan die Sekretaris van die VMEO gerig, waarin hulle kommer uitgespreek het oor moontlike wanpraktyke wat om Artikel 14 van die Standaardelektrisiteitsverordeninge draai.

Artikel 14 lees soos volg:

"Herverkoop van elektrisiteit

14. Waar 'n persoon elektrisiteit deur die raad verskaf, weer verkoop -

(a) moet sodanige elektrisiteit, ten opsigte van elke koper, deur 'n submeter gemeet word wat, asook die installasie daarvan, deur die raad goedgekeur is;

(b) is die raad nie aanspreeklik vir enige onjuistheid of ander gebrek in enige submeter nie, of die raad sodanige submeter of die installasie daarvan goedgekeur het al dan nie;

(c) mag die heffing deur sodanige verkoper gevorder nie die tarief oorskry wat betaalbaar sou gewees het indien die koper 'n verbruiker van die raad was nie; en

(d) mag die herverkoopvoorwaardes nie minder gunstig vir die koper wees as die voorwaardes waarop die raad self elektrisiteit lewer nie en elke sodanige koper is daarop geregtig om te vereis dat die verkoper hom van alle sodanige rekenings, dokumente en ander inligting voorsien wat nodig mag wees om die koper in staat te stel om te bepaal of die elektrisiteitsrekenings deur hom ontvang korrek is."

Mnr Alwin Fortmann, Aangewese President

"Resale of electricity

14. Where a person resells electricity supplied by the council -

(a) such electricity shall, in respect of each purchaser, be metered through a sub-meter which, and the installation of which, has been approved by the council;

(b) the council shall not be held liable for any inaccuracy or other defect in any sub-meter whether or not the council has approved such sub-meter or the installation thereof;

(c) the charge made by such seller shall not exceed the tariff which would have been payable had the purchaser been a consumer of the council; and

(d) the conditions of resale shall not be less favourable to the purchaser than the terms on which the council itself supplies electricity and every such purchaser shall be entitled to require the seller to furnish him with all such accounts, documents and other information as may be necessary to enable the purchaser to ascertain whether the accounts rendered to him for electricity supplied are correct."

Die probeem wat gestel was, was dat wanpraktyke, met die herverkoop van krag deur 'n eienaar aan meer as een verbruiker op 'n perseel of aangrensende persele en waar die Raad die krag aan die gesamentlike verbruikers by die grootmaat voorsien, kan voorkom.

Mr President, when one ponders the situation it is evident that where electricity is measured and sold in bulk by the council by means of a two-part tariff of maximum demand and kW.h and this electricity is sold by the consumer to sub-consumers by means of a two-part tariff based on maximum demand and kW.h, it is almost impossible for him not to sell at a profit when applying the council's promulgated tariff, because of the diversity of demands of the sub-consumers.

What would happen if he resold electricity on a basis of a kW.h tariff only under the abovementioned conditions of purchase, is anyone's guess. I suppose the result here would depend on the Council's laid-down kW.h tariff.

In Boksburg the problem was approached in the following manner :-

Firstly, and this is also important, is that the consumer receiving electricity in bulk from the Council, **may** submeter each sub-consumer. The emphasis here being on the "may".

In other words the consumer is not obliged to sub-meter his sub-consumers.

If he should elect not to sub-meter he may for example adjust his rental of the premises to an amount to cover what the owner considers to cover his electricity cost.

However, the tariffs state clearly that where the consumer elects to resell electricity to his sub-consumers, he is then obliged to sub-meter by means of approved meters. This is also in accordance with the conditions stipulated in Section 14 of the Standard Electricity By-Laws.

Secondly, in an attempt to overcome the problem of profit by the consumer from his sub-consumers, the tariff in Boksburg contains a formula prescribing the method of resale of electricity.

It is of course clear that where the bulk supply is metered in kW.h and the sub-consumers are metered in kW.h, and furthermore where the tariff has a single kW.h scale, not a sliding scale and the kW.h meters used are correctly set, the problem of profit would not arise if the consumer applied the council's tariff to his sub-consumers.

Of course a major problem arises with the two-part tariff of maximum demand and kW.h.

The formula that Boksburg prescribed in its tariff of charges reads as follows :-

"(3) In respect of flats or blocks of flats the supply shall be metered in bulk and the charges in terms of sub-item (2) shall be payable.

(4)(a) Where the supply of blocks of flats is metered in bulk, the owner may sub-meter each tenant or sub-consumer separately, by means of approved meters.

(b) Where electricity is sold to individual tenants or sub-consumers, the owner is obliged to sub-meter individual tenants or sub-consumers separately by means of approved meters and the electricity so measured and sold, shall not be sold at a profit.

(c) Where electricity supply to individual tenants or sub-consumers is metered and sold, the following formula shall apply:

Tenant's or sub-consumer's account in Rand =

$$\frac{\text{Tenant's or sub-consumer's Consumption in kW.h}}{\text{Total consumption in kW.h}} \text{ times total monthly account in Rand"}$$

"(3) Ten opsigte van woonstelle of woonstelblokke word die toevoer by die grootmaat gemeet en die gelde ingevolge subitem (2) is betaalbaar.

(4)(a) Waar lewering aan woonstelle of woonstelblokke by die grootmaat gemeet word, kan die eienaar die verbruik van elke huurder of onderverbruiker afsonderlik, deur middel van 'n goedgekeurde meter, meet.

(c) Waar elektrisiteitstoevoer aan individuele huurders of onderverbruikers gemeet en verkoop word, moet die onderstaande formule toegepas word:

Huurder of onderverbruiker se Rekening in Rand =

$$\frac{\text{Huurder of onderverbruiker se kW.h verbruik}}{\text{Totale kW.h verbruik}} \text{ Vermenigvuldig met totale maandelikse rekening in Rand"}$$

The above formula thus only uses kW.h as a basis of determining the sub-consumer's accounts and the maximum demand element, if present in the bulk metering account or in the sub-consumer's account is ignored.

It could be argued that this formula is not perfect either and of course this is so. However it does offer a reasonable solution to the problem and the bulk consumer does not make one cent profit or loss.

It has been argued by others that the consumer is entitled to some extra income to cover his expenses he incures in sub-metering his sub-consumers.

Well, this may be the case.

For the consumer to receive reimbursement for his troubles, there is nothing to stop him adding a fee to the account to cover this contingency and I propose that this in fact is the best solution.

It would be interesting to hear from other engineers in the audience how they approach this problem and also if they agree that what Boksburg is doing is a fair approach.

Thank you Mr President.

DISCUSSIONS — BESPREKINGS

MR W BARNARD : Johannesburg

Mr President, I don't think Mr Fortmann is surprised at me responding to his paper because he and I have argued this point for a number of years.

The first problem, I think, is the use of the word "wanpraktyke". As I understand it, it means "irregular practices". Quite candidly I think that the Institute of Treasurers has this thing completely wrong. We have got to look at the objective of metering and sub-metering. It is my contention dat ons moet seker maak dat die subverbruiker nie uitgebuit word nie.

The sub-consumer must purchase his electricity at the same price that he would pay if he got it direct from the local authority and in fact it is in terms of that that this ordinance, which Boksburg is contravening all the time was promulgated. It says that you may not charge a subconsumer more than he would pay the local authority. Now I can't see how that is unfair and whether he makes a profit out of it or a loss is not our concern.

The other thing is that it is the only way that you can tell the sub-consumers on what basis they will be charged. It is the only way that you can monitor the resale of electricity. It's the only way you can protect your subconsumers. The ordinance also makes provision for the main bulk purchaser from the local authority to read the meters, to let his sub-consumer see how many units he has used. In fact, to give him access to the meter itself so that he can check the consumption. He can get the rate or tariff from the local authority and he can check that he is being charged that rate.

Now where I think Mr Fortmann has over-simplified the whole problem is that he is in fact wanting to give the bulk consumer the right to charge anything he likes for his electricity in some guise or other. Now he is supplying an essential service and he has the monopoly in suppling that and you're telling him he can add to the account any amount he likes and that is the thing we're trying to avoid in Johannesburg. We've got, I would say, tens of thousands of flats and for us to try to monitor that on the basis of a complex formula of this sort, I think is quite out of the question.

I would just like to mention that very recently at the first meeting I went to of the Electricity Control Board, they were looking at this particular clause because with the falling away of the Provinces, this is now going to be taken up in the Electricity Act, the Amended Act and their proposal was that you work out the average cost of your power. You then add 13% to it and you charge that and I said it's completely unworkable in a place like Johannesburg and I appealed to them to adopt the Provincial By-Laws that have been quoted here.

DR N BOTHA: Bloemfontein

Meneer die President, eerstens wil ek mnr Fortmann gelukwens met sy helder denke. U sal dus kan aflei dat ek ook daarteen gekant is dat enige verbruiker wat toegelaat word om elektrisiteit te herverkoop **moontlik** in 'n posisie geplaas word waar hy onbehoorlike winste kan neem.

U sal daarop let dat ek praat van onbehoorlike winsneming. Ons moet daarop let, dat die wins sou afhang in die onderskeie tariewe. Daar sou gesê kon word dat die tariewe behoort sodanig te wees sodat onbehoorlike winsneming onmoontlik is. Hiermee stem ek egter nie saam nie — elektrisiteitstariewe is 'n beleid saak. Indien 'n plaaslike owerheid byvoorbeeld grootmaatverbruikers relatief gesproke tot kleinverbruikers wil begunstig — dan is dit sodanige raad se prerogatief.

Mnr die President, ek glo dat slegs 'n gemagtigde elektrisiteitsvoorsiener geregtig is op winsneming. Ek ondersteun dus die voorstelle van mnr Fortmann.

MNR J. G. BRÜMMER : Stellenbosch

Mnr die President, die relatiewe groot omset van huurders van woonstelle veroorsaak heelwat administratiewe probleme en plaaslike owerhede is deesdae meer geneig om grootmaat metering aan woonstelgeboue te verskaf. Dit het egter tot gevolg dat groot getalle verbruikers van elektrisiteit aan die genade van woonsteleienaars of hulle agente uitgelewer word.

Bestaande wetgewing bied in die meeste gevalle min of geen beskerming aan sub-verbruikers van elektrisiteit nie. Aangesien sub-verbruikers tans waarskynlik die grootste getal elektrisiteitsverbruikers verteenwoordig voel ek dat, in belang van regverdigheid en om aan die gees van die Elektrisiteitswet te voldoen, alle plaaslike owerhede iets op die volgende riglyne in hulle elektrisiteitsvordering behoort in te voeg nl.

Waar 'n verbruiker elektrisiteit wat deur die Raad verskaf word, weer verkoop vir gebruik op dieselfde perseel sal:

(a) die herverkoop onderhewig wees aan 'n ooreenkoms tussen verbruiker en sub-verbruiker, tensy die Raad se tarief anders bepaal;
(b) sodanige elektrisiteit, ten opsigte van elke koper, deur 'n submeter gemeet moet word wat, asook die installasie daarvan, deur die Raad goedgekeur is en voldoen aan die vereistes van BS. 5685(1979), soos gewysig. Daarbenewens moet alle submeters getoets en instand gehou word volgens die vereistes neergelê deur SABS Gebruikskode 01(1953), soos gewysig:

(c) die Raad nie aanspreeklikheid vir enige onjuistheid of ander gebrek in enige sub-meter aanvaar nie, of die Raad sodanige sub-meter of die installasie daarvan goedgekeur het al dan nie;

(d) die heffing deur sodanige verkoper gevorder nie die tarief mag oorskry wat betaalbaar sou gewees het indien die koper 'n direkte verbruiker van die Raad was nie; en

(e) die herverkoopvoorwaardes nie minder gunstig vir die koper mag wees as die voorwaardes waarop die Raad self elektrisiteit lewer nie.

Dit is belangrik dat ons die beginsel aanvaar dat dit nie verkeerd is vir die eienaar/verbruiker om 'n "wins" te maak met die herverkoop van elektrisiteit vir gebruik op dieselfde perseel nie, mits hy hom hou aan die reëls soos uiteengesit want hy het ook uitgawes in verband met die verskaffing, instandhouding en lees van sub-meters.

In Stellenbosch word woonsteleienaars die keuse gelaat of hulle elektrisiteit wil aankoop teen die grootmaat- (besigheids-) tarief of teen 'n huishoudelike tarief wat van toepassing is op wooneenhede. In eersgenoemde geval kan die eienaar 'n wins of verlies toon na gelang van omstandighede, terwyl dit in laasgenoemde geval net 'n "break even" kan wees, as meter onjuisthede buite rekening gelaat word.

MNR P. BOTES, Roodepoort

Mnr die President, Kan ek op 'n punt van orde u net miskien inligting verskaf wat u en u Uitvoerende Raadslede more moet oor besluit. Dit is 'n nuwe konsep elektrisiteitswet, en daarin staan baie duidelik die kwessie van verkope. Niemand mag aan wie elektrisiteit op 'n perseel gelewer word daardie elektrisiteit aan iemand anders op daardie perseel herverkoop teen 'n prys per kilowatt/uur, wat indien die hoeveelheid elektrisiteit wat hy herverkoop deur 'n geskikte meter geregistreer word meer is as die gemiddelde prys per kilowatt/uur wat die persoon wat die elektrisiteit herverkoop daarvoor betaal het plus 'n kommissie van 3% nie.

Is iemand wat elektrisiteit aldus herverkoop verplig om op versoek en op koste van die persoon aan wie die elektrisiteit herverkoop word 'n geskikte meter te installeer?

Dan die volgende ene, word die gemiddelde prys bedoel in paragraaf (a) bereken deur die totale bedrag van die rekening vir elektrisiteit gelewer aan die persoon wat dit herverkoop te deel deur die aantal kilowatt/uur op die rekening aangetoon?

Dit is alles in die nuwe konsep elektrisiteitswet.

Ek het gewonder toe ek nou so begin praat of u ooit kennis geneem het van wat in hierdie konsep elektrisiteitswet staan. Ek dink hier is verregaande punte. Hierdie is maar 'n gedeelte van groot probleme in die elektrisiteitswet. Ek wou dit net onder u aandag bring van wat hierin is en wat ons voor die deur staan.

MR D FRASER: Durban

Mr President, it's not always that I agree with my friend, Wessel Barnard, but in this instance I couldn't agree with him more.

Mr President our main concern surely is that the sub-consumers are not disadvantaged in relation to the directly metered consumers of the Council and I don't know why we're being such purists in insisting that the bulk metered consumer shouldn't make a profit when we make such handsome profits on the resale of Escom electricity.

Another problem that I can foresee is a sort of boomerang effect with Al Fortmann's proposal in that the sub-metered consumers could well be paying less than the directly metered consumers and you're going to have a whole stack of disgruntled directly metered consumers.

MR F VAN DER VELDE: Cape Town

Mr President, I'm a privatisation man — I ask the question "why do we need regulations?" I think this bill that is coming forward should be opposed quite strongly.

First of all, I would remind you, Sir, that the profits that a private man makes in a city pays for his salary, so if you make profits from the sale of electricity, or your consumer makes profits, he pays that in terms of taxation in one form or another which ultimately pays your salary in any case. If you have no-one making profits in your city, you wouldn't have a city in the first place.

