

DIE VERENIGING VAN
MUNISIPALE
ELEKTRISITEITSONDER-
NEMINGS VAN SUID-AFRIKA

SESDE TEGNIESE
VERGADERING
12 – 13 MEI 1976



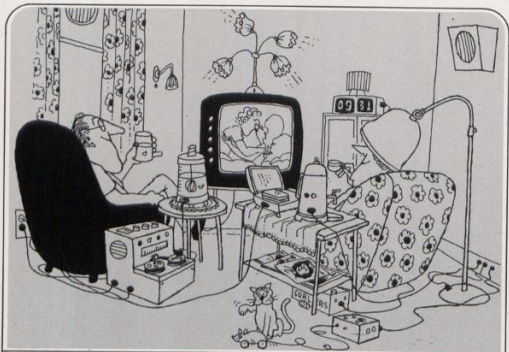
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SIXTH TECHNICAL
MEETING
12 – 13 MAY 1976



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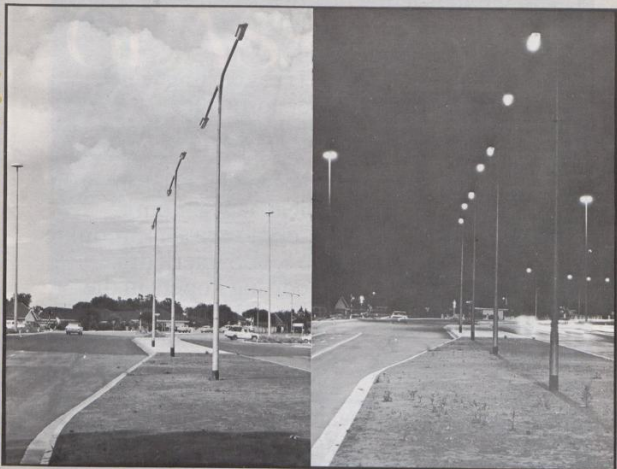
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MAY - MEI 1976

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**DS. P.J. VENTER HET DIE VERRIGTINGE GEOPEN MET
SKRIFLESING EN GEBED**

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DIE PRESIDENT, MNR EUGENE PRETORIUS, het al die aanwesiges hartlik verwelkom. 'n Spesiale woord van welkom is gerig aan Raadslid A.V. Combrink, Burgemeester van Rustenburg.



V.l.n.r. Mnr. Bennie van der Walt (Sekretaris), mnr. Eugene Pretorius, President van die V.M.E.O. staande terwyl hy die afgevaardigdes na die byeenkoms verwelkom, Sy Agbare die Burgemeester van Rustenburg, Rdl. André Combrinck, mnr. Ken Robson (Aanwesende President) en ds. P.J. Venter.

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VERWELKOMING DEUR SY AGBARE DIE BURGEMEESTER, RAADSLID A.V. COMBRINK

Mr. President, delegates and guests:
Rustenburg is indeed privileged to welcome the Association of Municipal Electricity Undertakings of S.A. in this our 2nd eldest town of the Transvaal.

Electricity today is a commodity of utmost importance in our country.

Links of international interest in the generating thereof exists in schemes like Caborra Bassa and the Kunene for example, in which bonds of friendship and mutual interest have been built between nations to the advantage of neighbours and ourselves.

Supply of electricity to neighbours like Lesotho, Swaziland and future homelands is of vital interest to them and to us, valuable in the process of building bridges of interdependence and sound relations.

Since the discovery of electricity, numerous technical developments throughout the years have made its valuable contribution to the upgrading of economies, developments and general living standards which made it into one of the most important achievements of mankind.

In this process, Mr. President, the technical knowhow, quality and ability of the engineer cannot be overstressed.

Today the municipal electrical engineer finds himself in an even greater and unique sphere of opportunity for a wide variety of human and engineering experience in developing and serving the community and in creating the circumstances and atmosphere so necessary to utilize his knowledge in building a happy and content citizen.

The invaluable services of an electrical engineers department might not always be appreciated by John Citizen, because he invariably takes it for granted as a must in the functioning of his commercial undertaking, industry or household appliances.

In the absence of electrical power supply, he all of a sudden reacts with violent criticism regarding his local government and electrical engineering department.

Human and technical failures are surely common to John Citizen too, but when this applies to every body but himself he sees it as reason enough to become aggressive if not down right insulting.

This pathology of character applies fortunately only to the uneducated or downright uncivilized, whereas the majority of people appreciate and are truly thankful for services rendered.

I would therefore like to make use of this opportunity to convey our sincere appreciation to you - the people behind our electricity supply - for the competent and responsible way in which you serve our cities and towns.

As in gedagte gehou word dat op Suid-Afrikaanse bodem in die koers van 12 000 megawatt krag opgegew word en dat dit meer as die helfte van die totale elektriese kragproduksie van die kontinent van Afrika verteenwoordig, dan besef mens die groot omvang van die werksaamhede van die elektriese ingenieurs van Suid-Afrika.

Onder hierdie opwekkingsinstallasies tel die hidro-elektriese skema by die H.F. Verwoerddam of die stoomturbine opwekking by Kriel wat die grootste van sy soort is in die Suidelike halfrond.

Dit is dan dat elke S.A. burger met trots kennis neem van die elektriese ingenieurs en hulle gehalte diens gelewer asook hul grootse bydrae tot die ontwikkeling van ons vaderland.

Kom dit nou by die verskaffing van hierdie krag stedelek en landelik, dan het die munisipale elektriese ingenieur 'n leese aandeel daarin.

Waar u dus te dagn het met die eindpunt van en benutting van elektriese energie is stadsrade toegewys op u kennis, advies, beplanning en tegniese vernuf tot die beskikbaarstelling daarvan aan sy ingesetenes.

Met die wêreld se oliekrisis is ons tans en sal ons mettertyd meer toegewys wees op elektriese energie as ooit tevore.

Goddank dat ons land geseë is met o.a. groot uraan-, steenkoolneerslae en riviere wat hul leen tot die ontwikkeling van hidro-elektriese skemas, om aan ons behoeftes bevredigend te kan voldoen in terme van elektriese energie.

Desnieteenstaande het ons van Sy Edele die Minister van Ekonomiese Sake kennis gemaak dat ons met gesonde oordeel elektrisiteit spaarsaam moet gebruik terhalwe dat hierdie lewensmiddel ook vir ons nasate beskikbaar sal bly.

Gegte afgewarandigdes - dit is hierdie grootse verantwoordelike taak wat hoofsaaklik toevertrou is aan u - die prof. elektriese ingenieurs van S.A. en Rhodésie.

Ek wil met groot vrymoedigheid namens alle munisipaliteite vir u sê dat daar geen twyfel is dat hierdie taak toevertrou is aan juis die mense wat nie net ten volle en behoorlik toegerus is vir die taak nie, maar wat hierdie bate van ons land na behore, getrou en met groot verantwoordelikhed sal hanteer.

Namens die Stadsraad van Rustenburg, my besondere dank aan mr. Emile de Villiers en sy departement vir hul hidrae en reëlings tot die sukses van hierdie kongres.

Ek wil u ten slotte 'n aangename kongres en verblyf in Rustenburg toewens en vertrou dat u elkeen persoonlike voordeel hieruit sal put.

Dit is dan aangenaam om hierdie Gede Tegniese Vergadering van die Vereniging van Munisipale Elektrisiteitsondernemings as amptelik gepoen te verklaar.



Sy agbare die Burgemeester
Rdl. A.V. Combrink.

MNR. E. DE C. PRETORIUS: (President): Baie dankie mnr. die Burgemeester en baie dankie vir die verwelkoming. Ek wil ook aan Ds. Venter sê baie dankie dat u vir ons die verrigtinge geopen het met skriflesing en gebed.

U Edelgare en Ds. u is welkom om ons verrigtinge by te woon sonk as wat dit vir u moontlik is. Ons sou graag wil sien dat u die hele 2 dae met ons moet wees, maar ek weet u is baie besig met en ek verstaan dat u net tot en met teopous saam met ons sal wees.

Hier is net 'n paar aankondigings memore.

Gentlemen I wish to direct your attention to the notes on the bottom of page 2. I presume that all of you have read them, and please the very last sentence - Smoking is prohibited in the Conference Hall and also in the tearoom must be adhered to.

There are some changes in the programme on the Agenda. On the first page you'll notice that right at the bottom of the page discussion leaders on the paper of Mr. Hartill is Mr. Adams and Mr. Smit. Now Mr. Adams is presently in London. He is attending a conference on distribution cables and Mr. S.H. Hawkeswood of Richards Bay will stand in for Mr. Adams. On page 2 the second item says "discussion on paper" actually it should read "continuation of discussion on paper". 'n Voorsetting van die bespreking van die referaat. This item will commence at 11 hours sharp.

There is also a slight change on page 2. Mr. Auton will deliver his paper before lunch interval and he will commence doing so at approximately 11h45 and discussion on the paper will commence immediately after lunch. Die afsluiting sessie sal om 15h30 plaasvind of so spoedig moontlik daarna. Verversings sal om ongeveer 16h00 bedien word.

Ek het verskonings ontvang van/of namens die volgende persone:

Councillor Bert Kipling of East London who as all of you probably know is unfortunate of having a leg amputated shortly after the Durban convention last year.

Also Mr Gerard Gerber who is in Switzerland to attend the funeral of his mother. Mnr Hennie Dreyer tot onlangs ook 'n lid van die Uitvoerende Raad van die Vereniging wat uit die munisipale diens getree het. Messrs. Babek, How, Adams, Stevens, Atteridge, all tendered their apologies. Thank you gentlemen. Now we can start with business. Start working.

I now call upon Mr Jules van Ahlfen and Mr John Morrison to lead the members' forum session. Will you please join me at the front table.

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A. VRAE WAT OORGESTAAN HET VAN 1975 KONVENSIË

VRAAG

1. Tans laat die Bedringsregulasie nie die installering van 'n sok in 'n badkamer (soos gedefinieer) toe nie selfs al is aardlekbeveiliging nou verpligtend. In 'n kombuis of wakamer word 'n sok oëter binne 2 meter van 'n kraan toegelaat as dit deur 'n aardlekreël beveilig word. Moet die regulasie ten opsigte van sokke in badkamers nie nou gewysig word nie?
2. Dit blyk dat ons in Suid-Afrika twee stelsels vir neutraalaarding het, sommige voorsieningsowerhede vereis dat die neutraal by die verbruiker se perseel geaard word en ander weer nie. Dit verwar kontrakteurs en die vraag word gestel of daar nie op 'n stelsel vir neutraalaarding gestandaardiseer moet word nie. Wat is die voordele van eenige van die stelsels sodat dit deur verskillende voorsieningsowerhede ondervind word?

TAK GOEIE HOOP

3. Dink lede van die Vereniging dat die verpligte installering van aardlekreëls, soos dit in die jongste wysiging van die Standaard Regulasies vir die Bedrading van Persele vereis word, heroorweeg word?

C.E. ADAMS - PORT ELIZABETH

B. NUWE VRAE:

1. Sou 'n installasiegebruikskode deur die SABS uitgereik word ter wysiging van SABS 950 1969 vir PVC geleibuis, sal lede dit oorweeg om so 'n kode af te dwing totdat dit oopneem in die nuwe bedringsregulasies?
2. Hou die huidige stelsel waarvolgens plaaslike owerhede verplig word om tenders aan te vra vir kontrakte met 'n waarde bo 'n sekere bedrag en na die toepassing van sekere voorkeure, die laagste tender te aanvaar enige voordeel in en dien dit enige goeie doel?
3. Besonderhede aangaande die voortdurende stroomdravermoeë van ondergrondse kabel is gereedlik beskikbaar. Onder die huidige omstandighede is dit belangrik dat kabele wat geïnstalleer is ten volle benut word. Onder las faktor omstandighede kan kabele met veiligheidsrotome bule voortdurende stroomdravermoeë dra maar inligting aangaande die veilige stroomdravermoeë onder sulke omstandighede is feitlik onbekikbaar. Kan iets aan die saak gedoen word?

C. LOMBARD - GERMISTON

4. **PRODUKTIVITEITSVERBREDING:** Die langtermyn-anti-inflasioneë voordele van ge-intensifiseerde opleiding en verhoogde produktiviteit, veral op wetenskaplike en tegniese gebiede, word vry algemeen sterk beklemtoon.

Dit is 'n bekende feit dat groot getalle professionele mense in ander lande in allerlei rigtings produktiewe werk voorsit buite hulle gewone werksure.

Artikel 62 van die Transvaalse Ordonnansie op Plaaslike Bestuur handel oor die „aanstelling van stadsklerk en ander beamptes“ (ook stadsingenieur en elektrotegniese stadsingenieur) en subartikel (3) lui soos volg:

„Geen beampte benoem kragtens die bepalings van hierdie artikel, mag betrede werk buite die munisipale diens verrig of hom daartoe verbind voor hy eers die spesiale toestemming van die raad gevra en verkry het nie. Sodanige toestemming moet verleen word by besluit van die raad en kan onderworpe word aan enige voorwaardes wat die raad na goeie denke vasstel.“

- Die volgende vrae kan met reg gestel word:
- a. In die lig van nasionale en internasionale ekonomiese probleme, behoort professionele mense, veral wetenskaplikes, ingenieurs en tegnici, nie op allerlei wyses aangemoedig te word om buite hulle gewone werksure onder produktiewe werk te verrig nie?
 - b. Aangesien dit die tendens is sedes die om beperkende maatreëls (soos 62(3) van die Ordonnansie) uit die algemene diensvoorwaardes van munisipale werknemers weg te laat, behoort die betrokke artikel in die Ordonnansie nie geskrap of tenminste sodanige gewysig te word dat die diskresie en voorwaardes uit die hande van individuele stadsrade geneem word nie?
 - c. Moet bykomende werk noodwendig in dieselfde rigting wees as 'n persoon se normale diens of sou dit terwille van afleiding of ontspanning verkieslik wees om buite gewone werksure 'n heetelant ander rigting in te slaan?

E.E. DE VILLIERS (RUSTENBURG)

In die nakoming van sekere vereistes van die Wet op Fabriek, Masjinerie en Bouwerk ten opsigte van elektrisiteitsvoorsiening mag die volgende vrae bespreking regverdig.

5. Ingevolge regulasie A.61(d) moet die elektrisiteitsvoorsieningsowerheid as „Bouer en uitgraver“ die Afdelingsinspekteur skriftelik in kennis stel waar sodanige bouwerk of uitgraving sal geskied en die verwagte datum waarop sodanige werk 'n aanvang sal neem. Die definisie van „bouwerk“ is so wyd dat dit enige denkbaar werk kan insluit in verband met die konstruksie of instandhouding van

A. QUESTIONS STANDING OVER FROM 1975 CONVENTION

QUESTION

1. As present the Wiring Regulations do not allow the installation of a socket outlet in a bathroom (as defined), even though earth leakage protection is now compulsory. In a kitchen or laundry a socket outlet is however allowed within 2 metre of a tap if protected by an earth leakage relay. Should the regulations regarding socket outlets in bathrooms now not be amended?
2. It would seem that in South Africa we have two systems of neutral earthing – some supply authorities require the neutral to be earthed at consumer's premises, others do not. This confuses contractors and the question is asked whether a system of neutral earthing should not be standardised on. What are the advantages of either systems as experienced by various supply authorities?

GOOD HOPE BRANCH

3. Do members of the Association consider that the compulsory installation of earth leakage relays, as required in recent amendments to the Standard Regulations for the Wiring of Premises should be reviewed?

B. NEW QUESTIONS:

1. Should a code of installation practice be issued by the SABS as an amendment to SABS 950 1969 for PVC conduits, would members consider enforcing such a code of practice until such time as it is incorporated in the new wiring regulations?
2. Is the existing system under which local authorities are compelled to call for tenders for contracts above a certain value and, after the application of certain preferences, to accept the lowest of any benefit and does it serve any good purpose?
3. Details regarding the continuous current carrying capacity of underground cables under various environmental conditions are readily available. It is important under present conditions to utilize all cables installed to their full extent. Under low load factor conditions cables may, with safety, carry currents in excess of their continuous current carrying capacity, but information regarding the safe current carrying capacity under such conditions is virtually unobtainable. Can anything be done about this?

4. **EXTENDING PRODUCTIVITY:** The long term anti-inflation benefits to be gained from intensified training and enhanced productivity, especially in the scientific and technical spheres, are being generally strongly stressed.

It is a well-known fact that large numbers of professional people in other countries continue productive work in varied directions outside their normal working hours.

Section 62 of the Transvaal Local Government Ordinance deals with the „appointment of town clerk and other officials“ (also town engineer and town electrical engineer) and subsection (3) reads as follows:

„No officer appointed under the provisions of this section shall perform or engage himself to perform remunerative work outside the municipal service without special permission of the council first had and obtained. Such permission shall be granted by a resolution of the council and may be made subject to any such conditions as the council may deem fit to impose.“

- The following questions may be pertinently posed:
- a. In view of national and international economic problems, should professional people, especially scientists, engineers and technicians, not be encouraged in various ways to do productive work outside their normal working hours?
 - b. Since the tendency exists to delete restrictive measures (such as 62(3) of the Ordinance) from the general conditions of service of municipal employees, should not the relative section in the Ordinance also be deleted or at least amended in such manner that the discretion and conditions be taken out of the hands of individual councils?
 - c. Should additional work necessarily be of similar type to a person's normal duties or be preferably of quite a different type for the sake of diversion or relaxation?

In respect of the observance of certain requirements of the Factories, Machinery and Building Work Act and Regulations relating to the electricity supply industry, the following matters may be worthy of discussion.

5. Reg. A. 61(d) requires an electricity supply authority, as a „Builder or excavator“ by definition, to notify the Divisional Inspector in writing of the „place where building or excavation work is to be performed and the anticipated date on which the work is to be commenced.“

The definition of „building work“ is so wide as to embrace every

elektrisiteitsels, vanaf die vervanging van 'n straalamp of sekering, die lê van 'n diensaansluitingskabel, die installasie van 'n transformator of skakelaar tot die konstruksie van 'n groot sub-stasie.

Nakoming van die regulasie bly onmoontlik te wees. Watter stappe neem Evkom en ander munisipaliteite in die verband en wat is die houding van die Departement van Arbeid met die toepassing van die regulasie en wat is die doel om hierdie inligting te voorsien? 6. Ingevolge Regulasie C.1(6) is persone wat algemene toetsing op masjinerie het onder ander verplig om "(d) enige toetsel of masjien tot stand te bring indien die gebruik daarvan op enige wys weens defek gevaarlik vir persone is of mag wees."

In 'n groot elektrisiteitselstel waar die 'masjinerie' oor 'n paar honderd vierkante kilometer versprei mag wees, is dit hoogs onwarskynlik dat die 'verantwoordelike persoon' teenwoordig sal wees op die kritieke oomblik om die werking van defekte masjinerie te staak. Dit blyk dat hierdie vereiste, wat beelwaarskynlik betrekking het op konvensionele fabriek, urealities is in 'n elektrisiteitsonder-neming. Wat is die sieningswyse van die Ingenieurs hier teenwoordig, wat hierdie verantwoordelikhede dra as die Verantwoordelike Persone vir hulles dorpe en stede.

7. Regulasie C.1(4) vereis dat "die verantwoordelike persoon wat algemene toetsing op alle masjinerie op die perseel moet lê, moet op 'n voltydse grondslag vir sodanige masjinerie aangestel word...ens". Die vertolking van die woorde voltyds in hierdie begrip was die onderwerp van onlangse korrespondensie met die Departement van Arbeid. Dit blyk onvoorkombaar dat, behalwe in klein onder-nemings, die "verantwoordelike persoon" vir baie funksies op onder-geskepte persone staat sal moet maak om die veelvuldige vereistes van die regulasie na te kom rakende ontwerp, konstruksie, bedryf en instandhouding van die veelvuldige en komplekse masjinerie teen-woordig in die elektrisiteitsnetwerk. Die aantal ondergeskepte persone sal natuurlik afhang van die grootte van die onderneming en sal toeneem namate die "Verantwoordelike Persoon" die installasie, instandhouding en bedryf van die masjinerie.

Dit sou dus interessant wees om te verneem tot watter mate die "Verantwoordelike Persoon" in ander Munisipale Elektrisiteits-onder-nemings persoonlike aandag op 'n voltydse basis vir die nakom-ing van hierdie vereistes gee.

D.H. FRASER (DURBAN):

8. Daar is seker min munisipale elektrisiteitsondernemings wat elektrisiteit teen dieselfde prys verkoop ondanks 'n eenvoudige aan-koopstarif soos byvoorbeeld ondernemings wat vanaf Evkom se Randas en O.V.S. Onderneming voorsien word.

Wat beskou lede eger as 'n aanvaarbare en redelike winsgrens met die verkoop van elektrisiteit om aan die anti-inflasioneer veld-toeg te voldoen om stygende pryse die hoof te bied in die lig van die jongste aangekondigde groot Evkom tarief verhogings?

9. Die meeste plaaslike besture in die Transvaal het nou die beleid van uniforme salarisskale vir sekere werknemers-kategorie aanvaar. Sal hierdie beleid in sy doel slaag om personeel te verkry en te behou solank die salarisse van senior amptenare deur 'n hoër gesag be-heer word en kan markwaardes soos bepaal deur die infrastruktuur van die plaaslike behagheids- en rywerheidssektor binne spesifieke munisipale gebiede geïgnoreer word?

J.K. VON AHLFTEN - SPRINGS

10.1 **FOUTEWE SABS MERKDRAEENDE ELEKTRIESE TOE-RUSTING:** Wanneer toerusting of bybehoud wat die SABS merk dra foutief raak, dan is voorsieningsowerhede groter dat dit aan die SABS gestuur word vir inspeksie. Die kontrakteur of verbruiker is seker groter dat dit deur die vervaardiger vervang word. Wat kan gesien word om hierdie botsende belange te bevredig?

10.2 **BESKERMING VAN STAATLIGPALE:** Watter stappe, indien enige, doen lede vir die beskerming van straatligpale in woongebiede waar "opry" tipe randstene gebruik word?

10.3 **TV-ANTENNAS:** Kan lede enige ondervinding rapporteer met die gebruik van die installasie aarding vir TV-antennas en wat is die wettlike implikasies hiervan?

10.4 **INFLASIE:** Is daar enige manier waardeur die VMEO as 'n liga-gaam 'n bydrae kan lewer in die stryd teen inflasie deur te verseker dat prysstygings, wanneer nodig, binne redelike perke gehou word?

10.5 **KONTRAKPRYSVARIASIES:** Dink lede dat K.V.V. gereg-verdig is op "voorraad" tipe items?

10.6 **AARDEKEENHEDE:** Watter onlangse ondervinding en ont-wikkeling kan lede rapporteer in verband met vals uitklinking van aardkeenehede by hoëfrekwensiestrome?

NATAL TAK NATAL BRANCH

11. **VERKOOPPRYSVASTELLING IN DIE ELEKTRIESE NY-WERHEID:** Wat is die doel van verkoopprysvastelling in sektore van die elektriese vervaardigingsbedryf en waarom word dit toe-gelaat terwyl ander vervaardigers deur wetgewing verbied word om

conceivable operation connected with the construction or mainte-nance of electricity distribution systems, from the replacement of a street lamp or fuse, the laying of a service connection, the installa-tion of a transformer or switch to the construction of a major sub-station.

Strict compliance with the regulation appears impossible. What steps do Escom and other municipalities take and what is the atti-tude of the Department of Labour in enforcement of the regulation and what is the purpose of providing this information?

6. In terms of Regulation C.1(6) persons who are appointed to be in general charge of machinery are required inter alia to "(d) stop the working of any apparatus or machine the using of which is, or may, in any way be dangerous to persons due to any defect."

In a large electricity distribution system, where the 'machinery' may be spread over several hundreds of square kilometres, it is most unlikely that the 'Responsible Person' will be personally on hand at the crucial moment to stop the working of all defective machinery. It appears that this requirement, while perhaps being relevant in the case of a conventional small factory, is unrealistic in the case of an electricity supply undertaking. What is the view of other Engi-neers present, many of whom carry this direct responsibility as the appointed Responsible Person for their town or city.

7. Regulation C.1(4) states that "the responsible person required to be in general charge of all machinery on the premises shall be appoin-ting on a full time basis for such machinery....etc."

The interpretation of the meaning of the words full time in this context has been the subject of recent correspondence with the De-partment of Labour. It appears inevitable that, except in relatively small undertakings, the appointee "Responsible Person" will have to rely on many levels of subordinates to ensure the numerous re-quirements specified in the Regulations relating to design, con-struction, operation and maintenance of all the varied and complex machinery present in an electricity distribution system are met. The number of such subordinates will naturally depend on the size of the organisation and the extent to which the "Responsible Per-son" becomes a manager, rather than a direct participant, in the in-stallation, maintenance, repair and operation of the machinery will increase accordingly.

It would be interesting to know to what extent "Responsible Per-sons" in other Municipal Supply Authorities devote their personal attention on a full time basis to the implementation of the require-ments of the Act and Regulations.

8. There are possibly very few municipal electricity undertakings who sell electricity at the same price despite an uniform purchase price of electricity e.g. undertakings being supplied from Escom's Rand and O.F.S. Undertaking.

What do members however consider a fair and reasonable profit margin on the sales of electricity in view of the anti-inflation cam-paign to combat price increases and the recently announced large increases in Escom tariff?

9. In the Transvaal most local authorities have now accepted the poli-cy of uniform salary scales for certain categories of employees.

Will this policy achieve its aim of staff procurement and reten-tion as long as the salaries of senior officials are subjected to the con-trol of a higher authority and can market values as determined by the infra-structure of commerce and industry within specific munici-pal areas be ignored?

10.1 **FAULTY SABS MARK BEARING ELECTRICAL EQUIP-MENT:** When equipment or accessories carrying the SABS mark are found to be defective in any way, the Supply Authority is usually anxious to return this to the SABS for inspection. The contractor or consumer is usually anxious to obtain a replace-ment from the manufacturer and requires the equipment in order to obtain this. What can be done to satisfy these conflicting inter-ests?

10.2 **PROTECTION OF STREETLIGHT POLES:** What steps, if any, are members taking to protect streetlight poles in resi-dential areas where "mountable" type kerbs are in use?

10.3 **T.V. AERIALS:** Do members have any experience to report on the use of installation earths for T.V. aerials, and, the legal im-plications of this action?

10.4 **INFLATION:** Is there any way that the AMEI as a body could contribute to the fight against inflation, to ensure that price in-creases, when necessary, are within fair limits?

10.5 **CONTRACT PRICE ADJUSTMENTS:** Do members feel that C.P.A. is justifiable on "stock" type items?

10.6 **EARTH LEAKAGE RELAYS:** What recent experiences and developments can members report concerning the spurious tripping of e/l relays by high frequency currents?

11. **PRICE FIXING IN THE ELECTRICAL INDUSTRY:** What is the purpose of price fixing in sections of the electrical manu-facturing industry and why is it allowed when other manufacturers are not permitted, by law, to do the same? We are at present com-

dieselfde te doen? Ons word tans verplig om tenders in te wag vir jaarlikse voorrade, wat in die geval van elektriese kables, gloeilampies en meters in der waarheid neerkom op tyd verkwisting aangesien identiese tenders ontvang word van alle leveransiers.

K.J. MURPHY - SOMERSET WES/WEST

12. **WET OP ELEKTROTEGNEIE DRAADWERKERS EN AANNEMERS:** Dit het baie duidelik geword dat daar 'n toenemende verwarring bestaan wat die inspeksie van "draadwerk" deur die voorsiener by fabrieksinstallasies betref as gevolg van die 1969 Umtali-vertolking van die pligte van die "gebruikers" van "masjinerie" ingevolge die Fabriekswet.

Ingevolge die Wet op Elektrotegniese Draadwerkers en Aannemers moet alle "draadwerk" deur die voorsiener geïnspekteer word ongeag enige vertolking wat aan die Fabriekswet gegee mag word en die stadium is blykbaar nou bereik waar met reg gevra kan word "Beantwoord die Wet op Elektrotegniese Draadwerkers en Aannemers werklik nog aan sy doel wat die inspeksie van "draadwerk" deur die voorsiener betref in die afwesigheid van 'n duidelike omlynde en verklaarde wettlike vertolking deur die owerheid?"

13. **STANDAARDELEKTRISITEITVERORDENINGE:** In die Standaard Elektrisiteitsverordeninge van die Transvaal bepaal Artikel 34 "Die raad is nie aanspreeklik vir die gevolge vir die verbruiker of vir enige ander persoon van enige staking, weiering, variasie stuwering of ander gebrek aan elektrisiteit wat die oorsaak al mag wees nie."

Hoe pas dit aan by Artikel 50(1) en (2) van die Elektrisiteitswet (Wet no. 40 van 1958) wat die aanspreeklikheid van 'n ondernemer betref vir skade of besering wat mag voorskiet uit die lewering van elektrisiteit aangesien dit wil voorkom uit Artikel 34 van die Standaardelektrisiteitsverordeninge teenstrydig mag wees met Artikel 50(1) en (2) van die Elektrisiteitswet en moontlik in 'n geging ultra vires verklaar sal kan word?

HÖVELDTRAK (J.A. VON AHLFTEN) HIGHVELD BRANCH

14. **GEWIKSKODE VIR OPENBARE VERLICHTING:** In die Gewikskode vir Openbare Verligting - SABS 098-1967 - word die tipes armature in die aanhangsel A uiteensetting tesame met 'n tabel van armatureienskappe vir straatverligting.

Ondanks die voorskryf van hierdie vereistes in tender spesifikasies vir armature is dit eerder die uitsondering as die reël dat plaaslik vervaardigde of ingevoerde armature ingevolge die SABS-kode getoets en gesertifiseer word. Wat is die verklaring hiervoor?

'n Tweede vraag wat hiermee gepaard gaan, is: Watter voordele is daar gemaak met die voorbereiding van 'n plaaslike kwaliteit en materiaalspesifikasie vir armature bedoel vir straatverligting in die RSA?

S.A.N.K.V.

15. **TOETS VAN BEVEILIGING:** Die moderne samelewing is geheel en al afhanklik van 'n betroubare en onbelemmerde versiening van elektriese krag en 'n vername faktor om dit te bewerkstellig is die instandhouding van beveiligingsroerusting. Vir hierdie rede word voorgestel dat beveiligingsroerusting aan streng jaarlikse toetsing en geskeduleerde instandhouding onderwerp word wat insluit:

Bedryfstoetsing van relais met vyf en tien keer die sokinstelling en tyd-vermenigvuldiging van 0,1 en 1,0 knuip- en herstryktoetsing. Sekondêre inspuut-toetsing op differentieële beveiligingsroerusting.

Uitklynktoetsing op ALLE beveiligingstoestelle. Luginspuiting van Buchholzrelais.

Toetsing van isolasieweerstande van stroomtransformator sekondêre stroombane en kontrole- en uitklynkroombane.

Toetsing vir kontinuïteit en isolasieweerstand van interuutklynk en differensieële loodsroombane behoort maandeliks gedoen te word.

Wat is die sieningswyse van afgevaardigdes en wat is die gebruik van ander ondernemings in hierdie verband?

16. **LIGARMATURE ONGESKIK VIR GEBRUIK:** Gevalle het ontstaan in die Port Elizabeth-onderneming voorgoek met die installering van die toetsige ligarmature in huishoudelike persele wat sonder die interne bedrading voorsien was en waar die kontrakteur die PVC-bedrading dus direk na die lampouwer geneem het. Die PVC-isolasie is egter nie bestand teen die hoë temperatuur wat in die armature ontstaan nie met die gevolg dat die ontblote geleier kontak gemaak het met die metaalkraag.

Het ander ondernemings soortgelyke probleme ondervind en is dit die mening van lede dat daar grondige redes bestaan vir 'n SABS-spesifikasie vir binnenshuise ligarmature?

TAK-OOSKAAPLAND (C.E. ADAMS) CAPE EASTERN BRANCH

- 17.1 Is die installering van straatverligting in die beginstadium van dorpsbestemming ekonomies geregtig?
- 17.2 Moet die verbruik van straatverligting in berekening gebring word om die betalendheid van die skema te bepaal?
- 17.3 Watter stappe word deur die Elektrisiteitsdepartemente geneem om die aanbevelings van die Niemand Kommissie met die voorsiener van elektrisiteit aan nuwe dorpsgebiede te implementeer?

elled to call for tenders for annual supplies, which in the case of electric cables, lamps and meters is in fact a waste of time as identical tenders are received from all suppliers.

12. **ELECTRICAL WIREMEN AND CONTRACTOR'S ACT:** It is quite clear that there is an increasing confusion regarding the inspection of "wiring work" by the supplier when it comes to factory installations as a result of the 1969 Umtali interpretation of the duties of "users" of "machinery" in terms of the Factories Act.