My basic question is "why are you worried about whether a consumer is disadvantaged or not?" I don't think one can read Mr Fortmann's paper in isolation from his other paper which, I presume, he's going to read to us next where he says quite clearly, and I hope I can quote you for something you haven't said yet. Mr President, he says "At the outset, I wish to stress that I am strongly in favour of a system of bulk metering." Mr Fortmann then goes on to list a whole lot of reasons why he, as a municipal seller of electricity, doesn't want to sub-meter tenants. He doesn't want to have to get his meter readers to climb up stairs, he doesn't want to have to send meter readers out, he doesn't want to have to pay for them, he doesn't want to have to pay for sub-main cables and so on. He wants the owner of that block of flats or that development to pay for it but he doesn't want them to make a profit to pay for all those things which he doesn't want to have to bear the cost of anyway.

Mr President, laissez-faire! If a person wishes to make a profit, let him make a profit. If a tenant doesn't wish to stay in his building he can go to another building and this is where I disagree with Wessel. He said the chap has a monopoly. I don't think he has a monopoly. No owner of a flat building has a monopoly. If a chap charges too much rental or he charges too much for his electricity or his water or his cleaning affairs or whatever it is, and he doesn't like it, he can go to another building, so I believe that we must leave well alone and the simplest way, and I've found this in practice, is to advise my client when he is a bulk consumer and has sub-tenants merely to use the tariffs that Council has. In other words he's buying at a

bulk rate — he might be buying at HV rate — and he sells it at an LV rate if he has a demand tariff or if he merely has a unit tariff he sells it to him at the consumer because where Mr Fortmann's formula falls down is when you have mixed tenants, e.g. in a shopping centre where you might have your anchor shop being a large Pick 'n Pay who themselves have a bulk meter and a number of tiny little shops who would just merely have an ordinary kilowatt/hour meter and then your formula doesn't apply and then you don't encourage your people to do so. So I'm very much in favour of having a few checks and balances, namely that the tenant is able to have his meter tested in the same way he is able to have a municipal meter tested and let the developer pay what he wants to and beware if he loses tenants as a result.

MNR E de C PRETORIUS: Potchefstroom

Wat is daarmee verkeerd as 'n persoon wat elektrisiteit herverkoop, 'n wins maak solank hy, wat Transvaal betref, voldoen aan Artikel 14(c) van die Standaardelektrisiteitsverordeninge?

Wat **my** bekommer, is dat die moontlikheid bestaan, veral onder lae lasfaktoromstandighede, dat 'n persoon wat elektrisiteit herverkoop en streng voldoen aan Artikel 14(c), 'n verlies kan ly.

Dit is my oortuigde mening dat 'n persoon wat elektrisiteit herverkoop dit behoort te mag doen teen 'n tarief wat hom behaag of pas. Hoekom moet hy aan bande gelê word? Evkom maak immers geen beswaar as plaaslike owerhede profyt maak op elektrisiteit wat hulle herverkoop nie. Die verordeninge behoort dienooreenkomstig gewysig te word.

Wat Boksburg betref, is ek van mening dat sy submetertariefbepaling **ultra vires** Artikel 14(c) van die betrokke verordeninge is.

MR A FORTMANN : Boksburg

Mnr Pretorius, ek wil net sê die Administrateur van die Transvaal mag natuurlik tevrede wees dat dit nie ultra vires was nie. Hy het dit goed gedink om goed te keur. Die tarief is deur die Administrateur goedgekeur.

Mr President, it seems to me that I think one could discuss this item until the cows come home and you won't easily find a solution.

Just a few points. It seems to me what Councillor van der Velde said, and someone supported him, Mr Pretorius, about why legislate at all, might be a better solution. Now I think this problem arose in a town which I shall keep nameless where someone read meters on behalf of the main consumer and the main consumer also had a complex of factories and he read all the sub-meters and the main meter and he charged the tenants the tariff the Council would charge. The result is that he made quite a handsome profit and the person concerned is known to quite a few of our members also which I shall also keep nameless, and they resold this electricity to the sub-consumers. The end result was that the main purchaser, the owner of the complex, who also had a factory there, he got his electricity free, as it were, and there was still change and this is what the Treasurers objected to.

Now the problem here with measuring maximum demand on the main meter is where there will be a problem and if you have a complex of factories or businesses or even a block of flats for which you're measuring maximum demand and kilowatt/hours because to you as a local authority that consumer is say a consumer which falls in that category, over 100 kVA in the case of Boksburg, but each individual consumer might be a consumer of less than 100 kVA and the tariff applicable then to consumers less 100 kVA is a straight kilowatt/hour tariff, which in Boksburg's case is quite a high tariff. The kilowatt/hour charge is a straight flat rate — so many cents per kilowatt/hour is quite a high tariff. So what would happen now is that if you told them you apply the tariff Boksburg has, the local authority has, we would charge the man maximum demand and kilowatt/hours so he would pay on the RXXX. He would have to recoup from 10 or 20 sub-consumers at a tariff completely different to the maximum demand and kilowatt/hour charge, he would now have to apply the straight kilowatt/hour tariff because his consumer is less than 100 kVA. So can you see if you do that, there could be a handsome profit for this consumer and it would be quite unwittingly done. That's why we saw fit to have a formula there which prescribes that you apply this formula and you ignore the maximum demand, if there would be a maximum demand of any sub-consumer or sub-consumers.

If there's a Pick 'n Pay complex, a large shopping complex which is owned by one person, and in that complex is a Pick 'n Pay shop which is probably drawing 1 500 kVA and there are smaller shops each drawing 50 kVA, but we meter that complex in bulk, say 2 000 kVA. We would prescribe then that the money recouped by the owner must be on a formula basis using straight units, kilowatt/hours, and ignoring any maximum demand, granted this is not perfect either and the load factor of, let's say, the Pick 'n Pay consumer, the large consumer, would affect the issue quite drastically. It could. So you share out the account in Rands proportionately to the units used of each one, including the Pick 'n Pay kilowatt/hours element and you ignore the maximum demand element. The result is that the owner would receive every cent that he's paid out to the local authority. The balance would not be perfect to the sub-consumers but we've had no problem and we've been applying this in Boksburg for quite a number of years and without any hassles.

Mr President, I think that's all I would like to say at this point in time anyway.

MNR J LOUBSER : PRESIDENT

Vriende, ons het nou grappies hieroor gehad maar dié probleem is eintlik redelik ernstig. Soos mnr Botes vir ons gesê het, is daar al 'n konsepwet wat ons moet bespreek. Iemand moes besluit het dat iets gedoen moet word aan hierdie saak. Ons ingenieurs hier onder mekaar kon nie tot 'n beslissing kom nie en dis hoekom iemand anders al so ver gegaan het om 'n konsep op te stel.

Die Tesouriers het hierdie saak na ons verwys vir kommentaar en ons het nie vir hulle antwoord gegee nie.

Die volgende ding wat gaan gebeur is dat hulle gaan met hulle eie oplossing vorendag kom, so ons moet dit redelik ernstig bespreek op die Uitvoerende Raadsvergadering.

QUALITY MANAGEMENT AND SABS 0157

MR J TOMS : SABS

Most of the delegates present will be buyers of Capital equipment for which they will thereafter be responsible. Long and reliable service in compliance with specification is what you will expect. Quality management during manufacture is the key to such service. It ensures that the correct materials are processed and assembled in accordance with design.

SABS 0157 is a code of practice for quality management systems which provides a definitive set of requirements for a practical quality management system. It addresses about 20 key stages in the planning, manufacture and testing of a product. Compliance with its principles benefits purchaser and manufacturer. The purchaser because he is assured that the right materials have been put together in the correct manner and the manufacturer because he is not turning out defective products.

The SABS Standardisation mark means:

1) That the product complies with the relevant Standard specification; and

2) That the manufacturer operates an assessed quality management system in accordance with SABS 0157. For those manufacturers who produce commodities falling outside the scope of a standard specification, the SABS will assess their quality management system for compliance with SABS 0157. If satisfactory, his name will appear in the SABS list of manufacturers of assessed capability.

In addition the SABS provides quality awareness programmes for management and shop floor personnel. These programmes explain the principles of SABS 0157, its financial benefits and its application on the shop floor.

Documentation on this topic is available from me, and I urge you to become quality conscious and to buy only those goods which have been manufactured with the application of SABS 0157.

NON-STANDARD ESCOM SUPPLY VOLTAGES

MR W RATTEY : Strand

This discussion may, in the light of the findings of the De Villiers Commission of Enquiry regarding standard frequencies and voltages, appear to be superfluous, but at the time this subject was first placed on our agenda, it was of real concern. Nevertheless it may now serve to strengthen the hand of those pursuing the establishment of a form of control over voltages of supply.

The cause for my concern at the time arose from the following chain of events:

In 1959 when Strand and Somerset West Municipalities were obliged to uprate their 3,3 kV primary supplies, Escom, who at the time had jacked up the secondary voltages of their 66/11/6,6 kV dual voltage transformers in order to provide an acceptable supply voltage to their rural consumers, persuaded the municipalities to accept a supply at 11 500 volts. Since that time more than 200 distribution transformers wound for this voltage have been installed by the two municipalities.

When the agreement with Escom was subject to renewal in 1974, the voltage was again raised, this time to 11,8 kV.

Although both municipalities support the principle of national standardisation, they have been obliged to develop a non-standard undertaking.

As a result of the installation of 66/11 kV transformer substations, the municipalities now have control of the 11 kV supply to their networks.

The decision now to be addressed is whether to continue with a non-standard system operating on 11 500 volts or to revert to the standard voltage and set all the existing transformers to the -5% tapping, in which case no allowance will be available to compensate for voltage drop on the 11 kV system.

In either case, an imperfect system will result and I would fully support any move to impose on Escom a governing body whose responsibility it would be to ensure that an agreement drafted by the supplier was made in terms of a nationally accepted voltage and that the term "nominal voltage" be disallowed.

Earlier in the proceedings of this convention, our past President made mention of a take-over bid by Escom in the form of their extensive representation to this convention. It is therefore with trepidation and trembling that I proceed.

Human energy: a major source of electrical energy.

Any chief executive of a large company will understand the enormous complexity of co-ordinating 60 000 employees and an annual turnover of nearly R5 000 million. In addition, Escom is over 60 years old and is the sole supplier of 94 percent of South Africa's electricity. It's a situation that could invite complacency and bureaucracy.

Aware of these problems, Escom's management has launched the most dramatic restructuring programme ever undertaken by a major South African company. It involves the optimum use of human energy by creating an atmosphere of enthusiasm, commitment and dedication amongst employees at all levels. By encouraging employees to voice their ideas of how improvements can be made within their own departments, combined with wide-spread initiatives by management, dynamic solutions are being generated on cost-saving, better service to customers and general efficiency.

From this programme, it is expected that millions of Rand can be saved each year, which will be translated into lower tariff increases. Already, electricity from Escom is among the cheapest in the world – despite the difficulties experienced in generating and distributing electricity throughout a country as vast as South Africa.

But we're not using the rest of the world as a criterion. Our concern is the role we have to play in the economic advancement of South Africa. We are intimately involved in the well-being of the public, of industry and agriculture, and in preserving our natural resources and the environment. This means that our efficiency affects not only our credibility with customers and investors, but also the future of our country and its people.

And that is why human energy – from management, and throughout the entire organisation – has become as important to us as the energy we sell.

ESCOM • EVKOM

All our energy for you.

GREY-PHILLIPS BUNTON MUNDEL & BLAKE 79003

IEC PLUG AND SOCKET COMMITTEE

MNR J LOUBSER : PRESIDENT

Een van die verdere items wat bespreking vereis is EC23: Internasionale Stopkontakte en Sokket kommittee.

Gentlemen, this committee, the South African Committee, has completed its job and we have finally reached an international standard. However, it does seem to me that most of the countries, although this international standard has been reached, are not going to that international standard plug and socket. I know we have some affiliates who differ with me on this subject. I have a personal view about this but I also appreciated their views. If somebody feels like getting up and saying something, from the affiliates, please.

MR J TOMS : SABS

Mr President, I succeeded Mr Grant on the International IEC Plug and Socket Committee and as Mr Loubser has just informed us, the publication is in preparation as I speak and it will appear in April and it will contain details of an international plug and socket systems for 250 V 16 amp systems. Personally I regret that what Mr Loubser says is quite true and that a decision has been taken that South Africa as a country will not adopt the international system but remain with the existing system

and I can well understand the commercial and logistic reasons for doing this but I would give a personal opinion that I think this course of action in the long term is wrong and I think that the third world countries will, in the fullness of time, adopt the international system and the evidence I have for this is from the delegates who attend IEC from the third world countries so I do feel that in twenty years' time we shall see a widespread adoption of the worldwide plug and socket system which is currently being published. Obviously a decision to adopt something like this has to be made on a national basis and obviously countries which have no system at the moment will be attracted to it because of its stabilisation and the interchangeability across borders that it will afford.

MR J LOUBSER : PRESIDENT

My view about this is that with our present plugs and sockets, the size, the physical size of these things, I have no objections about current carrying capacity or anything like that, but the physical size of these things makes them a bit impractical for the new innovative wiring systems. I'm not sure that Mr Toms was correct in saying that it hasn't been accepted. What was decided is that the job has been completed, in other words, we agreed to the standard specification. I don't think the decision has ever been made not to go to the international standard. Although the manufacturers offered to start on the design of a smaller plug and socket which could be housed in a smaller box, it will therefore be more adaptable to the innovative wiring systems.

At this stage it's only information.

BULK VS INDIVIDUAL METERING IN MULTI-FAMILY DWELLING UNITS

MR A H L FORTMANN : Boksburg

Mr President, before commenting on this subject, I would first like to read the question on this subject.

> "The American Society of Heating, Refrigeration and Air-conditioning Engineers found that energy savings as high as 35% can be achieved by switching from master (bulk) to individual metering in multi-family dwelling units. Since banning master (bulk) metering in 1978, Seattle estimates it has saved 30%, or 600 000 kW.h annually in the 400 apartments affected.
>
> What are the views of AMEU members in this regard as far as the South African practice of bulk metering for large blocks of flats is concerned?"
>
> "Die Amerikaanse Genootskap van Verwarmings, Verkoelings en Lugversorgings Ingenieurs het bevind dat energie besparings tot 35% bereik kan word as van grootmaat na individuele metering van woonstel-wooneenhede oorgeskakel word. Seattle het bevind dat sedert oorskakeling in 1978, 30% of 600 000 KWh jaarliks op 400 wooneenhede bespaar word.
>
> Wat is die sienswyse van VMEO-lede oor die Suid-Afrikaanse gebruik van grootmaat-metering van groot woonstelgeboue?"

At the outset I wish to stress that I am strongly in favour of the system of bulk metering.

Having had first-hand experience in the implementation of bulk metering in Boksburg during 1970 — not only in blocks of flats, but also in commercial buildings and offices, I would like to contribute to this discussion.

Let us accept the findings of the American Society of Heating, Refrigeration and Air-conditioning Engineers, which found that savings were achieved by switching to individual metering in multi-family dwelling units in Seattle, USA, with a "high" estimate saving of 30%.

I have not had the privilege of visiting Seattle, but Seattle is a city approximately on latitude 48° north — Cape Town lies approximately on latitude 34° south — so one can expect the climate in Seattle to be pretty cold.

My daughter's school atlas shows that the lowest temperature for Seattle reaches about -15° Celsius during the month of January.

Climatic conditions must obviously affect the use of electricity, with extreme temperature conditions, either very cold on the one hand, or very hot and humid on the other hand, probably having a more marked effect on the use of electricity and a greater resultant saving in energy with individual metering because consumers in this case will be more cautious in its use, as they are more directly affected by the payment of accounts.

Of course, on a bulk meter scheme, the consumers will still be liable for the cost of energy usage — whether this energy is measured through sub-meters by the owner of the building or included as part of the monthly rental — but in this latter instance, this will affect them indirectly.

Mnr die President, graag stel ek die vraag of die besparing of onoordeelkundige gebruik van energie die belangrikste faktore is wat met grootmaatmeet oorweeg moet word.

Hierdie is maar net een sy van die saak.

Ek glo dat in meer gematigde klimaatstoestande, soos wat in Suid-Afrika voorkom, die "besparing" van energie waarskynlik minder merkbaar sal wees en 'n geringe bydrae sal lewer tot die oorweging of kragverbruik in grootmaat, of by wyse van individuele meters gemeet moet word.

Die voordele verbonde aan die grootmaatmeet van elektriese krag, is talryk, waarvan die volgende sommige uitmaak :

1. Vir die stadsraad is daar 'n regstreekse besparing van arbeid en geld, deurdat daar net een meter gekoop, getoets, geïnstalleer en instandgehou hoef te word.

2. Dit is nie nodig om 'n groot voorraad meters en stroombrekers te hou nie en die roetine toetse van meters word tot 'n minimum beperk, omdat daar nou net een meter, in plaas van die talle, wat andersins in 'n woonstelgebou benodig sou word, deur die stadsraad aangebring is.

3. Vir die meterlesers is daar net een meter, in plaas van talle meters, om te lees. Dit is dus net nodig om na een punt toe te gaan om die meter te lees, teenoor die talle meters wat gewoonlik in groepe op elke vloer van 'n woonstelgebou aangebring is.

   Bykomend hiertoe, word minder tyd bestee met die op- en afklim van trappe, die oop- en toesluit van meterkaste, sowel as 'n vermindering in boekinskrywings, ens.

4. Wat rekeninge betref, is dit nodig om net een kontrak vir 'n woonstelgebou te voltooi, in plaas van talle vir dieselfde gebou.

   Net een deposito moet beheer word en net een rekening word uitgemaak.

   Hierdie benadering dra daartoe by dat daar 'n algemene besparing is in meterlesings, boekinskrywings, rekenaarwerk, rekeninge, posseels, meternavrae, rekeningnavrae, invordering van rekeninge en dies meer.

5. Waar individuele meters in woonstelgeboue geïnstalleer was, was daar altyd probleme met slegte skuld, ongemagtige aanskakeling van krag na afsluiting vir wanbetaling van rekeninge, peuter aan meters, die breek van munisipale seels aan die meters, die uitklink van die stadsraad se stroombrekers weens ver-

bruikersfoute wat dan dikwels na-ure deur die nooddiens elektrisiën aangeskakel moet word, wat arbeids- en vervoerkoste meebring.

6. Wat die bedrading in 'n woonstelgebou betref, veroorsaak die grootmaatmeet van krag 'n baie makliker en goedkoper manier van bedrading sonder lang en duur geleidings van die aansluitingspunt na elke woonstel.

Ek haal graag 'n uittreksel uit die destydse Elektrotegniese Stadsingenieur van Kaapstad se jaarverslag, soos dit in die April 1971 uitgawe van die "SA Electrical Review" verskyn het, aan. Dit lui so :

"The trend towards larger and taller blocks of flats presented a problem insofar as the metering of the supplies is concerned. Whereas it had been practice for the Council to consider each tenant in a building as an individual consumer with a separately metered supply, it has now become necessary to give one supply to each building to overcome the technical difficulties and the expense of long subservice connections from a common meter room to each flat."

Mnr die President, ten laaste wil ek net sê dat dit moeilik is — byna onmoontlik — om die besparing in kostes the kwantifiseer, maar ek meen dat die feite wat ek hierbo genoem het, ondubbelsinnig bewys lewer dat besparings met die toepassing van grootmaatmeet van elektriese kragverbruik, aansienlik is en na my beskeie mening die moontlike besparing in energie ver te bowe gaan.

Dankie Mnr die President.

TABLE 35 — MAXIMUM SYMMETRICAL FAULT CURRENT CARRYING CAPACITY OF CABLES MADE TO THIS SPECIFICATION

1	2	3	4	5	6	7
Conductor size	Copper conductor			Aluminium conductor		
	0,5s	1s	3s	0,5s	1s	3s
mm^2	kA	kA	kA	kA	kA	kA
16	3,3	2,3	1,4	—	—	—
25	5,2	3,7	2,1	3,4	2,4	1,4
35	7,2	5,1	2,9	4,8	3,4	1,9
50	10,4	7,2	4,2	6,8	4,8	2,8
70	14,5	10,1	5,9	9,5	6,7	3,9
95	19,7	13,8	8,0	12,9	9,1	5,3
120	24,8	17,4	10,0	16,3	11,5	6,7
150	31,0	21,8	12,6	20,4	14,4	8,3
185	38,3	26,8	15,5	25,2	17,8	10,3
240	49,7	34,8	20,1	32,6	23,0	13,3
300	62,1	43,5	25,1	40,8	28,8	16,6
400	82,8	58,0	33,5	54,4	38,4	22,2
500	103	72,5	41,9	68,0	48,0	27,7
630	130	91,3	52,7	85,7	60,5	34,9
800	166	116	67,0	109	76,8	44,3
1 000	207	145	83,7	136	96,0	55,4

NOTE: A symmetrical fault is carried by the cable conductors only and is independent of the method of earthing adopted. It is recommended that even where fast acting feeder protection is employed, a cable capable of carrying the prospective fault current for 1st be installed.

TABEL 35 — MAKSIUM VERMOË OM SIMMETRIESE FOUTSTROOM TE DRA VAN KABELS WAT VOLGENS HIERDIE SPESIFIKASIE VERVAARDIG IS

1	2	3	4	5	6	7
Geleier-grootte	Kopergeleier			Aluminiumgeleier		
	0,5s	1s	3s	0,5s	1s	3s
mm^2	kA	kA	kA	kA	kA	kA
16	3,3	2,3	1,4	—	—	—
25	5,2	3,7	2,1	3,4	2,4	1,4
35	7,2	5,1	2,9	4,8	3,4	1,9
50	10,4	7,2	4,2	6,8	4,8	2,8
70	14,5	10,1	5,9	9,5	6,7	3,9
95	19,7	13,8	8,0	12,9	9,1	5,3
120	24,8	17,4	10,0	16,3	11,5	6,7
150	31,0	21,8	12,6	20,4	14,4	8,3
185	38,3	26,8	15,5	25,2	17,8	10,3
240	49,7	34,8	20,1	32,6	23,0	13,3
300	62,1	43,5	25,1	40,8	28,8	16,6
400	82,8	58,0	33,5	54,4	38,4	22,2
500	103	72,5	41,9	68,0	48,0	27,7
630	130	91,3	52,7	85,7	60,5	34,9
800	166	116	67,0	109	76,8	44,3
1 000	207	145	83,7	136	96,0	55,4

OPM: 'n Simmetriese fout word slegs deur die kabelgeleiers gedra, ongeag die aardingsmetode wat gevolg word. Daar word aanbeveel dat selfs waar snelwerkende toevoerbeveiliging gebruik word, 'n kabel wat die waarskynlike foutstroom 1 sekonde lank kan dra, geïnstalleer word.

DISCUSSIONS — BESPREKINGS

MNR P BOTES : Roodepoort

Meneer die President, ons het al heelwat jare wat ons nou meters wat in huishoudelike gebruik is op grootmaat meet. Ons het nie eintlik probleme in die verband nie. Dit werk goed. Soos u sê hulle het die meters geïnstalleer net waar hulle wil. Dit hoef nie meer in een kamer te wees nie, ens, daar is natuurlik sekere besparings vir hulle. Onlangs het daar iets plaasgevind wat vir my nogal heelwat interessant is. As die woonsteleienaars of die woonstelbewoners nou nie hulle huur betaal nie, wat niks te doen het met elektrisiteit nie, maar nou agterraak met hulle normale huur, dan gaan die woonsteleienaars en skakel hul elektrisiteit af. Toe moes ek eers daardie sakie oorkom.

Dis al kommentaar wat ek daarop te lewer het.

MNR G ODENDAAL : Alberton

Meneer die President, ek het nou vandag lank geluister en ek sien werklik nie 'n probleem nie. In elk geval in die ou dorpie waar ek vandaan kom het ons nie 'n probleem nie. Ons het besluit hierso dat mense wat moet beskerm raak is die gewone man in die straat, die huisbewoner, so met ander woorde as dit nou kom by bulkmetering of watse soort metering ook al om die woonstelbewoner te beskerm. In die ou dae het ons hulle individueel gemeter en hy het dieselfde tarief gekry as die gewone huisbewoner. Omdat ons nou 'n demokratiese raad het, het hulle gaan besluit dat nuwe woonstelle moet in bulk gemeter word. Toe het ons net eenvoudig die tarief aangepas en dit is naamlik om presies weer dieselfde tarief te gee as wat hy vir 'n gewone huis gee, vir 'n gewone woonstel wat deur die raad gemeter word. Met ander woorde, veronderstel daar is 'n blok met twintig woonstelle, dan sal 20 x 'n basiese heffing van R5 is 20 x 5 = R100 plus nog een vir algemene beligting is R105 en daarna die eenhede teen 5,5 sent. Baie eenvoudig, niemand kan profyt maak nie. Die woonsteleienaar moet daardie eenhede verkoop teen dieselfde prys as wat enige huiseienaar dit kan kry.

Dan kom ons na die volgende aspek en dit is naamlik waar jy 'n gebou het waar daar ook besighede is. Nou ongelukkig het ons nou 'n bietjie meer werk daar. Gewoonweg as dit 'n besigheid is wat geen woonstelle het nie, dan sou ons hom hoogspanning gemeter het. Maar omdat daar nou 'n besigheid is met woonstelle sowel as besighede, moet ons vir hom op twee punte meter, so ons kan hom nie nou met die hoogspanning meter nie, hy het sy eie transformator en ons gee vir hom net twee stelle meters aan die laagspanning kant, een vir die woonstelle wat dan teen die tarief is wat ek reeds genoem het, en dan die tweede een, doodgewoon besigheid teen maksimum aanvraag en eenhede.

Dan, mnr die President, 'n besigheidsman wat nie vir homself kan sorg nie behoort nie in besigheid te wees nie en as daardie eienaar dan 'n profyt het, dan is dit sy eie saak.

MR F VAN DER VELDE : Cape Town

Mr President, I agree completely with Mr Fortmann. I mean why go to all the trouble with climbing stairs, to all the troubles that he listed, but, Mr President, if you are going to withdraw from responsibility, why should you regulate the people you are now putting the responsibility onto, and that's my whole point. If you're pulling out of responsibility, don't say well now I don't want anything to do with it but I'm still going to control him.

The other point I wish to respond to is that if you don't allow your owner to charge two types of tariff in a mixed situation like the supermarket example, how can you encourage Pick 'n Pay to use load shedding devices and energy control?

MNR K ALGERA : Rustenburg

Meneer die President, daar is een probleem wat almal vergeet. Ons as munisipaliteite word geklassifiseer vir ons aantal meters, en as ons ons meters verminder, gaan ons in 'n baie laer groep val. Met ander woorde, ons salarisse gaan aangeraak word.

MR D FRASER : Durban

Mr President, I'm not sure whether I quite understand what principle Mr Fortmann is advocating here. Is it intended that the block of flats be bulk-metered and no sub-metering be installed?

(MR FORTMANN:) The choice is the owner's of the block of flats. If he wants to resell electricity then he is obliged to install meters in terms of the Standard Electricity By-Laws. However, if he chooses not to resell electricity, then he may do so and he need install no sub-meters at all and he can then include an amount in this monthly rental to cover what he estimates electricity will be. This will not vary from month to month. Obviously he'll have to determine beforehand what he thinks it will be on an annual basis or whatever, and add that to his rental and cover his costs that way, which could in many cases be recommended.

(MR D FRASER:) Thank you, Mr President, for that clarification.

I think then in expressing my view on this, I would say I go along with the conclusions reached by Seattle and that is that if you don't meter the use of electricity by an electricity user, then there will be no incentive for him to economise with the use of that commodity.

In Durban, going back many years, it didn't meter water consumption and when it was metered, the consumption dropped dramatically. People still satisfied their water needs but without control and an incentive to economise or to control its usage, then I think we're heading in the wrong direction. I agree

that we shouldn't necessarily prescribe more than is necessary, but I think the whole drive in Escom at the moment is to promote the economic usage of electricity. So I would oppose the concept of not metering and the technicalities of metering the individual consumer, I think, are regularly overcome. Admittedly it may involve more on the part of meter readers to read a multitude of meters but from the technical point of view, these can be placed at different levels in the buildings and no matter how high the building is, there's no problem technically. It will cost more, I agree, the initial electrical installation will cost more but I think it's necessary to have that investment if you're going to promote the economic use of electricity.

(MR FORTMANN:) Mr President, could I just ask the question — do you sub-meter the water in individual flats in Durban?

(MR FRASER:) Well, they weren't doing that and that has led to tremendous problems too, particularly during the water restriction and with the penalty for using more than 400 litre per day. There were tremendous problems with the tenants of Council flats so the Council has now moved to the policy of metering individual water users.

MNR S STOFBERG : EVKOM

Daar is 'n praktiese probleem in die oplossing van mnr Fortmann wat reeds opgelos is deur mnr Giel Odendaal. Die praktiese probleem is dat die gemiddelde sente per kilowatt/uur in die winter hoog is in vergelyking met die somer want dit is juis in die winter dat die kort hoë laste op die gebou as geheel gemeet word en die lasfaktor dan daal.

Dan het die huiseienaar 'n wesentlike probleem. Die huurders kom almal by hom kla en sê "Kyk, hoekom betaal ek nou soveel sent per kilowatt/uur en my skoonmoeder by die huis betaal net so min en ek moet nou skielik hierdie groot sente per kilowatt/uur nou in die winter betaal net wanneer ek baie gebruik." Met ander woorde, die sente per kilowatt/uur spring dan op van 5 na 9 of 10 of 11 gedurende Julie maand.

Die oplossing is nie dat 'n mens individueel moet meet nie, die oplossing is dat die grootmaat tarief vir 'n groep woonstelle dieselfde struktuur moet hê as die tarief wat ook geld vir die individuele huis.

MNR R DE LANGE: Oos-Londen

Mnr die President, ek kan net vir u sê dit is vir my interessant wat mnr Fortmann hier voorgestel het. Ek wil maar net noem dat in my ondervinding, die van miskien van kollegas wat hier is, ek is 'n raadslid en stel meer belang in hoe die munisipaliteit kan bespaar, maar laat ons aanvaar die argument van mnr Fortmann, ek stem saam en daar is logika in wat hy sê. What's going to happen to all the meter producers. What's going to happen if they don't have all these meters. Here I can visualise all these companies and there's not going to be any work incentive. You're not going to have any more factories, ek weet nie wat gaan gebeur daarmee nie. Deur die woorde "daar is logika in" wat ons sê het ek ondervind as 'n lid van die Huurraad. Nou kry jy 'n blok van 10, 15, 20 of 30 woonstelle, wat ook al mag wees. Nou is daardie meters almal onder in die portaal. En laat ek vir u sê in die binneland sal dit waarskynlik nie so erg wees nie. Maar by die kus ondervind u dat die klimaat affekteer daardie meters. Dit is nou tegnies iets wat nie in my kraal is nie. Maar dit sal interessant wees om te weet wat die koste sou wees. Ons sê elke man moet betaal en dat die huurder kan uitgebuit word. Wie kan vir u sê daar is so baie uitbuiting vandag wat aangaan om nou te konsentreer om die ene. Die posisie is eenvoudig, ek sê vir u in my ondervinding wat ek gehad het, die verhuurder van daardie blok woonstelle moet op die oomblik betaal vir daardie gangligte, die mense moet betaal, die huurders moet betaal vir gangligte, trapligte. Nou ja, nou het jy daardie twee stelle wat daar aanvaar word. Daardie man moet nog 'n bydrae maak. Die kostes moet verhaal word.