In terms of the Electrical Wiremen and Contractor's Act Suppliers must inspect all "wiring work" irrespective of any interpretation given to the Factories Act and the stage has apparently now been reached where the question can quite rightly be asked "Does the Electrical Wiremen and Contractor's Act still really serve its purpose in regard to the inspection of "wiring work" by a Supplier in the absence of a clearly defined and declared legal interpretation by the authorities?"

13. **STANDARD ELECTRICITY BY-LAWS:** In the Standard Electricity By-laws of the Transvaal, Section 34 reads "The council shall not be liable for the consequences to the consumer or any other person of any stoppage, failure, variation, surge or other deficiency of electricity from whatsoever cause."

How does this tie up with Section 50(1) and (2) of the Electricity Act (Act. No. 40 of 1958) regarding the liability of an undertaker for damage or injury resulting from the supply of electricity as it would appear that Section 34 of the Standard Electricity By-laws may contradict Section 50(1) and (2) of the Electricity Act and could be declared ultra vires in any resulting proceedings?

14. **CODE OF PRACTICE FOR PUBLIC LIGHTING:** In the Code of Practice for Public Lighting - SABS 098-1967 - the types of luminaires are detailed in the appendix A together with a table of characteristics for these luminaires intended for road lighting.

Despite prescribing these requirements in tender specifications for luminaires it is rather the exception than the rule that locally manufactured or imported luminaires are tested and certified in compliance with the SABS Code. What is the explanation for this?

A second question that arises is what progress has been made in the preparation of a local quality and material specification for luminaires intended for road lighting in the R.S.A.?

S.A.N.C.I.

15. **PROTECTION TESTING:** Modern society is totally dependent upon a reliable and unrestricted supply of electric power, and a major factor in ensuring the maintenance of the security of the supply is the protective gear. For this reason it has been suggested that protective gear should be subjected to a rigorous annual testing and maintenance schedule, to include:

Operational tests of relays at five and ten times the plugging test and at time-multipliers of 0,1 and 1,0 creep and reset time tests.

Secondary injection tests on differential protection systems.

Tripping tests of ALL Protective devices.

Air injection of Buchholz relays.

Tests of insulation resistance of current-transformer secondary circuits and control and tripping circuits.

Tests for continuity and insulation resistance of intertrip and differential pilot circuits should be undertaken as monthly intervals.

What are the views of the delegates present, and what is the practice among the undertakings represented by the delegates?

16. **UNSUITABLE LIGHTING FITTINGS:** Instances have occurred recently in Port Elizabeth where enclosed type lighting fittings have been installed in domestic premises, and because the fittings are supplied unwired, the Contractor has taken the PVC insulated circuit conductors straight into the fitting, and terminated them on the lampholder. It has been found that the temperature rise in the fitting is far in excess of the softening temperature of the PVC insulation, and occasions have occurred where the metal gallery has become live because the insulation has softened and the conductor has made contact with the metal gallery.

Has any other supply authority experienced this problem, and do members feel there is scope for a SABS specification on interior lighting fittings?

- 17.1 Is the provision of street lighting in new townships at an early stage economically viable?

17.2 Should street lighting consumption be taken into account when determining the payability of a scheme?

17.3 What steps are being taken by Electricity Departments to implement the recommendations of the Niemand Commission in the provision of electricity to new townships?

- 17.4 Met die toepassing van 'n basiese beskikbaarheidsheffing maak dit 'n wesenlike verskil aan die finansiële struktuur van die Elektrisiteitsdepartement?
- 17.5 Watter stappe kan geneem word om die tegniese oorlegpleging tussen die Elektrisiteitsdepartement en Dorpsontwikkelaar te verbeter?
- 17.6 Is dit moontlik vir die VMEO om standaarde vir die L.S. -uitrusting vir dorpsbenutting te bepaal?

MNR/MR. J. BARRY - GLEN ANIL

- 18.1 Is lede van mening dat daar betekenisvolle ontwikkeling met die gebruik van (PME) sisteme vir L.S. verspreiding in Suidelike-Afrika sal plaasvind?
- 18.2 Indien wel, sal daar heelwaarskynlik 'n behoefte vir kombinasie neutraal- en aard tipe kabelle ontstaan. Die ontwikkeling van hierdie tipe kabelle in die V.K. en Europa is betreefs deur die behoeftes om lewendige laste te kan maak. Sal dit moontlik ook die geval wees in Suidelike-Afrika?

MNR/MR. FORSYTHER - AFRICAN CABLES

19. Met die hantering van grootkontrakte blyk dit die algemene gebruik van munisipaliteite te wees om aansienlike retensiegelede plus sekuriteitsborge te vereis. Die retensies is soms 20% van die totale kontrakwaarde met sekuriteitsborge van 10% van die kontraktraande. Retensies verminder na afhandeling van die kontrak maar gewoonlik word 10% vir 'n verdere 12 maande agterwees gehou. Dit moet besef word dat teneersaas hiervoor voorsiening maak wat die uiteindelijke kontrakprys sal verhoog. Daar kan geen rede gesien word om uitbetaling van die retensiegelede te weerhou sodra die toerusting afgelewer en getoets word aangesien die sekuriteitsborge dekking verleen. 'n Verdere volle betaling behoort gemaak te word sodra die toerusting oopgerig en in werking is.

Aangesien sekuriteitsborge minder uitgawe beteken as retensiegelede behoort hulle nie geheel en al uitgesluit te word van alle kontrakte en bestellings?

MNR/MR. P.P. CAPRA - GEC POWER DISTRIBUTION (PTY) LTD

20. Die SABS Kode vir straatverligting is gebaseer op CIE Publikasie Nr. 12. Met die hersiening van hierdie publikasie word aanvaar dat die SABS Kode gewysig sal word. Soos ek aangedui het toe ek die bespreking op mnr. Wood se 1975 referaat geopen het sal 'n aansienlike hoeveelheid bykomstige inligting deur teneersaas verskaf moet word. Die vraag ontstaan nou
- a. Is Munisipaliteite bereid om die addisionele koste te betaal wat gepaard sal gaan om hierdie bykomstige inligting te verskaf?; en
- b. Hoe beoog hulle om te bepaal of dit wel aan die vereistes voldoen?

MNR/MR. J.T. GRUNDY - PHOSWARE (PTY) LTD

VRAESTELLER: MNR. JULES VON AHLFTEN

Gentlemen this is your session. Dit is u forum. U kan sê wat u wil, maar ek gaan hou by die neergelegde tyd van 20 minute per vraag. Ek dink u het almal die prosedure gelees.

Gentlemen you have all read the procedure for the forum session and I think without wasting any more time we could start with question number A1.

- 17.4 Does the introduction of availability charges significantly effect the financial structure of an Electricity Department?
- 17.5 What steps can be taken to improve technical liaison between the Electricity Departments and Township Developers?
- 17.6 Would it be possible for the AMEU to establish standards for L.T. equipment for use in townships?

- 18.1 Do members consider there will be significant developments in the use of protective multiple earthing (PME) in Low Voltage Distribution Systems in Southern Africa?

- 18.2 Should there be any such development there will presumably be a corresponding requirement for combined neutral and earthtype cables. The development of C.N.E. cables on the continent of Europe and in the United Kingdom has obviously been influenced by the necessity to cater for live jointing. Could this possibly be the case in Southern Africa?

19. When dealing with large contracts, it appears to be the general practice of all Municipalities to require large retentions in addition to surety bonds. The retention is often as much as 20% of the total contract price in addition to a surety bond to the value of 10% of the contract price. Retention is normally reduced once erection and commissioning is complete, but generally at least 10% is held for a further 12 months. It should be realised that tenderers add to their estimated price, the cost of financing these retention monies with the consequence increase in the overall contract price. Once the major equipment has been successfully tested and delivered, we can see no reason for withholding any of the delivered site value as the guarantee is covered by the surety bond. A further full payment should be made for the erection and commissioning on completion of this work as once again any defects are covered by the surety bond.

As surety bonds are much less costly than retentions, should not serious consideration be given to excluding retention payments from all contracts and orders?

20. The SABS Code for streetlighting is based on CIE Publication No. 12. With the revision of this publication, one assumes that the SABS Code will be revised. As I indicated when opening the discussion on Mr. Wood's 1975 Paper, a considerable amount of new data needs to be supplied by tenderers. For example average road luminance, overall uniformity, longitudinal uniformity, glare control mark.
- a. Are the Municipalities prepared to pay the extra costs likely to be involved in preparing these data and
- b. How do they intend to check for compliance?

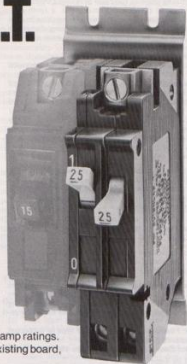


QUIZMASTER JOHN MORRISON

VRAESTELLER JULES VON AHLFTEN

2 INTO 1 DOES GO. FUCHS Q.T.

Fuchs Electrical introduces a new compact circuit breaker—the Q.T. The Q.T. has the same width as a standard circuit breaker, but now incorporates two separate switching units. Fuchs, pioneers in safety against possible electrical accidents now enables current safety legislations to be met. Even where space is limited for earth leakage units in an old installation. With the new Q.T., an existing 7-way board can be adapted to 14-way switching in a matter of minutes. Without expensive or unsightly alterations. The Q.T. can be substituted for any make of breaker or miniature circuit breaker. Q.T. comes in pairs of 10, 15, 20, 25 or 30 amp ratings. The range also includes main switches in 30 or 60 amp ratings. So if you wish to increase the capacity of an existing board, just remember the new Q.T. circuit breaker.



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QUESTION A1 Mr. D. Haig-Smith Queenstown: My answer to the permitting of the installation of a socket outlet in a bathroom is a definite NO.

From time immemorial not even a light switch was permitted in a bathroom and not even the compulsory installation of earth leakage relays in all new premises etc., should now allow the installation of a socket-outlet in a bathroom.

As all practising Municipal Electrical Engineers are only too well aware, much work is done all over the Republic by electrical contracting firms of which the Municipal Inspectorate is not advised and which therefore is not inspected and tested.

If socket-outlets are allowed in bathrooms in new or revised premises etc., although fitted with earth leakage relays, the installation of socket outlets in bathrooms will become an accepted fact and will be installed. I am sure, in many houses not fitted with earth leakage relays or in houses with faulty relays. Also the persons responsible for framing the regulation forbidding a socket-outlet in a bathroom realised or appreciated how very vulnerable a bare human body is when having no protection such as clothing or shoes etc. For this reason the approval now of a socket-outlet in a kitchen within 2 metres of a water tap or other earthed metal is satisfactory to my mind because very few people work in the kitchen in the nude - newly weds excepted of course - the kitchen floor is often of nonconducting material while the bathroom floor is very often wet plastic tiles on probably damp concrete and a more possible earth hazard situation. The bathroom is a place where water sloshed on the floor is quite acceptable but not so in other rooms in the house.

The fact that from time immemorial socket-outlets have never been permitted in bathrooms deters I am sure even the lower amateur electrician from installing a two conductor rip-cord outlet in a bathroom.

In my opinion Mr. Quizmaster therefore the regulation forbidding the installation of a socket-outlet in a bathroom should be strictly enforced.

Mr. J.V. Grant S.A.B.S.: When one considers the validity of one's own regulations, concerning bathrooms in this instance, it can be interesting and informative to look at the equivalent requirements in other countries. On examining some of the rules prevailing overseas at present it became expedient to divide a bathroom (i.e. a room containing a bath or shower) into zones, because this is being done in continental countries. These zones are based on the increasing danger as the bath is approached, each can be defined as follows, each zone extending from floor level upwards for 2.5 m:

- Zone 1. Any space not included in Zone 2 or Zone 3.
- Zone 2 extending 1 m from the bath, being the zone where persons in the bath could touch electrical equipment mounted therein.
- Zone 3 limited by the outside dimensions of the bath itself, being the zone where persons in the bath could touch electrical equipment and where the equipment is also liable to be affected by splashes and steam.

Various requirements are laid down, in some cases for each of the three zones, for fixed electrical equipment in bathrooms by the countries now mentioned. However, in the time available I intend to discuss only socket-outlets, as mentioned in the question.

UK and Rhodesia - Similar to our requirements as they exist now i.e. socket-outlets not permitted in bathrooms at all except for low power safety transformer units designed for supplying small appliances such as shavers. In this discussion reference to safety transformers means transformers with an earthed screen between windings and an unearthed secondary circuit.

USA - No apparent restrictions. (It could be remembered that the system is 120 V.)

Canada - As far as practicable from the bath provided a safety transformer (combined with the socket-outlet) is used or earth leakage protection is used with a sensitivity of 5 mA.

Australia - What are called general purpose outlets, rate at not more than 10 A and intended for general use with portable appliances, are not permitted. However, what are known as plug sockets for supplying one particular item of fixed equipment are subject to the following requirements:

- Not permitted in Zone 3 unless of a weather proof type or protected from splashes and steam (e.g. in a cupboard).
- Permitted in Zone 2 and Zone 1 if at least 12 inches above the floor.

France - Not permitted in Zone 3.
Permitted in Zone 2 provided a safety transformer is used.
Permitted in Zone 1 provided that the socket-outlet has an earth contact or a safety transformer is used.

Germany - Not permitted in Zone 3.
Not permitted in Zone 2. (In Germany the limit of Zone 2 is 0.6 m from the bath and not 1 m.)
Permitted in Zone 1 provided that the socket-outlet has an earth terminal or a safety transformer is used or earth leakage protection is used (sensitivity 30 mA).

I should mention that in France and Germany only Class II (i.e. double-insulated or equivalent) equipment is used with two contact socket-outlets.

It can be argued that people will continue to use portable appliances in bathrooms, particularly washing machines and heaters, whether or

not a socket-outlet is provided in the room. If this contention is accepted, then the Bureau, bearing in mind the foregoing information, feels that the safest method of so doing must be adopted and consequently puts forward the following suggestions for dealing with socket outlets in bathrooms:

Zone 2. Not permitted

Zone 3. Not permitted except for low power safety transformers, such as shaver units.

Zone 1. Permitted only if a safety transformer is used (this, of course, would include the use of shaver units etc.)

One further aspect mentioned in the question was whether a laundry could be classified with a bathroom. I feel that bathrooms should be regarded as more dangerous than laundries because persons must of necessity be barefoot and in large scale contact with water - not the case in a laundry. As a consequence their body resistance may be exceptionally low as far as susceptibility to shock is concerned.

May I leave these thoughts with the meeting for consideration?

Mr. D.F. Kneale E.C.A.: The E.C.A. considers that the socket outlet should be allowed in the bathroom, provided it is suitable protected by an earth leakage relay. When one considers that the cost of installation of dual voltage shaver socket outlets in hotel bathrooms could be reduced by the use of a common auto-transformer, protected by an earth leakage unit, then further consideration in this regard should be given by the S.A. Bureau of Standards Committee dealing with the revision of the wiring code. Thank you.

QUIZMASTER JOHN MORRISON

Question Number A2 has been submitted by Mr Murphy of Somerset West. Would you like to give your contribution Mr Murphy?

Mr. K.J. Murphy Somerset West: I would just like to know what the advantage or disadvantage of the two systems are. Thank you.

Mr. R.W. Barton Welkom: I think that an entire paper could be written in reply to this question.

The earthing of the neutral at a consumer's premises is usually resorted to when other forms of earth, such as buried plate electrodes, cannot be relied upon to pass sufficient current, in the event of an earth fault, to operate the protective circuit breaker or fuse.

At the same time the supply authorities neutral is earthed at a number of points in an attempt to reduce the resistance to earth of the neutral to a low value, 2 ohms being a generally accepted figure.

The object of the exercise is to ensure adequate earthing of non-current carrying metalwork on the consumer's premises and so obviate conditions dangerous to life and property on the occurrence of an earth fault.

The question asks whether a system of neutral earthing should not be standardised on.

I am of the opinion that it should, with the proviso that another reliable earth should also be provided by the supply authority. This could take the form of cable sheaths and armouring, in the case of underground systems, or a special earthing conductor run on the poles, in the case of overhead systems. This earthing conductor should be equal in current-carrying capacity to the neutral, which in turn should be the same as the phase conductors. Neutral and earth conductors should be connected together at all convenient points.

I believe that in this country, of periodic droughts, no reliance whatever can be placed on buried plate or rod electrodes for earth fault tripping purposes and all-metal water mains are a thing of the past and no longer available to us for earthing purposes. The system of neutral as earth plus an earthing conductor, which is permitted in terms of the Standard Wiring Regulations, and which is in effect not earthing at all, but bonding, provides a reliable belt-and-braces method of routing earth fault currents back to the supply transformer neutral point, thus ensuring clearance of the fault by the protective circuit breaker or fuse. Further a broken neutral or earth conductor does not cause a dangerous situation to arise.

This arrangement has worked in Welkom since 1950, so far without any ill effects.

It would be interesting to hear from Engineers operating the other type of system mentioned in the question, that is where the neutral is insulated throughout and earthed only at the supply transformer. Do they find any advantages inherent in this system as compared with the multiple earthed neutral system? The use of core balance earth leakage relays perhaps reduces the need for protective multiple earthing, but a broken neutral can still have disastrous results with the insulated neutral system.

Mr. D.H. Fraser Durban: Mr. Quizmaster just in response to that invitation from Mr. Barton, Durban does indeed operate with the system of a separate earth wire on its low voltage distribution and the neutral earthed only at the transformer end. To my way of thinking if you are going to run a separate earth wire there is no need to bond the neutral conductor, because in event of a broken neutral, as I see it, you do run the risk of channelling your neutral current back through the consumers earth electrodes and while this might not do any harm provided you have sufficient or adequate cross section it does mean that you won't detect the presence of a broken neutral. In fact in practise the problems arising from broken neutrals have been insignificant and I would advocate either one system or the other. The protective multiple earthed system and then you omit the earth conductor thereby saving in your distribution mains or you run an earth wire. Thank you.

Mr. A.H. Fortmann Boksburg: Actually I feel that the neutral should be earthed at the consumer's premises and the question put here was should we standardize and I feel some form of standardization would be welcome and should be pursued. If the neutral is earthed at the cable end it's easier in a box entering the house as is the case in Boksburg we require a contractor to run an earth wire back from the neutral from the distribution board to the earth terminal where the council's neutral is earthed and this gives an alternative earth should the earth connections to down pipes or water pipes be removed due to plumbers working and so on. Then there is the safety of the earth connection from the terminal in the distribution box back to the council's earth point where the earth and neutral are coupled. Thank you Mr. Quizmaster.

Mr. J.V. Grant S.A.B.S.: Thank you Mr. Quizmaster, from the point of view of your wiring regulations and the contractor, forgetting about all you chaps here, what the regulations and the installations want to see is I think a standard thing. In other words when you have an earth point for the installation it does not matter how you bring it there but I think it should not be a consumer's responsibility to put in something which he can mess about with. It should be an earth point provided by the supplier in each installation. I'm sure this has been discussed many times before but this is how I see it and I haven't heard the previous discussions. Please standardize on having an earth point for the installation never mind what you do. Thank you.

Mr. W. Barnard Johannesburg: Mr. Quizmaster we in Johannesburg are strongly opposed to multiple earthed neutral system. Our experience is that it can create a dangerous situation. We firmly believe that the only solution is to run a separate earth from your transformer which is earthed by means of an earth plate to each consumer. In the case where you have a multiple earth neutral system and you get a break of the neutral on the supply side it means that the neutral currents now flow back to your earth point via many deviant parts and we have in actual fact found in Johannesburg that under those circumstances you can get dangerous potentials on water taps, fences, gates, poles any spurious parts which the neutral current chooses to take back to the transformer.

Mr. E. de C. Pretorius President: Mr. Quizmaster just in reply to Mr. Barnard's remarks, the problem can be overcome by using a split neutral.

Mr. K.J. Murphy Somerset West: Could we perhaps by show of hands determine how many undertakings represented here today actually insist on the earthing of the neutral on the consumer's premises. This is basically what it involves. I am not advocating an isolated neutral system but whether or not you insist on the earthing of the neutral on the consumer's premises.

Mr. J. Morrison Quizmaster: May we leave this question here gentlemen and the determination of what to do to individual municipalities. Thank you.

QUESTION A3 Mr. W. Barnard Johannesburg: Before I discuss this question I wish to comment that I tried to use the shaver socket outlet in my bedroom this morning. It was fitted to the dressing table and it did not operate. On examining it a bit more closely I found it was not connected, it must be in zone one apparently. Mr. Quizmaster regulation 226F of the Standard Wiring Regulation requires earth leakage protection to be fitted on lighting a socket outlet circuits in domestic premises, hotels, boarding houses, blocks of flats. We have since applying this regulation had many complaints, we have a number of problems. If I can just give you two examples very briefly. We had one case of a lady in Greenide who could not keep her earthleakage relay in and over the long weekend she could only have it repaired by Monday by then she had lost a complete deep Freeze full of meat valued at about R300.00. The fault was found to be a faulty neutral in the lighting fitting in the bathroom. Now this is quite a difficult thing to detect and the contractors were not prepared to try and prepare this over a long weekend. I then had a second case which was the Milpark Holiday-Inn where they had a faulty heating unit in one of their kitchens and this kept tripping out the earthleakage. This resulted in tremendous inconvenience because it even tripped out the emergency lighting in that hotel. My contention is that there is absolutely no justification for protecting lighting circuits with earth leakage relays. I took out some statistics in Johannesburg between 1942 and 1973, that's for approximately 31 years, we had 91 electrocutions. Of these only three were on the light circuits, the one was caused by the victim working on the light circuit in the roof space, the other two were caused by plugging in to the light adaptor some other appliance. My contention is that this could happen on the older installations where earthleakage protection in any case is not compulsory. But in a new installations where we no longer permit this type of lighting where you have a piece of cord dangling down from the roof with the lamp holder at the end of it. I think that the probability of using this for appliances is very remote particularly where you have adequate number of socket outlets. I believe that this matter is receiving attention and it is my view that compulsory earth leakage protect only applies to socket-outlets, although I fully agree that we should encourage consumers, wherever possible, to put earthleakage protection on their whole installation.

Mr. D.F. Kneale E.C.A.: The E.C.A. supports any move to eliminate earth leakage on lighting outlets on all domestic installations.

Mr. Jules von Ahlfen Quizmaster: Thank you Mr. Barnard. I think the Bureau will agree that this is more or less the approach as Mr. Barnard summed it up and this does also answer our question.

QUESTION B1. Mr. E. Trautmann Ladysmith: The present respective regulation 40(F) emphasizes the rigid mechanical continuity of conduit, joints and accessories and demands the approval of the supply undertaking.

Since Ladysmith has got its reservations in respect of allowing non-metallic conduits I am concerned about the attempt to enforce any code of practice to become compulsory to member engineers.

I feel that members should be asked in a questionnaire to submit suggestions in respect of expansion joints, flexibility of conduit boxes, fixing of tubes etc. before a specification is drawn up.

Mr. J.H. Fieldhouse Affiliate: Should a code of installation practice be issued by the S.A.B.S. as an amendment to S.A.B.S. 950 - 1969 for P.V.C. Conduits would members consider enforcing such a code of practice until such time as it is incorporated in the new wiring regulations?

The South African Bureau of Standards have over the years issued various codes of practice for the use and installation of materials to ensure that these materials are used and installed in accordance with sound practices.

An appendix C was issued as a supplement to S.A.B.S. 791 - 1975 for U.P.V.C. sewer and drain pipes and fittings and reads:- This appendix should be considered as a detailed supplement to S.A.B.S. publication 0112 and 058. It's purpose is to indicate the practices that should be followed to ensure that U.P.V.C. sewer and drain system are assembled and laid in a manner such as to ensure trouble free service.

While S.A.B.S. 950 1969 governs the manufacture of P.V.C. non metallic conduit and accessories for use in electrical installations no code of practice for the correct installation exists. The plastic conduit manufacturers association have requested the S.A.B.S. to issue such a code of practice as an appendix to S.A.B.S. 950 prior to when such a code is incorporated in the new standard wiring regulations. The S.A.B.S. have agreed to this and machinery is in motion for it's publication.

Most local authorities accept the use of P.V.C. non metallic conduit systems provided it carries the S.A.B.S. mark and is installed in accordance with the standard wiring regulations. The technique and workmanship is left to the installer and in many cases the manufacturers installation recommendations are not adhered to.

The result is an installation in which there is a lot left to be desired regarding workmanship.

The preamble to the standard wiring regulations emphasises this point and South Africa has a very good record for sound engineering, design, and safety precautions both in material and methods.

It is estimated that approximately 8 million metres of P.V.C. conduit is installed in South Africa annually and it is felt that when a code of practice for it's installation is issued by the S.A.B.S. Municipal Engineers give serious consideration to it's implementation by incorporating such a code in the local bye-laws governing electrical installations.

Mr. D.F. Kneale E.C.A.: Mr. Quizmaster, thanks for the opportunity to say a few words. The electrical contractors are of the opinion that more use could be made of plastic conduits. We know that there are problems such as inadequate supporting and workmanship of the actual bending of the conduit, the laying of the conduit, but more effective utilization of this more efficient method of doing the job could be made. We will support any code or practise or directive that is being formulated or is to be formulated to put this into operation. Thank you.

TEA INTERVAL - TEEPOUSE

QUESTION B2. Mr. C. Lombard Germiston: This question has been posed in view of the following:

- (i) That lower prices are often tendered when calling for public tenders and that it is often found that lower prices are offered for the same items when calling for quotations instead of public tenders.
- (ii) That claims in respect of local content and preferences are, in many instances, often exaggerated but that it is virtually impossible for this to be proved by the local authority. Such tenderers thus gain an unfair advantage over their competitors.
- (iii) That tenderers offering equipment first being introduced on the local market, but as yet untried under local conditions are often submitted at prices considerably below those of other tenderers in order to get a leg in. In terms of the Local Government Ordinance the local authority is obliged to accept the lowest tender unless reasons why the lowest tender should not be accepted can be advanced to the Administrator. However, in the case of newly introduced equipment it is often impossible to submit such reasons based on solid grounds.

Of course, once bought and found to be inferior or unsuitable in service, there would be sufficient reason for rejecting future tenders for the same equipment.

The point is therefore that the local authority is often forced to buy untried and unproved equipment and only after going through the costly experience of finding the latter unsuitable, can it take the necessary steps on future occasions to obtain permission to buy the same equipment.

A further point is that once such a tenderer has established a local market for his equipment, his prices are often raised to such an extent that even if his equipment is acceptable, it is no longer competitive. The local authority is then landed with a relatively small quantity of an odd make, and possibly design, of equipment which they spare must be carried. This draws attention to another disadvantage under the present system, namely that it makes it virtually impossible to carry any degree of standardisation into effect.

There are certain sound reasons for the calling of public tenders but it is questionable whether under the present system, the disadvantages do not outweigh the advantages.

Mr. M.P. Clarke Newcastle: In the first instance the reference is to the existing system whereby local authorities are compelled to call for tenders for contracts above a certain value and in the basic principle I see no disadvantage. In fact, I believe it keeps us all on our toes—we the buyers, by having to spell out our requirements clearly, which implies that we have to get our definitions right and our ideas straight and for the sellers, I believe it keeps the competitive spirit alive and healthy by virtue of the need to keep an accurate control of their costing and pricing.

I don't deny that Mr. Lombard has a point that these things can be manipulated, are often difficult to check and therefore of questionable value. I would leave it to that.

In practice the disadvantage arises from the time-wasting processes that are really the fault of our Council procedures; unless each local authority puts its house in order with proper delegation of authority and so on, there is no doubt that problems can and do arise. These should be tackled at the source and rectified.

Which leads me to a serious problem related to the first one. This is the definition of "a certain value". The Natal system is based on a R2 000 ceiling and in my view this is far too low to be realistic and practical. The erosion of the buying power of money is such that doubling the amount could easily be justified and this could be the time and place for us to come forward with practical steps to rectify the matter. I recommend this to the convention for consideration.

The second part of the question I identify as being "compelled to accept the lowest tender after certain preferences". I have no quarrel with the adjustment for local content—this can only be for the benefit of our country by virtue of the stimulation of our industries, our economy and employment conditions. Whether the current levels of adjustments or the method of applying them are reasonable or adequate, I have personal doubt, but this should be reviewed to ensure that it still serves the purpose for which it was intended and I think this is the point that Mr. Lombard has amplified in his introduction this morning.

Let's look at this by all means. But let us not say that it does not have a place in this whole matter. Some of our affiliate members should be asked to comment at this particular point.

My real query under this part of the question is related to the words "compelled" and "lowest". Now, in both the Cape and Natal provincial systems under which I have worked, I have invariably been able to persuade my Council to accept tenders other than the lowest tender where my reasons and motivations have been adequate. That is not to say I always recommend tenders that are not the lowest tender; I emphasize where special circumstances exist and these tenders can be shown to require particular equipment or works to serve the best interest of the community, my experience has been that Councils will and do take these factors into account. From my own personal experience, I can say that if there is no new equipment and I am unsure of the actual application to my particular requirements, I would not hesitate to use this as motivation in my recommendation and I have not found a Treasurer or Auditor who has thrown everything out on that particular score.

In conclusion therefore, Mr. Quizmaster, I believe that the system is basically acceptable but it needs to be reviewed in the light of modern circumstances both in respect of values and procedures and therefore I say it serves a practical purpose, but that we should clean it up.

QUESTION B3. Mr. C. Lombard Germiston: I think the question is quite clear and does not require any further elucidation. It is, of course, realised that this matter is also tied up with the system fuel level and the current-time characteristics of the overload protection provided for the cables. Thank you.

Mr. F.J. Prins S.A.B.S.: Up to about 1970 the distribution cables installed would have been manufactured in accordance with either the Imperial version of S.A.B.S. 97 or with B.S. 480. These specifications are very similar to those of the Electrical Research Association of Great Britain published methods for the calculation of the cyclic rating factor and emergency loading for cables made to B.S. 480 laid direct in the ground or in ducts in reports Refs. F/T 184, F/T 190 and F/T 192 and in two papers based on these reports. These methods are summarized in a form convenient for direct use in Report Ref. F/T 186. There is as yet no equivalent for cables manufactured to the new metric specifications, but the information given in the above reports could be adapted as

necessary. It should be noted that there is no emergency rating for cables installed in air.

1. ERA Report F/T186 details methods of calculating the cyclic and emergency short time ratings of underground cables installed by direct burial or in single way ducts.
2. The calculation although simple, is somewhat tedious to undertake. If a circuit is likely to be run at an emergency rating in excess of its "continuous current rating" it would be well for the engineer to prepare curves of permissible overload against time in anticipation of the emergency situation.

3. One general set of curves for all cables cannot be produced as the degree of overload permissible is dependant on:

- a) The type and size of cable
- b) Soil T/R
- c) Soil Thermal Diffusivity—Soil T/R x density x specific heat
- d) The load history over the previous 24 hours.

4. If the load has been fairly constant—for example if the cable has been run at say 'x', of its rating then it is possible to prepare a set of curves as in fig. 1 showing the permitted overload for 1, 2, 3, etc. hours following a long period at 20%, 40%, 60%, 80% of normal full load rating.

5. The daily load cycle is known, it is possible for the cable to be run during peak periods at a load in excess of its normal full load rating. If for example the daily load cycle were a peak period of X hours followed by a normal load of (24 - X) hours at q x peak load, then the permissible overload for the X hour period can be read from figure 2.

6. For other more complicated load cycles the report details methods of calculating the cyclic rating factors which can enable significant economies to be made in the selection of cable feeder sizes on new installations, or allow existing circuits to be uprated if they were designed on a normal full load rating basis.

7. Most cable runs will have short "in air" lengths at each end of the run. As the "in air" rating is sometimes less, sometimes more than the "direct buried" rating depending on relative values of air temperature, soil T/R etc. it would be unwise to consider emergency or cyclic ratings if these "in air" sections are a significant length. Probably a length of say 15 metres would be safe, but it would be wise to calculate the conductor temperature of the end sections or perhaps provide additional forced cooling.

Mr. D.H. Fraser Durban: Mr. Quizmaster, I presume the enquiry relates to High Voltage cables because the size of low Voltage cable is normally determined by consideration of voltage drop. In respect of High Voltage cables, I would suggest that the design should be based on cable rating under average conditions and any benefit from cyclic loading or good installation environment regarded as a sort of bonus to cater for overload conditions, which invariably arise due to growth of load or abnormal weather conditions. By experience, cables in use for distribution up to 11 kV are able to withstand relatively rough treatment and failures in service due to thermal overloads are very unusual.

The art of power distribution is not highly precise and the examination of all factors as suggested, to determine the exact capability of the cable, would be beyond the normal resources of control room staff when emergency conditions arise. In the case of very important feeders to which Mr. Palser has referred, it may however, be wise to undertake advance calculations in this regard.