Meneer, hoor wat ek vir jou sê dat elke man vandag, hy is bekommerd oor wat sy betaling is en sy huurgeld, daardie man, die eienaar, ek glo nie hy kan so maklik eksploiteer nie, hy moet sy rekening toon. Die huurders het die reg om te sê "Ek wil daardie rekening sien — wat gaan daardie koste wees?"

MNR R MALLINSON : Somerset-Oos

Mnr die President, as ek mnr Fortmann reg verstaan, dan wil hy dit nou oorlaat aan die woonstelbewoner om te besluit wat sy salaris aan die einde van die maand gaan wees as die persoon kan besluit wanneer hy gaan meters insit of nie. So dit gaan weer 'n direkte effek hê en soos u gesê het, die hoeveelheid meters wat geïnstalleer is gaan hy in elk geval nie installeer nie want dit is kapitaal onkoste vir hom.

MNR A FORTMANN: Boksburg

Mnr die President, die keuse is aan die eienaar van die blok woonstelle, die eienaar wat daardie blok bou, om te besluit of hy sub-meters wil insit of nie. Ek moet sê die meeste installeer sub-meters, met ander woorde die meeste eienaars sit meters in en lees die kraggebruik en herverkoop die krag wat verbruik is deur die woonstelbewoners. Maar dis sy keuse. Daar is baie min wat dit nie doen nie so dit is nie die woonstelbewoner wat daar besluit nie, dis die eienaar van die blok woonstelle wat besluit of hy sub-meters wil installeer of nie.

Ek herhaal Benoni het die geval van een blok woonstelle wat nie sub-meters het nie en wat die eienaar maak, elke maand verdeel hy eenvoudig die rekening in verhouding tot die aantal woonstelle wat bewoon word. Ek kan vir u dit sê, dit veroorsaak ontsettende onaangenaamheid. Daar is gesinne van ses en daar is gesinne van enkellopendes, en hulle betaal presies dieselfde. Ek weet dat daardie betrokke woonsteleienaar sal nooit weer so iets doen nie.

PACKAGE SUBSTATIONS

MR J C VAN ALPHEN: SABS

From the early sixties, a then new concept of package substation was introduced to replace the conventional brick substation, or the outdoor transformer and ring main unit inside a fence.

The concept was to have a slender unit of acceptable height with the transformer in the centre and MV and LV compartments on either side. The accent was on simplicity and, where they are pavement mounted, acceptability as street furniture.

In the late sixties, an SABS committee was appointed and SABS 1029 — "Miniature Substations" was published in 1975. For easy reference, I shall refer to these package substations as "mini-subs". The committee decided on two basic concepts, i.e. Type A, the slender type (Figure 1), and Type B, the bulky unit in which the LV compartment also occupies the long side of the transformer (Figure 2).

Inevitably, complexities and sizes grew and the slender Type A mini-sub made way almost entirely to the Type B mini-sub.

Looking at ballpark figures for an average Type B mini-sub which has a three phase ring main unit in the MV compartment, one may find typically the following cost of each compartment.

Transformer	R 5 500	(37%)
MV Compartment	R 5 000	(33%)
LV Compartment	R 4 500	(30%)
	R15 000	(100%)

Messrs C Beaurain and S J van der Walt quote in their paper a cost evaluation of 40-40-20%. Whichever of the two evaluations is taken, however, the transformer is only 37-40% of the mini-sub.

The SABS is deeply conscious of the concern expressed during last year's AMEU convention in Benoni with regard to the cost effectiveness of today's mini-sub which have grown far beyond the original concept of a Type A mini-sub. The thought behind this contribution is therefore to indicate some areas in which the Bureau believes cost savings could be established.

Mr Kees van Alphen

The Transformer Unit

It was originally thought that the transformer should be removable in order that a faulty transformer can be replaced or an existing transformer be replaced by one of higher rating.

The reliability of mark-bearing distribution transformer to SABS 780 (which also covers transformers for mini-subs) has been shown to be so well controlled that the facility of being able to unbolt the transformer from its base and the adjacent compartments seems to be unwarranted.

Engineers may perhaps not be aware of the strict requirements with regard to the accessibility of bolt heads and nuts which are arranged in such a way as to be inaccessible to unauthorised persons or are otherwise made tamper-proof (Amendment No 2 to SABS 1029). The transformer and the two compartments are each bolted to the underbase and against each other and again over this a separate roof is bolted down. This is an expensive and time-consuming operation and it would seem that the time is ripe for removing this requirement from SABS 1029 and allowing the whole mini-sub to be fabricated as an integral unit.

The MV Compartment

It seems to be believed that fuses or the magnefix-type single phase switching unit is user-unfriendly and operator-unfriendly.

For industrial or commercial circuits where only one customer is supplied from the mini-sub, this would seem to be an unnecessarily severe judgement. In the case of loss of one phase, such customers can act and prevent loss to rotating machines. Such situations are similar to rural three phase supplies with drop-out fuses where each transformer serves one customer only.

Whilst it is accepted that the loss of one phase in a residential area is user-unfriendly, it must be asked how often this occurs. I believe that, amongst others, Johannesburg Electricity Department uses the magnefix-type fused ring main unit and I gathered that there have not been significant complaints of transformer fuses blowing. It would appear that the mark-bearing transformers used in the mini-sub have the reliability necessary to make the fuse type single-phase switching main unit practicable. Such unit can be built into the slender Type A mini-sub which keeps cost down.

It has also been said that the fused single phase switching unit is operator-unfriendly. This may be so, but then how often need the unit be used live. If there is a cable fault, the circuit is to be made dead and would there be a hardship in making the circuit dead for the limited period that the fused ring main unit needs to be switched phase by phase?

The LV Compartment

The mini-sub is essentially an expensive unit because of the many requirements imposed upon it for safety of the transformer and MV and LV compartments. Distribution and meter pillars are units which are not subjected to many of the constraints.

As the LV cubicles get larger, doors become larger with the associated problems of handling these doors in high wind conditions.

It is believed that the LV compartment should be limited to fuse pillars or moulded case circuit breakers.

Whilst a number of mini-sub suppliers manufacture a unit of good quality, there are others which fall short of essential requirements. For instance:

Is wiring of correct copper size?
Are busbars capable of withstanding short circuits?
Is there a possibility of isolating the busbars from the transformer?

Corrosion Protection

Transformers, protected against corrosion in accordance with SABS 780, are normally placed on a concrete plinth, preferably with a layer of damp course on the concrete surface.

In certain corrosive conditions, such as in near-coastal areas, special precautions need be taken, but should all mini-subs be protected against corrosion by a galvanised base, often covered by an epoxy tar paint, when this does not apply to transformers?

Conclusion

It would be appreciated if your Association, Mr President, would consider the desirability.

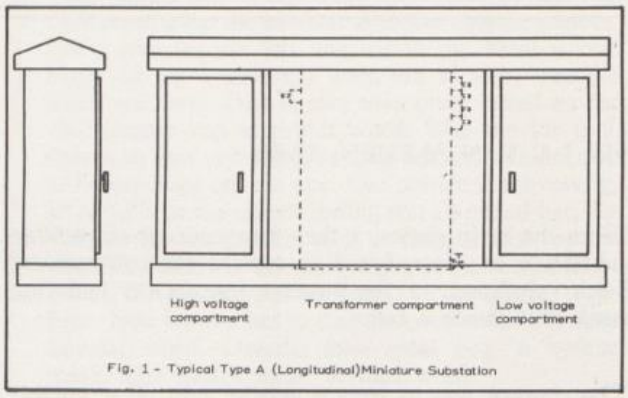


Fig. 1 - Typical Type A (Longitudinal)Miniature Substation

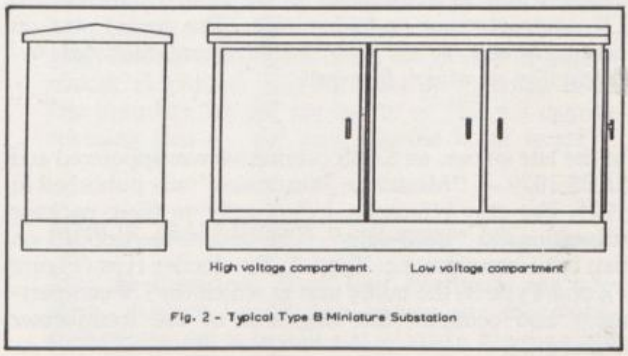


Fig. 2 - Typical Type B Miniature Substation

DISCUSSIONS — BESPREKINGS

MR G BICK: Affiliate

After ten years experience in SABS standardisation, we need another look at what has been learnt over this period. As suppliers, we would gladly welcome standardisation to provide more cost effective power distribution solutions, particularly where electrification of Black areas is urgently needed but where adequate financing is a limiting factor.

Areas where standardisation could be achieved are:

1. Low voltage switchgear — particularly the costs in mounting, wiring, fitting, etc.
2. High voltage switch.
3. Level of finish — fit for the purpose, rather than a showpiece.

For a typical 315 kVA mini-sub, a cost breakdown is approximately:

Transformer	33%
High voltage switchgear	30 - 35%
Steelwork *	20 - 25%
Low voltage switchgear	10 - 15%

* Steelwork includes the roof, base, cubicle, LV facia, wiring, etc.

Advantages of standardisation include:

mass production
lower costs
shorter deliveries
better quality.

These advantages would certainly be of benefit to purchasers of mini-subs. As suppliers, we would welcome a review of the SABS specification to increase standardisation and pass on these benefits to buyers.

MR M P P CLARKE. Randburg

Speaking from a user angle, I should like to point out that we, and I don't believe Randburg is unique, do have a need for changing the transformer separately from the mini-sub so I personally, I think I speak for many engineers who would not support a move to a welded all in one structure. It is far more difficult to change or to disconnect the HT cabling on the switchgear than it is to change the transformer. You can often juggle the LT cables a wee bit, get a slightly bigger transformer in, but you don't like to mess around with the HT cable so I personally think we should not be looking at a welded type of structure.

The second point is that on the HT switchgear side itself, while originally it may well have been possible to use, in a more general way, the single phase switch types that were mentioned, and I think these are still used successfully and fairly extensively. There are many operating conditions in our circuit in which these cannot be successfully used and one has to look at some form of three phase, call it either oil-immersed or gang type switches, so there is certainly a need, in my opinion, to have something a little bigger than the narrow unit that was originally envisaged when these mini-subs started.

MR D FRASER: Durban

I think perhaps that slim design evolved quite largely from Durban's initial entry in the mini-sub market and I think we were the only ones using the single phase epoxy resin switching devices for many years. I don't know, perhaps we still are. The problem which has arisen recently, however, is that in going to higher fault levels, this unit with the higher fault level, 350 MVA, is in fact more expensive than the three phase oil-immersed switching units so that we are having to broaden out a little bit on the HV compartment anyway to accommodate the lower priced oil-immersed ring main unit, but I couldn't agree with Mr van Alphen more in the appeal to keep things simple and reduce the refinement which, I think we could easily convince ourselves, were necessary, but if you really examine it, probably we could well do without.

MNR P BOTES: Roodepoort

Ek wil net heeltemal verskil met wat die sprekers voorheen gesê het. Ek gebruik nog al die tyd van die begin af 'n baie smal eenkas miniatuur substasie. Daar is nie kompartemente nie. Daar is drie kompartemente maar dit is vasgesweis en ons verander so 'n mini-sub met die las en alles binne 'n kwessie van drie ure. Ek het geen probleme daarmee nie.

Dan die ander punt is natuurlik, ek gebruik uitsluitlik feitlik die aflas epoksie skakelaars wat baie maklik is.

Ek is tevrede met die spesifikasie soos dit hier is. Ek glo dat 'n mini-sub is 'n mini-sub. Dit is iets kleins. Dit moet op die sypaadjie pas. Hy moenie in die pad van ander mense wees nie en ek het geen probleme daarmee nie. Daar is baie van hulle in Roodepoort.

MR K MURPHY: Somerset West

At the other end of the scale, I could just perhaps point out to our members that there are certain snags and pitfalls in trying to save. We in Somerset West have, for example, taken over areas reticulated by Escom. One township, notably round about 750 erven, and in this township the rings with the mini-subs are fed by fuse units and then the mini-subs themselves are in turn fed from an 11 kV system by means of cables that have been solidly bolted up together and then the mains to the transformer and so forth. The joints have been treated with the insulated type of putty and tape around it and when you have a fault, believe me, you really have a fault and you really have a problem. That is not to be recommended.

MR K VAN ALPHEN: SABS

Mr President, there will, of course, be variations in preference but there seems to be room for improvement.

SABS 780 "Distribution Transformers" went through a similar learning phase in 1966, twenty years ago. In those days, there was a large proliferation of requirements for distribution transformers as there is today for mini-subs.

The price of a distribution transformer expressed in real rand dropped to 40% of the price paid in 1966. This is a real rand reduction of 60%. We believe that a cost saving is possible for mini-subs.

We believe that the SABS committee should take up the challenge.

A NEW STANDARD ON EARTH RODS : SABS 1063

MR J C VAN ALPHEN : SABS

Where the earthing is dependent on earth rods driven into the soil, corrosion can have a catastrophic effect on the efficiency of the earthing. Extensive tests carried out by the USA Naval Civil Engineering Laboratory over a seven year period indicated that the best corrosion performance was obtained with Types 302 and 304 stainless steel rods and this information has been included in SABS 0199.

Copper clad steel rods have adequate corrosion resistance and can be easily driven but they have the disadvantage of causing galvanic corrosion when in contact with steel pipes buried with the rod. The rate of corrosion of the copper itself, as deposited on the steel rod, is in most soils very low as indicated by a study carried out by the US National Bureau of Standards. In this study, the corrosion of copper pipes and sheets buried for periods up to 14 years were studied. One study indicated that 26 out of 47 rods showed slight pitting but in the other 21 rods, the rate of pit formation varied from 15 micron per annum to 84 micron per annum. This means that a common cheap rod as is frequently sold in South Africa, with a 40 micron copper coating (see Figure 2) will last approximately 2,7 years before the steel substrate will be exposed. Once the steel is exposed to the soil in large areas, extremely rapid galvanic corrosion of the steel will take place and the steel will corrode much faster than an uncoated steel rod. The specification requirement of 250 micron for the copper coating thickness was based on an average installation lifetime of 20 years which will allow a corrosion rate of 12,5 micron per annum (see Figure 1).