Mr. S.G. Hancock Affiliate: There is no doubt that in the past the current carrying capacity of power cables for continuous (or preferably "sustained") loading, has been a predominating factor in system planning, with little attention paid to the effect of fluctuating load cycle patterns. These leave their cables effectively under-employed for a proportion of their active life, and it is right to improve this, not only under the current economic climate.

The sustained current carrying capacity of a power cable is calculated by balancing the internal PR loss at a predetermined maximum conductor temperature against the thermal dissipation to the ambient, whether in ground or air. The conductor temperature is a characteristic of the dielectric material determined during development of the cable design to give an extrapolated life of 20 years or greater. The number of cables which operate satisfactorily for far longer service lives is some measure of their effective under-utilisation due to load factor effects.

Methods of calculating factors for cyclic loading on cables laid direct or in ducts were developed by the Electrical Research Association in the UK some years ago, based on the essential principle of not exceeding the maximum conductor temperature for sustained continuous loading. The calculation is simple in mathematical terms and is unique to the load cycle profile involved, but it requires reference to tables of auxiliary functions related to the thermal properties of the ambient soil and steady state temperature rise ratios for the size of cable concerned. Metric versions of these tables are unknown at the present time, but are likely to be capable of interpolation fairly readily.

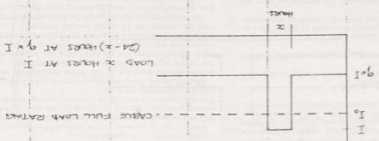
As the method is based on a regularly repeated 24-hour load cycle, in theory the whole of the cycle needs to be taken into account. The calculation can, however, usually be reduced without loss of accuracy, to a 6-hour period immediately prior to the point of maximum core temperature together with the rms value of the whole cycle acting over the previous 18 hours. The time of maximum core temperature can fre-

CABLE 6350/11000 V 3c 95 mm² (0.15 W) PLC SWMS

SOIL T/R 1.2 °C m/W

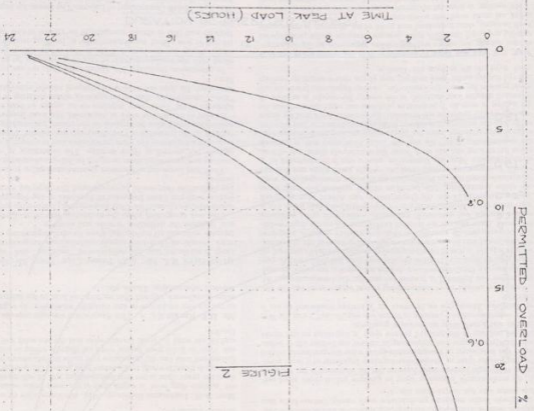
SOIL THERMAL DIFFUSIVITY 2×10^{-6} m²/s

DAILY LOAD CYCLE



$$\text{PERMITTED OVERLOAD} = \frac{I_0}{I - I_0} \times 100\%$$

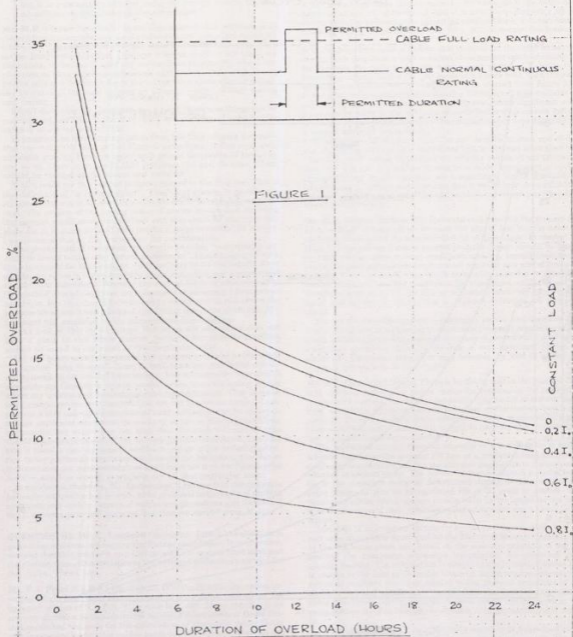
FIGURE 2



CABLE 6350/11000 v 3c 95mm² (0.15in²) PILC SWAS

SOIL T/R 1.2 °C m/W

SOIL THERMAL DIFFUSIVITY 2×10^{-6} m²/s



quently be determined by inspection of the load cycle, or at worst by a trial calculation.

Loading conditions consisting of regularly repeated periods of current flow of constant magnitude alternating with reduced or zero loading are particularly simple to assess, although reference to further tables is still required.

"Emergency" loadings based on a conductor working temperature above that for sustained loading should be approached with considerable caution as the effective service life will almost invariably be reduced.

Mr. H.F. Forsyth Affiliate: As the question indicates continuous current-carrying capacity of underground cables is comparatively readily available in tabular form. It must be emphasised however that any such tabulation is based on stated environmental conditions and deviations from these can modify current ratings. The question is however surprising in that the subject of cyclic or intermittent loading of underground cables is well documented and provided the necessary data is supplied the extent to which cables can be uprated for limited periods in specific circumstances can be calculated. In general the crux of the matter and basis for all such calculations is that the conductor temperature must not exceed the maximum recommended operating temperature applicable to the dielectric system. The information necessary to enable the required calculations to be made is briefly as follows:

1. Cable or feeder under consideration.
 2. Method of laying i.e. direct in ground or in ducts, depth and number and proximity of other cables.
 3. Soil constants to be used i.e. thermal resistivity and thermal diffusivity.
 4. Shape of applied load over a 24-hour cycle.
- With the above information it is then practicable to determine a revised rating for the cable in question under the specified conditions.

VRAAG B4. Mnr. P.J. Botes Rooipoort: Ek wonder net mnr. die Vraaag in hoe 'n mate in die praktyk toestemming geva word van die Raad soos verskeie werk ingevolge artikel 62 van die Transvaalse Ordonnansie op Piasaleke Bestuur? Ek verys in die geval na ons eie T.V. Ster, maar dit is seker omdat by nie toestemming ingevolge hierdie artikel geva het nie waarom by sonder sy bekende Bange-sjarme opgetre het. Volgens my sienwyse verkie artikel 62 nie die persone wat private werke doen nie maar lê sekere voorbehoude neer. Dit mag eger deur Stadsrade so gelees word asof hierdie artikel privaatwerk in sy geheel verbied. Die Stadsrektoragniese Ingenieur kan in verskeie hoedanigheids buite werksure produktiewe werk verrig, indien hulle dan nie ander iets het om te doen nie, nl.:

1. As professionele Ingenieur waar in gedagte gehou moet word eerstens teken van professionele fooie en dat dit ongewens is om werke te beplan wat by later as Stadsrektoragniese Ingenieur self moet goedkeur. Dit is miskien in laasgenoemde geval waar die genoemde artikel van die Ordonnansie van toepassing is, en wel om beheer uit te oefen. Dit het onlangs in die praktyk gebeur waar 'n Ingenieur na-ure werke beplan wat hyself later in werksure goedkeur.
2. As verantwoordelike persoon in terme van regulasies C1 van die Wet op Fabriek, Masjinerie en Bouwerk vir 'n kleiner Stadsraad en vir 'n fabriek.

In hierdie gevalle moet toestemming vooraf verky word van die Departement van Arbeid. Dit is eger bekend dat die Johannesburgse Afdeling van die Departement van Arbeid nie geneë is om sulke aanstellings goed te keur nie. Hierdie aanstellings dien hul doel want ek persoonlik was vir 'n jaar of twee aangestel as verantwoordelike persoon vir die Stadsraad van Meyerton waar ek wel leiding verky en dit is 'n moeilike oorgangspunt. Voordat 'n verantwoordelike persoon aangestel kan word. Daar was net nie iemand beskikbaar nie en die ongekwalifiseerde persone wat gewoonlik waarnaem, vorsaarsak groot probleme waaronder die betrokke Stadsrade vir jare gebukkend mag gaan. Dit is miskien noodsaaklik dat die Departement van Arbeid hom uitspreek oor sulke aanstellings. Die betrokke artikel verbied nie werk buite munisipale diens nie. In Rooipoort en in ander munisipaliteite word vryelik toestemming verleen veral ten opsigte van lesings aan kolleges en universiteite. Mnr. die Vraesteller, weet u 'n Stadsraepiek in 'n vaste betrekking wat nie werk buite die munisipale diens met of sonder toestemming doen? Ek voel dat enige Stadsraad wat 'n aansoek weier sonder grondige redes is hul plig ten opsigte van landsbelange versak. Aan die anderkant is dit wel belangrik om beheer te kan sittoefen op die gewenste praktyk uit te skaal. Bykomende werk hoef nie buite die rigting te wees as 'n persoon se profesie nie want die werk wat by uiteraard deeglik kan aanbid, is die waarin hy opegeel is en soos ek reeds genoem het mnr. die Vraesteller, as daar Ingenieurs is wat na-ure nog tyd het om ander werk te doen, sien ek nie rede waarom by verbied moet word om dit te doen nie. Dankie.

Mr. A.J. van den Berg Krugersdorp: Wat die eerste vraag betref is ek van mening dat indien wetsrektoragniese, ingenieurs en tegnisi aangehoedig sou word om buite hulle gewone werksure ander produktiewe werke te verrig, daar inderdaad met groot oë na, se maar, 'n organisasie gekies sal moet word wat soetsi steestaan.

My mening is gegrond op ervaring insover dit selfdiscipline vey om jou primere taak nie te verwaarloos ten koste van 'n sekondere taak nie. Wanneer 'n mens in 'n beskermende posisie werk en jou organisatoriese struktuur sodanig is en al jou aandag word in beslag geneem deur jou werk, dan meen ek jou 'n goeie balans verky. Die omge-

keerde is eger ook waar wanneer 'n organisasie so beman word dat slegs 'n gedeelte van die mannekrag doeltreffend benut word, dan raak die balans versterk. Mense is onder die indruk dat hulle nou nog iets by hul normale pligte kan doen en dit dui vir my op 'n ongesonde toestand.

Ek dink ons kan net drie keer 'n dag eet, eenkeer op 'n dag in dieselfde bed slaap en ook slegs eenkeer 'n werk goed doen onder normale omstandighede.

Indien ons mense kans sien om meer as een werk doeltreffend te verrig gedurende 'n 24 uur dag, dan meen ek moet ons weer ons eie werksituasie analiseer om toe te sien dat daar genoeg werk is vir elke man. Slegs dan sal ons produktief wees. Moontlik sal ons dan vind dat mannekrag beskikbaar sal word om die ander produktiewe werk meer produktief te verrig.

Ons moet onthou dat hoer produktiwiteit verky word deur meer werk met minder mense goed te kry - en ek dink ons moet eers by onself begin.

Mnr. E. Trautmann Ladysmith: Mnr. die Vraesteller, ek is teen die voorstel, en om die volgende redes:

Hedendaags is die werk van 'n Stadsrektoragniese Ingenieur as gevolg van personeletoekort so stremmend, dat selfs jonger mense die ontpanning na ure nodig het om fiks te bly vir die volgende dag se pligte. Hoeveel ingenieurs moet hulle diensure nie nog verleng om tred te hou met die ophopende werk nie.

Ek dink dat die Raad die enigste is wat kan bepal of sy ingenieur nie te hard gedruk word nie, of alle pligte onmiddellik nagekom word en dus toestemming vir bykomende buite munisipale werke gegee kan word. Ek sal lewers aan die hand doen dat ingenieurs wat saams nog nie te moeg is nie, die werk vir die Raad aanpak, wat baie dikwels aan raadgevende ingenieurs oorgeel word alhoewel onseël bekwaam genoeg vir meeste van die werke behoort te wees.

Die besparings vir die dorpe sal die inflasiedruk vermind. Miskien kan die stadsrade ook eendag oortolk word dat so 'n werkende personeel 'n spesiale waardering verky.

Mr. J.L. McNeil Kokstad: Mr. Quizmaster I can't believe that any municipal engineer could find the time to do what is envisaged in this question before us and in fact I would say that if it starts with the top people it will go right down and you will find that your electricians and your cablejoiners are also going to take their time to doing extra mural work so therefore I strongly oppose any move to permit any employee of any category what so ever to undertake any extra mural work of this nature. Thank you.

Mnr. A.H. Fortmann Boksburg: Mnr. die Vraesteller ek weet nie of dit 'n goeie ding is of 'n slegte ding is om werk buite normale ure te doen nie maar daar is net een kommentaar wat ek wil maak en dit is hoekom is daardie vraag in die eerste plek gestel. Dit is seker omdat ingenieurs van baie van die ingenieurs vullie hulle wil iets ekstra bui vir hulle sak. Nou as hulle goed betaal word sal daardie vraag in ek geval nie opduik nie want hulle sal tevrede wees met die een werk wat hulle het. Dankie.

Mr. D.F. Kneale E.C.A.: This Association strongly opposes any move to permit any employee of any category whatsoever to engage in any extra-mural work beyond that required of him in his normal Master-Servant relationship. Thank you.

QUESTION B.5. Mr. D.C. Palsler Cape Town: Mr. Quizmaster, there is no doubt that the definition of "building" and "excavation" work, insofar as electricity supply undertakings are concerned, is extremely wide and all embracing. Even for civil engineering contractors and engineers the definition is wide and onerous.

This was recognised when the regulation was promulgated and the South African Council for Civil Engineering Contractors lodged an objection with the Chief Inspector of Factories at the time pointing out the difficulties that would be experienced in complying with this regulations.

The Chief Inspector of Factories granted exemption to building contractors and permitted them to report building and excavation work at periods not exceeding three months. The contractor is required to maintain a register of the work undertaken and to submit a copy of this register to the Inspector of Factories every six months. Presumably this concession could also be applied to electricity undertakings.

Insofar as excavation work is concerned, the local Inspector of Factories in Cape Town only requires us to report to him all cases of "deep" excavations, that is, for instance where shutting of trenches is necessary. He does not require us to report normal excavation work to him.

In conclusion, therefore, Mr. Quizmaster, I do not see any real problem with the implementation of this Regulation as far as electricity undertakings are concerned. I think that when this regulation was framed it was aimed more specifically at building contractors rather than us and that it should accordingly be viewed in this light. Thank you.

Mr. A.A. Weich Department of Labour: The reason for Regulation A6 requiring that building activities shall be reported to the Divisional Inspectors of Labour is because approximately 200 persons are killed annually on building work. We therefore want building activities to be reported in order to be able to check up on the sites.

QUESTION 88. Mr. A.A. Smith Port Elizabeth: Mr. Quizmaster, I'd like to mention a few points on Question 88 which may help members formulate an opinion. The first point is one I am sure all members will be aware of. That is although municipalities may purchase power at the same tariff the actual cost per unit would depend on the system load factors, which of course may be different. Other factors which would give rise to a different cost per unit would result from their different cost structures, which depend on their different capital requirements, system power losses, salaries and wages to mention but a few points. And this is where we come to the contentious matter of profit. Many Municipal Electricity Departments make a contribution towards the relief of rates and carry the entire burden of street lighting. Now profit I would call the difference between running expenditure which includes capital charges and income. From the Annual Reports of a few cities in the Republic that I have seen a contribution towards the relief of rates is in the order of 8% of the income and I would go along with that. I also feel that Municipal Electricity Departments should make a contribution to a capital development fund of about 2% of the revenue. The total profit therefore would be in the order of a 10%. In conclusion I would like to remind members that most Municipal Electricity Departments are a monopoly and I mention this hoping it will have a sobering effect to any possible excessive demands for profit.

Thank you Mr. Quizmaster.

Mr. E. de C. Pretorius President: Ek sal baie kort wees. Die eerste saak is wat word beskou as wins? Is dit die bedrag wat aan die algemene fonds oorbetalend word op belatings te verlig of sluit dit ook die bedrag in waaruit sekere kapitaal projekte gefinansier word. Ek gaan my net oetspits op die wins wat toegewys word aan die algemene fonds ter verligting van belasting. Eerstens is dit gereverdig? Ek se ja.

Die tweede punt is wat beskou lede as 'n aanvaarbare en 'n redelike winsgrens. Nou hierdie winsgrens moet myns insiens gekoppel word aan die verhouding van nie-belastbare eiendom tot die totale waardasie van 'n sekere munisipaliteit. Ek kan van onderverinding praat wat ek kom van 'n dorp waar hierdie verhouding eintlik buite verhouding is en in Potchefstroom is dit die nie-belastbare waarde van eiendom R58 miljoen teenoor 'n totaal van net iets or die R200 miljoen. Dit is nou munisipale eiendom uitgesluit. U sien dit is 'n geweldige hoë verhouding. Die Stadernad is aangewese op 'n sekere bron van inkomste wat baie heperk is. Die vernamste bron van inkomste is eiendomsbelasting. En as jy nie eienom het om te belas nie waar gaan die inkomste dan vandaan kom. Dit kan alleenlik kom uit die winste wat jy maak op dienste. Ek wil graag 'n gedagte in u midde lê en dit is dat die profyt as 'n persentasie van die totale uitgawe van die water en elektrisiteitsdepartement of enige dienste departement bereken word as $p = x + 5\%$ waar x die verhouding is in persentasie van nie-belastbare eiendom tot totale waardasie.

Mr. W. Barnard Johannesburg: Mr. Quizmaster I'm sorry to disagree with the President. I should say that the Minister of Economic Affairs and myself would both disagree with him. I feel that he is trying to solve one problem by creating another problem. The problem is that Local Authorities have an inadequate provision of other services, essential and non-essential. The solution is to find other sources of income. Now it is not right to say that the only source is from services. There are at least 25 different sources of income which are not open to local authorities at this stage. Just to mention one would be a tax on petrol for the provision of roads. I don't want to go into detail but my feeling is that this local authorities should make a profit of something like 10% on electricity undertakings, surely for the development of the electricity undertaking. Thank you.

Mr. D.C. Palsler Cape Town: Mr. Quizmaster, I am afraid I do not agree with Mr. Barnard.

It is quite possible that, notwithstanding the fact that municipal electricity undertakings may obtain their electricity in bulk from Eskom at a common tariff rate, their individual tariffs may differ, one from the other.

This difference need not necessarily reflect different profit margins but could conceivably reflect certain other factors in their cost structures that are not the same from undertaking to undertaking, possibly because of differences in reticulation philosophy or in the relative sizes of the undertakings. There is no doubt, however, that municipalities are using their electricity undertakings, to varying degrees, as taxing machines. After all, the running of towns and cities has to be financed and the only sources generally open to municipalities are through taxation on property and to a lesser extent on electricity and water. It is generally accepted universally, including South Africa, that it is fair and equitable for electricity undertakings to make some contribution towards the running of towns.

You might recall that some time back the Government appointed Borckenbagen Commission reported, in a White Paper, on the financial relations between the central government, the provinces and local authorities. One of the conclusions they reached in respect of trading and utility services was the "reasonable" surpluses should be available for transference to general revenue in the relief of taxation. At the time, as stated in the White Paper, the Government accepted in principle the findings of the Committee but, as Mr. Barnard has mentioned, the Minister of Economic Affairs in January this year was quoted as stating that he considered this to be unhealthy practice. I

think the Minister has instructed the Administrators of the various provinces to investigate the matter. It is possible that he perhaps was not aware of what was written into the Borckenbagen report nor what the Government's view was at the time. So there would appear to be some contradiction here in Government policy. I believe, however, that the United Municipal Executive is looking into this matter.

Nevertheless, it is generally accepted that the transference of reasonable surplus to the relief of rates is the right and proper thing to do. The philosophy behind this is that there are generally far more consumers of electricity than there are ratepayers. Accordingly, dilution of the relatively heavy burden on ratepayers is transferred in diluted form to the electricity consumers thereby enabling the financial burden of running the City to be borne by all individuals, be they ratepayers or electrically consumers.

I agree with Mr. Barnard that if this money could be found elsewhere it would be a good idea. If local authorities had alternative sources of taxation open to them, such as taxation on petrol or motor cars, for instance, the position would be eased.

In the paper delivered by Dr. Cowden at last year's A.M.E.U. convention in Durban and entitled "Capital Budgeting", Dr. Cowden presented a table scheduling the contributions made by 270 electricity undertakings in South Africa to the relief of rates. These contributions ranged from a few percent to well over 100 percent, with the medium around 25%.

We in Cape Town contribute about 12% of our income on Revenue Account with further contributions of about 3% each to a Tariff Stabilization Fund and the Consolidated Capital Development and Loans Fund. I understand Durban contributes about 7%, Johannesburg 7%, Port Elizabeth 5% and Pretoria 2%. Perhaps I should not have quoted these figures as they appear low relative to Cape Town's 12%.

In conclusion, Mr. Quizmaster, I would express my personal view that I consider that a profit margin of around 5% to 15% would not be an unreasonable contribution to make from electricity to the relief of rates.

Mr. K.J. Murphy Somerset West: Mr. Quizmaster, I would just like to draw your attention to the fact that where electricity reticulation systems are taken over with the permission of the electricity control board a profit of 10% on the cost of electricity is permissible. This seems to be a reasonable figure. I don't agree with my friend Mr. Palsler when he goes up to 15%. You know for years certain countries have been making a good profit out of oil. Now the Arabs have gone wise and we are all crying. I'm not suggesting that ESCOM are going to be like the Arabs, but it is pointless complaining about the price of electricity if you have been making handsome profits on them.

Thank you.

Mr. W. Barnard Johannesburg: I just want to give you some brief information Mr. Quizmaster. It was about four weeks ago that I went down to Cape Town with a delegation to see the Minister of Economic Affairs to discuss this question of profits on electricity. After having listened to him for an hour and not being given the opportunity to make any remarks he told us that he has now decided that the status quo will be maintained until the Brown Commission have investigated all sources of income for local authorities.

Mr. K.G. Robson President Elect: I am going to try very hard to speak like a councillor, Mr. Quizmaster!

It seems to me that Mr. Barnard is skating over the question of the responsibility of electricity undertakings with his 10% which he wishes to allocate for use purely by electricity undertakings.

Obviously we have some measure of responsibility financially in that we make use of a good deal of Municipal ground for substations, cables, etc. But I have come to the conclusion that perhaps the A.M.E.U. has neglected somewhat this matter of an undertaking's responsibility to the General Rate Fund. I think we have not given enough guidance to treasurers and councillors.

We find that many figures are quoted and one cannot be sure if percentages of total General Rate Fund income or of just income from the rates are being quoted. I suggest that we should ensure that not only treasurers and councillors and even the Minister of Economic Affairs are expressing opinions on the matter.

This Association should endeavour to give some guidance as to what might be a reasonable scientifically calculated contribution, as the financial responsibility of an electricity undertaking to the General Rate Fund.

I believe that the recent statement by the Minister of Economic Affairs was somewhat ill-advised. It appeared to me to be an off-the-cuff comment which has very serious implications.

May I suggest to this meeting that the A.M.E.U. give some attention to the problems. None of us appear to be certain as to the amount of the contribution - should it be 5% or even 15% as mentioned by Mr. Palsler. I have felt always that 7½% is a reasonable figure but there is really no scientific basis to this amount.

I believe that the A.M.E.U. is in a position to give guidance in this matter. Thank you.

Mr. M.P.P. Clarke Newcastle: If the Executive are going to look at this, I think it is very important for the Engineers to express their opinion. The position is that I personally have no objection to contributing for cable routes in the ground or paying for standing streetlight poles on pavements or doing things of this sort. This is fine. This is a

real portion of our cost providing - and here is the rub - the water department pay the same sort of tax if you could call it that. And the sewerage dept., and any other service using public property. And if you start on this basis then go the whole hog and let us investigate fully, but bear in mind that the basic philosophy should be that subsidies are to be frowned on. Every service should be self supported. Now I know we subsidise farmers, maybe the milk, maybe cheese, maybe sugar or some other things. In fact, we live with subsidies. But for goodness sake let us try and eliminate them if at all possible in our particular sphere, and start right at the basic principle. I think that is what Mr. Barnard was driving at.

Mr. E. Trautman LadySmith: Mr. Quizmaster when LadySmith designed new tariffs a couple of years ago, we found in a survey of 86 Municipalities, 46 made a profit and 40 made a loss at that time. Gains up to 81% were noted.

The Electricity Act provides a margin in Section 14, from which it is clear, that no profit other than a profit is permitted for the supply of electricity. Section 25, dealing with charges for supply by licensees has to be read in this spirit, and I feel, that tariffs should be so designed, that the smallest possible profit margin can be expected.

When the rule is applied to all services, that they should be self sufficient, the fairest tariffs can be offered.

Mr. D.C. Paiser Cape Town: Mr. Quizmaster, If you would kindly let me add one point that I forgot to mention just now. That is that there is a reference to surplus profits in the Electricity Act (Act No. 40 of 1958) under Section 25(3)(a) which requires a licensee to distribute amongst consumers 25% of the surplus profit of the undertaking for that year. In other words, 25% of one's surplus profit is supposed to go back to the consumers. Surplus profit is defined basically as the difference between revenue and expenditure. This does not apply directly to municipal electricity undertakings which are exempt from licensing under the Act, but rather to Eskom, but it does nevertheless illustrate that surplus profits have been recognised by the Act. I do not know if this has been referred to before. As far as I know this has never been drawn to our attention. I came across it for the first time the other day. Thank you.

VRAAG B9 Mr. A.J. van den Berg Krugersdorp: Stelling:

Die meeste plaaslike besture in die Transvaal het nou die bevel van uniforme salarisskale vir sekere werknemerkategorieë aanvaar.

VRAE:

1. Sal hierdie beleid in sy doel slaag om personeel te verkry en te behou solank die salarisse van senior amptenare deur 'n hoër gesag beheer word?
2. Kan markwaarde soos bepaal deur die infra-struktuur van die plaaslike beseigheids- en nywerheidssektor binne spesifieke munisipale gebiede geïgnoreer word?

BESPREKING:

Alhoewel die gedagte van eenvormige salarisskale vir plaaslike besture deurgaans met wantroue behandeling word is dit reeds 'n nuwe begrip nie. U sal onthou dat die vergelyking van salarissegraad van emersortige poste van vergelykbare dorpe deurgaans die uitgangspunt van Raad sowel as die Suid-Afrikaanse Vereniging vir Munisipale Werknemers vroeër jaar wanneer 'n geskil of 'n versoek om hoër salarisse te ontvang was. Hierdie gebruik het onteenseglik veroorsaak dat alhoewel daar verskeie tussen individuele dorpe was die sogenaamde "markwaarde" 'n vaste beseig was en in die bres gesien was salarisse nog altyd min of meer eenvormig.

Die huidige verstand teen eenvormige salarisse is moontlik die gedagte dat 'n persoon werksaam in 'n klein dorpie met moontlike laer lewenskoste dieselfde salaris as 'n werknemer in 'n geïndustrialiseerde gebied met 'n ypaarandaande hoër lewenskoste gaan ontvang. Alvoers ons egter probeer om hierdie knelpunt op te los moet ons moontlik kyk wat die bewegings vir hierdie stap van die TMWV was.

In 'n tydperk van stygende inflasie en dalende produktiwiteit moet die Bestuursraad van die TMWV besin oor 'n aanpassing toe lede van die TMWV gekonfronteer was met 'n salarisverhogingsneig.

Die TMWV het op 'n besondere hoër vlak met die Staatsdienskommissie saamgewerk om 'n nuwe benadering te verkry naamlik dat die koopkrag van besoldiging nie net getoets moet word aan die hand van die verbruikersprysindeks nie maar dat daar in ag geneem moet word dat die werknemers se lewensstandaard ook met styg.

Die TMWV het dus ingeval met dit wat die Staatsdienskommissie begiep, naamlik om 'n stelsel in te voer waarvolgens besoldiging op 'n gebaseerde basis geblyf word met die styging in die verbruikersprysindeks met inagneming van 'n styging in lewensstandaard.

Daar kan dus 'n grafiek getrek word vir byvoorbeeld 5 jaar vorentoe wat dan ontleed word in jaarlike projeksijs of soos dit verkies word. Aanpassings in salarisse word dan gedoen sodat die verhoogde salarisse in die toekoms oor 'n tydperk van ongeveer 12 maande deur die verwagte styging in verbruikersprysindeks en lewensstandaard ingehaal word, by welke geleentheid daar dan weer 'n salaris aanpassing gemaak word vir die volgende jaar soos verlang.

Die samesprekings met die Staatsdienskommissie het dit ook duidelik geblyk dat dit baie swaarkom om 'n Stadsklerk se salaris te koppel aan die van die hoof van 'n Staatsdepartement of van enige ander Stadsklerk van 'n munisipaliteit van dieselfde kategorie. Oorhandelings ten opsigte van die Stadsklerke se posisie word nog gevoer

met die Departement van Plaaslike Bestuur, maar ten opsigte van alle ander werknemers van plaaslike owerhede is die volgende besluit op die Nywerheidsraad vir Plaaslike Owerhede in die Provinsie van Transvaal geneem:

"(i) Dat salarisse van toepassing op 1 Julie 1975 met 7% aangepas word en dat die salarisse van toepassing op 1 Julie 1975 vanaf 1 Januarie 1976 verder aangepas word met minstens die persentasie gelyk aan die verskil tussen die verbruikersprysindeksstyging vanaf 1 Julie 1974 tot 30 Junie 1975 minstens 7% en dat die uitdrukking "salarisse van toepassing" die salarisse op die TMWV skale beteken, maar dat die SAVMW alle salarisse as inbegrepe beskou."

Die TMWV streef na eenvormigheid en wil 'n sinvolle en realistiese salarisstruktuur vir sy lede daarstel sodat ongelike mededinging tussen sy lede uitgeskakel sal word.

Aansien die waarde van die Stadsklerkposte van plaaslike owerhede gelykstaande gearg met die van sekere poste in die Staatsdiens word daar dus nou in samewerking met die Staatsdienskommissie en die provinsiale owerheid ondersoek gedoen ten opsigte van sodanige koppeling.

Verder gaan die TMWV 'n omvattende ondersoek instel ten opsigte van die aantal goedgekeurde poste op die diensraad of elke plaaslike owerheid sowel as die getal vakatures teenoor sodanige poste. Elke plaaslike owerheid sal dus gegewens verstrek ten opsigte van die beraam- en vergoeding wat aan die pos gekoppel is. Sodoende sal die arbeidsmarktoestand vir die Transvaal as geheel op die beste wyse bepaal kon word - voorwaar 'n ontsaglike taak maar 'n taak waarde die waarde in plaaslike bestuur in Transvaal nie genoeg na waarde geskat kan word nie. Ek verwaglik te betwyfel dit oëmer of hierdie instansie of enige ander die kennis en middele tot hulle beskikking het om so 'n taak te kan uitvoer.

Die waarde wat in hierdie stadium aan 'n pos van Stadsklerk of enige ander pos gekoppel sal word hang saam met die sleutelakke R18 200 tot R18 600. Afhangende van die grootte van 'n dorp wat in iedergelyk die deurslaggewende kriterium is, word die Stadsklerk en die personeel van 'n betrokke dorp sistematies volgens hierdie ranglys geplaas. Of hierdie gebruik wetenskaplik is of suksesvol gaan wees sal slegs die toekoms kan beantwoord. Feit bly staan dat dit eenvormig sal wees en dat daar bitter min, indien enige, plaaslike owerhede is wat vandag streng volgens peesvalering - waarderings 'n salarisgraad vir 'n pos bepaal. Dit geskied meestal volgens vergelyking met plaaslike besture van dieselfde orde en is maar op sy beste 'n lukraakmetode. Om dus blindelings die voorstelle van die TMWV te kritiseer sal dwars wees aangesien die hand eers diep in die hoese gestek sal moet word.

Wat die eerste vraag betref naamlik of hierdie beleid daarin al slaag om personeel te verkry en te behou solank die salarisse van senior amptenare deur 'n hoër gesag beheer word, wil ek weer na die rede vir hierdie omstandighede verwys. Indien salarisse van Stadsklerke nie beheer was nie en elke Raad kon volgens sy eie mening en oordeel die salaris van sy Stadsklerk bepaal, kan 'n slegs maar dink in welke chaotiese toestand die vergoedingspele van plaaslike owerhede kon gewees het.

As regards obtaining and retaining staff local authorities will have to pin their hopes on the fact that the present salary scales and those proposed by the TMEA are in most cases higher and more attractive than those offered by local authorities. In addition, working conditions also play an important role and this is an aspect over which a local authority can exercise direct control. The situation, climate and aesthetic appearance of a town are equally important and absolute equalization can in fact never be thought of. This view also answers the second question partially. The question is perhaps fully answered if it is borne in mind that there is probably no local authority which relies only on its own population for its staff. It is an established fact that especially tradesmen are a reasonably migrant group of workers, continually on the lookout for better benefits. Resignations by these people are a daily occurrence in spite of high salaries and pleasant working conditions.