This corrosion rate can normally be obtained in most soils but in very corrosive acid soils or soils with a concentration of chlorides or sulphur the rate will be much higher and the lifetime of the earthing system will be accordingly shorter. In South Africa a thickness of 250 micron will, however, give the required protection in the majority of soil conditions. Even if calculation of the required coating thickness indicates that a thinner coating can be used in certain soils with a low corrosion rate, it has to be borne in mind that the rods are driven into soil and rock and that some mechanical abrasion of the copper coating will inevitably take place. The copper coating therefore has to be thick enough to still provide adequate protection after some copper has been abraded off. This protection can never be obtained with a coating of 40 micron or less. In order to fulfil the practical requirement for an adequate lifetime, the coating of the rod must not only be thick enough to withstand corrosion for the required length of time but it must also be free from porosity. Due to the nature of the plating process, it can happen that the coating on a rod will apparently have the required coating thickness but with a rough surface which looks as though it is only surface roughness. Examination under a microscope, however, reveals a picture as shown in Figure 3 which is a photograph of a microscope section of a rod with 50x magnification. Comparison of this with Figure 1 showing a section of a sound rod shows that even though the rough surface appears to have the same thickness as the smooth rod, there are areas on the rod with a coating thickness as low as 40 micron. The lifetime of this rod will obviously be less than the lifetime of a rod with a non-porous coating. In Figure 2 the coating thickness of a commonly available cheap rod with a coating thickness of 40 micron can be seen. Comparison of this with a rod with a 250 micron coating clearly indicates that a lifetime of only three years can be expected with this rod before rapid corrosion of the steel substrate will start causing a rapid increase of the earth resistance of the rod. Another requirement of the SABS specification is that the rods should have an ultimate tensile strength of 500 MPa.

This strength requirement ensures that earth rods conforming to the specification can easily be driven into the soil without bending or breaking. The strength of the rods and couplers are such that, e.g., three lengths can be coupled together and driven down to a depth of 4,5 m. In conclusion it can be said that an earth rod conforming to the SABS specification will provide adequate service during its expected lifetime.

DISCUSSIONS — BESPREKINGS

MR A FORTMANN : Boksburg

I'd like to ask Mr van Alphen, with these copper-coated rods, they're driven into the ground and sometimes driven into ground with very rocky conditions. How much of this copper is literally pulled off by force by gliding past and rubbing past bits of sharp rock?

MR K VAN ALPHEN : SABS

Yes, hard soils do indeed affect the integrity of the copper coating. SABS 1063 therefore includes not only tests for thickness, but also percussion strength and stripping tests in order to test the adherence of copper to the base.

The commonly offered cheap rod will suffer badly from hard soils and large bare areas will certainly reduce the useful lifetime of a rod.

Fig. 1: SABS 1063 earth rod

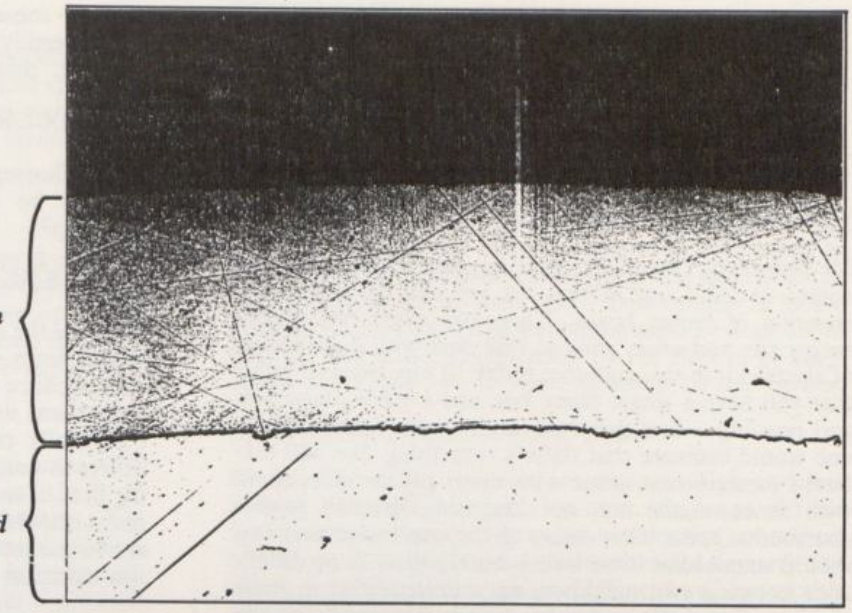


Fig. 2: Cheap rod commonly supplied

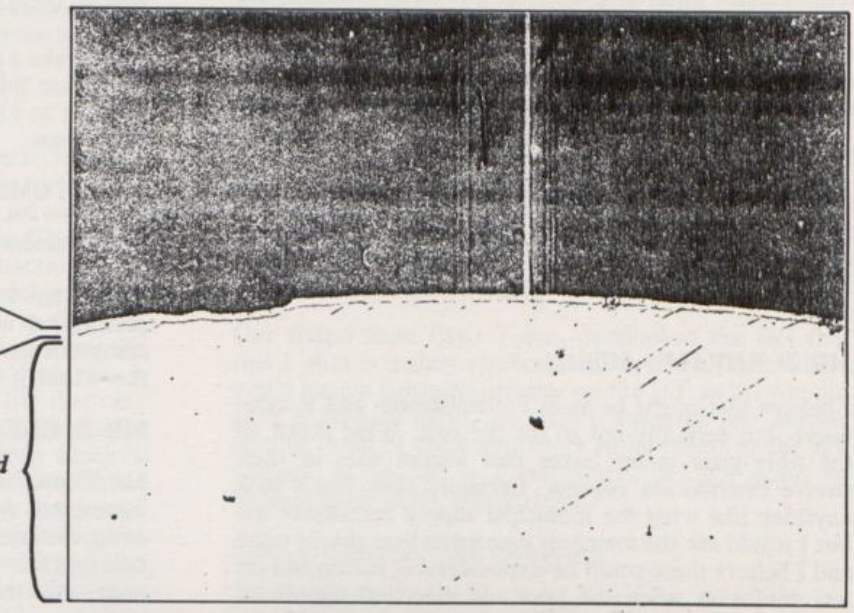
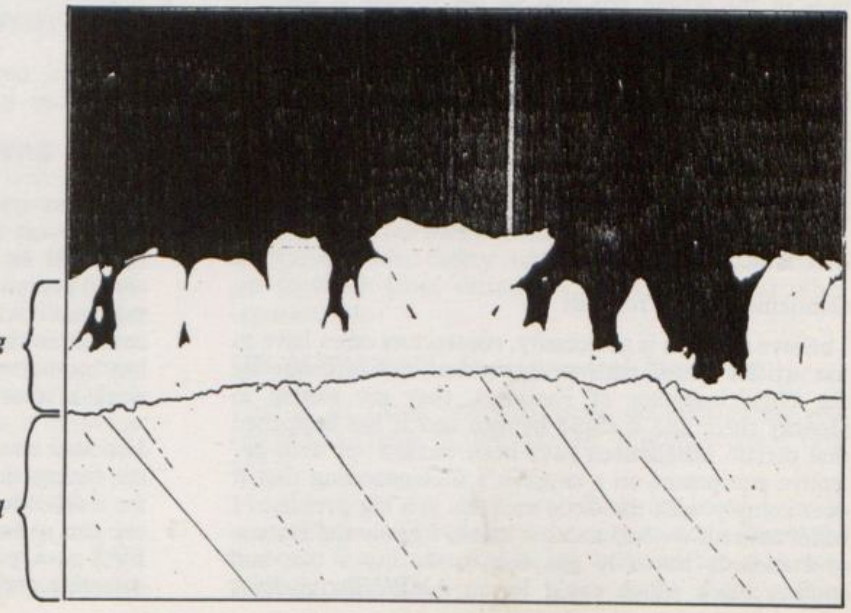


Fig. 3: Earth rod with incorrectly applied coating



QUESTIONS — VRAE

MR D KNEALE. Affiliate

Mr President, One of the most important questions that comes to mind out of that list we sent to you is the question of meter boxes. There are over 100 supply authorities and other persons that deal with distribution of electricity in this audience today. If one bears in mind that you have a single phase box and a three phase box and possibly a box that contains a ripple control relay, one would estimate that there's something like 300 different meter boxes, some with doors on the side, some with doors on the top, not forgetting Escom's twelve distribution areas. One comes to the conclusion that one should standardise these boxes. Surely there is no difference between two neighbouring municipalities in their requirements as far as a meter box is concerned and the question of savings to the consumer, I believe, could be considerable because these meter boxes are obviously made in different patterns and are quite costly. Could not something be done about this.

MR E de C PRETORIUS : Potchefstroom

Mnr die President, mnr Kneale se probleem kan ek nie mooi verstaan nie want daar is tog standaard meterkabinette wat in SABS, ek ken die nommer nou nie, en ons maak gebruik daarvan. Ek weet nie wat die probleem is nie.

MR D KNEALE: Affiliate

I believe that might be so in Potchefstroom and Roodepoort, but certainly not so for the rest. What about all the fibre-glass meter boxes that Escom uses in their twelve distribution regions. Certainly they don't look anything like what the municipal supply authorities use but I would ask the members present to bear this in mind and I believe there could be a considerable saving and far less confusion when the poor old electrical contractor puts in the wrong box and he has to take it out.

MR J LOUBSER: PRESIDENT

Mr Kneale the other question you've got is will the AMEU support the introduction of a mark to identify electrical installation materials and equipment that have been authorised in terms of SABS 0142: The Code of Practice for the Wiring of Premises.

MR D KNEALE: Affiliate

Gentlemen, Mr President

I believe that this is a necessity, contractors often have to use articles issued with an Authorisation Certificate by the Chief Inspector of Factories, they are unable to identify them and it could happen and it has happened that certain installations have been carried out with defective equipment on a supplier's understanding that it does comply with the Code and this is a big problem. I believe that if we had another mark, I know the Bureau of Standards has only got one mark, but if we had another mark which could be an AMEU/Escom/ECA mark — somebody could think of a suitable logo — this would readily identify the article at the place where they are sold, that's the electrical wholesalers.

MR J LOUBSER: PRESIDENT

The following question is: Should standard graphical symbols be compulsary for all electrical installation drawings?

MR D KNEALE: Affiliate

I believe the consulting engineers sitting in this audience would deem it to be a good idea that the drawings that they produce have standard graphical symbols so that the electricians who work for the contractors don't have to continually refer to a new schedule of symbols which differs as much as night differs to day from one consulting firm to another without being derogatory at all. Some move should be made at the Bureau of Standards to arrive at a set of standard graphical symbols for the use of the electrical installation and distribution industry.

MR F VAN DER VELDE: Cape Town

Just to take a point by another well-known engineer here — I agree fully that one should have standardisation of symbols as long as they are the same symbols that my office uses.

MR J TOMS: SABS

Mr President, Lady and Gentlemen

I just want to inform the delegates that there is an IEC publication which lists standard symbols which is very comprehensive and I suggest that it's no use re-inventing the wheel if this IEC vocabulary exists.

MR D KNEALE: Affiliate

Mr Toms, in 1972, I attended a Graphical Symbols Committee Meeting in Athens but it certainly didn't cover electrical diagrams as such. It was graphical symbols for radio circuits. I'd like to enquire whether there is such a document at international level.

MR J TOMS: SABS

There is, now, you were speaking of 1972, I believe. Since then it has been completed.

MR D KNEALE: Affiliate

The next question put forward by the contractors is should every incandescent fitting be approved in terms of the Code by the Recommendations Committee? This would prevent the use of non-heat resistant wire between the lamp holder and the fixed wiring. Now we do have a committee that recommends products as suitable for use but incandescent fittings don't seem to fall within the work of that committee.

I know it could be an onerous task but there are numerous fittings that are put up in houses today that only last for a short period of time because the incandescent lamp cap gets so hot that the wiring actually melts. It's usually PVC or a piece of rip-cord, and the fitting becomes defective and useless after a short period of time.

MR A FORTMANN: Boksburg

I'd just like to know, surely if the Recommendations Committee looks at an appliance or a fitting and approves it then this sort of problem would have been resolved at that stage. I don't see how this can come about afterwards.

MR D KNEALE: Affiliate

The problem there, Mr President, is that they don't look at incandescent fittings at all because this is beyond the point of outlet and there is nobody checking up to see that these fittings are properly wired before they are distributed by the fitting manufacturers or suppliers.

MR M P P CLARKE: Randburg

Just to add to that, Mr President, the essential point with the Recommendations Committee is that we look at items that have been brought to the Committee. We haven't as yet gone out to look for items that should be brought to the Committee. In other words, manufacturers and suppliers who are wanting to market a product will go through a specific channel which includes, inter alia, the SABS, and then come to us for recommendation. That's how it's worked.

MR J TOMS: SABS

I can't really add very much to what Mr Clarke has said. The Recommendations Committee responds to external stimulus. It doesn't go out of its way to look for work but I take Mr Kneale's point and through Mr Clarke the Recommendations Committee has two functions and perhaps I ought to make this clear in case delegates are not aware of it. It has a function in looking at electrical equipment of all types whether it comes within the definition of an installation or not and in that role it makes a recommendation through the AMEU that certain equipment has been examined and is regarded as safe. It's other role, in respect of authorisation which is specific to equipment that is used in an electrical installation as defined by the regulations, is to make a report to the Chief Inspector of Occupational Safety as to its safety for general use and if the Chief Inspector accepts the recommendation, he will issue a Certificate of Authorisation so you can see from this that the Recommendations Committee has two distinct roles and depending on the application, will respond accordingly.

MNR P BOTES: Roodepoort

As ons nou praat van inkandesent of gloeidraad tipe lampe en houers en daardie tipe van ding, hoeveel duisende miljoene is daar nie op die mark nie? Gaan jy nou vir elkeen van daardie spesifiek sê jy mag daardie ene gebruik? Hoe gaan jy dit identifiseer? Hoe gaan dit werk? Daar's net één oplossing en dit is as daar 'n beeld van standaarde spesifikasie daarvoor is. So ek dink as die Elektriesekontrakteurvereniging sou 'n versoek rig aan die Buro van Standaarde om 'n standaardspesifikasie daar te stel, sal dit die saak oplos maar ek glo nie die VMEO kan daardie dinge oplos nie. Ek glo nie ons is daarvoor ingestel om daardie tipe werk te onderneem nie. Ek meen ons praat hierso van ernstige dinge maar hierdie lamp, en dis tog vir my so wonderlik ook dat die kontrakteursvereniging wat gewoonlik die mense is wat die ontmoontlikste goed installeer wat nie pas nie, nou kom vra vir so 'n spesifikasie. Ek moet hulle darem gelukwens dat hulle nou begin dink ook. Ek dink ons steun hulle as hulle 'n aansoek rig tot die Buro van Standaarde om 'n standaardspesifikasie op te stel.

MR D KNEALE: Affiliate

Could I reply to that by saying usually the electrical contractor does not supply the fittings, they are purchased by the owner, in all good faith that they are a good product and the electrical contractors are asked to put them up so he has no control over the quality of the wiring and fitting as such and I believe this is in the interests of the public that something must be done about this. A compulsory specification by the Bureau of Standards, Mr Toms, would seem to me to be the answer.

MR I MacHUTCHEN: Cape Town

Mr President, this question on separate high and low voltages at substations came up some while ago and has to do with the fact that for earth termination resistances of greater than 1 ohm, it is recommended to earth the HV and the LV earths separately. Now if we have a cable distribution system with mini-subs, a high voltage fault will generate a voltage in excess of 2 kV between the LV earth and the mini-sub metal enclosure which is tied to the HV earth. Should the high voltage and low voltage earths in this case not be bonded together so as to avoid this voltage difference developing in such close proximity, the AMEU Code of Practice for the application of PME and low voltage distribution systems recommends that the LV and HV earths are tied together where the earth termination resistance is less than 1 ohm.