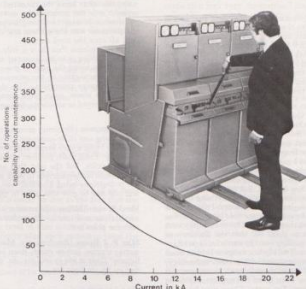
I am of the opinion that we should consider the proposals of the TMEA very carefully and give the scheme a chance to prove itself. In any case, I think that the lack of a reasonable alternative which would provide the solution, forces us to act in this manner.

Thank you Mr. Quizmaster.

LUNCH INTERVAL - MIDDAGETE POUSE.

Dr. R.B. Anderson C.S.I.R.: Mr. Quizmaster, I'm not sure that I can say what I have to say after that very excellent lunch. I just thought that you would be interested in the fact that the national lighting flash count scheme is well under way. That is the installation of counters all over South Africa and South West Africa, 300 Out of the 400 counters which were provided by the bodies participating in this scheme have been placed, but there are a number of gaps in the coverage for the whole of the Republic and very shortly we would very much like to ask a number of Municipalities whether they would be prepared to accept lighting flash counter, install it and read it on either a daily basis at best this is what we really require, but at a weekly basis at worst, for the next 10 years. This is not a very onerous task. The counter is very easily read and very easily maintained. We will supply the counter. So if you do get a letter from us asking if you can install a counter I would much hope that you will accept, because you will fill in a gap that we cannot in other ways fill properly like our friends in Uppington. I do not

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laars gegaan en gesê mense julle hanteer aardlek eenhede op 'n groot skaal en daar is nie 'n probleem met daardie fabriek en so aan nie. Laast ons daardie aardlek eenhede kry en daarna kyk. En hulle het goed gegerig Mnr die vraesteller en wat ons daaruik gekry het wil ek net graag vir u noem. Ons het byvoorzehel van een Grootshandelaar 23 fransiese aardlek eenhede gekry. Dan vind ons een aardlek eenheid is foutief nog 22 van daardie aardlek eenhede is daar absoluut niks mee verkeerd nie. Dit is die probleem waarmee ons te doen het Mnr die vraesteller. En ek wil dit pertinent aan u stel dat die Kontrakteurs nie in staat is om 'n aardlekfout te vind in die stelsel nie. En dit is waar ons aardlek probleem ontstaan. Verder dink ek hoe meer ons van hierdie probleme kry Mnr die vraesteller hoe beter sal ons na hierdie probleem kyk. Ek sal graag verder hierop wil uitreë as ons byraag 10 (6) kom. Dankie.

Mr W Bozycko (Estcourt): Mr Quizmaster, I don't think that this is largely a question of specific articles that we are complaining about. It is the lack of respect for SABS mark and it is getting worse and worse when people look at the article which bears the mark and say well look SABS has no meaning. Now I think Mr Quizmaster that we and the SABS must find some form whereby these faulty and problematic appliances or whatever it may be that we must find a way to improve the respect for the mark not necessarily the specific problems with the individual article. I think this is the basic problem.

Thank you.

Mnr A A Middlecote (SABS): Mr Quizmaster, I'm not going to accept Mr. Smith's function. There is nothing about the Bureau I'm going to talk about can regain the respect Mr Bozycko seems to think is required for the mark. I just want to correct something from our friend from Benoni. This is all my fault not the Bureau's. I'm the Chairman of the Wiring Regulations Committee and I must admit I've been jolly weak. You know for years I've warned the members of the AMEU that to make the installation of earth leakage relays compulsory on the whole installation would be dangerous. They insisted, but no one else had the power and it came from your members - don't let anything be said about that. I was weak. Can I apologize for it. I'm sorry. I did at least say that I expected that there will be red faces one year later. That was a sort of cover up and thank heaven there were red faces and they were all AMEU members. And I'd like to point out that the Bureau was quite right in not worrying about pulling out the earth leakage relay. We had warned them that if a stove or an electric range is held in bond or a shall we say in a humid atmosphere and with present technology, unless you are willing to pay 6 or 7 times more for your stoves you will have a leakage to earth until it has been given the opportunity to be dried out. Now this is your problem. I'm sorry. There may be occasional leakages which is due to a fault, this we have to accept. Then it is no longer my trouble, but I just like to point out that you were warned that certain practices would be dangerous at this period of technology. Maybe in a year or 5 years time, it might be all right. Thank you.

Mr D F Kneale (E.C.A.): Mr Quizmaster the electrical contractors are certainly not infallible. I know some of them are possibly not adequately equipped to test and verify whether the equipment is faulty, but we would like to be in a position to send the equipment where it appears to be faulty to the SABS direct, because what happens now is we fight a little. We reckon the equipment is faulty. It goes to the supplier and then to the manufacturer. They do readily replace it and no result ever comes out of their problem. The old equipment is used over and over again. Thank you.

Mr E Trautmann (Ladysmith): Mr Quizmaster, I think we should put our foundations right. The problem originated in Natal and I would just like to repeat that the whole issue was started by the Bureau of Standard's a few years ago when they asked us for co-operation to give a sort of a feed-back to them. Now you must not forget that we tried to assist. Thank you.

Mnr P J Botes (Rodepoort): Mnr die Vraesteller, ek dink ons moet die voorstel wat ek gedoen het, naamlik dat ons 'n standaard vorm ontwerp, aanvaar. 'n Vorm waarop die nommer, die maak van die kommoditeit gemeld word met 'n verskeie op die vorm dat hierdie kommoditeit aan die Buro gestuur word en dat 'n kopie van hierdie vorm wat aan die vervaardiger gestuur word, 'n kopie van hierdie vorm aan die Buro gestuur word vir hulle aandag en kennisname en opvolging. Dankie.

QUESTION B10.2

Mr. K H D McMillan (Umtata): Mr Quizmaster I find myself equally at a loss on the solution of this problem with the member who has submitted this question for discussion.

It is our experience in Umtata that even street light poles erected frequently get damaged by the more conventional type of gutter and kerbing frequently get damaged by carelessly driven vehicles.

We have, in fact, had incidents where street light poles mounted on the ends of islands have been damaged by the beds of lowloaders encroaching over the island when making a turn too fine, despite the presence of conventional kerbing. The absence of any kerbing only makes street light poles more susceptible to damage from incidents of this nature.

The SABS code of practice for the lighting of streets and highways states that columns be set back from the carriageway edge by a minimum distance of 0,46 metres and recommends that this distance should, if possible, be 1,5 metres or more. The code maintains that the incidents of collision with street poles decreases as the distance of the columns from the edge of the carriageway increases.

This is a logical assumption. The code does not, however, state the type of kerbing on which this assumption is based, but presumably the incident of collisions would be greater with mountable type kerbing. Setting back the poles from the road edge is not, however, the complete solution.

To my mind the use of mountable type kerbing only has an aesthetic advantage over conventional kerbing. Ramps leading into premises are not required by this method.

On the other hand the potential danger to street poles is vastly increased as is the incentive for motorists to park their vehicles on the pavements. It leads to difficulties in the drainage of storm water from the premises into the gutters and once there the water is inclined to spill all over the road surface.

It is my opinion that there is only one solution to this problem, if this type of kerbing is to be accepted and that is to plant quick growing street trees along the edge of the carriageway. These will discourage drivers from parking on the pavements and will in some measure give the street poles protection. This does, however, defeat the object of setting the street poles back from the kerbing. Namely, the safety of drivers involved in accidents, but one cannot have it both ways. Thank you.

Mr R Simpson (Honorary member): You know I can't let this go without passing one little comment. It often amuses me you know, on one occasion I had a very belligerent argument with one of these people on traffic safety. Their main problem seem to be to stop motorists from running into poles, but the part that worries me a lot is that pavements where built for pedestrians to walk on. Now nobody has ever thought of the pedestrians being knocked over. You know, it is an amazing thing and one has to give this a bit of thought.

Mr J K von Ahlfen (Quizmaster): Mr Simpson, we at least have one consolation and that is the pedestrians gets replaced automatically, and the poles not.

Mnr P J Botes (Rodepoort): Meneer die Vraesteller, hierdie vraag water stappe, indien enige, doen lode vir die beskerming van straatligpale? Daar is nie so iets nie. As 'n persoon 'n straatligpaal wil omry dan ry hy vir hom om.

VRAAG B10.3

Mnr H W Odendaal (Albertyn): Mnr die Vraesteller, ek weet nie of ek dit as 'n kommentaar moet beskou nie en dit misken maar net is omdat ek nou TV is 'n stokperdie het nie. Mnr die Vraesteller ek het aangeneem dat hierdie vraag verwyd na die installasie-aarde, met ander woorde sal ek maar sê ons aardingspunt. Nou ek het na die gebruikskode gekyk, en gesien in artikel 343 van SABS 06 1973, wat die gebruikskode vir die installering van antennesels bepaal, lees as volg: Een van die volgende moet gebruik word as die aardnet wat vereis word om antennesels teen atmosferiese elektrisiteit soos 'n direkte weerligstraat te beveilig. 'n Aardingsstelsel volgens en dan verwyd ons weer na die ander een SABS 03 (a) 1975 wat eintlik trouens beskerm teen weerlig die aarding daarvoor of (b) indien (a) onprakties is en mits die betrokke weerligstelsel grootpleng is en geen beswaar daarteen geopper het nie die aarde van 'n elektrisiteitsvoorsieningsstelsel. Nou kom ons na Artikel 8 (12) van die SABS 03 (a) van 1973 verwyd ons 'n verbinding onder sekere omstandighede van die elektrisiteits aarde na die waterleidingsaardingspunt op 'n wyse wat die voorsienings owerheid goedgekeur. Nou Mnr die Vraesteller na die beste van my wete is daar nie 'n enkele plaaslike owerheid in Transvaal wat enige verbinding hierbo genoem offisiese sal goedgekeur nie, uit vrees dat oorspannings weens weerlig onnodiglig toegang tot die elektriese stelsel sal he, maar of ons nou daarvan hou of nie feitlik alle TV antennes wat in die jongste tyd installeer is, verbind met die installasie aarding deur middel van 'n 'n koue waterpyp of dakke en geute en vrees ek dat die Voorsieningsowerheid niks hieraan kan doen nie en voorsien ek ook geen wetlike implikasies van die ooggant van die voorsieningsowerheid nie. En dan Mnr die Vraesteller, hier gaan ek nou 'n stelling maak en ek vrees dat Dr Anderson my seker in vlamme sal afskiet, maar kom ons probeer maar. Die mening is al gehuldig dat 'n persoon veiliger is in 'n huis wat die TV antena so gearde is dat daar geen direkte verbinding met waterpyp of dakke en geute is nie. 'n Direkte weerligstelsel op die antena sal dan nie lei tot noodlottige gevolge vir 'n persoon wat op daardie omlidk aan 'n waterkanaal raak nie. Nou in hierdie geval Mnr die Vraesteller, beskou net eenvoudig dat daar is 'n huis en daar steek 'n antena by die hoogste punt. Nou ons het almal maar geleer dat die weerlig sal nie op die hoogste punt alhoewel ek verbeel my dat in die vroeër dae het ek geleer van 'n A-straal en 'n B-straal en die A-straal die bepaal die wette wat ons gewoonlik ken, maar die B-straal slaan waar hy wil. Maar desdae is daar baie meer navorsingswerk gedoen in die verband en 'n mens hoor nie meer daarvan nie. Nou grond ek hierdie laaste stelling wat ek maak het op die feit dat ek aanneem daar sit die hoogste punt nou op daardie huis en nou gaan daardie weerligstelsel slaan en nou veronderstel ons dit is die A-straal en by gaan daardie antena tref. Nou is dit ook so bezaal dat die hoog-

ste weerstand nadat die man nou hierdie antenna installeer het en hy het sy aardpene ingeslaan dan omskrif die gebruikskode 30 ohm maar dan moet hy nou terugkom en hy moet hom nou aan die waterpyp verbind en nou ja, nou hoop ons dit gaan beter. Nou sit ek en dink as daardie aardeletraal nou daansloeg, dan weet ek nie. "In Man lees ook dat daar baie, daar kan duisende ampères loop, maar in hierdie geval is dit maar so 'n paar honderd ampère en met daardie 30 ohm wat daar is kan hy seker ook hoër wees. En nou is vroulike toegelig in die badkamer en sy vat aan 'n kraan op daardie oomblik en nouja nou hoop 'n mens maar dit sal nie noodlotlike gevolge hê nie.

Mnr die Vraesteller ek wil net die byvoeging het dat in die praktyk in ons gebied het ons as sulks tot dusser nog nie moeilikheid gehad nie. In meeste gevalle waar die antennes installeer word, word die aardingspene getrou ingeslaan. Natuurlik wat daar wel gebeur is daar word natuurlik veel te wense oorgeaak insake die werklike verbinding aan die aardingspene. Partykeer kry 'n mens 'n verbinding wat soos 'n halter wat om 'n perde se nek gedraai is en somtyds vind ons ook dat die lengte van die penne wat ingeslaan word nie beantwoord aan die gebruikskode nie. Dankie.

Mnr J K van Afliten (Vraesteller): Die volgende vraag is ons inflasie. Nou dit is 'n vraag van die Natalak. Would they like to elaborate on this question of inflation and what contribution can the AMEU make? Mr Lewis who was supposed to talk on this problem is not present. There appears to be no discussion on this question.

Then may we proceed to **Question B10.5**

QUESTION B10.5

Mr C Lombard (Germiston): Mr Quizmaster, it is assumed that this question refers to items obtained by a purchaser ex stock from a supplier.

I would say where an item is offered ex stock subject to prior sale, the price quoted should normally not be subject to C.P.A.

There may, however, be instances where the final cost of an item held in stock may not be known. This could be due to the fact that the supplier has obtained the item from a manufacturer and that the manufacturer's price to the supplier is subject to C.P.A. As a result of the delay in the publication of indices (and in this connection it may be mentioned that it takes about 3 months after each month to issue the indices for that month in respect of labour and materials) the price adjustment payable to the manufacturer may not yet be known at the time when the supplier submits his quotation to the purchaser. Under these circumstances it can be justified if he makes his quotation subject to C.P.A.

A supplier may, of course, also reason that when he offers an item held in stock and of which the final price is known, he will have to replace that item at a higher cost, as the manufacturer's price to him is subject to C.P.A. and he therefore makes his quotation to the purchaser subject to C.P.A. It is doubtful that there is any moral justification for this line of reasoning. Thank you.

Mr J Morrison (Quizmaster) I know that in some instances companies do operate on credit from overseas and it is noticeable that C.P.A. contracts now are often worded that the price is subject to adjustment at the time of payment, by the Municipality. This is quite an important thing when you are paying a particularly large contract where you are paying your Overseas Companies on a long term credit and during that period the valuation of Pound of the rand changes. Any other contribution on this? No further discussions.

Tea interval - Teepeuse

QUESTION B10.6

Mr. J D Dawson (Uitenhage): Mr. Quizmaster, in respect of this question I had some difficulty in trying to decide what type of earth leakage relays were being affected and what type of high frequency currents were causing the problem. I have assumed that the problem is associated with sensitive earth leakage protection.

I must immediately say that I have had no personal experience of problems of this nature in my area of the Republic and neither have any of my fellow East Cape Engineers.

However there have apparently been difficulties in other areas and I am indebted to one of the major suppliers of sensitive earth leakage equipment for the following information which may be of assistance.

I do not intend to attempt to describe the theory of the effect of high frequency currents on a sensitive earth leakage relay as this can probably be better done by an expert from one of these organisations, except to quote a statement from the report they gave me on this problem "that it can be said that a high frequency earth or earth leakage fault current in principle can trip the earth leakage unit at a lower current than a power frequency current".

Sources of higher frequency current can exist either as permanent or temporary currents. The permanent sources mainly exist in industrial installations but could possibly exist also in domestic installations. Examples are mercury arc rectifiers, thyristors and fluorescent lights (under certain circumstances) and dimmers.

Temporary sources could be switching operations causing a "current spike" which can be considered as a high frequency current of very short duration or the capacitance to earth of an installation, e.g. a

length of cable creating an earth leakage current. In this latter case the leakage current increases proportionately to frequency and at say 1000 Hz would be 20 times higher than at 50 Hz.

Examples of these types of occurrences are known of in the Republic and have been brought to the attention of the suppliers of earth leakage equipment.

Solutions to the problem as presently known could be to

- incorporate a high frequency filter in the unit;
- remove the source of the high frequency current;
- improve the quality of the installation to reduce the earth leakage current.

To incorporate a high frequency filter could under exceptional circumstances mean the necessity of allowing an electrocution to be caused as a result of a high frequency earth fault current against which the protection had been sensitised and it is not considered desirable to solve the problem by interfering with the basic function of the earth leakage unit.

Solution (b) requires the removal of the apparatus or equipment causing the high frequency earth leakage current and as the equipment is installed for a purpose this may not be possible or you could possibly install a special R/L unit designed to cater for specific high frequency earth fault currents and if the installation of this type of relay does not conflict with standard wiring or supply regulations.

Solution (c) is the recommended answer to the problem as presently known and requires the improving of the quality of the installation to an extent where the earth leakage current is reduced to a level which will not cause the relay to trip.

This is the approach being taken overseas where the problem is receiving the serious attention of the I.E.C. and I understand that draft I.E.C. documents clearly distinguish between the requirements of the earth leakage relay relative to power frequency and other frequencies.

The idea in the draft I.E.C. documents is to define the limiting values for frequency and current amplitude permitted to be superimposed on the power frequency earth leakage fault current under which the relay is required to operate satisfactorily. Outside these limits it will become the responsibility of the user to correct either the equipment or the installation.

The present SABS specification for earth leakage units is based on power frequency only but it is possible that the SABS specification will be modified to follow the I.E.C. specification when this is finalised.

I hope this comment has helped to clarify the existing position but I must reiterate that any credit in this respect is not due to me but to one of the suppliers of earth leakage equipment who provided me with this information in very detailed form and from which I have attempted to present a summary. Thank you.

Mr. S J van der Walt (SABS): Mr. Quizmaster, there are a few things I would like to put straight here. First of all, the present SABS standard on earth leakage units is under revision and we're having a very close look at the IEC which is quoted. One point that I would like to straighten is that the present IEC document does not add to the power frequency requirements so there are a number of points which are relevant here. First of all, we must accept that an earth leakage unit is doing the protection by the current balance principle or core-balance principle, if you may call it that, and when this principle is violated the unit is compelled to function and to trip. This can happen under various conditions. Obviously if you've got high frequency components in the voltage of a system where there is a substantial conductor to earth earth capacitance available, the capacitive current to earth will be substantially increased as a result of high frequency components and you may get tripping. Now, you can obviate this by making the earth leakage unit insensitive to high frequency components which may run you into trouble due to the requirements of the human body at certain shock levels versus time that can be withstood and you may run into trouble as far as the very high leakage current tripping times required both from the IEC requirement as well as the SABS requirement. There is a limit as to how far the manufacturer can go: And there are certain instances where you are bound to pick up trouble from an installation layout point of view. Just one typical example is if you use a long length of cable on the load side of an earth leakage unit with a device, a motor or any other device on the end of it, during switching, you've got tremendous capacitive charging current which will trip the earth leakage unit. I can say, basically and in principle, whenever you've got a non-linear element in the circuit, diodes, thyristors, switches, anything that can cause transients, and you couple this to a conductor to earth capacitance, you can experience trouble. Now, the committee entrusted with the task of revising SABS 767 recognizes these problems and they have taken a decision to incorporate in the document an appendix. The aim of this appendix is to give guidance on these problems. It is not going to be a fully fledged system design performance, the aim is merely to pinpoint a number of combinations of installation possibilities where you are certain to pick up trouble. Thank you.

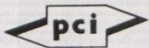
Mr H J Steyn (SABS): Mnr die Vraesteller, flouiserer lampe is ook in die gebrang wat dit aanbetref. Die goed lek altyd na die flouiserer lamp hane. En as jy genoen flouiserer lampe op 'n sekere baan het en die aardlek klink nie uit nie, dan moet u daardie aardlek via die vervaardiger na Mnr van der Walt by ons terugstuur, want dan is daer iets met die aardlek verkeerd. Ek wil eintlik net die punt ondersteun, mnr die Vraesteller, dat ligte behoort nie myns insiens op aardlek 'n beskerming te wees nie. Dankie.

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Mnr J A Loubser (Benoni): Mnr die Vraesteller ek wil eintlik 100% met Mnr Steyn nou saamstem na aanleiding van die ondervering wat ek met Mnr Middletoe opgedoen het. Hy het my al voorheen gewaarsku teen ligte ook op die aardlekbeveiliging maar ek dink voordat ons werklik ligte afhaal van die aardlekbeveiliging is dit nodig dat die gewone afdelingswinkels nie meer hierdie sogenaamde BC adaptors moet verkoop nie. Tot my skok het ek hierdie week nog agtergekry dat 'n mens nog steeds hierdie goed kan koop. U weet as iemand daardie ding kan inproop by 'n ligmonter, dan is dit nog steeds moontlik dat iemand deur middel van daardie lig doodgeskik kan word. So um een of ander rede moet ons daardie ding geheel en al van die mark af verwyder kry en hoe weet ek nie. Dankie.

Mr A A Weich (Department of Labour): Mr Quizmaster, I cannot contribute much towards this very learned discussion, but on the question of whether lights should be on the earth leakage relay it is my opinion, and one that I will back up officially, that they should not be on it. There is no necessity for anything else but power plugs to be on it. One must look at the statistics. It's all very well to say that somebody can be killed. No doubt, somebody will be killed. I'm not suggesting that the statistics be 100% safe for the next 50 years, but when you look at the statistics you must come to the conclusion that people are only hurt or killed on power plugs. Thank you.

Mnr H Barnard (Geaffilleerde): Mnr die Vraesteller, ek wil miskien net hiervoer die intrapslag noem dat ek het nou al so baie van die aardlekrelés gehoor dat ek dink 'n mens moet 'n spesiale konferensie hou om hierdie ding behoort te kan uitstryk, maar ek kan nie verstaan wat die mense se probleme is nie. U weet by 'n vorige geleentheid het ek dieselfde ding gesê en ek wil herhaal dit is vir my nie verstaanbaar nie, want gedurende die periode wat ek in Brakpan was en ek glo ook nou terug! Mnr Durant daar is, het hy nie klages gekry van die aard nie, want dit is eintlik iets hierdie wat by die inspekteurs, die Bedravingsinspekteurs tuishoor. Hulle sorteer hierdie ding geheel en al uit en ek voel dat dit is absoluut tydroewend om met hierdie kles van probleem te sit. Dit is nie nodig nie. Die SABS daar is 'n hele paar voorstelle in verband met hierdie goed, dat aardlek rele en die goed wat foutief is teruggestuur word na die SABS toe. Soos dit is op die komblik en ek wil nie vir hulle party trek nie, want ek het self 'n appeltjie of twee met hulle skil, maar ek kan my net nie self voorstaan dat as al hierdie goed teruggestuur word na hulle toe, waar gaan hulle die personeel vandaan kry om dit na te gaan. Punt nommer een. Punt nommer twee, 'n Mens is so geneig om sommer net te sê: "Kyk hierdie ding is foutief stuur hom na die SABS toe." En wanneer by daar kom vind u dat die helfte van hulle of 'n driekwart of negentig persent van hulle is nie foutief nie. Dis maar net een van daardie gevalle waar ek dink 'n mens moet hulle uitsorteer voor die tyd en daar wil ek Mnr Fortman van Boksgroep se voorstel ondersteun, Indien daar vermoed word dat enige apparaat foutief is, laat die betrokke plaaslike owerheid 'n sertiikaat uitreik, aan die kontrakteur wat betrokke is en op sterkte van daardie sertiikaat kan die apparaat dan by die vervaardiger vervang word en dan kan daardie foutiewe apparaat direk na die SABS gestuur word voordat dit 'n kans kry om terug te gaan na die fabriek toe waar hulle miskien die ding kan dokter. Dankie.

QUESTION 111

Mr K J Murphy (Somerset West): Mr Quizmaster, as you noticed I was on my way before you finished speaking. With regard to this question I just like to say this is not a dig at the manufacturers or suppliers. It's simply a question. I don't know if price fixing is necessary to protect certain industries in South Africa or not. But in the case for example of metre, electricity metres in particular, if one receives a low tender it is usually for a make coming from behind the Iron Curtain or something like that and as you steer clear of it and all the others are identical. We would just like to know why? Thank you.

Mnr F J van der Merwe (Carletonville): Mnr, die Vraesteller, verkoopprys vasstelling in sektore van die elektriese vervaardigingsbedryf is iets waarvan ons nie die tyd al heeltemal gewoond geraak het. Wat die werklike rede hiervoor is en waarom dit toegelaat word in die elektriese vervaardigingsbedryf, terwyl ander vervaardigers deur wetgewing verbied word om dieselfde te doen, sal seker deur ons affiliaatiedes verduidelik kan word.

In die Transvaalse Provinsie is ons natuurlik gebind deur die Standaard Finansiële Verrigtinge om kwotasies en Tenders in te vin voordat goedere aangekoop word. Dit gebeur dan gereeld dat goedere teen identiese pryse vir sulke tipes, Na my persoonlike mening is die aanvaar van Tenders, Mnr, die Vraesteller, kry dit nou reg om so iets tuis te bring by Tesourie-afdelings van Stadere: As daar lede is wat al daarin gegly slaag het vernem ons graag van hulle, ek kon dit egter nog nie regkry nie.

Om terug te kom tot verkoopprys vasstelling: Daar was onlangs 'n berig oor die radio asook in die pers van 'n verspreider van motorbande wat begin het om bande teen 15% onderkant die vasgestelde prys aan te bied. Hy is skriftelik in kennis gestel dat hy dit nie mag doen nie en indien by sou volhard sou buitebandvervaardigers weer om verdere voorrade aan hom te voorsien. Hy het egter nie aan die dreigement gehoor gegee nie en gaan nog steeds aan en sy besigheid floreer.

Is daar nie dalk van die elektriese vervaardigers wat items, wie se pryse op ringpryse vasgepen is, ook teen 15% onderkant die vasgestel-

de prys wil verkoop nie? Ons lewe in 'n tyd van inflasie en wat word gedoen deur die privaatsektor om dit te bekamp; Mnr, die Vraesteller, die absolute minimum Prysverhogings wet net outomaties op die verbruiker oorgeda, en geen poging word aangewend om profyte effens te verminder nie. Is dit nie meer lomsend om goedere teen 'n laer wintgrens aan te bied en so 'n groter omset te verkry nie? 'n Verspreider van elektriese kables het onlangs gesê "I am mainly interested in bulk selling, I would much rather sell R1 million of goods at half percent profit than R100 000 at five percent".

Uit ondervering weet ons almal as ons tenders vra vir jaarlikse voorrade en in item word aangebied teen 'n verminderde ringprys, daar goed moet besin word voordat 'n aanbeveling gemaak word om die goedkoper item aan te koop, want dit mag minderwaardig wees. Gevolglik word 'n ringprysitem, wat goedkoper aangebied word, altyd moet agterdog bejein. Het dit nie tyd geword dat heeltemal afgesien moet word van ringpryse nie sodat daar meer kompetisie kan wees tussen voorsieners.

Wanneer tenders ingewin word vir jaarlikse voorrade en aanbevelings moet gemaak word oor watter kontrakteur items moet voorsien wat op ringpryse aangebied word, plaas dit die Elektrotegniese Ingenieur ook in 'n onbenydenswaardige posisie. Wie moet hy bevoordeel? Die kontrakteur wat die meeste besoeke aan sy kantoor afgelê het en hom be moontlik 'n paar keer in 'n hotel getraakteur het of die kontrakteur wie se produk, na die mening van die Elektrotegniese-Ingenieur die beste diens sal lewer.

'n Sprekende voorbeeld hier is wanneer tenders ingewin word vir voorsiening van brandstof en smeerolie vir Stadere se voertuie - die van u wat Meganiëse Werksinkels onder u beheer het, sal weet hoe moeilik dit is om 'n aanbeveling te maak. Tenderpryse is almal eenders en boonop het die Die Maatskappy wat die vorige jaar se tender gekry het sy eie brandstoftanks petrol- en dieselpomp geïnstalleer. Wat maak 'n mens nou, Mnr, die Vraesteller? Gee dit maar aan dieselfde Olie Maatskappy? - waarvoor het u dan tenders gevra? Is dit nou nie 'n vernorsing van tyd, arbeid en papier nie?

Mnr, die Vraesteller, ek dink ek het genoeg gesê, laat ons vernem wat lede se opinie omtrent die vraag is.

Mr H Franks (Affiliate): Mr Quizmaster, I would just like to say a few words as far as kWh metres are concerned which might prove of some interest and might be a small contribution. The meters association is an international body and prices are in our case set in the United Kingdom. We do not fix prices in South Africa. We merely act upon instructions from our principles overseas regarding these prices, because our principles give a basic minimum price and the majority of us all quote a question based on some five years ago to which all companies who manufactures meters locally replied by nothing more was heard until fairly recently when indications were that the matter was again being investigated. Although there were prices one very often frowned upon many feel that in the case of meters firstly good value for money is obtained and secondly the quality if of a very high standard. Therefore the only way suppliers can compete with one another is on service. So all in all the customer is, it is hoped getting a fairly good deal. Thank you.

QUESTION 112

Mr J L McNeil (Kokstad): Messrs Quizmasters, this is still a question of considerable interest, raised by Mr von Ahlften, and with all due respect, I also feel that the interpretation given at the Untali (1969) Conference leaves considerable doubt in our minds. I say this because of one particular, and I contend, important phrase, which is to a point of consumption quoted in the definition of WIRING WORK.

We all know what this means with reference to 'fixed wiring'; which would be where electricity is used by a motor, heating elements, an electrode boiler, a welder, a rectifier perhaps - to give straight-forward examples. And so up to this point the Supplier is wholly responsible for inspecting, testing and thereafter connecting. To my thinking a transformer or set of transformers, in a factory used solely to provide voltages more suitable for factory use can hardly be regarded as devices that 'consume' electricity such as in the cases of apparatus precisely mentioned. From another point of view, I wonder whether in the case of a factory where a "responsible person" should be appointed and the "user" is unable to obtain the services of a suitable person (and I refer to one with electrical knowledge) to be responsible as mentioned at Untali, the supplier would be compelled to carry out the 'inspecting & testing before connecting'.

I might add that I have always been curious as to why 'Wiring Work' in a factory having its own generating plant need not be so inspected and tested.

So I too would welcome further clarification. Thank you.

Mr A A Smith (Port Elizabeth): Mr Quizmaster, I don't know if the fact that this question is on the AMEU agenda has set the ball rolling or not. My Department has just now received a letter from the factory inspector stating that all wiring work of all new installations must be tested and from the letter one can plainly interpret that it means all installations i.e. Factories, everything. Thank you.

Mr W Bozyezko (Estcourt): Mr Quizmaster, I was going to say exactly the same as what the gentleman has just said. We also have received a letter from the inspector of machinery referring to the fact that



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aangaan nie. Kan ek met duidelikhed kry omtrent hierdie saak asseblief.

Onder die Elektrisiteitswet is ons nog nie as verspreiders registreerbaar nie. Ons is dus nog glad nie geregistreerde verspreiders nie tensy die munisipaliteit afstand doen van sy verspreidings-reg en daar is net drie punte in ons gebied waar die Stadsraad alreeds besluit het dat hulle gewilling is om afstand te doen van die reg, maar ons het nog nie sover gekom om aansoek te doen by die Elektrisiteitsbeheerraad nie omdat ons maar omtrent 'n maand of twee gelede daarvan gehoor het dat hulle afstand jee doen van hulle reg. Gevolglik is die munisipaliteit nou steeds die verspreider in ons gebied en gevolglik is ons nie by magte volgens die brief van die Fabrieksinspekteur om te gaan bedradinginspeksies doen in daardie gebied nie. Ek sal nie omgee om dit te doen nie maar ons wil darem duidelikhed kry. Miskien toets ek verniet.

Mr die Vraesteller, hierdie het nou weer in my gedagte iets anders laat kom. As dit die geval is dat die Bantoe-administrasieraad nou nie voorsiener is nie dan is munisipaliteite ook nie voorsieneris nie dan is ek bevrees het ons ook nou minder werk want EVKOM sal al die installasies moet toets. Dankie meneer.

Mr J K van Ahlfen (Vraesteller): Mr Fuls ek glo nie u sal daarmee wegkom nie. U sal moet toets net soos ons almal moet toets.

Dit sluit ons Forum af vir vandag en ek handig weer terug aan die President. Dankie vir al die bydraes en lewendige bespreking.

VERDAAG - ADMOURN 17h00

QUESTION B13

Mr W Boyezko (Estouart): Mr. Quizmaster, I have no doubt, most of us here present have read the question under discussion and view this question with concern.