MR V RAYNAL: Affiliate

Our friend from Cape Town, overlooked the fact that this 1 ohm is mainly applicable to overhead lines where you'd have a lightning arrester on the HT and if you did have a flash to earth, we didn't want the low voltage neutral point of the transformer to be raised to the HV voltage. It, as far as I am aware, did not apply to underground cable fed systems.

MR A FORTMANN: Boksburg

Mr President

I have a question for Mr Roskam if he's here. The Machinery and Occupational Safety Act has now been in operation for a few years and it's something new and also something very new in that are these Safety Committees that are in operation and I know we in Boksburg have wrestled with this and we in fact have instituted this now and it's going ahead. I wouldn't say it's going very well. It's going, but it has its drawbacks. I wonder if Mr Roskan could tell members here how the new Machinery and Occupational Safety Act is operating. He's probably got feedback from various local authorities and other organisations.

MR M ROSKAM: Department of Manpower

First of all, thank you very much for inviting my colleague and myself to this meeting. It is appreciated very much.

Mr President, the new Act which has now been in operation on 5 October for two years, is, according to the feedback we receive, operating well and has been successfully applied.

There are, of course, certain problem areas but it will take a long time before these are ironed out. The Safety Representative which must be appointed is one of the basic philosophies which the Act requires, that is self-regulation, in other words the onus is placed on the employer or user to ensure proper compliance with the safety standards.

I can't give you any statistical information at this stage except that our staff is continually monitoring and inspecting the various premises and ensures that the safety representatives and safety committees are indeed being appointed.

DR N BOTHA: Bloemfontein

Meneer die President, terwyl u ons kans gee, mag ek nog 'n vraag vra vir hierdie EPPIC mense?

Mnr die President, voordat ek die vraag vra wil ek net vir u sê wat doen ons tans in Bloemfontein. Ons is besig met navorsing daar saam met die Universiteit waar ons proefdiere neem en in 'n elektriese veld plaas. Ek kan u verseker dat hierdie muise spring dat dit bars daar op en af en die Vrystaatse keurders het my gevra dat ons hierdie proef volgende jaar moet probeer vir die Vrystaatse rugby span.

I'm just wondering if anybody can give us any thought, their views, perhaps the EPPIC people, on the possible harmful effects of the electric magnetic fields or extra high voltage lines on human and animal life.

MR G MARSHALL: Affiliate

I thought we'd nearly concluded this meeting without any question of that nature being raised.

Mr Hobbs, who addressed us about the bird life — he has an interesting comment to make on this and it's that birds seem to enjoy sitting on transmission line towers exposing themselves to very high electric fields without suffering any ill effects at all. In fact they seem to enjoy it but perhaps we as engineers have to make a slightly more serious comment than that and of course the matter has received attention for over a decade now and has been attended to in many countries where research programmes have been initiated but I think Dr Botha is to be congratulated for having initiated this programme in Bloemfontein. The Department has supported it and has the use of a very gifted embryologist to look into this matter. He might very well say why should we be able to do more in South Africa than others are doing whose needs for this are greater than ours, but I think it's interesting to note that in this country we can manage to initiate research programmes and keep them running for the kind of time which is necessary for an embryologist to produce a result. You can appreciate that many years, many generations, have to go by before one can be sure that some embryological effect is not occurring and I think this particular experiment which is being done in Bloemfontein will be very useful from that point of view from the exposure to the pure electric field. There is some work at the same time going along the lines of exposure to magnetic fields and a man down in Cape Town is pursuing that at the moment but I think all I can say is that the matter is in hand, there is no evidence of any deleterious effects at the moment and I'm sure if anything should be found which would give rise to regulations or recommendations, they will be arrived at in the fullness of time.

MNR P BOTES: Roodepoort

Meneer die President, voordat ek iets oor die veiligheids-kennisgewings sê, wil ek net graag ook net weer iets sê oor die installering van optiese vesel en in die besonder Johannesburg se eerste. Soos u weet is Roodepoort altyd een voor Johannesburg en ek wil u in kennis stel dat die eerste optiese veselkabel 'n hele aantal jare gelede in Roodepoort geïnstalleer is deur die poskantoor in Witpoortjie.

Mnr die President, Evkom het veiligheids kennisgewings en plakkate ontwerp wat die veilige gebruik van elektrisiteit aan gebruikers uitbeeld. Hulle is bereid om hierdie kennisgewings en plakkate beskikbaar te stel vir munisipaliteite wat daarvan gebruik wil maak. Hulle sal die Evkom embleem vervang met dié van die betrokke stadsraad en dit sal u nie veel kos nie, net die drukkoste en papierkoste sal van u verhaal word.

Baie van hierdie plakkate is ontwerp vir gebruik in Swart dorpsgebiede en het glo heelwat byval gevind.

Die plakkate is beskikbaar. U kan daarvan saamneem. U kan direk met Evkom skakel of ek kan u aansoek oordra. Mnr Thal by Megawatt Park sal u in hierdie verband kan help.

MNR E NAUDE: Carletonville

Meneer die President, ek wil graag aansluit by Mnr Fortmann en ook 'n vraag vra oor die Wet op Masjinerie en beroepsveiligheid — iets wat ons naby aan die hart lê omdat ons, soos u weet, tromp-op geloop het met die Fabrieksinspekteur.

My eerste vraag is of iemand miskien vir my 'n handleiding kan gee waar dit sê dat involge hierdie Wet, die werkgewer in 'n plaaslike owerheid gekanaliseer word na die Stadsklerk toe. Orals waar ek bel en vra, hoor ek hierdie ingevolge dié Wet, wie is die werkgewer in die munisipaliteit, word daar vir my gesê "Stadsklerk". Ek aanvaar dit so, maar ek sal dit net graag op wit en swart wil hê dat 'n ou nie op 'n stadium kom dat dit iemand se opinie is wat nou verder uitkring en nou op wit en swart staan. As die Stadsklerk dan die aanspreeklike persoon is of die werkgewer is, dan moet hierdie kennisgewing persoonlik op hom gedien word want hy's tog die man wat nou gaan pa staan of aangekla word.

MR M ROSKAM. Department of Manpower

Die munisipaliteit, dit bly natuurlik die werkgewer en die persoon word eintlik deur die munisipaliteit aangewys. Dis die Stadsklerk. Dit is in die algemeen die geval, maar die Stadsklerk kan ook weer delegeer en hy delegeer normaal na die hoofde van die departemente. So dit is meer 'n organisatoriese benadering van die probleem. As daar 'n oortreding is, dan word eintlik gekyk wie nalatig is en daardie persoon sal aangekla word. Maar wat mnr Naude gesê het in verband met die dien van kennisgewings, dit is natuurlik heeltemal abnormaal as 'n inspekteur aan een van die arbeiders 'n kennisgewing sou dien. Die kennisgewing moet behoorlik op die munisipaliteit gedien word, of die Stadsklerk.

WELCOME SPEECH FOR AMEU DELEGATES TO LUNCHEON ON TUESDAY, 2 SEPTEMBER 1986

MR P WATT: Affiliate

Ladies and Gentlemen

On behalf of the Aberdare Group, which includes Asea and Scottish Cables and all its staff and employees, I would like to extend a warm welcome to you today. The association between Aberdare and members of the AMEU goes back a long way. In fact, we regard today's get-together as having historical significance. For it was here, 37 years ago, on 17 May 1949, that this factory was officially opened in the presence of 250 delegates who were attending the 31st Convention of the AMEU in Port Elizabeth.

If any of you were present on that occasion, you will recall that instead of the seven coaches which brought you here today, a fleet of more than fifty taxis were hired to do the same task. Instead of my welcoming address, you would have heard Sir George Usher, founder and the then Chairman of Aberdare Cables, explain proudly why he had invested £400 000 to build this factory here at Standford Road.

To quote him:

"My faith in the future of South Africa is clearly exemplified by the responsibility which I have undertaken in establishing this large cable manufacturing unit here. We are striking a new note in introducing an industry which we know will contribute materially to making the country largely independent of overseas supplies of electric cable, thereby saving the necessity for providing foreign exchange for this purpose. It will be our endeavour to produce an article of peerless quality which will enable us to compete effectively not only in the home markets, but also in the principle markets of the world."

Sir George's address was unique for two reasons:

Firstly, it marked the beginning of the Aberdare Group in South Africa, and secondly, it was the first public radio link between South Africa and the United Kingdom — the ceremony was broadcast live between the audience here in Standford Road and the sister company in Aberdare, South Wales.

Perhaps the significance of this exposure to the wonders of telecommunication was not lost to Aberdare on that day. While starting off as a manufacturer of electric power cables for the utility and mining industries, the company soon began to manufacture telephone cables on this site as well. However, by the late sixties, the volume of production had reached a level at which it became necessary to establish a new operation concerned solely with the manufacture of telephone and other communication cables. The new operation was established in the

The President of the AMEU, Mr Jan Loubser expresses thanks and appreciation to Mr Peter Watt, Managing Director of Aberdare Cables for the excellent lunch given to the delegates.

nearby Markman Industrial Township in 1973 and is today a major supplier of telecommunication cable to the South African Post Office and industry in general.

Over the years, rapidly developing changes in both technology and markets have not been lost on the group. We have become heavily involved in the technology of optical fibre and control systems. As our talk at this morning's meeting illustrated, there is a convergence between the technologies of power and telecommunications and today the Aberdare Group is well represented in both. We have also had to adapt to changing market circumstances such as a heavily over-traded and over-capitalised power cable market. Coupled with increasing international pressure on our country, we therefore felt it was in the interests of both ourselves and the country to associate Aberdare last year with Scottish Cables and the cable making interests of Asea Electric. This decision was taken to reduce manufacturing costs and strengthen our overall technical and market competence.

Today the Aberdare Group has six manufacturing sites around the country, employs over 2 000 people, and has a turnover in excess of R250 000 million — a far cry indeed from the 600 people originally employed by Aberdare and a first year's turnover of £2 million.

We have also become a South African owned and managed company within the Powertech Group, although we do maintain links with our remaining overseas shareholding

ers. We feel this is a good arrangement as it allows us access to international technology where required and is particularly useful especially in circumstances in which the country presently finds itself. The threat of sanctions looms large in our minds and I can assure you that with our international relationships and local expertise, we will continue to provide you with the high quality products and services to which you have become accustomed.

In closing, I would like once again to refer to the man who founded Aberdare and who became a well known and respected international businessman. When Sir George was asked why his business ventures were always successful, he replied:

"In the usual way. Get to know the people who want the goods, try to give them exactly what they want, and give them the fullest possible information."

We at Aberdare stand by that philosophy.

Once again, welcome and thank you for sharing a little history with us.

Thanks to Gary Johnson and Joy Ward and his team.

Thanks to Rob Phillips and Stan Gunn for an excellent paper.

CLOSING SESSION — AFSLUITING

MNR JA LOUBSER: PRESIDENT

Ons het andermaal aan die einde van hierdie 11e tegniese vergadering gekom en dit is nou my voorreg om dankie te sê aan almal wat meegewerk het om van die byeenkoms 'n sukses te gemaak het. Aan Mnr. Charles Adams en sy personeel (wat aanbiedinge ontvang het) ons hoogste lof vir die wyse waarop u al die plaaslike reëlings behartig het. Also a word of thanks to Mrs. Audrey Adams. Thanks to Aberdare Cables/Standard Bank for the folders; the Hotel Elizabeth for the facilities and assistance and once more to the affiliates Messrs Merz and McLallan and Aberdare Cables for the lovely luncheons also to all the speakers who have taken the trouble to prepare themselves for their papers.

MNR A FORTMANN: AANGEWESE-PRESIDENT

Mnr die President, namens al die afgevaardigdes dank ons u vir die goeie leiding wat u aan die vergadering gegee het. Ons sê ook baie dankie aan u vrou Martie wat die dames bygestaan het.

MNR JA LOUBSER: PRESIDENT

Baie dankie mnr. Fortmann. Ek wil net ook baie dankie sê vir ons sekretaris, mnr. Bennie van der Walt. Ons wens hom sterkte toe en vertrou dat hy nog baie jare vir die VMEO sal werk. 'n Voorspoedige reis word u almal toegewens.

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De Wet LDM, Adjunk-Elektrotegniese Stadsingenieur, Posbus 215, Boksburg 1460
Du Plessis CJ, Posbus 868, Kempton Park 1620
Du Plessis GC, Adjunk-Elektrotegniese Stadsingenieur, Posbus 94, Krugersdorp 1740

F
Foubister JAD, Deputy City Electrical Engineer, PO Box 82, Cape Town 8000

G
Gowie E, PO Box 35, Matatiele 4730

H
Hill DR, City Electrical Department, PO Box 147, Durban 4000
Hobbs JL, Deputy Electrical Engineer, PO Box 45, Uitenhage 6230

K
Klopper TJ, Elektrotegniese Ingenieur, Posbus 201, Heidelberg 2400

L
Labuschagne PHJ, Adjunk Direkteur, Tegniese Dienste, Atherstonestraat 19, Vanderbijlpark 1900
Lamprecht BC, Privaatsak X014, Benoni 1500
Liebenberg HDG, Posbus 64, Ladybrand 9745

M
Malan JG, Adjunk-Elektrotegniese Stadsingenieur, Posbus 13, Kempton Park 1620
Matthews GS, Deputy Electrical Engineer, Private Bag X014, Benoni 1500
Montgomery JA, PO Box 25, Edenvale 1610
Mulder JAC, Posbus 60, Piketberg 7320

O

Opperman DJ, Adjunk-Elektrotegniese Stadsingenieur, Posbus 45, Springs 1560

P

Peens JG, Posbus 6, Wesselsbron 9680
Perryer HO,Acting Town Electrical Engineer, PO Box 113, Queenstown 5320
Pretorius JW, Adjunk-Elektrotegniese Stadsingenieur, Posbus 23, Nigel 1490

S

Smit AH, Posbus 3, Bethal 2310
Smit JJ, Adjunk-Eletrotegniese Stadsingenieur, Posbus 3, Witbank 1035
Smit AM, 22 Bournemouth Str, Summerstrand, Port Elizabeth, 6001
Steyn SJ, Adjunk-Elektrotegniese Stadsingenieur, Posbus 113, Potchefstroom 2520
Surthees EH, Deputy Town Engineer, PO Box 215, Boksburg 1460

V

Van der Walt CJ, Privaatsak X014, Benoni 1500
Van Schalkwyk AP, Adjunk-Elektrotegniese Stadsingenieur, Posbus 288, Bloemfontein 9300