The Section 50 of the Electricity Act is quite explicit as regards the charges an Undertaking could face should any damage indicated in this Section be suffered by a consumer or any other person for that matter. It also limits defence to proving negligence by the consumer or other persons not in the employ of the Undertaking.

In other words, Mr. Quizmaster, the Undertaking is guilty unless it can find a scapegoat.

Daarenteen stel die Standaardelektrisiteitsverordeninge van die Transvaal, Artikel 34, dit as volg, en ek haal aan.

"Die Raad is nie aanspreeklik vir die gevolge van die verbruiker of vir enige ander persoon van enige staking, weiering, variasie, stuwing of ander gebrek aan elektrisiteit of wat die oorsaak al mag wees nie."

Both in my opinion are extreme, the Section 50 of the Electricity Act excessively severe and Section 34 of the By-laws too lenient, and I am confident that, given the opportunity this body of me, through our Executive, can provide, by virtue of the vast knowledge and experience in the supply of power, a suitable wording for both levels of Law making, whereby the interests of the supply authority and that of the consumer could be protected.

Soos die Wet nou lees, beskerm Artikel 50 van die Elektrisiteitswet die belange van die verbruiker, en Artikel 34 van die Transvaalse Verordeninge probeer om die belange van die voorsiener te beskerm.

Mynsienings kan Artikel 34 van die Standaardelektrisiteitsverordeninge van die Transvaal, soos deur die Provinsiale Raad goedgekeur, nie die wette van die Parlement teë gaan nie, en moet dus van nul en gener waarde beskou word.

Allow me, Sir, to draw members' attention to yet another bit of legislation, Regulation C53(1) of the Factories and Building Work Act requires, and I quote,

"All Electrical apparatus and conductors to be so selected, arranged, installed, protected, worked and maintained as to prevent danger to persons so far as is practicable"

I like this common sense approach to the problem. Mr. Quizmaster, is it not the time to consider all the aspects of the engineering and technical legislation, eliminate all conflict and provide the engineering fraternity with one set of Laws for the benefit of all concerned.

Mr D H Fraser (Durban): I comment as follows on the letter dated 18th September, 1974 which is set out in Item 42 of the U.M.E. agenda for the meeting on the 11th, 12th and 13th March.

While I agree that it would be as well to clarify the position by amending Section 50(2) of the Electricity Act 1958 by the addition of the words "or to any other cause beyond the control of the defendant" at the end thereof, I do not agree with the views expressed in the memorandum by a Legal Adviser to a Local Authority that the effect of Section 50 of the Act is to place an absolute liability on the supplier and that it would be liable for any damage or injury caused by electricity escaping from its plant even if it is established that the damage or injury was caused by a circumstance beyond its control.

In the case of Botes v. Potchefstroom Municipality and Another 1949 TPD 141 the Court considered the effect of Section 49 of the 1922 Electricity Act which is identical to Section 50 of the 1958 Act upon the position under the Common Law whereby a supplier would only become liable for damage or injury occasioned by its negligence. The Court concluded that the Section must be interpreted in the light of the Common Law as the Legislature could not have intended to make such drastic inroads into the Common Law as to impose an absolute liability on the supplier.

The learned judge stated that "To give it the proper interpretation, in my view, this section goes no further than to transfer the incidence of onus under the Common Law. When the facts set out in Section 49 are established then negligence is presumed".

In the light of this decision it is open to the supplier to rebut that presumption and escape liability by proving that the damage or injury was not caused by its negligence.

This being the case the defences to a claim for damages listed in Section 50(2) of the Act cannot be intended to be exhaustive and a supplier is not thereby precluded from succeeding in its defence of a claim by alleging and establishing the absence of negligence on its part.

It is submitted that the decision in Botes' case is correct for if the Legislature had intended to impose on the supplier an absolute liability one would have expected it to frame Section 50(1) accordingly and one would not have then expected it to provide, as it has done, in Section 50(2) for defences which are inconsistent with such absolute liability.

All the bylaw does, if it is accepted that Section 50 of the Act merely serves to shift the burden of proof to make it clear that the Council in supplying electricity will not be liable if it is established that the damage or loss has been occasioned by "Act of God or other cause beyond the control of the Council affecting the supply of electricity". However, in terms of Section 50 the onus will be on the Council to prove this.

As stated above I agree that it would be as well to put the matter beyond doubt by amending subsection 50(2) in the manner suggested.

QUESTION B15

Mr L. Fitcher (Kempton Park): Mr. Quizmaster, protection testing is a subject with so many facets that it would well be discussed at length. However as our time is limited I will touch briefly on a few points in order to stress its importance.

The question of protection testing is a matter, which through better experience gained last year, has become a subject of prime importance in our electricity undertaking. The need for regular testing and inspection of protective circuits and their associated equipment can certainly not be overstressed. The fires which occurred in two of our major substations, resulting in damages to equipment and buildings, were caused by the failure of a very simple piece of apparatus whose value would be in the region of R1. The fires in both cases were caused by failure of a circuitbreaker to trip under fault conditions. The protection could not operate due to the fact that the tripping fuse in the particular panel was defective, and therefore despite the fact that the IDMT relay operated, the breaker was unable to isolate the fault. The faults on both occasions were situated some 2 KM from the substation and the resultant fault current was for quite some period, of insufficient magnitude to cause the back-up protection on the main incoming breaker to operate. You can well imagine what the results were. The fire aspect could well be the subject of another discussion. Subsequent to this experience an inspection and test of the tripping fuses on all 11 kV breakers in major stations was carried out, and it was found that no less than 12 breakers out of a total of 127, were in the 'ON' position, and unprotected due to a faulty fuse in the tripping circuit. This, Mr Quizmaster, is only one example of the need for regular inspections and tests. The following test and inspection procedures have been instituted to ensure maximum security in respect of the protective circuits and their associated equipment.

A. Operational testing of OCB's 11kV

1. By secondary injection; every six months.
2. By manual relay tripping; once every month.
3. By local control on the OCB; once every month
4. By supervisory remote control; once every month.

B. Operational testing of 66 kV OCB'S

1. By secondary injection; every six months.
2. By manual relay tripping; once every month.
3. By supervisory remote control; once every month.

C. Testing of pilot cables

1. Differential (Solkor) pilot cables; test with megger (500 V) every six months.

D. Terminal connections

1. All terminal connectors in protective and supervisory circuits for tightness every three months.

E. Tripping Batteries

1. 110 Volt DC tripping supplies at the major substations are checked every Friday. A systematic check cycle is carried out on all the minor switching stations.

F. Transformers

1. 66/11 kV 15/20 MVA Transformers are inspected weekly for oil leaks and insulators are cleaned every six months. Buchholz gas relays must be checked once a year, together with temperature, alarm and tripping devices.

G. Record File

1. Apart from the station log book entry, a separate record must be kept of every test carried out. The test sheet is then filed for future reference.

A record is kept of every fault-trip on an OCB and the OCB is serviced after every second fault-trip.

In conclusion I would like to inform the members here present, that

the tripping fuses in individual 11 kV panels have in our major substations and switching stations, been replaced by links.

Mr. D.H. Fraser (Durban): In considering this question it is necessary to take into account what is practicable in addition to what may be desirable. It will be necessary to determine priorities from the aspect of cost and manpower resources.

The frequency of testing will depend, therefore, on the relative importance of the installation and the load supplied. The type of relays and the environment too are other factors and air conditioning or pressurisation of relay rooms may sometimes be necessary.

The staff situation in Durban and probably in most South African Municipalities, will not allow routine testing on the scale suggested. In some respects this may be just as well because of the very greatly enhanced risk of interruption of supply due to human error, in the process of testing, of proved relays and protection circuitry are thoroughly tested and checked prior to commissioning. It is my view that relays, current transformers, connections and circuitry should be interfered with as little as possible.

The trip supply is of course the heart of the protection system and in my Department one electrician is permanently employed on battery checking. Major 132 kV and 33 kV Substations are checked monthly and others at intervals of 6 to 8 weeks. Continuous monitoring of trip circuits is usual in major installations and advantage should be taken of the opportunity to check trip circuits by manual operation of protective relays to trip the circuit breaker whenever equipment is taken out of service.

In practice the extent of malfunctioning of protection in Durban is reasonably low. Of 332 faults on high voltage circuits in a recent 19 month period 6 or 7 mal-operations occurred.

Regarding the specific suggestions made, I offer the following comments:

(1) Operational Tests

Operational tests should be carried out when plant maintenance is undertaken or when the circuits are being restored after a fault.

The tests would be limited to checking sequential relay operation and would not include timing or sensitivity tests. With modern relays full timing tests need only be carried out at intervals of 3 to 5 years.

(2) Secondary Injection Tests

The use of test windings is not recommended and primary injection is only necessary if the C.T. and relay connections have been disturbed when it should be mandatory. Where facilities exist spill current measurements should be taken when plant maintenance has been completed.

(3) Tripping Tests of all Protective Devices

Tripping tests should be carried out in conjunction with routine maintenance.

(4) Air Injection of Buchholz Relays

Air injection of Buchholz Relays is only necessary on large site assembled transformers and should only be necessary when major maintenance is undertaken, i.e. lowering of oil to remove bushings. For factory assembled transformers pre-installation checks on the relay alone should be adequate.

(5) Test of Insulation Resistance

This is not undertaken on a routine basis in my Department and I am not aware of any problems having occurred in the control and tripping circuits due to deterioration of insulation. Certain C.T. failures have been attributed to moisture absorption due to poor manufacture.

(6) Pilot Tests

Pilot testing is only normally undertaken when work is undertaken on the pilot cable and relatively few problems have been experienced. Moisture ingress into a P.V.C. insulated and sheathed pilot on two major 132 kV circuits did present difficulties until hygroscopic sleeves which had been used in the joints were replaced. Solkor "R" pilot wire protection is almost exclusively used in Durban and short or open circuits in pilots are immediately apparent as the system fails to safety causing the feeder to trip.

Mr. P.R. Rosen (Affiliate): Mr. Quizmaster, I would like to associate myself with the remarks made by Mr. Fraser. I think that his protection tested at the frequency that he does in our experience is just about right. Mr. Futcher's remarks I think are almost a stage of perfection. We certainly could not get sufficiently trained staff to handle the relays that we have and I would think that any municipality would have great difficulty in getting trained staff. About 5 to 6 years ago I saw some statistics in Britain where ever protection now operation was investigated and it was found that nearly 60% of non-operations could directly be attributed to maintenance not a lack of maintenance. People had forgotten to put trip fuses back, people had left a relay in a condition that it could not operate. So I would say rather do less maintenance more thorough than have the wrong people doing relay maintenance. Thank you.

Mr. A. J. v.d. Berg (Krugersdorp): Mnr. die Vraesteller die hart van enige beveiligings- en instellingsaangeleentheid is natuurlik jou klinkkrabbron (bv. batterie, spanningstransformator en gelykrichter) wat te alle tye in staat moet kan wees om krag te kan voorsien aan die klinkstroombane van die beveiligings- en instellingsaangeleentheid. Nou gepaardgaande hiermee is dat die koppelingsterminals tussen die kragbron en die klinkstroombane heds van voldoende skaalkels voorsien moet word eerder as van sekeringe. Verlos eerder 'n klinkkrabbron as 'n hele substansie.

Beveiligings- en instellingsaangeleentheid wat aan streng jaarlikse toetsing en geskeduleerde instandhouding onderwerp word en perdek werk is van nul en geen waarde wanneer die klinkkrabbron dood is of 'n klinkstroombaansekering gebraak is.

Eik dink dit is belangrik dat daar 'n balans of grens moet wees tussen te veel of te min toetsing asook tussen te veel of te min instandhouding, die regverdiging daarvan, die beskikbare personeel, die koste-impaktes daarvan en die nadelige gevolge wat moontlik kan voortspruit uit die toetsing (bv. onbeplande kragonderbrekings, foutiewe of los verbindings op klinkstroombane na toetsing). Na baie jare se ondervinding en deur statistiek behoor daar bepaal te kan word wat die tydsverloop behoort te wees tussen roetine toetsing asook geskeduleerde instandhouding.

Graag wens ek kommentaar te lewer oor wat voorgestel word dat beveiligings- en instellingsaangeleentheid aan streng jaarlikse toetsing en geskeduleerde instandhouding onderwerp word wat insluit:

1. Bedryfstoeitsing van relais met vyf en tien keer die sokinstelling en tyd-vermenigvuldiging van 0.1 en 1.0 krap- en herstellystoeitsing

Om jaarlikse bedryfstoeitsing van relais van 'n redelike groot munisipaliteit uit te voer is 'n baas onbegonne taak wat personeel oor 'n lang tydperk voltydts sal heug hoeg. Die aangewese besnederling sou ek sê is dat die toetsing gedoen word op geinstalleerde wese toetsing voor dat dit in bedryf gestel word en daarna dat individuele relais wat onder voortdoetsing nie funksioneer volgens die instellings nie, getoets word.

2. Sekondere inspuitsing-toetsing op differensiale beveiligings- en instellingsaangeleentheid

Jaarlikse sekondere inspuitsing-toetsing op bestaande toetsing van 'n redelike groot munisipaliteit is 'n groot taak waarvoor voltydse personeel benodig sou wese. Basies is ek nie ten gunste van jaarlikse sekondere inspuitsing-toetsing nie omrede dit meer nadelige gevolge kan hê teoorde die voordele daarvan verbode. Ek is ten gunste van 'n eenmalige primere- en sekondere inspuitsing-toetsing op nuut geinstalleerde toetsing voor dat dit in bedryf gestel word, daarna kan met individuele inspuitsing-toetsing gedoen word wanneer probleme opduik.

3. Uitklinktoetsing op ALLE beveiligings- en instellingsaangeleentheid

Ek is ten gunste van twee-jaarlikse uitklinktoetsing op alle beveiligings- en instellingsaangeleentheid en nie jaarlikse toetsing nie.

4. Luginspuitsing van Buchholz-relais

Ek is nie ten gunste van luginspuitsing van Buchholz-relais nie omrede dit 'n baie gevolge meeganiese apparaat is binne-in die waarde weinig verkeerd kan gaan en ek het nog nooit gehoor van 'n Buchholz-relé wat nie gewerk het nie.

5. Toetsing van isolasiewerke van stroomtransformator sekondere stroombane en kontrole- en uitklinkstroombane

Ek is nie ten gunste van jaarlikse toetsing nie omrede dit meer nadelige gevolge kan hê teoorde die voordele daarvan verbode en ook dat dit 'n voltydse werk sal wese. Ek is wel ten gunste van 'n eenmalige toetsing op nuut geinstalleerde toetsing voor dat dit in bedryf gestel word en daarna sels toetsing wanneer probleme sou ontstaan.

6. Toetsing vir kontinuiteit en isolasiewerke van interuitklink en differensiele loodsstroombane behoort maandeliks gedoen te word

Ek is nie ten gunste van maandelike toetsing nie, omrede daar weinig in 'n maand verkeerd kan gaan asook die ekstra werk wat dit op die toetsafdeling plaas, maar wel van ses-maandelike toetsing.

QUESTION B16

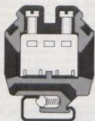
Mr. K. J. Murphy (Somerset West): Mr. Quizmaster, the question is entitled "unsuitable light fittings," but it is really unsuitable "wiring" of light fittings. In opening this discussion I'm reminded of the number of times in which people like Mr. Prins of the Bureau of Standards have warned us that P.V.C. insulation under conditions of high temperature and pressure will deform and this is exactly what has happened. Now I don't know if Mr. Adams who posed the question had looked into the regulations at all, but I want to read you regulation 307 of Standard Wiring Regulation P.V.C. insulated cables may be used only where precautions are taken against deformation. liable to occur with such insulation from the combined effect of high temperature and compresses stresses on the insulation due to the weight of the conductors or other cables. Furthermore P.V.C. insulated cables shall not be brought into lighting fittings or other fittings unless it is ensured that the temperature of the insulation is not liable to exceed 135°F or 15 to 7°C. To limit the risk of deformation of the insulation now from this it appears that you have here a clear cut case of the comprehension of the Regulations. I would however support Mr. Adams's suggestion that possibly the Bureau of Standards wouldn't mind looking into the possibility of a code of practise for the manufacture of these light fittings in which this particular type of problem may occur. I would also thank Mr. Adams for drawing our attention to this because I feel that our installation inspectors could do well to look into these fittings and see what the Contractors are doing. Thank you.

Mr. J. T. Grundy (Affiliate): Mr. Quizmaster Mr. Smit has already indicated that there is to be issued an SABS specification for interior luminaires. I haven't seen this Mr. Quizmaster but the answer is fully given in I.E.C. Publication particular Committee number 34 that deals



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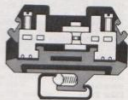
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with lamps and related equipment sub-committee 34(d) which deals with luminaires and then there's draft specification in carrying out the test on luminaires for the particular national mark. The test has to be carried out with the supply wiring within the luminaire. And if I may quote Mr Quimaster the relevant particular paragraph says that the luminaires shall be connected to the power supply with wiring and any materials, for example insulating sleeves supplies with the luminaire for the purpose. It states that external wiring to the luminaire not supplied with it shall be of a type representative of common practice and with insulation suitable for 90°C. It goes on further Sir, to say that if the luminaire is marked requiring a cable of insulation temperature higher than 90°C then the wiring of the appropriate rating shall be used. That is I.E.C. draft 34 (d) Committee. Thank you.

Mr J W Smit (SABS): Mr. Quimaster, first of all Mr Murphy said that it wasn't unsuitable lighting fittings it was really unsuitable wiring, I think. He got the whole story wrong. It's not the wiring that's unsuitable I think most cases it is really the fitting that causes the trouble. They are very very bad some of them, from the point of view of heating and I think you can almost put any sort of wiring in there and it won't last, but I believe Mr Prins can give us some information on that. I just want to correct that I think the problem really starts with the light fitting. Now surely Mr Grundy has now referred to a specification which we are preparing for interior luminaires. Well actually I think I did say that yesterday what I wanted to say was there was a spec for fluorescent luminaires and that won't cover this problem, because it does not really arise with fluorescent luminaires. Now I think the best way to handle this problem would be to try and solve it by having a safety specification for a light fitting and I think I can state this to you that within the next 12 months, perhaps 18, our safety specifications will cover lighting fittings and I think that should be sufficient to take care of this problem because a temperature rise would be I think one of the things that we will cover certainly. I do not think we need a performance specification for it simply because most of these fittings, at least lets say about 50% of them are imported and we will in any case not get at them through a performance specification. We will only be able to look at the local fittings where with a compulsory specification we would of course reach them all. I think Mr Chairman that more or less answers the question which is directly asked here.

Mr F J Prins (SABS): Mr Quimaster, Mr Smith has touched on this question on the lighting fittings and as far as the fluorescents are concerned they've probably covered it in their new specification. The question comes to these tungsten lamp fillments. I have in my own laboratory fittings that have been put in my architect, correctly lamped. As you know you can put from anything up to 100 watt in the same envelope in a fitting even though the fitting may not be designed for it and in my own laboratory I had six lamps correctly rated at 60 watt lamps in them which eventually fell down. We checked those and we measured temperatures at the lampholder of about a 180C. Now this is nothing unusual, but the kind of fittings where the circulation is blocked like the ones that you have got here in this hall. They are all blocked. There is no air circulation, no cooling there. It's not unusual to get temperatures up to 200°C on that lampholder. So P.V.C. insulated cable is the very last thing that should ever be used in lamp fittings, because at the normal rate the graded P.V.C. is rated at national conductor temperature of 70°C. They talk about high temperature P.V.C. going up to a 105°C which I doubt very much. My experience has shown me that ordinary P.V.C. even at ambient temperature will flow under any pressure. There is another point. Over a 110°C copper oxidizes very fast and flakes off. So normally over 110°C you tin the copper to protect it against oxidation and over 150°C the tinning doesn't help any more either then you've got to go to nickel plating or silver plating. So the moment you come to a tungsten lamp fitting you definitely do not use P.V.C. I would never recommend that. You must come to one of the other asbestos insulated materials for lower temperature up to about 110°C. Silicone insulated cable you can take today continuously at about 180°C if you shorten the life probably to 250°C. There is new materials like etha ethylval acetate which is excellent up to a range of about 152°C, but the problem is that those cables cost money and people are not prepared to pay it. When we brought out schedule 4 in the compulsory specification of flexible cords, we originally we had these pendant cords included but we very soon had to bring out an amendment to exclude them from the specification because we would have put all fitting business manufacturing out of business, because if you look at them they are basically all using straight forward P.V.C. cord or flexible cord for these lamp fittings.

Mr A A Smith (Port Elizabeth): I think it might be of interest if I gave you briefly the details of the incident which gave the rise to this question. I think it is of interest also in view of the remark made yesterday on earth leakage units and lighting circuits. It was a light fitting, a bowl type lighting fitting, with a metal base that was installed in a kitchen and the P.V.C. wire passed through the metal base through a small hole which had a rubber grommet on the inside and eventually because of the heat of the fitting the conductor touched the metal base. Now there is an interesting point too. The lady of the house had an aluminium ladder and she climbed the ladder and the aluminium ladder touched the stainless steel sink and she on the aluminium ladder touched the fitting and got a severe shock. So I hope that is of interest to you people. Thank you.

QUESTION B17

Mr John Barrie (Affiliate): This is an inflationary age in which we live and society is becoming increasingly conscious of the rate at which we consume our natural resources. On those occasions that I have flown over cities like Cape Town or Johannesburg, I have derived a great amount of pleasure from the sight of the jewelled carpet of lights below me. This pleasure has, however, been diminished to a marked degree by the thought of the capital cost involved in the installation of street-lighting systems and the enormous amount of power and related fossil fuel that are consumed every night of the year and very often also during daylight hours for testing or by malfunction. We cannot turn the clock back but perhaps it would be as well to critically analyse what we plan to do in the future.

Grave doubts have been expressed in many quarters - and these quarters include the ratepayers who must foot the bill - as to whether really fancy streetlighting is actually essential in new urban areas. Could we not think in terms of a more elementary approach to street-lighting rather than attempt to turn night into day.

I chanced to read a remark by A H Fortman in the AMEU proceedings where the provision of high mast lighting resulted in a decrease in the murder rate and an increase in the number of rapes. I always thought rape was a fate worse than death but perhaps these figures prove me wrong. Whatever standard of streetlighting is ultimately installed I think it is only fair to accept that the consumption of electricity should be taken into account in determining payability. It is indeed introduced the practical difficulty of metering this consumption but I am sure that a fair and reasonable assessment of the likely powers usage is not beyond the realms of possibility. Perhaps this is what Ohm's Law is all about!

Having introduced the topic of containment of costs we could perhaps go on to look at the Niemand Commission recommendations. In broad terms the Cabinet has accepted Local Authorities should provide trading services at their own cost and I do not think that a technically orientated conference of this nature should waste its time pondering the vagaries of the Treasury in their efforts to control the flow of capital in the Country. The question that really needs an answer here is, "Have any of our undertakings found a practical means of giving effect to this recommendation?"

The answer to this part of the question is in all probability closely allied to the next section where I ask what effect availability charges have had on the financial structure of Electricity Departments. Perhaps some of our tariff experts could comment on the background to the determination of availability charges.

In this modern day and age Electricity Departments are becoming increasingly over-worked and understaffed. This has inevitably led to a noticeable increase in the amount of installation work being carried out on behalf of Electricity Departments by township developers. The principle seems to be fairly well accepted but there have been certain practical problems - for example a regrettable tendency to change specifications during the course of a job and a certain amount of difficulty in obtaining an unequivocal policy decision. What are the various undertakings doing to improve this liaison and by the same token what do the undertakings require Developers to do to improve technical and other liaison?

A lot of these problems would be resolved by the adoption of a standardised distribution system using universal components. This would have the effect of shortening delivery times and hopefully reducing costs although it must be conceded that a more individualistic bunch that Municipal Electrical Engineers would be hard to find. A quick tour of inspection through my store where you could see physical evidence of the difference in approach between 6 or more undertakings. Can we have some comment on the feasibility of a standardised approach? Thank you.

Mr A J van den Berg (Krugersdorp): Mnr die Vraesteller, toe ek hierdie vraag aan my Stadessourier gestel het, was sy antwoord onmiddellik: "Straatverligting is op geen stadium ekonomies geregeerd nie."

"Straatlignetwerke is 'n sosiale luukse en die installering daarvan, indien bekostig, kan word uit belastingsonde, meen ek is ekonomies geregeerd in die begin stadium omdat dit ongerief en hoër kostes tot gevolg sal hê veral wanneer jou grondinformatie die installering van kabels en straatligplaatse bemoeit omdat die verspreidingsnetwerk voltooi is."

Onder geen omstandighede meen ek moet die verbruik van straatverligting in berekening gebring word nie omdat dit 'n sosiale luukse is.

Die Niemand-Kommissie se bedoeling was om die prys van erwe te probeer afhou sodat die gewone man ook 'n erf kon bekostig.

Ek is van mening dat vraag en aanbod steeds die prys van woonerwe bepaal. Omstandighede wat geehoers het toe die ondersoek gedoen is verskil hemelebreed van die huidige omstandighede.

As gevolg van die Niemand-Kommissie se onuitvoerbaarheid, sees entrepreneur in die Ordonnansie, is sake vir Krugersdorp nie veel anders as wat dit in die verlede gewees het nie.

Die uitgangspunt dat handelsinstansie self die kapitaal moet voorsien om dienste te installeer omdat dit op 'n winsmotief gegrond is, is moontlik waar maar -

- die koste om dienste te verskaf is so hoog dat die tarief vir elke dorp aanreups en buitensprek hoog sal wees as wins op besteding gevestig moet word indien die dorp winnig ontwikkel;
- geen ontwikkelingsstempo word gewaarborg nie en dus skiet die verliese die hoogte in;

(c) eenvormige tariefstelsels vir 'n munisipaliteit is noodsaaklik volgens die huidige Ordonnansie (ook net sorpe) want nou betaal die gevestigde dorpe gedeeltelik vir die nuwe dorp se uitgaas.

Vir die redes genoem nader ons die dorpsreanaar vir 'n rentevrye lening en betaal alles aan hom terug namate die dorp ontwikkel. Hierdie is nie 'n wysiging op ons vorige metode nie en die Niemand-Kommis-sie maak voorsiening hiervoor. Danke.

QUESTION B18

Mr R W Barton (Welkom): Mr Quizmaster, this contribution is very short because time is very short. As stated in the answer to question A (2) I think that in our country with its droughts and resulting high resistance soil conditions which negate the use of conventional earthing methods protective multiple earthing is strongly favoured. On the other hand if earth leakage relays are developed to the point of reliability where earthing or bonding of non-current carrying metal work is no longer important then protective multiple earthing would not be necessary. And if I can do 18(2) at the same time Mr Quizmaster, Question (b) 18(2) asks whether the development of combined neutral and earth type cables will be influenced in Southern Africa by the necessity of live jointing. I do not believe that there is a need for live jointing since in the last 30 years I have not had one complaint from a consumer whose supply was disconnected for a short while to enable a T-joint to be made. I do not doubt the electrician on the job gets it in the neck occasionally, but I had no complaints Mr Quizmaster.

Mr H F Forsyth (Affiliate): The use of Protective Multiple Earthing on low voltage reticulation systems is at this stage widely accepted in the United Kingdom and in Europe. Certain supply authorities in South Africa are also adopting this approach particularly in the servicing of new township developments. It will be appreciated that widespread introduction of P.M.E. systems in South Africa will have repercussions in the cable making industry. Part 1 of the question posed to this forum is an attempt to obtain some indication of the extent to which P.M.E. systems will be introduced in South Africa over the next few years.

As suggested in Part 2 of the question the use of P.M.E. systems may offer certain economic advantages as far as cable costs are concerned in that combined neutral and earth type cables can be used and the CNE conductors may be concentrically applied. Effectively, therefore, a three-core cable can replace the conventional four-core in a three-phase system. Overseas it is common practice to provide individual service connections by means of T- or branch-joints off the main feeder and such joints are made with the main feeder energised. Consequently development of CNE cables has had to take account of the necessity to make T-joints on energised feeders without breaking the combined neutral and earth conductor. Thus in those CNE cable types where the neutral-earth conductor is comprised of concentrically applied wires a waveform type of application has been adopted which enables access to be obtained to the phase cores for jointing purposes without breaking the neutral conductor. This of course is not a necessity if live jointing is not a requirement - helically applied conductor wires could be used. Should there be a substantial demand for C.N.E. cables for use on P.M.E. systems and, to allow for live jointing (or for any other reason), these cables are required to have a waveform type of combined neutral and earth conductor it is evident South African cable manufacturers will have to consider equipping themselves with the appropriate manufacturing plant. However it is on this aspect that a note of warning must be sounded - in any such development, unless the members of this association and other supply authorities can reach agreement on the precise type of C.N.E. cable to be produced in a limited range of rationalised conductor sizes any cost benefits could be eroded by inadequate utilisation of expensive plant.

Mr F Prins (SABS): This question involves the two questions, will the use of p.m.e. systems increase and, if no, will it be by overhead reticulation or by cable reticulation? If by overhead reticulation, the question falls away. If by cable, then a decision will have to be taken as to what type of cable.

The most important aspect of a p.m.e. system is the continuity and integrity of the neutral and live working on a cable without interruption of the neutral is an advantage. In the U.K. the Department of Energy has approved three types of c.n.e. cable for use on p.m.e. systems, i.e. Consec, Districable and Waveform, all of which have a

"metallic" sheath and all of which lend themselves to live working without interruption of the neutral. In the Consec design three paper insulated aluminium conductors are laid up and sheathed with an aluminium sheath which combines the function of the neutral and the earth conductor. In the Districable this function is carried out by a lead sheathed circular aluminium conductor laid-up with the three phase conductors. The dielectric is either cross-linked polyethylene or ethylene propylene rubber. The Waveform cable is similar to the Consec cable but with wave-wound aluminium wires replacing the aluminium sheath and either cross-linked polyethylene or ethylene propylene rubber replacing the paper dielectric.

None of these types of cable is at present manufactured in South Africa and possible future manufacture will depend on consumer demand.

It should be noted that all these cables utilize aluminium conductors and aluminium sheaths or armouring.

Mr W Barnard (Johannesburg): Mr. Quizmaster, in my opinion PME will not be used extensively in this country. It certainly will not be used in Johannesburg either overhead or underground. In my opinion the additional cost of having a separate earth conductor and not having it earthed all along the run but only earthed at the supply point is negligible in comparison with the advantages as far as safety is concerned. If I may just comment very briefly on the second question, we have never liked the idea of making T-joints or any joints for that matter. We would much rather put distribution pillars on the pavements and take the cable directly into a point like that where you can more readily take out connections, where you can do the necessary testing and I think at together at the very small additional cost you can have a far superior installation.

Mr D H Fraser (Darban): Mr. Quizmaster, perhaps just to give an indication of another city's thinking in this respect, I would say firstly that live jointing is essential particularly in the commercial centre of a city where the placing of pillars for service connections would generally be difficult. I would go along with the service pillar in a residential reticulation. On the point of the use of PME I would say that this is entirely dependant on the relevant cost of the two systems and it seems that we've got the sort of chicken and the egg situation here in South Africa where until we know what the cable's going to cost, we can't really establish what the economic relationship is. On the question of underground or overhead low voltage reticulation I've always found it difficult to justify, much as I would like to, the use of underground in residential reticulation when one compares the cost of the two systems and I know that we tend to lag behind most other Municipalities in this regard who happily seem to have been able to convince themselves that it is right from an economic point of view to use an underground reticulation. I would certainly like to follow soon. Thank you.

Mr P J Botes (Roodepoort): Mnr die Vraesteller, ek wou nie eintlik iets gesê het nie, maar nu ek nou geluister het wat hier nagaan wil dit vir my weer voorkom asof die kabelvervaardigers weer besig is om een of ander kabel op ons af te dwing. Mnr die Vraesteller, kort kort dan het ons 'n ander kabel wat hier op ons afgedwing word. Dan is dit hierdie PEX kabel en aller-hande goeters. Nou kom hier weer ené wat afgedwing word. Ek glo nie daar is 'n noodsaaklikheid vir daardie kabel nie. Soos ek nou gebou het by almal nieemand het hom nodig nie, maar nou moet by kom. Danke.

Mr D C Palser (Cape Town): Mr. Quizmaster, I wasn't going to speak on this one, but in hearing what was said of that, I must say something. We in the Cape have been using the PME system now for about 30 years at least. We have had no trouble with it at all. Many years ago, ten years ago, I think, we converted from overhead to underground all new installations in residential areas. In our underground we find that the additional cost of undergrounding is more an offset by the reduction maintenance. We obviate all this wire throwing and other problems like that. We have no problems at all. Thank you.