W

Whitehead HR, PO Box 147, Durban 4000
Wille J, Posbus 7, Lichtenburg 2740

AFFILIATE MEMBERS/GEAFFILIEERDE LEDE

3M South Africa (Pty) Ltd., Mr. JHJ van Vuuren, PO Box 10465, Johannesburg 2000
ALCOM Systems (Pty) Ltd, PO Box 39586, Bramley 2018. (011) 887-0900
A. Jackson, PO Box 4814, Cape Town 8000
Aberdare Cables Africa Ltd., PO Box 494, Port Elizabeth 6000
AECI Limited, Mr RWL Phillip, PO Box 1122, Johannesburg 2000
AEG Telefunken (Pty) Ltd., PO Box 10264, Johannesburg 2000
African Cables Limited, PO Box 172, Vereeniging 1930
African Electric, PO Box 14040, Wadeville 1422
Alusaf, PO Box 284, Empangeni 3880
Anglo Scottish (Pty) Ltd., PO Box 2001, Pinetown 3600
Anode Alec. Engineering, PO Box 673, Brakpan 1540
ASEA Electric (Pty) Ltd., PO Box 157, Bedfordview 2008
ASH Brothers (Pty) Ltd., PO Box 6061, Johannesburg 2000
ATC (Pty) Ltd., PO Box 663, Brits 0250
Ballenden & Robb, PO Box 78734, Sandton 2146
Beka (Pty) Ltd., PO Box 120, Olifantsfontein 1665
Biderman, Finn, Beekhuizen & Ass., PO Box 1351, Cape Town 8000 (021) 243177
Bowthorpe-Hellermann-Deutsch, PO Box 27063, Benrose 2011
Brian Colquhoun, O'Donnel & Partn., PO Box 31757, Braamfontein 2017
Brown Boveri SA, PO Box 1500, Johannesburg 2000
Cahi, De Vries & Brink, PO Box 1079, Bloemfontein 9300
Cahi, De Vries & Brink, PO Box 26321, Arcadia 0007
Cegelec (Pty) Ltd., PO Box 8023, Elandsfontein 1406
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Clinkscales, Maughan Brown & Partn., PO Box 196, Port Elizabeth 6000
Conradie DJJ & Partners, PO Box 17031, Groenkloof 0027
Conradie DJR & Venter, Posbus 1009, Bloemfontein 9300
Crabtree JA (Pty) Ltd., PO Box 413, Springs 1560
CU AL Engineering, PO Box 18228, Dalbridge 4014
Cullinan Electrical, Private Bag 18, Olifantsfontein 1665
Custom Tooling, PO Box 192, Kempton Park 1620
Cutler-Hammer (SA) Limited, PO Box 14089, Wadeville 1422
De Villiers & Moore, PO Box 472, Durbanville 7550
Drewett, Hubble & Pokorny Inc., PO Box 47270, Parklands 2121
Du Toit CA & Partners, PO Box 2509, Cape Town 8000
Du Toit CA & Partners, PO Box 4256, Pretoria 0001
Duncansby (Pty) Ltd., PO Box 10508, Strubenvale Springs 1570
Eberhardt-Martin, PO Box 85027, Emmerentia 2029
Electrical Contractors Association, Mr DF Kneale, PO Box 5327 Johannesburg 2000
Electrical Moulded Components, PO Box 872, Honeydew 2040
Electrical Protection Company, PO Box 1034, Boksburg 1460
Electro Network (Pty) Ltd., PO Box 57458, Springfield 2137
Erenco SA (Pty) Ltd., PO Box 32102, Braamfontein 2017
Everitt & Germishuizen Inc., PO Box 1369. Randburg 2125
Fainsinger GS & Associates, PO Box 2142, Windhoek 9100
FARAD (Pty) Ltd, PO Box 312220, Braamfontein 2017
Ferreira & Vennote, Posbus 28985, Sunnyside 0132
Fuchs Electrical Industries, PO Box 3758, Alrode 1451
Gardner & Carpenter, 278 Oxford Street, East London 5200
GEC Cables Company, Mr BD Scott-Hayward, PO Box 482, Bedfordview 2008
GEC Measurements SAD (Pty) Ltd, Mr R Roulston PO Box 686, Bergvlei 2012
GEC Power Distribution Limited, PO Box 13024, Knights 1413
GEC Projects Company, Mr A Welgemoed, Private Bag 1, Bramley 2018
Golnix, PO Box 342, Belville 7530
H.V. Test and Power Control C.C., PO Box 1086, Gallo Manor, 2052 (011) 802-2850
Hawker Siddeley Africa (Switchgear), PO Box 417, Roodepoort 1725
Hawker Siddeley Electric Africa, PO Box 14359, Wadeville 1422
Heineman Electric S.A. Limited, PO Box 881, Johannesburg 2000
Hill Kaplan Scott & Partners, PO Box 39643, Bramley 2018

Huletts Aluminium Limited, Mr FC Montgomery, PO Box 25, Olifantsfontein 1665
Interswitch (Pty) Ltd, PO Box 11048, Johannesburg 2000
JJ Anderssen Raadgewende Ingenieurs, Posbus 1197, Kaapstad 8000
James Croswell & Associates, PO Box 480, Rivonia 2128
Jordaan Hayward & Vennote, Posbus 11314, Brooklyn 0011
Karl Pfisterer (SA) Pty Ltd., PO Box 6530, Dunswart 1508
Ken Shepstone & Partners, 76 Valleyview Road, Morningside 4001
Kilpatric SA (Pty) Ltd, Mr B Gilbert, PO Box 6869, Johannesburg 2000
Klockner-Moeler (SA) Pty Ltd, PO Box 100, Kempton Park 1620
Kwikot Limited, PO Box 389, Benoni 1500
Liebenberg & Stander, Posbus 2917, Kaapstad 8000
Lumex (Pty) Ltd, PO Box 39045, Bramley 2018
Marais GH en Vennote, Posbus 1789, Pretoria 0001
McWade Productions (Pty) Ltd, PO Box 142 Olifantsfontein 1665
Merlin Gerin (Pty) Ltd, PO Box 869, Isando 1600
Merz & McLellan, PO Box 31012, Braamfontein 2017
Middelburg Steel & Alloys, PO Box 781815, Sandton 2146
Midland Equipment (Pty) Ltd, PO Box 440, Kempton Park 1620
MK Electric (Pty) Ltd, Mr WP Smith, PO Box 83300 South Hills 2136
Motorola SA (Pty) Ltd, PO Box 39586, Bramley 2018
Nei Zimbabwe (Pty) Ltd, PO Box 1975, Salisbury Zimbabwe
Nordland (Pty) Ltd, PO Box 522, Muldersdrif 1747
Norman Cornish, PO Box 82552, Southdale 2135
North & Robertson (Pty) Ltd, PO Box 309, East London 5200
Oak Industries (SA) Pty Ltd, PO Box 1172, Pietermaritzburg 3200
Ogatin (Pty) Ltd, PO Box 514, Roodepoort 1725
Olen & Foster, 710 Nedbank Centre, Strand Street 8001
Ove Arup & Partners, PO Box 52285, Saxonwold 2132
Pirelli General Cables (SA) Pty Ltd, PO Box 605, Florida 1710
Plantech Associate Inc., PO Box 20206, Alkantrant 0005
Power Engineers (Pty) Ltd, PO Box 44, Eppindust 7475
Power Installations (Pty) Ltd, PO Box 303, Edenvale 1610
Powerlines (Pty) Ltd, PO Box 1989, Johannesburg 2000
Preformed Line Products SA (Pty) Ltd, PO Box 958, Pietermaritzburg 3200
Programming Skills (Pty) Ltd., Posbus 4137, Randburg 2125 (011) 782-6493
Protective Switchgear, PO Box 8738, Johannesburg 2000
R.R. Slatem, PO Box 67452, Bryanston 2021
Raychem (Pty) Ltd, PO Box 134, Olifantsfontein 1665
Raymond Theron, Bouwer & Viljoen, Posbus 1155, Upington 8800
Republic Power & Communication, PO Box 418, Bergvliet 2012
Reyrolle Parsons of S.A., PO Box 8080, Elandsfontein 1406
Robertson FH & Associates, PO Box 542, George 6530
Rocla (Pty) Ltd, PO Box 92, Roodepoort 1725
S A U K, Posbus 1747, Randburg 2125
Scottish Cables, PO Box 188, Pietermaritzburg 3200
Scottish Cables S.A. Limited, PO Box 2882, Johannesburg 2000
Servitek (Pty) Ltd, PO Box 8374, Elandsfontein 1406
Siemens S.A. (Pty) Ltd, PO Box 4583, Johannesburg 2000
Sigmaform S.A. (Pty) Ltd, PO Box 32, Maraisburg 1700
Simplex Ge-Lighting (Pty) Ltd, PO Box 5210, Benoni South 1502
Square D Electrical Products, PO Box 1273, Krugersdorp 1740
Stiebel Eltron (Pty) Ltd, PO Box 35935, Northcliff 2115
Stone-Stamcor (Pty) Ltd, PO Box 50292, Randburg 2125
Swithboard Manufacturers (Natal), PO Box 40086, Red Hill 4071
Thorn Lighting S.A. (Pty) Ltd, PO Box 43075, Industria 2042
Tinning & Galv. Industries (Pty) Ltd, PO Box 3779, Alrode 1451
Tubewrights (Pty) Ltd, PO Box 1905, Vereeniging 1930
Unie Staalkorporasie (SA) Beperk, Posbus 48, Vereeniging 1930
Uniplan (Pty) Ltd, PO Box 7259, Johannesburg 2000
Vaja Products (Pty) Ltd, PO Box 35247, Northcliff 2115
Van Niekerk JD en Vennote, Posbus 50645, Randburg 2125
Van Niekerk, Kleyn & Edwards, Mr BK Frow, PO Box 121, Silverton 0127
Vorster, Van der Westhuizen & Vennote, Posbus 398, Loevenstein, Bellville 7530
Waco Distributors, PO Box 461, Johannesburg 2000
Westinghouse Electric S.A., PO Box 782887, Sandton 2146
Weyers, Botha & Hubee, PO Box 7100, Hennopsmeer 0046
York Fibreglass Pressings, PO Box 39064, Queensburgh 4070
Yorkshire Switchgear (SA) Pty Ltd, PO Box 157, Pinetown 3600
Zakrzewski Associates Incorporated, Mr D Frost, PO Box 859, East London 5200

UNDERTAKINGS — ONDERNEMINGS

Adelaide Municipality, PO Box 38, Adelaide 5760
Alberton Municipality, PO Box 4, Alberton 1450
Alexandria Munisipaliteit, Posbus 73, Alexandria 6185
Aliwal North Municipality, PO Box 46, Aliwal North 5530
Ashton Munisipaliteit, Posbus 22, Ashton 6715
Barberton Municipality, PO Box 33, Barberton 1300
Beaufort West Municipality, PO Box 9, Beaufort West 6970
Bedfordview Municipality, PO Box 3, Bedfordview 2008
Benoni Municipality, PO Box 45, Benoni 1500
Bethal Municipality, PO Box 3, Bethal 2310
Bethlehem Municipality, PO Box 551, Bethlehem 9700
Bloemfontein Municipality, PO Box 288, Bloemfontein 9300
Boksburg Municipality, PO Box 215, Boksburg 1460
Bonnievale Municipality, PO Box 10, Bonnievale 6730
Bothaville Municipality, PO Box 12, Bothaville 9660
Brakpan Municipality, PO Box 15, Brakpan 1540

Brandfort Munisipaliteit, Posbus 13, Brandfort 9400
Bredasdorp Municipality, PO Box 51, Bredasdorp 7280
Brits Municipality, PO Box 106, Brits 0250
Bultfontein Munisipaliteit, Posbus 3, Bultfontein 9670
Burgersdorp Municipality, PO Box 13, Burgersdorp 5520
Cape Town Municipality, PO Box 82, Cape Town 8000
Carletonville Municipality, PO Box 3, Carletonville 2500
Carnarvon Municipality, PO Box 10, Carnarvon 7060
Carolina Municipality, PO Box 24, Carolina 1185
Ceres Municipality, PO Box 44, Ceres 6835
Cradock Municipality, PO Box 24, Cradock 5880
De Aar Municipality, PO Box 42, De Aar 7000
Delmas Municipality, PO Box 6, Delmas 2210
Despatch Municipality, PO Box 42, Despatch 6220
DeWetsdorp Municipality, PO Box 13, DeWetsdorp 9940
Div. Council of the Cape, PO Box 1073, Cape Town 8000
Dordrecht Munisipaliteit, Posbus 20, Dordrecht 5435
Douglas Munisipaliteit, Posbus 27, Douglas 8730
Dundee Municipality, PO Box 76, Dundee 3000
Durban Municipality, PO Box 147, Durban 4000
East London Municipality, PO Box 134, East London 5200
Edenvale Municipality, PO Box 25, Edenvale 1610
Empangeni Municipality, Private Bag, Empangeni 3880
Ermelo Municipality, PO Box 48, Ermelo 2350
Eshowe Municipality, PO Box 37, Eshowe 3815
Estcourt Municipality, PO Box 15, Estcourt 3310
Evander Municipality, PO Box 55, Evander 2280
Fochville Municipality, PO Box 1, Fochville 2515
Fort Beaufort Municipality, PO Box 36, Fort Beaufort 5720
Frankfort Munisipaliteit, Posbus 2, Frankfort 9830
George Municipality, PO Box 19, George 6530
Germiston Municipality, PO Box 145, Germiston 1400
Glencoe Municipality, PO Box 10, Glencoe 2930
Gobabis Municipality, PO Box 33, Gobabis 9140
Gordons Bay Municipality, PO Box 3, Gordons Bay 7150
Graaff-Reinet Municipality, PO Box 71, Graaff-Reinet 6280
Grahamstown Municipality, PO Box 176, Grahamstown 6140
Greytown Municipality, PO Box 71, Greytown 3500
Groot-Brakrivier Munisipaliteit, Posbus 15, Groot-Brakrivier 6525
Hartswater Munisipaliteit, Posbus 83, Hartswater 8570
Heidelberg Municipality, PO Box 201, Heidelberg 2400
Heilbron Munisipaliteit, Heilbron 9650
Henneman Municipality, PO Box 29, Henneman 9445
Hermanus Municipality, PO Box 20, Hermanus 7200
Hoopstad Munisipaliteit, Hoopstad 2670
Hopetown Munisipaliteit, Privaatsak X3, Hopetown 8750
Howick Municipality, PO Box 5, Howick 3290
Jan Kempdorp Munisipaliteit, Posbus 241, Jan Kempdorp 8550
Jeffreys Bay Municipality, PO Box 21, Jeffreys Bay 6330
Johannesburg Municipality, PO Box 699, Johannesburg 2000
Kakamas Municipality, PO Box 174, Kakamas 8870
Keetmanshoop Municipality, PO Box 25, Keetmanshoop 9020
Kempton Park Municipality, PO Box 13, Kempton Park 1620
Kenhardt Municipality, PO Box 15, Kenhardt 8900
Kimberley Municipality, PO Box 194, Kimberley 8300
Kingwilliamstown Municipality, PO Box 33, Kingwilliamstown 5600
Kirkwood Municipality, The Town Clerk, P.K. Kirkwood 6120
Klerksdorp Munisipaliteit, Posbus 99, Klerksdorp 2570
Knysna Municipality, PO Box 21, Knysna 6570
Koffiefontein Munisipaliteit, Posbus 7, Koffiefontein 9986
Kokstad Munisipaliteit, Posbus 8, Kokstad 4700
Komga Municipality, PO Box 21, Komga 4950
Koppies Municipality, PO Box 14, Koppies 9540
Kroonstad Municipality, PO Box 302, Kroonstad 9500
Krugersdorp Municipality, PO Box 94, Krugersdorp 1740
Kuruman Municipality, PO Box 4, Kuruman 8460
Kwa-Xuma Town Council, Private Bag X10, Kwa-Xuma 1868
Ladybrand Municipality, PO Box 64, Ladybrand 9745
Ladysmith Municipality, PO Box 195, Ladysmith 3370
Lichtenburg Municipality, PO Box 7, Lichtenburg 2740
Lydenburg Municipality, PO Box 61, Lydenburg 1120
Malmesbury Munisipaliteit, Posbus 52, Malmesbury 7300
Marble Hall Munisipaliteit, Posbus 111, Marble Hall 0450
Mudquard Munisipaliteit, Posbus 44, Mudquard 4610
Matatiele Municipality, PO Box 35, Matatiele 4730
Melmoth Municipality, PO Box 11, Melmoth 3835
Meyerton Municipality, PO Box 9, Meyerton 1960
Middelburg Municipality, PO Box 55, Middelburg 5900
Middelburg Municipality, PO Box 14 Middelburg 1050
MMabatho Municipality, PO Box 42, MMabatho 8670
Montagu Munisipaliteit, Posbus 24, Montagu 6720
Mooi River Municipality, PO Box 47, Mooi River 3200
Mossel Bay Municipality, PO Box 25, Mossel Bay 6500
Naboomspruit Munisipaliteit, Privaatsak X340, Naboomspruit 0560
Nelspruit Municipality, PO Box 45, Nelspruit 1200
Newcastle Municipality, PO Box 21, Newcastle 2940
Nigel Municipality, PO Box 23, Nigel 1490
Nylstroom Stadsraad, Privaatsak 1008, Nylstroom 0510
Odendaalsrust Municipality, PO Box 21, Odendaalsrust 9480
Ontwikkelingsraad Hoëveldgebied, Posbus 520, Witbank 1035
Ontwikkelingsraad Noord-Kaap, Privaatsak X5005, Kimberley 8300
Ontwikkelingsraad Oos-Kaap, Posbus 14025, Sidwell 6061
Ontwikkelingsraad Oos-Rand, Posbus 57, Germiston 1400
Ontwikkelingsraad Oos-Transvaal, Posbus 888, Nelspruit 1200
Ontwikkelingsraad Oranje-Vaal, Privaatsak X029, Vanderbijlpark 1900
Ontwikkelingsraad Sentraal Tvl., Privaatsak X449, Pretoria 0001
Ontwikkelingsraad Suid-OVS, Posbus 2313, Bloemfontein 9300
Ontwikkelingsraad Wes-Kaap, Privaatsak X7, Goodwood 7460
Ontwikkelingsraad Wes-Rand, Posbus 4414, Johannesburg 2000
Orkney Municipality, PO Box 34, Orkney 2620
Otjiwarongo Municipality, PO Box 2209, Otjiwarongo SWA 9210
Oudtshoorn Municipality, PO Box 255, Oudtshoorn 6620
Paarl Municipality, PO Box 12, Paarl 7620
Parys Municipality, PO Box 359, Parys 9585
Peri Urban Development Board, PO Box 1341, Pretoria 0001
Phalaborwa Municipality, PO Box 67, Phalaborwa 1390
Piet Retief Municipality, PO Box 23, Piet Retief 2380
Pietermaritzburg Municipality, PO Box 321, Pietermaritzburg 3200
Pietersburg Municipality, PO Box 111, Pietersburg 0700
Piketberg Municipality, The Town Clerk, Piketberg 7320
Plettenbergbaai Munisipaliteit, Posbus 26, Plettenbergbaai 6600
Port Alfred Municipality, PO Box 13, Port Alfred 6170