MNR J K VON AHLPTEN - VRAESTELLER
MR J MORRISON - QUIZMASTER

This winds up the Forum session of this Technical Meeting and it has been a pleasure to both of us to have chaired the session. With that we hand back to the President.

P. HARTILL,

C. ENG. M.I.E.E. F.I.E.S., F.A.P.L.E.

Mr. Hartill C.Eng. M.I.E.E. F.I.E.S. F.A.P.L.E. is Technical Director Phosco Ltd. He was Vice President of the British I.E.S. from 1961 to 1963. He is the current Chairman of the B.S.I. Committee on road lighting lanterns. He served on C.I.E. T.C. 4.6 Committee and with several of the Working Groups in the revision of C.I.E. Publication 12. "Recommendations for Lighting of Roads for Motorised Traffic."

DI PRAKTIESE TOEPASSING VAN DIE 12/2

Die grondbeginsels van die huidige Britse Gebruikskode vir straatverligting is meer as 40 jaar gelede neergelê en in 'n spesiale verslag van die Departement van Vervoer gepubliseer. Dit was die eerste dokument wat sy aanbeveling gegrond het op die visuele eienskappe van luminansie, luminansie-eenvormigheid en skitterbeheer in plaas van op die fisiese eienskap van illuminansie wat die grondslag gevorm het van vorige Britse Standard spesifikasies en wat geheel en al onbevredigend bewys is as 'n merietekriterium. Dit bied 'n duidelike voorbeeld vir 'n koper van straatligmonterings om 'n spesifikasie te lê wat sulke eienskappe dele as duursaamheid, veiligheid en gemak van instandhouding waaraan die leersieners gebind kan word. Dit hou egter min voordeel vir die padgebruiker in om die fisiese prestasie van 'n montering te spesifiseer in terme van krag en ligverspreiding aangesien die visuele prestasie van 'n installasie daarvan afhang hoe die monterings gebruik word in verhouding met die omgewingstoestande.

As gevolg van die gewelddige probleme daaraan verbonde om visuele eienskappe in meetbare terme te spesifiseer, wat vir kontrakdoel-eindes bevestig kan word, indien nodig, was dit 'n logiese uitvloeisel om 'n Gebruikskode te lê wat gerig is op die bereiking van bevredigende visuele prestasie deur gebruik te maak van monterings met 'n gespesifiseerde fisiese prestasie. 'n Nadeel van hierdie metode is dat 'n nasionale spesifikasie vir ligverspreiding 'n tegniese hindernis vir internasionale handel kan wees en net so kan 'n internasionale spesifikasie 'n algemene hindernis in die weg van vordering wees aangesien daar ontelbare vorms van ligverspreiding is wat bevredigende resultate kan gee as dit behoorlik toegepas word.

In hierdie opsig moet die uitgebreide navorsing wat die "Experts Committee on Road Lighting" van die CIE uitgevoer het aseklik vir alle ontwerpers van verligtingsausrusting en openbareverligtingingenieurs oor die hele wêreld van groot belang wees. Die hersiene uitgawe van "Publication CIE/12" bied in groot detail metodes om die eerste visuele eienskappe van 'n straatverligtingsinstallasie in numeriese terme na waarde te skat en dit ook vooraf te bepaal. Hoewel baie mense die gedagte uitgespreek het dat dit te gesofistikeerd en ingewikkeld vir praktiese doeleindes is, is dit nie bedoel om 'n Gebruikskode op sigself te wees nie meer eerder 'n Kode van Visuele Vereistes wat as 'n grondslag vir Nasionale Kodes moet dien en die vereistes inhoud is ingesluit om sy aanbevelinge in praktiese terme van ligverspreiding en meetkunde om te sit.

Die ghaltekriteria vir padverligtingsinstallasies waarvoor die aanbevelings nou in numeriese terme gegee word, word soos volg opgesom:

- (1) Die gemiddelde waarde van padoppervlakluminansie (L , min./L)
- (2) Die totale eenvormigheid van padoppervlakluminansie (L , min./L)
- (3) Die langseenvormigheid van padoppervlakluminansie (L , min./L)
- (4) Die verligting van omringende oppervlaktes wat aan die padoppervlak grens
- (5) Die beperking van ongemakskittering
- (6) Die beperking van ongeskiktheidskittering

Ten einde die syferwaardes van hierdie kriteria te bereken, moet die volgende fisiese eienskappe van die installasie bekend wees:

- (a) Die vorm van die ligverspreiding vir elke montering (Isocandela-luxdiagram, Figuur 1 en 2)
- (b) Die krag van die ligbron in lumen (Φ) en die benuttingsfaktor van die montering in sy ontwerp



THE PRACTICAL APPLICATION OF C.I.E.12/2

The principles of the present British Code of Practice for road lighting were conceived 40 years ago and published in a report by a special committee of the Ministry of Transport. This was the first document to base its recommendations upon the visual properties of luminance, luminance uniformity and glare control rather than upon the physical property of illuminance, which had been the basis of previous British criteria of merit. It is of obvious benefit to a purchaser of road lighting lanterns to have a specification covering such qualities as durability, safety and simplicity of maintenance, to which a supplier can be held. It is of little benefit to the road user, however, to specify the physical performance of a lantern in terms of power and light distribution, because the visual performance of an installation depends upon how the lanterns are used in relation to the environmental conditions.

Owing to the formidable problem of specifying visual properties in measurable terms, which could be substantiated for contractual purposes if necessary, it was a logical procedure to have a Code of Practice directed towards the attainment of satisfactory visual performance using lanterns of specified physical performance. A disadvantage of this method is that a national specification for light distribution may be a technical barrier to international trade; (1) similarly, an international specification could be a general barrier to progress, because there are innumerable forms of light distribution which can provide satisfactory results if properly applied.

In this respect the extensive research work carried out by the C.I.E. Experts Committee on Road Lighting must surely be of very great interest to all designers of lighting equipment and public lighting engineers throughout the world. The revised edition of Publication CIE/12 presents in great detail methods of assessing and pre-determining desirable visual properties of a road lighting installation in numerical terms. Although many people have expressed the view that it is too sophisticated and complicated for practical application, it is not intended to be a Code of Practice in itself, but rather a Code of Visual Requirements to serve as a basis for National Codes and all the ingredients are included for translating its recommendations into practical terms of light distribution and geometry.

The criteria of quality for road lighting installations, for which recommendations have now been given in numerical terms, are summarised as follows:

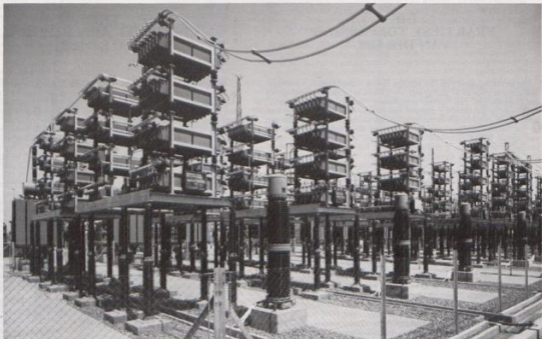
- (1) The average value of road surface luminance (\bar{L})
- (2) The overall uniformity of road surface luminance (L , $\text{min./}\bar{L}$)
- (3) The longitudinal uniformity of road surface luminance (L , min./L , max.)
- (4) The lighting of the surrounding regions bordering the road surface.
- (5) The limitation of discomfort glare.
- (6) The limitation of disability glare.

In order to calculate numerical values of these criteria, it is necessary to know the physical properties of the installation as follows:

- (a) The form of light distribution from each lantern (Isocandela and iso-lux diagrams, Figs. 1 and 2)
- (b) The power of the light source in lumens (Φ) and the utilisation efficiency of the lantern in its designed attitude.

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tot die gemiddelde luminansie (L_{min}/L) en dit word aanbeveel dat vir enige klas pad hierdie verhouding minstens 0,4 moet wees. Dit is moontlik om aan hierdie verhoed te voldoen as die monterings teen sulke lang intervale gespaesier is en dat die pad tot 'n mate 'n kollerige of dwarshandvoorkoms kan hê dat dit nie aanvaarbaar is wanneer dit subjektief na waarde geskat word nie. Om hierdie rede word 'n beperking op langseenvormigheid ook uitgedruk as 'n verhouding van minimum tot maksimum luminansie wat langs een lyn deur die waarnemer se posisie en parallel met die padas geneem word. Vir paasie en hoëspoed verkeersdra, beveld die C.I.E. 'n minimum langseenvormigheid van 0,7, maar daar vir paasie waar daar 'n spoedbeperking van 70 km/h of minder is, kan die verhouding tot 0,5 verlaag word. Dit moet besef word dat by lang spasiering kollerigheid uitgeskaal kan word as meer skittering veroorsaak word. Dit voer ekonomiese oorwegings in maar baie mense sal 'n bietjie meer skittering verkie as die dwarshandeffek vermy sal word.

Die balans tussen langseenvormigheid en skittering is een van die oudste probleme by straatverligting. Om hierdie probleem die hoof te bied, het die C.I.E. metodes geformuleer om die graad van sowel ongemak as ongeskiktheidskittering in numeriese terme te waardeer. Ongemakskittering word hoofsaaklik deur die aard van die ligverspreiding van die monterings beïnvloed maar dit word verminder deur die gemiddelde padluminansie te verhoog en die monteringshoogte groter te maak. Aangesien die effek van verhoogde lumenkontras is, word ongemak ook verminder deur die spasiering van die monterings te vergroot - wat langseenvormigheid vreesprek. 'n Spesifieke monteringsindeks (SMI) (Engels: Specific Lantern Index SLI) is ingevoer om die verspreidingskennepaak, wat konstant bly te dek en hierby moet 'n syfer getel word wat afgelei word van die volgende installasieparameters vir luminansie, n_l, monteringshoogte en monterings per kilometer om 'n skitteringskontroleerf (G) te verkry wat volgens 'n negepotensiaal ingedeel is en van Odraaglik (G = 1) tot Onmerkbaar (G = 9) wissel.

Aanbevole minimum waardes wissel van 4 vir sekondêre paasie met donker omgewings tot 6 vir belangrike paasie met helder omgewings.

Ongeskiktheidskittering word geëvalueer op die grondslag van die goed gevestigde Holladay/Stiles-formule wat 'n waarde gee aan die effek dat die aansporel van die oog deur skitteringsbronne veroorsaak word en dat die vermeer om voorwerpe deur lumenkontras waar te neem sodoende verlaag word. Dit word uitgedruk as 'n ekwivalente sluerluminansie (L_v) wat afhanglik is van die illuminansie (E_g) wat deur 'n skitteringsbron op die waarnemer se oog veroorsaak word en die hoek (θ) tussen die sigrigting en die middelpunt van die skitteringsbron. Vir praktiese toepassings word die aansporelsluerluminansie volgens die volgende formule deur die gemiddelde padoppervlakluminansie (L) en die ekwivalente sluerluminansie benader:

$$L_v = \frac{10 E_g \text{ cd/m}^2}{\theta^2} \quad \text{waar } \theta \text{ in grade}$$

Die hoeveelheid ongeskiktheidskittering word bereken volgens die lumenkontras onder skitteringstoestande tussen 'n voorwerp wat net waarnembaar is en die padoppervlak minus die waarde sonder skittering uitgedruk as 'n persentasie van die waarde met skittering dit staan as die drumpelinkrement (DI) (Engels: threshold increment TI) bekend en kan by benadering deur die volgende formule uitgedruk word:

$$TI = \frac{65 L_v}{L} \%$$

Alle skitterbronne binne sig moet natuurlik in aanmerking geneem word en die effek opgetel word. In 'n afsonderlike tegniese verslag van die C.I.E. oor skittering en eenvormigheid word 'n grafiek ingesluit waarvan die waarde van TI vinnig van bekende waardes van L_v en L aflees word.

Die metodes waarvolgens lig beheer en monterings geringsak kan word om die vereiste waardes van luminansie, eenvormigheid en skittering te verkry, is eenheidig. Dit is ook getoon dat selfs met gespaesierde ligverspreidings, soos die wat met die bestaande nasionale gebruikskodes gebruik word, aansienlike variasies in die resultate visuele eienskappe kan voorkom as die monterings in 'n gegewe meetkundige patroon geringsak word. 'n Stap in die rigting van die vereenvoudiging van hierdie probleem is gemaak met die nuwe C.I.E.-indeling van ligverspreidings wat die valhoogte van die lig wat langs die pad uitgestraal word, die langverspreiding en die mate van skitteringskontras in aanmerking neem. Daar is drie gedefinieerde kategorie vir elke van hierdie faktore sodat 3x3x3 = 27 verskillende tipes ligverspreiding met hierdie indeling beskikbaar is. Daarbenewens het ons ses bekende standaard monteringsrigtings vir die installasie van 'n enkele, sentraal, verspreid, verspreid en teenoorgestel vir dubbelaanpassing en dubbel-sentraal en teenoorgestel plus sentraal vir dubbelaanpassing. Om installasies te beplan, moet ons dus weet hoe 'n besondere ligverspreiding reageer wanneer dit volgens enige van hierdie standaard rigtings ingestel word.

Die nuwe indeling van ligverspreiding sal sonder twyfel van waarde wees internasionaal en in die bevordering van die standaardisasie van tipes. Tot dusver is die benamings afsonderlik, semi-afsonderlik en nie-afsonderlik om verspreidings hoofsaaklik in die vertikale vlak in te deel en selfs die het nie eers dieselfde betekenis in alle lande gehad nie. Enige vorm van verspreiding kan beskryf word met die nuwe stelsel wat

should be at least 0,4. It is possible to comply with this requirement when the lanterns are spaced at such long intervals that the road may show considerable patchiness or cross-banding to such an extent that it would not be acceptable when appraised subjectively. For this purpose a limitation on longitudinal uniformity is also given expressed as a ratio of the minimum to the maximum luminance measured along a single line through the observers position and parallel with the road axis. For roads carrying high speed traffic the C.I.E. recommended a minimum longitudinal uniformity of 0,7, but for roads on which there is a speed limit of 70 km/h (44 m.p.h.) or less the ratio may be reduced to 0,5. It will be appreciated that at long spacings patchiness can be reduced at the expense of creating more glare. This introduces economical considerations, but many people would prefer a little more glare if cross-banding could be avoided.

The balance between longitudinal uniformity and glare is one of the classic problems of road lighting. To meet this problem the C.I.E. have formulated methods of assessing degrees of both discomfort and disability glare in numerical terms. Discomfort Glare is mainly influenced by the character of the light distribution from the lanterns, but is alleviated by increasing the average road luminance and by raising the mounting height. Because the effect of glare is cumulative, discomfort is also reduced by increasing the spacing of the lanterns which tends to mitigate against the longitudinal uniformity. A Specific Lantern Index (SLI) has been introduced to cover the distribution characteristics, which are constant, to which must be added a figure derived from the installation parameters of luminance, mounting height and number of lanterns per kilometre to arrive at a Glare Control Mark (G) on a nine-point scale, ranging from "Unbearable" when G = 1 to "Unnoticeable" when G = 9.

Recommended minimum values vary from 4 for secondary roads with dark surrounds to 6 for more important roads with bright surrounds.

Disability Glare is evaluated on the basis of the long established Holladay/Stiles formula which quantifies the effect of raising the adaptation level of the eyes by sources of glare and thereby reducing the ability to perceive objects by luminance contrast. This is expressed by an equivalent veiling luminance (L_v) which depends upon the illuminance (E_g) on the observer's eyes produced by a glare source and the angle between the direction of view and the centre of the glare source (θ). For practical application the adaptation luminance is approximated by the average road surface luminance (L) and the equivalent veiling luminance by the formula:

$$L_v = \frac{10 E_g \text{ cd/m}^2}{\theta^2} \quad \text{when } \theta \text{ is expressed in degrees.}$$

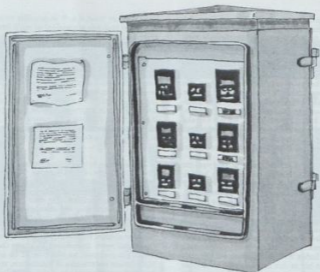
The amount of disability glare is calculated by the luminance contrast between an object and the road surface just perceptible under glare conditions minus its value without glare, expressed as a percentage of the value with glare. This is known as threshold increment (TI), and may be expressed approximately by the formula:

$$TI = \frac{65 L_v}{L} \%$$

All glare sources within view must of course be taken into consideration and the effects summated. In a separate C.I.E. technical report on glare and uniformity a graph is included from which the TI value can be quickly read against known values of L_v and L.

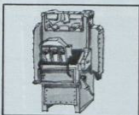
The ways in which light can be controlled and lanterns disposed to provide required values of luminance, uniformity and glare control are infinite. It has also been shown that even with specified light distributions, such as those used in conjunction with existing national codes of practice, considerable variations can occur in the resultant visual properties when lanterns are installed in a given geometric arrangement. A step towards simplification of this problem has been made by the new C.I.E. classification of light distributions which take into account the throw of the light emitted along the road, the lateral spread and the degree of glare control. There are three defined categories of each of these factors so that there are 3 x 3 x 3 = 27 different types of light distribution available in this classification. In addition, we have six well-known standard mounting arrangements for installation geometry, single side, central, staggered and opposite for single carriageway roads; twin central and opposite-plus-central for dual carriageways. For planning installations, therefore it is necessary to know how a particular light distribution performs when installed at any of these standard arrangements.

The new classification of light distribution will no doubt be of value internationally in promoting standardisation of types. Hitherto, the designations cut-off, semi-cut-off and non-cut-off have been used to classify distribution mainly in vertical planes, and even these have not had the same meaning in all countries. Any form of distribution can be described by the new system which takes into account the general



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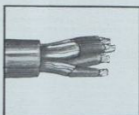
l.v. electrical distribution equipment from the specialists.



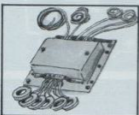
Lucy 11 kV, 350 MVA fused ring main units. Maximum demand indicators. Ammeters and voltmeters, selector switches, 11 kV striker pin fuses. Cable boxes and utility boxes.



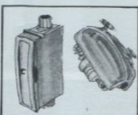
Simplex busbar trunking, cable trunking, under-floor ducting, rising mains.



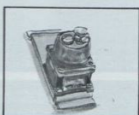
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algemene eienskappe van ruimtelike verspreiding in aanmerking neem en dit het 'n aansienlike uitwerking op visuele prestasie.

Vir algemene praktiese gebruik is die gerieflik om inligting oor die prestasie van 'n montering met 'n gegewe prestasie te hê as dit ooreenkomstig 'n besondere inrigting of 'n reëlmatige stel van geseleerde word. In 'n afsonderlike tegniese verslag stel die C.I.E. metodes vir die monteringvervaardiger oor om data in tabel- of grafiese vorm aan te bied. 'n Alternatiewe metode word hier voorgestel wat die prosedure vir so-wel die vervaardiger as die installasie-ontwerper kan vergemaklik.

Die beperkings op spasiering met verwysing na padbreedte om aan die vereistes vir totale en langsluminansie-eenvormigheid te voldoen, kan grafieshaal deur 'n diagram van die tipe in Figuur 8 uitgedruk word. Hierdie diagram is van toepassing op 'n enkelantingrigting vir die monterings met verspreidings soos in Figuur 1 op 'n padoppervlak van tipe R1. 'n Afsonderlike diagram word vir elke inrigting en tipe padoppervlak voorsien.

Aangesien die spasiering en padbreedte in veelvoute van die monteringshoogte (h) uitgedruk word, sal die gemiddelde padluminansie vir enige spasiering/hoogte-verhouding eweredig wees aan die lamp-lewering in lumens (o) en omgekeerd eweredig aan h^2 . Vir installasie-ontwerper is dit gerieflik om 'n Luminansie-indeks in te voer wat gelyk is aan $\frac{1000 \cdot L \cdot h^2}{\bar{L}}$, waar L die vereiste gemiddelde padoppervlakluminansie

is. In Figuur 9 is luminansie-indekskrommes by die diagram gevoeg sodat vir 'n besondere lamp en monteringshoogte die vereiste spasiering om die vereiste gemiddelde luminansie op 'n gegewe padbreedte vinnig bepaal kan word. As die vervaardiger 'n reeks sulke diagramme sou produseer, sal dit 'n eenvoudige saak vir die installasie-ontwerper wees om 'n luminansie-indeks uit te werk en op die geskikte uitleg vir plaaslike toestande te besluit.

Soortgelyke diagramme vir dieselfde montering op padoppervlak tipe R4 word in Figuur 10, 11 en 12 vir enkelant-, verspreide en teenoorgestelde inrigtings getoon. Die uitwerking daarvan om die strek van Smal na Breed in die CIE-indeling te vergroot – soos in die iso-candela-diagramme in Figuur 13 getoon word, word in Figuur 14 vir 'n enkelantingrigting op padoppervlak tipe R4 getoon. Die prestasie van enige tipe ligverspreiding kan op die wyse aangedui word en verdere voorbeelde word in Figuur 15 en 16 vir konvensionele semi-afsonderings met laedruk-natriumlampe vir lang valhoogte en gemiddelde strek getoon. Figuur 17 toon die prestasie van tipiese monterings met 'n aksiale mediaan wat laedruk-natriumlampe gebruik – die hoofstraal is teen 'n hoek van 48° dwarsgerig.

Die begrip **effektiewe breedte** word in die Britse Kode gebruik en dit neem die oorhang van 'n montering oor die pad en berekening.

Dit word soos volg gedefinieer:

Inrigting

Middel

Enkelkant of verspreing

Teenoorgesteld

Effektiewe breedte

Padbreedte

Padbreedte minus oorhang

Padbreedte minus twee keer

die oorhang

Dit kan nuttig wees wanneer 'n pad effens te breed is om die vereiste minimum eenvormigheidsverhouding te verkry as daar geen oorhang is nie. Die spasiering om die vereiste gemiddelde luminansie te voorsien, kan dan die toepaslike diagram bepaal word vir die werklike breedte van die pad en 'n oorhang wat verkieslik nie 'n kwart van die voorsiene monteringshoogte oorskry nie. Die eenvormigheid sal bevredigend wees as die resultante effektiewe breedte nie die grenslyn op die diagram oorskry nie.

Aangesien hierdie tipe diagramme gegewe ligverspreidingsvorme en gedefinieerde kaatsienskappe van die padoppervlak met mekaar in verband bring, kan hulle, indien nodig, deur onafhanklike toets geïnterfasier word. Die werklike resultate wat verkry word, sal natuurlik wissel met veranderinge in die aard van die padoppervlak. Dit is getoon dat die luminansiekoëffisiënte vir 'n droë pad soveel as 5:1 oor die loop van 'n jaar kan wissel en gevolglik kan waardes wat 'n gegewe tipe padoppervlak ontwerp is slegs deur veldtoets bevestig word as toestand dieselfde is.

Die CIE-aanbevelings is beperk tot minimum vereistes vir droë padoppervlakke en dit word beskou dat 'n aansienlike bydrae tot verkeersveiligheid ook onder swak weerstoestande bewerkstellig sal word.

Dit word tans voorgestel dat 'n totale luminansie-eenvormigheid van minstens 0.2 vir nat toestande 'n redelike teiken is, maar die werk gaan nog voort om geskikte meetmetodes te vind. In hierdie verband is 'n belangrike faktor dat wanneer lig reëlmatig van die luminansie is 'n belangrike faktor dat die illuminasie van die intensiteit nie maar wel aan die luminansie van die montering of ligbron. Dit kan geïnterfasier word deur in nat weer 'n installasie te ondersoek wat bronne met lae intrinsieke luminansie soos buisfluoresensie- of laedruk-natriumlampe gebruik en dit te vergelyk met 'n installasie wat klein bronne met 'n hoë luminansie in monterings met 'n lae fitsoopervlak gebruik. Die verskil in luminansie wanneer die pad nat is, sal met laasgenoemde installasie aansienlik groter wees hoewel die gemiddelde luminansie en luminansieverskil vir albei installasies in droë weer soortgelyk kan wees. Dit is belangrik om te beseef dat aansienlike variasies in die aard van 'n padoppervlak voorkom weens verkeersslytasie, neerslag van on-

properties of spatial distribution and this has a considerable bearing on visual performance.

For general practical use it is convenient to have information on the performance of a lantern of known distribution when installed at a particular arrangement on straight lengths of road. In a separate technical report the C.I.E. suggest methods of data presentation by the lantern manufacturer for this purpose in tabular or graphical form. An alternative method is here proposed which may simplify the procedure both for the manufacturer and for the installation designer.

The limits of spacing and in relation to the road width to meet the requirements for overall and longitudinal luminance uniformity at a given standard arrangement could be conveniently indicated by a diagram of the type shown in Fig. 8. This diagram applies to a single-side arrangement of lanterns with distributions as Fig. 1 on type R1 road surface. A separate diagram is necessary for each different arrangement and for each type of road surface. Since the spacing and road width are indicated in multiples of the mounting height (h), for any spacing/width ratio the average road luminance will be proportional to the lamp output in lumens (o) and inversely proportional to h^2 . For installation design it is convenient to introduce a Luminance

Index (λ) equal to $\frac{1000 \cdot L \cdot h^2}{\bar{L}}$, where \bar{L} is the required average road sur-

face luminance. In Fig. 9 Luminance Index curves have been added to the diagram, so that for a particular lamp and mounting height the spacing can be quickly determined to provide a required average luminance on a road of given width. If a series of such diagrams were produced by the manufacturer, it would be a simple matter for the installation designer to work out a Luminance Index and decide upon the most suitable geometry for the local conditions.

Similar diagrams for the same lantern on type R4 road surface are given in Figs. 10, 11 and 12 for single-side, staggered and opposite arrangements.

The effect of increasing the spread from Narrow to Broad in the C.I.E. classification, as shown in the isocandela diagram of Fig. 13, is indicated for a single-side arrangement on type R4 surface in Fig. 14. The performance of any type of light distribution can be depicted in this way and further examples are given in Figs. 15 and 16 for conventional semi-cut-off lanterns, Long Throw and Average Spread, with low pressure sodium lamps. Fig. 17 shows the performance of typical Axial Median lanterns with low pressure sodium lamps, the main beams being directed transversely at an elevation of 48°.

The concept of Effective Width is used in the British Code which takes into account the overhang of a lantern over the carriageway. It is defined as follows:

Arrangement

Central

Single-side or staggered

Opposite

Effective Width

Carriageway width

Carriageway width minus overhang

Carriageway width minus twice overhang

This may be useful when a road is a little too wide to obtain the required minimum overall uniformity ratio at a given arrangement if there is no overhang. The spacing to provide a required average luminance can be determined from the appropriate diagram for the actual width of the carriageway and an overhang preferably not exceeding one quarter of the mounting height provided. The uniformity will be satisfactory if the resultant Effective Width does not exceed the limit line on the diagram.

Since diagrams of this kind relate to given forms of light distribution and defined reflecting properties of the road surface, they can be certified by independent tests if required. The actual results obtained after installation will, of course, vary with changes in the nature of the road surface. It has been shown that luminance co-efficients for a dry road surface can vary by as much as 5:1 in the course of a year (3) and consequently values designed for a given type of road surface can be substantiated by field tests only when service conditions are similar. The C.I.E. recommendations are restricted to minimum requirements for dry road surfaces and it is considered that a significant contribution to traffic safety will also be maintained under adverse weather conditions.

At present it is suggested that an overall luminance uniformity of at least 0.2 for wet conditions is a reasonable target, but work is still proceeding to determine suitable methods of measurement. In this connection an important factor is that when light is reflected regularly from a specular surface to the eyes of an observer the luminance at the point of incidence is not proportional to the illuminance or intensity, but to the luminance of the lantern or light source. This can be verified by examining, in wet weather, an installation using sources of low intrinsic luminance, such as tubular fluorescent or low pressure sodium lamps, in comparison with an installation using similar sources of high luminance in lanterns with low flashed areas. The diversity of luminance when the road is wet will be considerably greater with the latter installation although the average luminance and diversity may be similar in both installations in dry weather. It is important to recognise that appreciable variations do occur in the nature of a road due to traffic wear, deposition of impurities, surface dressing and

suiverhede, herbedekking en veranderende weerstoelende. Vir installasie-ontwerp moet die beslissing by die Openbare Verligtings-owerheid word oor watter toelating vir ongunstige toestande gemaak moet word. Soortgelyke oorsigging geld ook by die opstel van 'n Nasionale Gebruikswaarde.

Basies moet die aanbevelings van 'n kode daarop gerig wees om die CIE-gaalkriteria in droë weer te bereik met inagning van die vorm van die ligverspreiding in verhouding tot gespesifiseerde tipes padoppervlak en 'n toepaslike verduisteringsfaktor kan dan toegelate word om 'n waarde van die gemiddelde padluminansie te verkry. Dit moet beseef word dat as die grense vir spasiering en padbreedte vir voldoende eenvormigheid bereik word die resultate heel moontlik onbevredigend sal wees wanneer toestande ongunstig is weens eksternere faktore wat buite die beheer van die verligtingsontwerper is en redelike rople belyning is dus wenslik. Sover dit ongemak- en ongeskiktheidskittering aangaan; aangesien hulle tot 'n groot mate deur die Spesifieke Monteringsindeks (SMI) beïnvloed word, sal daar 'n beperking op die aantal ligverspreidings in die lang valhoek-kategorie van die nuwe CIE-indeling wees wat gebruik kan word om die aanbevole waardes van Skitterkontrole (G) en Drumpelinkrement (DI) te verkry. Die SMI is 'n fisiese eienskap van die montering maar die waarde van G word volgens die volgende formule deur die installasie-eienskappe luminansie, monterehoogte en spasiering bepaal:

$$G = SMI + 0,97 \log L + 4,41 \log h' - 1,46 \log p$$

waar h' die monterehoogte bo die waarnemer se ooghoogte (gewoonlik as 1,5 m geneem) en p die getal monterings per kilometer is.

Die ekwivalente sluerluminansie (L_v) word bereken vir 'n waarnemingspunt 'n kwart van die padbreedte van nabykant af en die uitwerking van monterings aan albei kante moet in aanmerking geneem word.

Die waarde van L_v word dus aansienlik deur die installasie-inrigting en die drumpelinkrement (DI) beïnvloed word en sal byna omgedrae eweredig wees aan die padoppervlakluminansie.

Dit is voorgestel dat vir kontrakprosedures nadruk moontlik op monteringsprestasie geleë sal word, wat gereëfer kan word eerder as installasieprestasie wat 'n objektiewe en nie 'n strengere vereiste is nie.⁴ Dit is ook voorgestel dat ongeveer agt tipes ligverspreiding, wat op die grondslag van die CIE-indeling gekies word, die meeste van die verduisterings sal dek en dat 'n oordeelkundige keuse dit moontlik sal maak om repte vir installasie-inrigtings vir 'n gebruikskode te ontwikkel sonder om aansienlike variasies in visuele prestasie in te voer.⁴ In die huidige program van die CIE-komitee word daar nog met die werk in die verband voortgegaan. Die gedagte is uitgespreek dat 'n reëlstelsel ontvuldig mag wees totdat meer oor die onderlinge verhouding van die aanbevole kriteria bekend is.⁴ Daar is byvoorbeeld reeds aanduidings dat eenvormigheid belangriker is as die gemiddelde waarde van padoppervlakluminansie.⁴ Daar sal sekerlik tydens die volgende vier jaar meer lig deur die CIE-deskundiges op hierdie veld gewerf word.

In die tussentyd moet dit erken word dat die nuwe internasionale aanbevelings 'n groot verandering in die tegniek van straatverligting is en dat dit baie waardevol sal wees om verkeersveiligheid oor die hele wêreld te bevorder. Die is nou vir die verligtingsingenieurs om die tegniese probleme uit te stryk en dit in praktiese terme oor te sit.

BYLAAG

Die CIE-indeling van ligverspreiding

(1) Slaghoogte

Die eлевasie van die bundelmiddelpunt * in die hoof-vertikale pool-diagram

Kort slaghoogte	$\theta < 60^\circ$
Tussenslaghoogte	θ tussen 60° en 70°
Lang slaghoogte	$\theta > 70^\circ$

(2) Strek

Die inklinasiehoek met die afwaartse vertikale as van die montering met 'n vlak wat die ligbron bevat en parallel met die padas is en die bundel* net sny.

Smal strek	$\theta < 45^\circ$
Gemiddelde strek	θ tussen 45° en 55°
Breed strek	$\theta > 55^\circ$

(3) Beheer

Die spesifieke monteringsindeks word deur die volgende formule gedefinieer:

$$SMI = 13,84 - 3,31 \log I_{80} + 1,3 (\log I_{80}/I_{88})^{0,5}$$

$$- 0,88 \log I_{80} + 1,29 \log F$$

waar I_{80} en I_{88} die intensiteite by 'n eлевasie van 80° en 88° log van die waarnemer in 'n vertikale vlak parallel met die padas is. F is die **flits-oppervlak** van die montering wat teen 'n eлевasie van 76° in hierdie vlak gesien word.

Beperkte beheer	$SLI < 2$
Matige beheer	SLI tussen 2 en 4
Streng beheer	$SLI > 4$

*Die bundel word gedefinieer as die soliede hoek wat by die fotometriese middelpunt van die montering onderspan word wat die maksimum intensiteit en al die intensiteite groter as 90% van die maksimum bevat.

changing weather conditions. For installation design the decision must rest with the Public Lighting Authority concerned as to what allowances should be made for unfavourable conditions. Similar considerations also apply in drawing up a National Code of Practice.

Basically, the recommendations of a code would be aimed at achieving the C.I.E. criteria of quality in dry weather, taking into account the form of the light distribution in relation to specified types of road surface and an appropriate depreciation factor could be allowed in arriving at a value of average road luminance. It will be appreciated that if the limits of spacing and road width for adequate uniformity are approached, the results are likely to be unsatisfactory when conditions are unfavourable due to extraneous factors beyond the control of the lighting designer and reasonable generous planning is therefore desirable. As regards discomfort and disability glare, since these are considerably influenced by the Specific Lantern Index, there will be a limit to the number of light distributions in the Long Throw category of the new C.I.E. classification that can be used to obtain the recommended values of Glare Control Mark (G) and Threshold increment (TI). The SLI is a physical property of the lantern but the value of G depends also upon the installation properties of luminance, mounting height and spacing by the formula:

$$G = SLI + 0,97 \log L + 4,41 \log h' - 1,46 \log p$$

where h' is the mounting height above the observer's eye level (taken as 1,5m. above the road surface) and p is the number of lanterns per kilometer.

The equivalent veiling luminance (L_v) is calculated for an observation point at one quarter of a road width from the near side and the effect of lanterns on both sides must be taken into account. Its value is therefore considerably influenced by the installation geometry and the threshold increment (TI) will be nearly inversely proportional to the road surface luminance.

It has been suggested that for contract procedure emphasis is likely to be placed upon lantern performance, which can be verified, rather than upon installation performance, which would be an objective and not a rigid requirement.⁽³⁾ It has also been proposed that about eight types of light distribution, selected on the basis of the C.I.E. classification, would cover the majority of requirements and that a judicious selection would permit recipes for installation geometry to be evolved for a code of practice without introducing significant variations of visual performance.⁽⁴⁾ Work on this subject is still proceeding in the current programme of the C.I.E. committee. The view has been expressed that a recipe system may be untimely until more is known about the inter-relationship of the recommended quality criteria.⁽⁵⁾ For example, there is already some evidence that uniformity is of greater importance than the average value of road surface luminance.⁽²⁾ There will, no doubt, be more enlightenment in this field from the C.I.E. experts during the next few years.

In the meantime it must be acknowledged that the new international recommendations constitute a major advance in the technique of road lighting and will be of great value in promoting traffic safety throughout the world. It remains for lighting engineers to iron out the technical problems and translate them into practical terms.

APPENDIX 1

The C.I.E. Classification of Light Distributions.

(1) Throw:

The elevation of the beam's centre in the principal vertical polar curve.

Short Throw	$\theta < 60^\circ$
Intermediate Throw	θ between 60° and 70°
Long Throw	$\theta > 70^\circ$

(2) Spread

The angle of inclination to the downward vertical axis of the lantern of a plane containing the light source and parallel with the road axis, which just intercepts the beam*.

Narrow Spread	$\theta < 45^\circ$
Average Spread	θ between 45° and 55°
Broad Spread	$\theta > 55^\circ$

(3) Control

The specific lantern index defined by the formula:

$$SLI = 13,84 - 3,31 \log I_{80} + 1,3 (\log I_{80}/I_{88})^{0,5} - 0,08 \log I_{80}/I_{88} + 1,29 \log F$$

where I_{80} and I_{88} are intensities at 80° and 88° elevation towards observer in vertical plane parallel with road axis; F is the "flushed area" of the lantern viewed at an elevation of 76° in this plane.

Limited Control	$SLI < 2$
Moderate Control	SLI between 2 and 4
Tight Control	$SLI > 4$

* The beam is defined as the solid angle subtended at the photometric centre of the lantern containing the maximum intensity and all intensities greater than 90% of the maximum.

FIG. 3.

HELDER GEBIED WEENS
VOORKEURWEERKAATSIING
BRIGHT AREA DUE TO
PREFERENTIAL REFLECTION

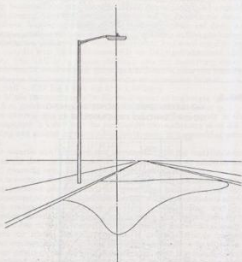


FIG. 4.

POINT LOCATED BY ANGLES α AND β
PUNT WAT DEUR HOEKE EN

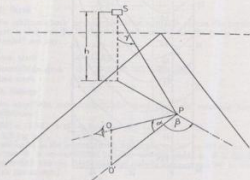
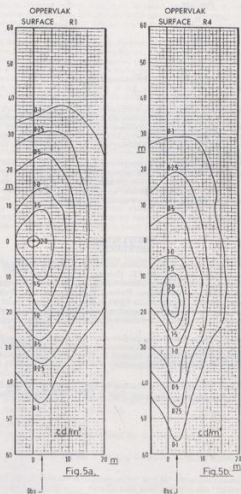


FIG. 5.

ISO-LUMINANSIEKONTOERE VIR MONETERING
VERSPREIDING SOOS IN FIG. 1.
ISO-LUMINANCE CONTOURS FROM LANTERN
DISTRIBUTION AS FIG. 1.



MONTEERHOOGTE
MOUNTING HEIGHT = 10m
1 = 20000 Lm

FIG. 6.

BENUTTINGSFAKTORKROMME
UTILISATION FACTOR CURVE

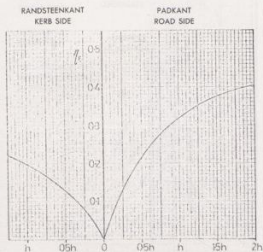


FIG. 8.

GRENSE VAN LANGS- EN
TOTALE EENVORMIGHEID VIR
MONTERINGSVERSPREIDING SOOS IN FIG. 1.
LIMITS OF LONGITUDINAL
& OVERALL UNIFORMITY
FOR LANTERN DISTRIBUTION AS FIG. 1.

ENKELEKANT IN RIGTING
SINGLE SIDE ARRANGEMENT

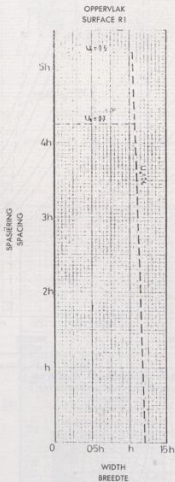
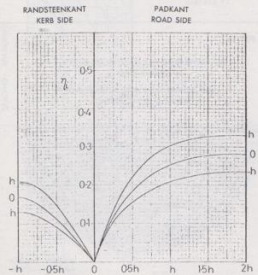


FIG. 7.

LUMINANSIELEWERINGSDIAGRAM
LUMINANCE YIELD DIAGRAM

OPPERVLAK
SURFACE R4



PRESTASIEDATA VIR MONTERING SOOS IN FIG. 1.
PERFORMANCE DATA FOR LANTERN AS FIG. 1

FIG. 9.

SINGLE SIDE
ENKELKANT

FIG. 10.

OPPERVLAK
SURFACE R1.

OPPERVLAK
SURFACE R4

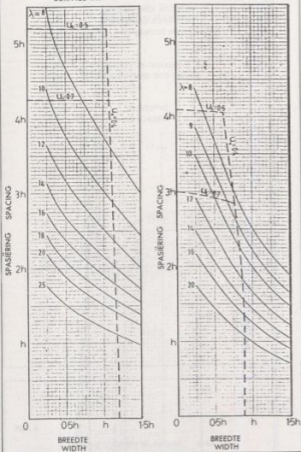
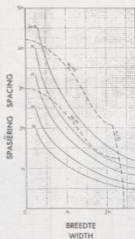


FIG. 11.
PRESTASIEDATA VIR MONTERING
SOOS IN FIG. 1. VERSPRING
PERFORMANCE DATA FOR LANTERN AS FIG. 1
STAGGERED

OPPERVLAK
SURFACE R4



PRESTASIEDATA VIR MONTERING SOOS IN FIG. 1.
PERFORMANCE DATA FOR LANTERN AS FIG. 1.

FIG. 12.

OPPOSITE
TEENOORGESTELD
OPPERVLAK SURFACE R4

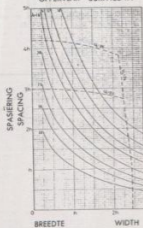
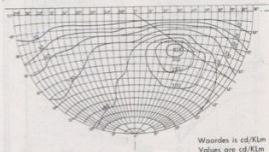


FIG. 13.

LIGVERSPREIDING MET TUSSENSLAGHOOGTE
EN BREË STREK

LIGHT DISTRIBUTION WITH INTERMEDIATE
THROW & BROAD SPREAD



Waardes is cd/Klm
Values are cd/Klm

FIG. 14

PERFORMANCE DATA FOR LANTERN AS FIG. 13 SINGLE SIDE

SURFACE R4
OPPERVLAK

PRESTASIEDATA VIR MONTERING SOOS IN FIG. 1

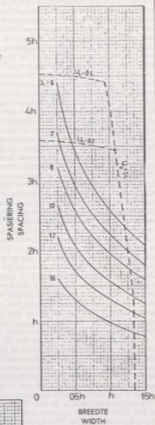
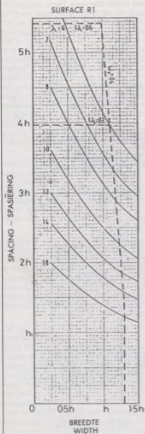


FIG. 16



PERFORMANCE DATA FOR LANTERN AS FIG. 13 SINGLE SIDE SURFACE R1.

FIG. 15

TIPIESE ISO-CANDELADIAGRAM VIR MONTERING MET LAEDRIJK NATRIUMLAMP

TYPICAL ISO-CANDELA DIAGRAM FOR LANTERN WITH LOW PRESSURE SODIUM LAMP

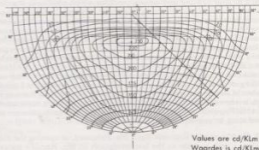
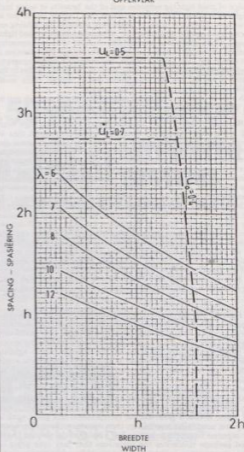


FIG. 17

PRESTASIEDATA VIR MONTERINGS MET AKSIALE MERIDIAAN

PERFORMANCE DATA FOR AXIAL MEDIAN LANTERN

SINGLE SIDE
ENKELKANT
SURFACE R4
OPPERVLAK



Mr. J T Grundy (Affiliate): Mr President from the Institute of Lighting Engineers of S.A. I am asked to convey good wishes to your Association. Having said that Mr President I think as there may be some possible confusion regarding the CIE I should explain that CIE 12/2 is quite a formidable documentation. In the discussion of Mr Woods paper last year I did give a short summary of the draft and the technical reports that were involved and the fact that a team of international experts have spent 4 years studying this important subject of Road Lighting. Therefore what Mr Hartill is going to do this morning is to give a very brief rundown as it were of the implications of CIE 12/2 in regard to road lighting and certain principles which apply to the design and development of lighting. Now next week at the SANCI Conference he will again deal with CIE 12/2 but in this case he will be dealing with it from what you might like to term a lighting engineers point of view. That is in regard to the design, development and manufacture of the equipment which is relevant to CIE 12/2. I hope I gave you some idea of what is proposed in connection with this matter and having said that CIE 12/2 was built up by international experts of whom Mr Hartill was one, I hope the discussions will be interesting. I don't think we should give in to all proposals of these international experts but I think we should also be just and give them the credit where this is due and if there is any criticism then I think we should also let them know what we in the Republic of S.A. think. So gentlemen I have great pleasure in introducing to you my colleague Mr Hartill.

S.H. Hawkeswood (Richards Bay): Mr. President, in opening the discussion, I wish to refer to the last paragraph in Mr. Hartill's paper, namely:

"It remains for the lighting engineer to iron out the technical problems and translate them into practical terms."

I believe that this statement emphasises the manner in which Mr. Hartill has endeavoured to solve what is becoming an increasingly complex subject and what he has so capably presented in his paper this morning.

We are indeed fortunate, Mr. Hartill, that you have been able to find the time to visit us here in South Africa to give us the benefit of your considerable knowledge, both theoretical and practical, of CIE 12/2 end of the lighting of public roads.

Of particular interest in your paper, was the use of very descriptive and well prepared slides to demonstrate its important design parameters - a very real contribution to our knowledge and understanding of the design of road lighting schemes and of the benefits of using high mast lighting schemes. There is a question that I would like to put to you. You have shown a number of examples whereby the lighting engineer can more readily determine the various parameters in road lighting design. There are still a considerable number of time consuming calculations necessary to arrive at an optimum design. My question is to what extent are C.P. used in design, the computer design programme made available to the lighting engineers of the public bodies in the U.K. and if so, do you see any difficulties in having these made available to lighting engineers in South Africa?

I wish now to propose a vote of thanks to Mr Hartill and ask you to all join me in thanking Mr Hartill in the traditional way.

Mr. J.W. Smit (SABS): Now Mr Hartill has touched on high mast lighting using some interesting examples. I want to suggest that to make high mast lighting economically viable we need to increase the peak intensity angle perhaps to 60 degrees and I would almost be tempted to say even further, perhaps to 65. A look at the international glare formula shows that the most important term in this formula is a term which uses the intensity at 80°. It is a negative term which means that the glare mark will decrease that means the glare will increase as the intensity at 80° increases. The coefficient of this term is minus 3.31 (I like the 3.31) and I think we should change it to 3.3 as an accuracy of 0.3% in this empirical formula is not possible. Now I want to content that by increasing the angle of maximum intensity one will not increase intensity at eighty degrees all that much. I think I can say that and I would like to hear Mr Hartill views on it because if we could do it I think we could make motorway lighting economically viable for the use of high mast installation and I think that would be a great step forward. If we think about the light sources available at the moment particularly high pressure sodium I think there is a future for high mast lighting on motorways. I would like to have your comments on that Mr Hartill.

Mr. P. Hartill: The first question I have got down here is the question of computer programmes. Now the biggest of these technical reports for the carrying out is, I think it had about a 140 pages as it gives very great detailed computer programmes for planning road lighting installations of all kinds. Now, as I see it, the average public lighting engineer does not want to do that and so a computer programme would be necessary the same time in preparing the basic data from which he could plan a scheme. Now this was the object of the lantern data presentation which I applied in this paper and there are, in technical report no. 5, other suggested ways of presenting data which can be used by the ordinary practising public lighting engineer. My own opinion of these, some of them, is that a great deal of interpolation and guess work is necessary and now if that is necessary then it seems rather extravagant to use computers to get the accuracy, but I feel that the method I have suggested perhaps minimises the variations that may take place or minimises any variation in the forms that would be subjectively significant anyhow is used intelligently. One could of course tailor make an

installation with computers but there is so much work involved unless the road was perfectly dead straight, constant with constant type of road service and so on. Then you get bends and junctions and things like that; one has to use one's practical knowledge for sighting columns and some empirical way of doing it as far more satisfactory I should imagine. Mr. Smit made a suggestion or made the comment that it would be more valuable if the CIE 12 were a code of practice if it did tell you how to do a job and not just tell you the results. Well this is obviously what you will appreciate, the intention not to tell you how to do it but to tell you the results that would be advisable to obtain if you can and it would appear that a great deal of this work will fall upon the designers and manufacturers of road lighting lanterns and previously they can publish their polar curves and Isocandella diagram and they were quite simple to use. Now the problem is for the manufacturer to present similar data which can be equally certified by independent tests if it is required. We have a mark system at the British Standard Institution for the performance of main road lanterns and any manufacturer has to submit these lanterns to the British Standard Laboratories and get a certified test from them to obtain this mark and this of course, one of the objects of my suggestion was that this could be done for the actual visual properties of luminance and uniformity and not merely the physical properties of candle power intensity illumination. The comparison of cost between high mast lighting and conventional, now there is still a great deal of work being pursued in this connection by various societies in the United Kingdom. The capital cost of an installation is (for say lighting a motor way) appears to work out somewhat higher than a conventional scheme but there is evidence to suggest, but no positive facts to go on, that in the long run the maintenance cost of replacing lamps and general attention could be justified or the saving in those could be justified. One of the great advantages of high mast lighting is of course that you can put your mast where it suits you to put, and if you have a variable light distribution you can adjust that to suit the results you want. You can't do that so much with conventional columns but when servicing high masts on motor ways, if they are out of the way, you can do it without any disruption of traffic. On the last installation I showed you a slide how they are mounted right along the centre of the reservation which is only 2 m wide with a double barrier rail all the way and it was perfectly possible to maintain these lanterns as they are all mounted on raising and lowering equipment - to raise and lower those, change lamps, tend to them, clean them, without even zoning off the fast lanes of the motor way. The actual light distribution for high mast lighting - now again that similar scheme I referred to has the main beam around 65° in fact it is a multiple with standard cut-off lanterns suitable for 10 or 12 m height individually. In the CIE glare formula the intensity at 80°, as Mr. Smit has said, is a very predominant factor in that formula and if you have one lantern, 10 or 12 m height with a certain intensity of 80° by the time you have gone up to say 30 m height you theoretically go to have to get 9 times the number of lanterns. Well that means that the actual intensity of 80° is also multiplied by 9 and your specific lantern in that case comes right down to well below one. So you might think that this works out a very high glare mark but it does not because the specific lantern index refers to the lantern qualities and when you have height above the observer's eye level. Well now, when you put that in again back comes your glare mark and according to calculations which I have made you get a higher CIE glare mark with 9 lanterns at 30 m height than you do with one lantern at 12 m height although the distribution is exactly the same.

Mr. R. Fuls (ORBAR): Mr Hartill, Mr Smit just mentioned that the energy cost is very important. The NIPR in S.A. on their statistics for S.A. have found that in S.A. by 1980 we'll have a shortage of 1½ million skilled workers. In other words that we will have problems in S.A. as far as maintenance is concerned because of staff shortages, especially qualified staff. We have got it already and it is going to increase so I would like to know as far as high mast lighting is concerned how this is going to affect us? Thank you.

Mr D.H. Fraser (Durban): My questions are very simple Mr President, not technical but we do have queries put to us as municipal engineers regarding the justification for lighting roads at all and I wondered whether Mr Hartill could give us the arguments to return to those that query this as to the justification economically for lighting of roadways from the point of view, presumably of a reduction in accident rates, and whether there's an evaluation and what factors are taken into account in determining the luminance levels that are adopted with the various classes of roadways. Thank you.

Mr MacKay (Cape Provincial Administration): I just like to say Mr President we have just finished an installation at the Tygerberg Hospital which is not altogether roadway but it consisted of 28 High Masts (30 m masts) and as far as I remember the cut-off angle is about 70°. This was put in entirely on an economic basis. It was costed against the conventional scheme and it includes a certain amount of throw away post top lanterns that as a development takes place those lanterns will be discarded and high mast will be put in their place. At the moment they are serving a useful purpose but this whole scheme was put in because it was in fact cheaper to install and of course very much cheaper to run. It consists of high pressure sodium and lanterns and we have at the moment 28 masts, I think that the final scheme will be in fact 32 masts but this was completely economically justified. Thank you.

Mr. P. Hartill: Mr. Fuls on the energy cost; there could be a shortage by 1980 in S.A. for qualified staff for maintenance. Well it is certainly true that a high mast requires knowledgeable maintenance but on the other hand there will be relatively fewer masts to attend to. I think this is really a question but I don't feel myself very qualified to answer because I don't know the quality or the conditions of the labour in your country. Mr. McKay mentioned a very interesting example of a hospital lighting scheme he had done with high mast which had actually proved to be economical against a similar conventional scheme. I'm very interested to hear this. Mr. Fraser, justification for lighting roads at all. Well now, there is another section of the CIE recommendations, well it comes in the basic volume actually, which is entitled the cost benefit of road lighting under various factors in which you could decide whether the cost was justified. In fact, the only positive one, and it admits this, the CIE report admits this - the only positive one they can base figures on is the saving in regular accidents. Now we have in the U.K. a Department that have been carrying out for many years now extensive statistics and there is now positive evidence in the United Kingdom which fully justifies road lighting. The general saving from even improving the lighting to the standard of the CIE, of the Standard of the British codes for that matter, is saving 40% to 50% in the accidents and that's quite a conservative sort of figure. Well, so much about these very convincing statistical evidence and it is becoming a little easier to get money out of the treasury for doing road lighting schemes and a quite extensive length of motor way lighting have now

been carried out in Great Britain which eventually will no doubt give even more reliable evidence but the general evidence throughout the world, in countries who have done this, is that there is a definite cost saving of a very considerable order. The other sort of cost saving of course are that if you light roads you can make more use of them at night but there is no real evidence to say how much more they are used for. Mr. Lynch of Salisbury - erecting of high mast in residential areas. I gather that where they have been used for lighting townships in South Africa they have been done primarily for security reasons and have been showing to be valuable in that respect. For ordinary residential areas I think really that it is a question of geometry. If you have a very wide square well you can probably light neatly with a high mast or two, rather than a large number of lower columns and if you are lighting an area which is adjacent to a residential area well than you can by careful control of the lighting units usually prevent extraneous light causing a worry to the local residents. Mr. Lynch also mentioned the actual capital cost of high mast as compared with lattice towers. Now I have seen high masts made of concrete or steel with internal spiral staircases and all sort of things inside it, but what we mean by a mast today is quite a slim thing rather like a ship's mast and even a 30 m or 40 m high mast need not be more than 17" (whatever that means in meters) diameter at the base and tapering to about 4 1/2" at the top and that type of mast usually works out very much less costly than an equivalent lattice tower which is not so nice to look at and takes a lot more room. Thank you.

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(ii) Is daar dalk versteekte finansiële koste wat my rentekoers verminder?

(iii) Word my rekening maandeliks met die rente gekrediteer – of net een keer per jaar? (As u maandeliks gekrediteer word

soos by Nedbank, verdien u spaargeld saamgestelde rente, en u belegging groei soveel vinniger.)

(iv) Word ek beskerm teen 'n skielike daling in rentekoerse – en gaan ek baat as die koerse weer klim?

(v) Kan ek geld trek as ek wil?

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G. AUTON, C.Eng., F.I.E.E.

Mr. Auton is the Technical Director of the Brush Switchgear/South Wales Switchgear companies (Hawker Siddeley Group) and was born at Leeds and educated at Leeds College of Technology. He is married with five children and lives at Rothley in Leicester. After 20 years with Yorkshire Switchgear, he moved to Manchester to become Chief Engineer of Long & Crawford Ltd., where he specialised in distribution switchgear. He joined Brush Switchgear Ltd. in 1971 as Products Manager for switchgear and subsequently became Products Director, a position he held until 1974.

He was recently awarded the S.G. Brown Medal by the Royal Society for his work in connection with Vacuum Circuit Breakers.

VACUUM CIRCUIT BREAKER SWITCHGEAR

BY G. AUTON, C.Eng., F.I.E.E.

SUMMARY

The paper reviews developments both in vacuum interrupter design and in their incorporation into switchgear equipment and considers the operational requirements in the form of comparisons with other types of switchgear. Application problems are reviewed, covering distribution systems both in the public supply and industrial networks, and it is shown where economies/improvements can be made in sub-station layouts. The principal theme of the paper is that of 6.6/11kV equipment, but design work is currently proceeding on equipment for 24kV and 36kV, and some of the ideas are developed to show the possible trend for the future.

1.0 INTRODUCTION

It has been known for some 40 years that one of the most effective ways of interrupting an a.c. circuit is to do so by means of contacts in vacuum. Unlike all other interrupters there is no gas in the arc, but only metal vapour which condenses very rapidly as the current falls to zero, giving a most predictable performance and a very fast rise of dielectric strength between opening contacts. During the last decade, high power interrupters have been developed, and vacuum circuit breakers are commercially available. Their advantages are becoming increasingly apparent over a widening application.

The lengthy development of vacuum interrupters has centred on two main problems:

- to obtain, cleanse and assemble compatible insulation and metals having negligible occluded gases, so that a sealed and stable vacuum at a pressure below 10^{-4} torr (mm of mercury) could be maintained for a period exceeding 20 years.
- to develop contacts that would produce sufficient metal vapour to sustain a stable arc down to a few amperes and yet withstand high-current arcing without gross melting.

SEE FIG. 1

The arrangement of a typical vacuum interrupter is as shown in Fig. 1. This comprises a butt contact within a sealed envelope of a ceramic or glass body with stainless-steel end plates. The moving contact is sealed into the enclosure by means of stainless-steel bellows and the contact arrangement is screened by a stainless-steel screen (sputter



VAKUUM-STROOMBREKER-SKAKELTUIG

DEUR G. AUTON, C.Eng., F.I.E.E.

OPSOMMING

Hierdie referaat bied 'n oorsig oor sowel die ontwerp van vakuüm-onderbrekers as oor die inlywing daarvan in skakeltoeg-voerusting en verder aandag aan die bedryfsvereistes in die vorm van vergelykings met ander soorte skakeltoeg. Daar word 'n oorsig gegee van gebruik-probleme in distribusiesistels van sowel private as nywerheidsnetwerke en daar word aangedui waar besparings of verbeterings in substasie-uitgele teweeggebring kan word. Die hoofitem van die referaat is 6.6/11kV-toerusting, dog ontwerpwerk in verband met toerusting van 24kV en 36kV is tans aan die gang en sommige van die idees word verder toegelig om die moontlike tendense vir die toekoms aan te toon.

1.0 INLEIDING

Dit is reeds sowat 40 jaar lank bekend dat een van die mees effektiewe maniere om 'n wisselstroombaan te onderbreek, is om dit deur middel van kontakte in 'n vakuüm te doen. In teenstelling met alle ander onderbrekers is daar geen gas in die boog nie, dog slegs metaaldamp wat baie vinnig kondenseer wanneer die stroom tot zero daal, wat 'n hoogs voorspelbare werkverrigting en 'n baie vinnige verhoging van di-elektriese sterkte tussen die oopmakende kontakte meebring. Gedurende die afgelope dekade is die oopmakende kontakte ontwikkel en vakuüm-stroombrekers is in die handel verkrygbaar. Hul voordele in 'n steeds groter wordende aantal gebruike word al hoe meer duidelik.

Die langdurige ontwikkeling van vakuüm-stroombrekers is op twee hoofprobleme toegespits:

- om versoenbare isolasie en metale met baie min geabsorbeerde gasse te verkry, skoon te maak en te monteer, sodat 'n versleide en stabiele vakuüm teen 'n druk van minder as 10^{-4} torr (mm kwik) vir 'n tydperk van meer as 20 jaar gehandhaaf kan word;
- om kontakte te ontwikkel wat genoegsame metaaldamp sal ontwikkel om 'n stabiele boog tot op 'n paar ampere te dra en terselfdertyd hoëstroom-boe te weerstaan sonder om te veel te smelt.

SIEN FIG. 1.

Die samestelling van 'n tipiese vakuüm-onderbreker word in fig. 1 aangedui. Dit bestaan uit 'n stuikkontakt binne 'n keramiek- of glas-omhulsel met endplate van vlekrye staal. Die bewegende kontak word in die omhulsel versleë deur middel van 'n vlekrye staal-konsertina en die kontak-ingring word afgeskerm deur 'n vlekrye staalkern ('n

shield) which performs the function of voltage grading and prevents condensing metal from the contacts contaminating the inside surfaces of the interrupters, where it would otherwise reduce the insulation value. A much smaller shield is provided to cover the bellows to protect them from metal particles and to ensure the maximum possible life.

1.1. Contact Material

The properties required of contact material are:

- 1) good mechanical strength and electrical conductivity,
- 2) good thermal conductivity to assist rapid cooling of the arc roots,
- 3) sufficient metal vapour from low-current arcing to control current chopping,
- 4) limitation of metal vapour and thermionic emission from high-current arcing, to permit voltage recovery at current zero.
- 5) low weld and cold adhesion strengths at the contacting surfaces to give easy and consistent separation,
- 6) separation of the contacting surfaces with only small asperity, to preserve the electric strength of the gap,
- 7) low and uniform erosion, to give a long operating life.

As no single metal has all these characteristics, mixtures have been evolved ranging from alloys and bulk interspersions, e.g. copper and bismuth, to a sintered matrix consisting of a semi-refractory porous base infiltrated with a softer metal, e.g. chromium and copper.

SEE FIG. 2

1.2 Contact Geometry

With plain disc contacts, as used on contactors, arcs up to approximately 10kA peak are naturally diffused, with many cathode spots and can be extinguished easily. Above 10kA peak, the arc is stationary, concentrates towards a single spot on the contact surface causing local overheating which cannot cool fast enough at current zero to prevent re-ignition of the arc. Increasing the size of the contact without other changes has little effect because the overheating is local. If the arc can be kept moving over the contact surface, it remains diffused and local overheating is avoided. Then, the effect of increasing the size of contacts is to increase the interrupting ability. There are two main forms of high-power contact where the current path is contrived to achieve self-induced electromagnetic movement of the arc.

In one form the contacts are modified discs with contacting hubs. Each contact has a regular series of slots curling outwards from the hub, producing a series of curved fingers. As the contacts open, an arc appears between opposite hubs and moves on to the fingers. Current flowing in opposite matching fingers produces a self-driving loop to commute the arc around the slotted peripheries. This arrangement is shown diagrammatically in Fig. 2.

In the second form known as the Contrate shape, the contacts are recessed around their centres with contacting rims. Here also a regular series of fingers is produced by slots cut in the rims at an angle to the axis. As the contacts open, an arc appears between rims and current flowing in opposite matching fingers commutes the arc around the slotted rims. At high currents, in both forms, there are many moving parallel arcs spread around the contacts.

2.0 INTERRUPTER DEVELOPMENT

The vacuum interrupter is a power device, capable of dealing with tens of kiloamperes and must not be confused with the vacuum contactor which is vastly different in design, manufacture and performance. Contactor duties demand something like 10 million operations - that is 100 times more than the power interrupter, but only one tenth of the fault current with which the interrupter is required to deal. The contactor in fact operates at a much slower speed and over a shorter stroke, its contact material and geometry are different from the interrupter, although the degree of vacuum used is of the same order. Interrupters are now available to cover short circuit currents up to 40kA and rated currents up to 2000/3000 amps.

Contact materials are a very important aspect of interrupter development and this, coupled with improvements in the design of the contact screen are the principal areas for advancement. All circuit-breaker interrupters are designed around copper-based alloys and it has been found that certain combinations are particularly well suited for minimum arc erosion. However, other combinations have comparable interrupting capability, but have lower contact resistance and are therefore better suited to high-rated current applications. The latest developments for high voltages indicate that much greater withstand voltages can be achieved across comparable contact gaps inside interrupters, in combination with refinements in contact screen design.

It is of course a fundamental requirement of contacts in vacuum that they shall have high weld-breaking characteristics. In the condition of

verstuivingsskerm) wat die funksie van 'n spanningsgradeerder vervul en voorkom dat kondenserende metaal van die kontakte die binne-opervlaktes van die verbreker besoedel, waar dit andersins die isolasiewaarde sal verminder. 'n Veel kleiner skerm word voorsien om die konsertina te bedek teneinde dit teen metaaldeeltjies te beskerm en die langs moontlike lewensduur te verseker.

1.1 Kontakmateriaal

Die vereistes waaraan kontakmateriaal moet voldoen, is die volgende:

- 1) goeie meganiese sterkte en elektriese geleivermoe;
- 2) goeie termiese geleivermoe om die vinnige afkoeling van die boog-sorteel aan te help;
- 3) voldoende metaaldamp van laestroom-boogvorming om onderbreke stroomresponisie te bebeer;
- 4) beperking van die metaaldamp- en termioniese uitstraling van hoë-stroomboogvorming, om spanningsherwinning teen zero-stroom te bewerkstellig;
- 5) lae swais- en koue hegtingssterktes op die kontak-opervlaktes om maklike en konsekwente skeiding moontlik te maak;
- 6) skeiding van die kontak-opervlaktes met slegs 'n beperkte skorpie, teneinde die elektriese sterkte van die opening te bewaar;
- 7) lae en eenvormige erosie, teneinde 'n lang lewensduur te verseker.

Ansiesien geen enkele metaal al hierdie eienskappe besit nie, is daar mengsels ontwikkel wat gewissel het van aliole en grootskaalse vermengings van bv. koper en bismut tot 'n gesinterde matrys, bestaande uit 'n half-geleierde porseus basis wat met 'n sagte metaal, bv. chroom en koper, geïnfiltreer is.