Port Elizabeth Municipality, PO Box 116, Port Elizabeth 6000
Port Shepstone Municipality, PO Box 5, Port Shepstone 4240
Postmasburg Municipality, PO Box 5, Postmasburg 8420
Potchefstroom Municipality, PO Box 113, Potchefstroom 2520
Potgietersrus Municipality, PO Box 34, Potgietersrus 0600
Pretoria Municipality, PO Box 440, Pretoria 0002
Prieska Munisipaliteit, Posbus 16, Prieska 8940
Queenstown Municipality, PO Box 113, Queenstown 5320
Randburg Municipality, Private Bag 1, Randburg 2125
Randfontein Munisipaliteit, Posbus 139, Randfontein 1760
Reitz Munisipaliteit, Posbus 26, Reitz 9810
Richardsbay Municipality, Private Bag, Richardsbay 3900
Riverdale Municipality, PO Box 29, Riverdale 6770
Robertson Municipality, PO Box 52, Robertson 6705
Roodepoort Munisipaliteit, Posbus 217, Roodepoort 1725
Rustenburg Munisipaliteit, Posbus 16, Rustenburg 0300
Sandton Municipality, PO Box 78001, Sandton 2146
Sasolburg Municipality, PO Box 60, Sasolburg 9570
Secunda Munisipaliteit, Die Stadsklerk, Secunda 2302
Senekal Munisipaliteit, Posbus 20, Senekal 9600
Smider-Paarl Munisipaliteit, Privaatsak X6003, Smider-Paarl 7624
Somerwet East Municipality, PO Box 21, Somerset East 5850
Somerset West Municipality, PO Box 19, Somerset West 7130
Springs Munisipaliteit, Posbus 45, Springs 1560
Standerton Munisipaliteit, Posbus 66, Standerton 2430
Stanger Municipality, PO Box 72, Stanger 4450
Stellenbosch Munisipaliteit, Posbus 17, Stellenbosch 7600
Stilfontein Munisipaliteit, Posbus 20, Stilfontein 2550
Strand Munisipaliteit, Posbus 3, Strand 7140
Stutterheim Municipality, PO Box 2, Stutterheim 4930
Swakopmund Munisipaliteit, Posbus 53, Swakopmund 9180
Swellendam Munisipaliteit, Posbus 20, Swellendam 6740
Thabazimbi Stadsraad, Posbus 90, Thabazimbi 0380
Tongaat Municipality, PO Box 33, Tongaat 4400
Tzaneen Munisipaliteit, Posbus 24, Tzaneen 0850
Uitenhage Munisipaliteit, Posbus 45, Uitenhage 6230
Umtata Municipality, PO Box 57, Umtata 5100
Upington Munisipaliteit, Upington 8800
Vanderbijlpark Munisipaliteit, Posbus 3, Vanderbijlpark 1900
Vereeniging Munisipaliteit, Posbus 35, Vereeniging 1930
Verwoerdburg Munisipaliteit, Posbus 14013, Verwoerdburg 0140
Viljoenskroon Munisipaliteit, Posbus 37, Viljoenskroon 9520
Virginia Munisipaliteit, Posbus 156, Virginia 9430
Volksrust Munisipaliteit, Posbus 48, Volksrust 2470
Vrede Munisipaliteit, Posbus 155, Vrede 2455
Vredendal Munisipaliteit, Die Stadsklerk, Vredendal 8160
Vryburg Munisipaliteit, Posbus 35, Vryburg 4600
Vryheid Munisipaliteit, Posbus 57, Vryheid 3100
Walvisbaai Munisipaliteit, Posbus 86, Walvisbaai 9190
Warmbad Munisipaliteit, Posbus 48, Warmbad 0480
Warrenton Municipality, PO Box 10, Warrenton 8530
Welkom Munisipaliteit, Posbus 708, Welkom 9460
Wellington Municipality, PO Box 12, Wellington 7655
Wepener Munisipaliteit, Posbus 31, Wepener 9944
Wesselsbron Munisipaliteit, Posbus 6, Wesselsbron 9860
Westonaria Municipality, PO Box 19, Westonaria 1780
Winburg Munisipaliteit, Posbus 26, Winburg 9420
Windhoek Munisipaliteit, Posbus 1055, Windhoek 9100
Wit Rivier Munisipaliteit, Posbus 2, Witrivier 1240
Witbank Munisipaliteit, Posbus 3, Witbank 1035
Wolmaransstad Munisipaliteit, Posbus 17, Wolmaransstad 3630
Worcester Munisipaliteit, Privaatsak X3046, Worcester 6850
Zastron Munisipaliteit, Zastron 9950

HONORARY MEMBERS - ERELEDE

1915 - 1936
Dr HJ van der Bijl - Electricity Supply Commission
J Roberts - Durban
E Poole - Secretary/Treasurer

1938
LL Horrell - Pretoria

1944
GH Swingler - Cape Town

1945
AT Rodwell - Johannesburg

1950
Dr JH Dobson - Johannesburg

1951
HA Eastman - Cape Town

1955
W Bellad-Ellis - East London
JC Fraser - Johannesburg
C Kinsman - Durban

1956
WH Milton - Electricity Supply Commission
Alderman A Morton Jaffray - Salisbury
Major SG Redman - Merz & McLellan, Johannesburg
Councillor CEK Young - Pietermaritzburg

1957
DA Bradley - Port Elizabeth

1958
Colonel EG Ewer - Pietermaritzburg
A Foden - East London
CR Halle - Pietermaritzburg

1960
Councillor FJ Castelyn - Bloemfontein
Councillor LP Davies - Springs

1962
SR Simpson - Bulawayo
JL van der Walt - Vereeniging

1963
CG Downie - Cape Town

1964
JC Downey - Springs
RL Kane - Johannesburg

1965
GJ Muller - Bloemfontein

1967
Councillor JD Marais - Johannesburg
JR Telles - Lorenco Marques

1969
W Beesley - Lusaka
PA Giles - East London
D Murry-Hobbs - Port Elizabeth
EL Smith - Boksburg

1971
D Hugo - Pretoria
ACT Frantz - Cape Town
HT Turner - Umtali
R Leishman - Johannesburg
RMO Simpson - Durban
W Rossler - Pretoria
F Stevens - Durban
JF Lategan - Stellenbosch

1973
RG Ewing - Past Secretary

1975
Councillor HG Kipling - East London
C Lombard - Germiston
DC Plowden - Johannesburg
JG Wannenburg - Chief Inspector of Factories

1977
Dr RL Straszacker - Electricity Supply Commission
AA Middlecote - SABS
GC Theron - Vanderbijlpark
AC Waddy - Pietermaritzburg

1979
RW Barton - Welkom
Councillor HJ Hugo - Roodepoort

1981
JD van Wyk - Council for Scientific and Industrial Research
Dr RB Anderson - Council for Scientific and Industrial Research
John Morrison - Affiliate

1983
TC Marsh - Affiliate
JK von Ahlften - Springs

1985
AA Weich - Chief Inspector Occupational Safety
KG Robson - East London
Councillor RL de Lange - East London
E de C Pretorius - Potchefstroom
W Barnard - Johannesburg

PAST PRESIDENTS / VOORMALIGE PRESIDENTE

1915-17	*JH Dobson	Johannesburg
1917-19	*J Roberts	Durban
1919-20	*B Sankey	Port Elizabeth
1920-22	*TCW Dodd	Pretoria
1922-24	*GH Swingler	Cape Town
1924-26	*J Roberts	Durban
1926-27	*B Sankey	Johannesburg
1927-29	*JM Lambe	East London
1929-31	*R Macauley	Bloemfontein
1931-33	*LL Horrell	Pretoria
1933-34	LF Bickell	Port Elizabeth
1935-36	*GG Ewer	Pietermaritzburg
1936-37	*A Rodwell	Johannesburg
1937-38	*JH Gyles	Durban
1938-39	HA Eastman	Cape Town
1939-44	*IJ Nicholas	Umtata
1944-45	*A Rodwell	Johannesburg
1945-46	JS Clinton	Zimbabwe (Harare)
	*JW Phillips	Zimbabwe (Bulawayo)
1946-47	GJ Muller	Bloemfontein
1947-48	C Kinsman	Durban
1948-49	*A Foden	East London
1949-50	DA Bradley	Port Elizabeth
1950-51	CR Hallé	Pietermaritzburg
1951-52	JC Downey	Springs
1952-53	*AR Sibson	Zimbabwe (Bulawayo)
1953-54	*JC Fraser	Johannesburg
1954-55	GJ Muller	Bloemfontein
1955-56	*DJ Hugo	Pretoria
1956-57	*JE Mitchell	Zimbabwe (Harare)
1957-58	*JL van der Walt	Krugersdorp
1958-59	CG Downie	Cape Town
1959-60	*RW Kane	Johannesburg
1960-61	RMO Simpson	Durban
1961-62	C Lombard	Germiston
1962-63	*PA Giles	East London
1963-64	JC Downey	Springs
1964-65	RW Barton	Welkom
1965-67	*D Murry-Nobbs	Port Elizabeth
1967-69	GC Theron	Vanderbijlpark
1969-71	HT Turner	Umtali
1971-73	JK von Ahlften	Springs
1973-75	JC Waddy	Pietermaritzburg
1975-77	E de C Pretorius	Potchefstroom
1977-79	KG Robson	East London
1979-81	PJ Botes	Roodepoort
1981-83	DH Fraser	Durban
1983-85	W Barnard	Johannesburg

* Deceased/Oorlede

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Hess I, De Roek, Cushat Lane, Constantia 7800
Honnibal GT, PO Box 17031, Groenkloof 0027
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Psotta KU, Malherbestraat 9, Upington 8800
Reichert WJ, P/a Universiteitsingenieur, Universiteit van Kaapstad, Privaatsak, Rondebosch, 7700
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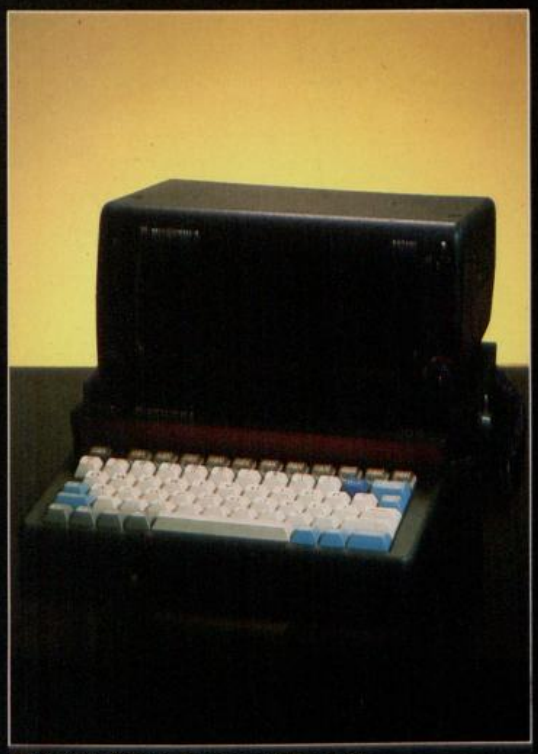

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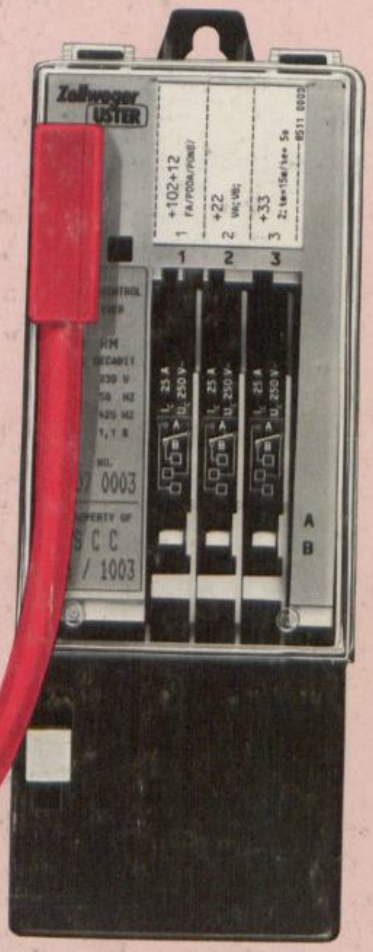

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