SIEN FIG. 2.

1.2 Die Meekunde van die Kontak

By gewone skyfkontakte, soos in kontaktoes gebruik, word boei tot 'n spits van ongeveer 10kA natuurlikewys versprei, met baie katodekolle, en wat maklik uitgedoof kan word. Bokant 'n spits van 10kA sal die boog, indien dit stilstaan, is 'n enkele plek op die oppervlakte van die kontak konsentreer, wat plaaslike oorverhitting veroorsaak, wat nie teen zero-stroom vinnig genoeg afkoel om herontsteking van die boog te verhoed nie. Die vergroting van die oppervlakte van die kontak sonder ander wysigings het min of geen uitwerking nie, omdat die oorverhitting plaaslik van aard is. Indien daarin geslaag kan word om die boog oor die hele oppervlakte van die kontak aan die beweging te hou, bly dit verspreid en plaaslike oorverhitting word verhoed.

In daardie geval is die uitwerking van die vergroting van die kontak te dat die onderbrekingsvermoe verhoog word. Daar is twee hoof-vorms van hoë-kragkontakte waar die stroompad beplan word om selfgeïnduseerde elektromagnetiese beweging van die boog te bewerkstellig.

In die eerste vorm is die kontaktegewysige skywe met kontakvormende nawe. Elke kontak het 'n reëlmatige reeks geleue wat vanaf die naaf na buite uitstral en dus 'n reeks geboue vingers vorm. Soos die kontakte opmaak, ontstaan 'n boog tussen die teenoorgestelde nawe en beweeg na die vingers toe. Stroom wat in die teenoerkaar gestelde bypassende vingers vloei, skep 'n self-antreiwende lus om die boog rondom die geleufde buiterande te kommuteer. Hierdie rangskikking word in fig. 2 diagrammities aangetoon.

In die tweede vorm, bekend as die "Contrate"-vorm, word die kontakte rondom hul middelpunte met kontakvormende vellings ingelaat. Ook hier word 'n reëlmatige reeks vingers gevorm deur geleue wat in die vellings ingesny word teen 'n hoek met die as. Soos die kontakte opmaak, ontstaan 'n boog tussen die vellings, en die stroom wat in teenoorgestelde bypassende vingers vloei, kommuteer die boog rondom die geleufde vellings. By albei vorms is daar, teen hoë stroomvloei, 'n groot aantal ewewydige bewegende boei wat rondom die kontakte versprei is.

2.0 DIE ONTWIKKELING VAN ONDERBREKERS

Die vakuum-onderbreker is 'n kragstoel wat tientalle kiloampere kan hanteer en moet nie verwar word met 'n vakuumkontaktoer nie, wat heeltemal daarvan verskil in ontwerp, vervaardiging en werking. Die werk van 'n kontaktoer verg sowat 10 miljoen handelings - dit is 100 keer meer as die kragonderbreker, dog dit vorteenwoordig slegs een-tiende van die foutstroom wat die onderbreker moet hanteer. In werklikheid werk die kontaktoer teen 'n baie laer snelheid en met 'n korter slag en sy kontakmateriaal en afmetings verskil van die onderbreker, alhoewel die vakuumgraad wat gebruik word, naasby dieselfde is. Onderbrekers is nou beskikbaar wat kortsluitingsstrome van tot 40kA en aangesaane strome van tot 2000/3000 ampere kan dek.

Kontakmateriaal is 'n baie belangrike aspek van die ontwikkeling van onderbrekers en, tesame met verbeterings in die ontwerp van die kontaktoer, vorm dit die vernaamste gebied vir bevordering. Alle stroombreker-onderbrekers word ontwerp rondom aliole met 'n koperbasis en daar is gevind dat sekere kombinasies uitnemend geskik is vir die minimum-vererving van die boog. Ander kombinasies besit egter 'n vergelykbare onderbrekingsvermoe, dog het 'n laer kontak weerstand en is dus meer geskik vir die aanwending van hoë-aangesaane stroom. Die jongste ontwikkelings met betrekking tot hoë stroomspannings dui aan dat groter weerstandspanninge oor vergelykbare kontakspannings binne-in onderbrekers verkry kan word, in kombinasie met die verfynde ontwerp van die kontaktoer.

Dit is natuurlik 'n fundamentele vereiste van kontakte in 'n vakuum dat hulle hoë swaibekende eienskappe moet hê.

absolute cleanliness and purity, even the sustained contact pressure can cause a degree of cold welding. Welding can become even more significant when the breaker is subjected to peak-current "making" and through current duties and therefore the contacts must have a characteristic to facilitate a weld fracture without harmful effects upon interrupter performance. Contact assembly must be fully co-ordinated with the operating mechanism to provide enough energy for contact separation under all conditions.

Vacuum interrupters have the unique capability of very high dielectric recovery, such that interruption almost always occurs at the first available current zero and this therefore corresponds to maximum arcing time of 10-15 milliseconds, and according to the type of mechanism employed would give total break times in the order of 2-3 cycles.

3.0 OPERATING MECHANISMS

Vacuum interrupters, with their short travel and butt contacts, are well suited to solenoid closing. By optimising the mass/force/time characteristics of the closing system and by the introduction of initial magnetic restraint and sequential flux shift to the plunger, operating powers of 0.6kW and 2.3kW have been achieved for ratings of 12.5kA and 25kA respectively.

SEE FIG. 3

Fig. 3 shows the closing system adopted. When solenoid 1 is energised to close the breaker it creates a magnetic flux in plunger 2, across main gap 16, through yoke 17 and through cling plate 18 to the base of the plunger resting on it. The rising flux holds the plunger down until predetermined saturation of the cling plate diverts the continuing rise of flux to the annular gap 19 where it enters the plunger and augments the flux in the main gap. The lift then exceeds the cling. The plunger rises, introducing an increasing gap at its base. The cling-plate restraint rapidly reduces as most of its flux shifts to the annular gap and the plunger now has the full force necessary to close the breaker. (Fig. 3b). This condition obtains at an operating voltage below the 85% specified minimum value. If the voltage falls below the actual minimum value, the plunger will not move, i.e. it operates either correctly or not at all.

If the solenoid voltage is high, it has very little effect on the closing speed because the plunger lifts off at a predetermined flux. Therefore, hammering of the breaker due to excessive solenoid voltage is avoided and its life is increased. The only significant effect of high solenoid voltage is a shortening of the time for the flux to rise to its operating value. Conventional spring/motor wound mechanisms can also be provided with matching characteristics.

3.1 Mechanism and Drive

Fig. 3 indicates closing sequence. Plunger 2 moves vertically over a nominal travel of 14mm from position shown in 3a to that in 3b. Lever 3 is lifted on to latch 4 whilst linkage 5 turns bell crank 6 clockwise to drive rod 7 to the right. The rod is screwed over its whole length and carries, for each phase, a contact spring 8, pretensioned between lock-nuts 9 and trunnioned sleeve 10 resting against lock-nuts 11. As the rod moves to the right the trunnioned sleeves turn levers 12 anti-clockwise to lift insulated links 13 and contacts N. After free travel the contacts meet under pressure from the springs. The sleeves stop and the rod continues further against the springs to produce a snatch gap 21 between sleeve and nuts 11.

When massive butt contacts are closed, there is a pronounced tendency to bounce and many vacuum devices suffer from this defect, causing undesirable extension of pre-arcing and increased erosion. This mechanism and structure described have been co-ordinated to eliminate bounce by rigidity of drive and flexibility of mounting. The horizontal drive rod 7 lies close to the structure and its thrust is rigidly in line with the frame and is unaffected by the vertical flexibility. The vertical drive to each interrupter has its reactions contained within the local assembly. The screwed drive rod permits infinite adjustment of initial settings and its radial flexibility avoids binding.

Opening: A high-speed electromagnet delivers an impulse to the overtopped links 5, which collapse to the right (Fig. 3c), and finally knock the now unloaded latch 4 clear of lever 3 allowing it to fall and reset the linkage. During the collapse, rod 7 accelerates to the left under the influence of contact springs 8 and return springs 14. The snatch-gaps close and the moving rod opens the contacts and settles smoothly against the air buffer 15.

3.2 Mechanical Performance

SEE FIG. 4

Fig. 4 shows the closing and opening strokes of the actuator rod and contacts, with related d.c. operating currents and typical 50 Hz alternating voltage and current. The effect of contact erosion due to arcing is to decrease the contact gap from 8 mm to 11 mm over the life of

Waar daar toestande van absolute reinheid en suiverheid heers, kan selfs die volgende drukking van die kontakte 'n mate van koue swaaiing tot gevolg hê. Swaaiing word selfs meer betekenisvol wanneer die onderbreker aan spitsstromsluiting en deurstrom-werking onderwerp word en daarom moet die kontakte die vermoë hê om 'n swaai-breek te vergemiklik sonder benadeling van die werking van die onderbreker. Die samestelling van die kontakte moet ten volle met die werksmeeganisme gekoördineer word teneinde genoeg energie vir kontakskeding onder alle omstandighede te verskaf.

Vakuum-onderbrekers besit die unieke eienskap van baie hoë dielektriese herstelvermoë, in so 'n mate dat die onderbreking byna altyd by die eerste beskikbare stroom-zero plaasvind, en dit stem dus ooreen met die maksimum-boogtyd van 10-15 millisekondes, en in ooreenstemming met die tipe meganisme wat gebruik word, sal dit onderbrekingstye van sowat 3-4 siklusse meebring.

3.0 WERKSMEGANISME

Vakuum-onderbrekers, met hul kort slag en stukkontakke, is baie geskik vir solenoïde-sluiting. Deur die massa/krag/tyd-eienskappe van die sluitingsstelsel tot die optimum te verhoeg en deur die invoering van aanvanklike magnetiese stremming en die gevolglike vloedsverandering na die plunjer, is werkbare faktore van 0.6kW en 2.3kW vir aanslae van 12.5kA en 25kA onderskeidelik verkry.

SIEN FIG. 3.

Fig. 3 toon die sluitstelsel wat aanvaar is. Wanneer solenoïde 1 bekrag word om die stroombreker toe te maak, skep dit 'n magnetiese vloed in plunjer 2, oor die hoof-gaping 16, deur luk 17 en deur kleeft-plaat 18 tot by die voetstuk van die plunjer wat daarop rus. Die stigende vloed hou die plunjer af totdat die vooraf bepaalde versadiging van die kleeftplaat die steeds stygende vloed na die ringgaping 19 afkeer, waar dit die plunjer binnantree en die vloed van die hoof- en vorm 'n groter wordende gapping by sy voetstuk. Die terughouvermoë van die kleeftplaat verminder sinning aangesien die meeste van sy vloed na die ringgaping verskuif en die plunjer nou die volle krag het wat nodig is om die stroombreker toe te maak. (Fig. 3b). Hierdie toestand ontstaan teen 'n werkspanning onderkant die gespesifiseerde minimum-waarde van 85%. Indien die spanning tot onderkant die werklike minimum-waarde daal, sal die plunjer nie beweeg nie, m.a.w. dit werk of korrek of gladnie.

Indien die solenoïdespanning hoog is, oefen dit min invloed op die sluitsnelheid uit, aangesien die plunjer teen 'n vooraf bepaalde vloed oplog. Die hamering van die onderbreker weens 'n te hoë solenoïdespanning word dus vermy en die lewensduur van die onderbreker word verleng. Die enigste betekenisvolle uitwerking van hoë solenoïdespanning is die verkorting van die tyd wat dit nodig is om tot sy werkwaarde te styg. Konvensionele veer/motorgewikkelde meganismes kan ook van aanpassende eienskappe voorsien word.

3.1 Meganisme en aandrywing

Fig. 3 toon die toemaak-volgorde. Plunjer 2 beweeg vertikaal oor 'n nominale werkslag van 14 mm vanaf die stand in 3a getoon na die in 3b getoon. Heffboom 3 word opgelig tot ho-op knip 4, terwyl koppeling 5 die klokslinger 6 kloksgewys draai om nags 7 na regs te dryf. Die staaf is oor sy hele lengte van skroefdraad voorsien en dra ten opsigte van elke fase 'n kontakveer 8, vooraf-gespan tussen sluitmoere 9 en draagt-pal - huls 10, wat teen sluitmoere 11 rus. Soos die staaf na regs beweeg, draai die huls die hefboome 12 anti-kloksgewys om die geïsoleerde skakels 13 en kontakte M op te lig. Na 'n vrye werkslag kom die kontakte bymekaar onder die spanning van die veer. Die huls kom tot stilstand en die staaf beweeg verder teen die veer in om sodoende 'n gryp-gaping 21 tussen die huls en moere 11 te vorm.

Wanneer massiewe stukkontakke toemaak is, daar 'n sterk neiging om te spring, en baie vakuum-toestelle is aan hierdie gebrek, wat enige wenslike verligting van vooraf-boogvorming en normale erosie tot gevolg het. Die meganisme en struktuur wat hierbo beskryf is, is gekoördineer om springing te voorkom deur middel van die stewigheid van die aandrywing en die buigsameheid van die motering.

Die horisontale aandrywingstaaf 7 lê naby aan die struktuur, sy stoetbeweging is stewig in lyn met die raam en word nie deur die vertikale buigsameheid beïnvloed nie. Die reaksies van die vertikale aandrywing na elke onderbreker word binne-in die planlike samestel bevat. Die geskroefde dryfstaf maak 'n baie groot aantal verstellings van aanvanklike instellings moontlik en sy radiale buigsameheid voorkom binding.

Opening: 'n Hoë-spoed-elektromagnetiese verskaf 'n impuls na die geskermde skakel 5, wat na regs wegsak (Fig. 3c) en uiteindeelik die nou ongelanede knip 4 van hefboom 3 af weglaan en dit sodoende toelaat om te val en in die skakels weer terugstel. Gedurende die wegsakking het staaf 7 na links versnel onder die invloed van kontakveer 8 en terugveer 14. Die gryp-gapping sluit, die bewegende staaf maak die kontakte oop en gaan lê gladweg teen die lugbuffer 15.

3.2 Meganeisne Werkverrigting

SIEN FIG. 4.

Fig. 4 toon aan die op- en toemaakslae van die dryfstaf en die kontakte, met verwante d.c.-werkstrome en tipiese 50 Hz wisselende spannings en strome. Die uitwerking van kontak-erosie weens boogvorming is om die kontakgaping van 8 mm tot 11 mm oor die leeftyd van die

the interrupter. The snatch gap decreases correspondingly from 6 mm to 3 mm. Performance is unimpaired and proved at both boundary conditions, so that the breaker once adjusted initially is set for the life of the interrupter.

The mechanical design life of the various styles and ratings of high-power vacuum interrupters lies between 10,000 and 50,000 close/open cycles. The actual mechanical life is greatly influenced by the characteristics of the breaker as a whole. As already considered, sympathetic integrated design can significantly increase these figures.

4.0 ELECTRICAL PERFORMANCE

The reaction of the vacuum interrupting devices when opening asymmetrical currents is significantly different to that of oil circuit breakers. The vacuum device does not produce the high stress which is normally imposed upon oil filled arc control devices and their enclosures, and the absence of the relevant mechanical reactions amply illustrates the advantages which can be gained both in the mechanical structure of the switchgear itself and in the reduction of dynamic loadings in switchgear substation structures.

The vacuum circuit breaker does not have a critical-current and its performance even down to very low inductive currents presents a level characteristic.

4.1 Low Inductive Currents

As with most switching devices, the interruption of small currents in highly inductive circuits presents certain difficulties, because the recovery voltage is at its most active when the current is at zero. There is a tendency for the current to be forced to an early zero, known as current chopping which produces the likelihood of electromagnetic energy being trapped in the inductive system.

Figure 5a and 5b show the type of over-voltage produced by oil and vacuum circuit breakers under test station conditions with no connected capacitance.

Figure 5c shows how this transient condition is substantially damped by the addition of capacitance, which may be the inherent capacitance of the equipment itself or added capacitance in the form of capacitors or cables. Some 450 tests have been done and the subject is well understood and need not cause any problems.

4.2 Capacitive Currents

In switching capacitive currents, the problem is basically one of voltage escalation due to successive restrikes. Voltage escalation can occur due to the changing polarity of the A.C. voltage being added to the standing voltage on the capacitor terminals and theoretically there is very little limit to the voltage rise, though in practice it is limited naturally by circuit conditions.

The vacuum circuit breaker is particularly successful in this switching duty in that its extremely rapid dielectric recovery qualities, even at comparatively short contact separation, is the prime reason for its freedom from restrikes. Some 250 tests have been carried out over a range of currents up to 450 amp. with various source impedances on a 15kV circuit with peak voltages always less than 24kV to earth.

4.3 Motor Switching Tests

The switching of large high-voltage motors presents a different series of conditions and requirements to that of the simple inductive circuit. All switching devices are, to a degree, prone to pre-strike at contact "make", but the V.I. has the characteristic of being able to interrupt the high-frequency current which precedes the power current, hence producing a series of high-frequency over-voltages with a steep wave front.

These over-voltages are impressed upon the end windings of the machines, as with transformers when subjected to surges. This can be harmful to random wound stators as are used on some smaller motors, but is unlikely to harm regular wound machines of larger horsepower, as would normally be switched by a vacuum circuit breaker.

SEE FIG. 5

Another aspect of degradation is the possible effect of insulation erosion caused by the high-frequency current, but this can be avoided by design and quality control of H.V. motors, just as with other apparatus.

When switching out under running conditions the instantaneous voltage appearing across the contacts is extremely small by virtue of the back E.M.F. from the machine and this avoids any stress on either the circuit breaker or the motor insulation (see Fig.6).

SEE FIG. 6

With stalled-rotor switching there is no back E.M.F. from the machine and the oscillogram illustrates the difference from the running condition. The voltage swing is then comparable with that associated with normal static load switching and may even be aggravated by additional transient conditions.

If the vacuum circuit breaker is caused to open during the starting period and is so timed that contact separation is co-incident with a current zero then it is possible to create a condition that is similar to current chopping, in as much that the energy stored in the machine core is

underbreker te vergoet. Die grypspanning verminder dienocenerkomstig van 6 mm tot 3 mm. Werkverrigting bly onaangetas, soos by albei grenstoestandebewys, m.a.w. as die onderbreker eenmaal ingestel is, bly dit lewenslank ingestel.

Die meganiese ontwerp-lewensduur van die verskillende soorte en aanslae van hoë-krag vakuum-onderbrekers lê tussen 10,000 en 50,000 oop/toemaakslusse. Die werklike meganiese lewensduur word grootliks beïnvloed deur die eienskappe van die onderbreker as geheel. Soos reeds aangedui, kan hierdie syfers aansienlik verhoog word deur 'n simpatiese geïntegreerde ontwerp.

4.0 ELEKTRIESE WERKVERRIGTING

Die reaksie van die vakuum-onderbrekingsstoelstele wanneer hulle asimmetriese strome onderbreek, verskil aansienlik van die van olie-stroombrekers. Die vakuum-toestel produseer nie dieselfde hoë streming wat normaalweg op olie-gevlude boogbehoortsteelstele en hul omhulsel geplaas word nie, en die afwesigheid van die betrokke meganiese reaksie lewer ruim bewys van die voordele wat verkry kan word, sowel in die meganiese struktuur van die skakeluitself as in die vermindering van dinamiese beladings in skakeluit-substansiesterukture.

Die vakuum-stroombreker het nie 'n kritiese stroom nie en sy werkverrigting, selfs tot by baie lae induksiestrome, bly gelykmatig.

4.1 Lae Induksiestrome

Soos by die meeste skakeltoestele, hou die onderbreking van klein strome in hoogs induktiewe stroombane sekere probleme in, omdat die herstelspanning op sy aktiefase is wanneer die stroom op nul is. Daar is 'n neiging vir die stroom om na 'n vroeë nulpunt gedwing te word, wat bekend is as stroomafkapping en wat waarskynlik aanleiding gee tot die vasvang van elektromagnetiese energie in die induksiestel.

Figure 5a en 5b toon die soort oorspanning wat by olie- en vakuum-stroombrekers onder toetsstoelstele en sonder aangeskakelde kapasitanse ontstaan.

Figure 5c toon hoe hierdie oorgangstoestand aanmerklik gedemp kan word deur die byvoeging van kapasitanse, hetsy die inherente kapasitanse van die toerusting self of bykomstige kapasitanse in die vorm van kapasitore of kables. Sowat 450 toetse is uitgevoer, die onderwerp word goed verstaan en daar behoort geen probleme te ontstaan nie.

4.2 Kapasitiewe Strome

By die skakeling van kapasitiewe strome is die basiese probleem die een van spanningstyging weens agtereenvolgende opvolgingspannings. Spanningstyging kan ontstaan weens die veranderende polariteit van die W.S.-spanning wat gevoeg word by die staande spanning op die kapasitor se aansluitpunte en teoreties is daar baie min beperkings op die styging van die spanning, alhoewel dit in die praktyk op natuurlike wyse deur die stroombaantoestande beperk word.

Die vakuum-stroombreker is besonder suksesvol in hierdie skakel-funksie, insoverre dat sy uiters vinnige di-elektriese herstelvermoë, selfs by betreklik kortstandige kontakskedings, die hoofrede vir sy vryheid van opvolgingspannings is. Sowat 250 toetse is oor 'n reeks strome tot by 450 ampere uitgevoer, met verskeie bron-impedansies op 'n 15kV-stroombaan met spitspannings van steeds minder as 24kV na aarde.

4.3 Motoriese Skakeltoetse

Die skakeling van groot hoë-spanningsmotore bring 'n reeks toestande en vereistes mee wat verskil van die van 'n eenvoudige induktiewe stroombaan. Alle skakeltoestele is onderhevig aan opvolgingspannings by die "maak" van die kontak, dog die vakuum-onderbreker besit die vermoë om die hoë-frekwensiestroom wat die kragstroom voorafgaan, te onderbreek en sodoende 'n reeks hoë-frekwensie-oorspannings met 'n skerp golffront te skep.

Hierdie oorspannings word afgedruk op die ontwikkelings van die masjien, soos wat gebeur met transformators wanneer hulle aan stuwings onderwerp word. Dit kan skadelik wees vir onegally-gewikkelde stators wat in party kleiner motore gebruik word, dog dit sal waarskynlik nie skade aanrig aan gelykmatig-gewikkelde masjienet 'n hoër perdekrag, soos die wat normaalweg deur 'n vakuum-stroombreker geskakel word nie.

SIEN FIG. 5

Nog 'n aspek van gradering is die moontlike uitwerking van isolasieverwing wat deur die hoë-frekwensiestroom veroorsaak word, dog dit kan verhoed word deur die ontwerp en gehaltebeheer van H.S.-motore, net soos by ander toerusting.

Wanneer daar onder bedryfstoeestand geskakel word, is die oomblikke spanning oor die kontakte besonder klein weens die teen-e.m.k. vanaf die masjien en dit voorkom enige stremming op of die stroombreker of die isolasie van die motor. (Sien fig. 6).

SIEN FIG. 6.

By skakeling met 'n stilstande rotor is daar geen teen-e.m.k. vanaf die masjien nie en die oscillogram toon die verskil tussen die stilstande en die lopende toestand. Die spannings-swaai is dan vergelykbaar met die wat met normale statiese vrag-skakeling geassosieer word en kan selfs deur bykomstige oorgangstoestande vererger word.

Indien die vakuum-stroombreker gedurende die aanskakel-tydperk moet opmaak en die tydsinstelling is sodanig dat die kontakskedings saamval met zero-stroom, dan is dit moontlik om 'n toestand te skep wat soortgelyk is aan stroom-afkapping, insoverre dat die energie wat

trapped and can only discharge through the inherent equipment capacitance. This gives rise to an oscillatory high-frequency voltage which attempts to break down the extending contact gap. This may happen and be cleared by the interrupter, resulting in a further re-ignition and subsequent interruption. This mechanism is progressive and as the contact gap opens the voltages will increase to higher levels until such time as the energy has been dissipated by means of the re-ignition, and concluded with an interruption.

Tests on an actual machine at 6.6kV have indicated maximum voltages of 23kV peak which is well within the insulation level of the machine, but which could in fact be reduced by the provision of surge absorbers.

4.4 Over Voltage Testing

Power-frequency over-voltage tests are carried out to establish the integrity of the vacuum and fulfil the requirements of relevant specifications. Whilst it is not possible to determine accurately, degrees of vacuum by means of powerfrequency tests, evidence indicates that any serious degradation of the vacuum would rapidly extend to atmospheric pressure, and this is clearly detectable by power-frequency testing.

An over-voltage test also proves the insulation integrity of the inside surface of the ceramic enclosure, normally protected from condensing metal vapours by the sputter shield, as mentioned earlier.

The application of high-voltage to contacts in vacuum accelerates the particles between the contacts and can cause X-ray emission, but this is non-existent at working voltages on the equipment described, and the low level of emission at test voltages is safely attenuated by the sheet steel enclosures.

4.5 Impulse and Power Frequency Tests

In most respects the requirements for insulation withstand on vacuum switchgear are substantially the same as other forms of switchgear, including the requirement for isolation distances. However, the vacuum circuit breaker is unique in the aspect that in the event of an open circuit interrupter being "flashed through" by excessive surge voltage, it will clear at the first available zero, either preventing or minimising power frequency followthrough - a condition quite the reverse in more conventional equipment.

4.6 Temperature Rise Tests

Whereas contact temperature rise can readily be measured on other types of switchgear, this is not easily achieved with vacuum units. This however is no disadvantage as the contacts are enclosed in complete vacuum and there is no possibility of contact deterioration. All the heat from the contacts is conducted through the connections and their temperature rise is limited by specification.

5.0 DESIGNS OF EQUIPMENT

5.1 Evolution of New Products

For many years now metalclad switchgear designs have incorporated two essential features which have usually been combined in the aspect of circuit-breaker isolation, namely, to provide a safe isolation distance, and to enable the circuit breaker to be disconnected from its busbars to facilitate maintenance of the circuit breaker itself. More recently this has been extended on vertically isolated switchgear to incorporate an integral earthing facility by means of re-locating the circuit breaker, - a convenient and fortuitous development of British designs, which allowed system development and operation to reach new standards of safety and reliability. Despite the attractive facilities offered to the user of this equipment, there is no viable adaptation which puts a vacuum circuit breaker into the "standard form" of switchgear construction, described above.

The objective for the designer therefore is to provide an enclosure of lowest possible cost to enclose the slightly more expensive vacuum circuit breaker, and provide the necessary operational and safety facilities, ensuring always that the unique qualities of the vacuum interrupter are exploited to the utmost - not only in switchgear design but in the substations which subsequently enclose them.

5.2 The "Fixed" 11kV Circuit Breaker

On withdrawable gear we have two isolations, but it is reasoned that one isolating distance is adequate for safety. The vacuum interrupter is non-maintainable, and therefore demands very little of the expense normally devoted to mechanical manipulation of the vertical-isolated circuit breaker which is essential for the raising and lowering of the oil circuit breaker for maintenance purposes. These and many other considerations lead to the concept of the compact housing with fixed vacuum circuit breaker and isolator/selector to provide isolation and integral feederearthing facilities. Fig. 7 shows the most compact arrangement available for this class of equipment, noting that it is not

in die masjienken goberg word, vasgevang is en siegs deur die inherente kapasitansie van die toerusting kan ontaai. Dit gee aanleiding tot 'n ossilerende hoë-frekwensie spanning wat poog om die wyer wordende kontakgaping af te breek. Dit kan gebeur en kan deur die onderbreker opgeklar word, wat 'n verdere herontbranding en gevolglike onderbreking tot gevolg het. Hierdie meganisme werk progressief en, soos die kontak opmaak, styg die spanning tot hoër vlakke totdat die energie deur middel van her-onbrandings gedissipeer en met 'n onderbreking afgesluit word.

Toets met 'n werklike masjien teen 6.6kV het spannings tot 'n maksimum van 23 kV aangedui, wat heeltemal binne die isolasieveld van die masjien val, dog wat in werklikheid deur die gebruik van stuwings-absorbeers vermindert kan word.

4.4 Oorspanningstoetsing

Kragfrekwensie-oorspanningstoetsing word uitgevoer teneinde die integriteit van die vakuum te bepaal en aan die vereistes van die betrokke spesifikasies te voldoen. Terwyl dit nie moontlik is om grade van vakuum deur middel van kragfrekwensietoetsing akkuraat te bepaal nie, dui getuissis daarop dat enige ernstige degradasie van die vakuum baie gou tot atmosferiese druk sal toeneem, en dit word duidelik deur middel van kragfrekwensie-toetsing aan die lig gebring.

'n Oorspanningstoets bewys ook die integriteit van die isolasie van die binne-oppervlakte van die keramiek-omhulsel, wat normaalweg deur die verstuivingskerem teen kondenserende metaaldampe beskerm word, soos vroeër genoem.

Die aanwending van hoogspanning aan kontakte in 'n vakuum versnel die wisseling van deeltjies tussen die kontakte, en kan selfs die uitstraling van X-strale veroorsaak, maar dit kom nie in die toerusting onder bespreking by gewone werkspanninge voor nie en die lae peil van uitstraling teen toetspanninge word doeltreffend deur die staalplaat-afskortings verswak.

4.5 Impuls- en Kragfrekwensietoetsing

In meeste opsigte is die vereistes vir isolasie-weerstand in vakuum-skakeluitjies dieselfde as vir ander vorms van skakeluitjies, met inbegrip van die vereistes ten opsigte van isolasie-afstande. Die vakuum-onderbreker is egter uniek in dié opsig dat, in die geval waar 'n oop-stroombaan-onderbreker deur onzuimige stuwingspanninge "deurgreift" word, dit by die eerste beskikbare zero-punt aan die lig sal kom daar dit kragfrekwensie-deurvolging of verhoed of 'n minimum beperk - 'n toestand wat in meer konvensionele toerusting presies die teenoorgestelde is.

4.6 Temperatuurstygingstoetsing

Terwyl kontaktemperatuurstyging in ander tipes skakeluitjies maklik gemeet kan word, gebeur dit nie so maklik met vakuum-eenhede nie. Dit is egter geen nadeel nie, aangesien die kontakte in 'n algehele vakuum omsluit is en daar dus geen moontlikheid van kontakverwering is nie. Al die hitte vanaf die kontakte word deur die verbindings weggelei en hulle temperatuurstyging word deur die spesifikasies beperk.

5.0 ONTWERP VAN TOERUSTING

5.1 Ewoluise van nuwe produkte

Vir baie jare reeds het die ontwerp van metaal-omhulde skakeluitjies twee noodsaaklike eienskappe omvat, wat gewoonlik in die stroombreker-isolatie kombineer is, naamlik om 'n veilige isolasie-afstand daar te stel en om dit moontlik te maak vir die stroombreker om van sy geleisamme af ontkoppel te word teneinde die instandhouding van die stroombreker self te vergemaklik. Meer onlangs is dit uitgebrei na vertikaal-geïsoleerde skakeluitjies om 'n integrale aardingsfasiliteit te inkorporer deur die stroombreker te heriokaliseer - 'n gerieflike en toevallige ontwikkeling van Britse ontwerpe, wat die ontwikkeling en werking van die stelstel tot nuwe standarde van veiligheid en betroubaarheid moontlik gemaak het.

Tensypte van die aantreklike fasiliteite wat hierdie toerusting aan die gebruiker bied, is daar gaan gedigte aanpassing wat die vakuum-onderbreker in die standaardvorm van skakeluitjieskonstruksie, soos hierbo beskryf, sal plaas nie.

Die doelwit vir die ontwerper is dus om 'n omhulsel teen die laags moontlike koste daar te stel om die effens duurder stroombreker te omsluit en om die nodige operasionele en veiligheidsfasiliteite daar te stel, terwyl daar steeds seker gemaak word dat die unieke eienskappe van die vakuum-onderbreker toe die uiterste toe geëksploteer word - nie net in die ontwerp van die skakeluitjies nie, dog ook in die substasies waarin hulle uiteindelik geïnstalleer sal word.

5.2 Die "Vaste" 11kV-Stroombreker

By intrekbare skakeluitjies is daar twee isolasies, dog daar word geredeneer dat één isolasie-afstand genoeg is vir veiligheid. Die vakuum-onderbreker kan nie in stand gehou word nie, en verg dus baie min van die omskote wat normaalweg verbode is aan die meganiese hantering van die vertikaal-geïsoleerde stroombreker wat nodig is om die olie-stroombreker vir onderhoudsdoelendes op te lig en te laat sak. Dit sowel as baie ander oorwegings, lei tot die begrip van die kompakte omhulsel met 'n vaste vakuum-stroombreker en isolator/kieser om isolasie en integrale voerder-aardingsfasiliteite te voorsien. Fig. 7 toon die mees kompakte rangskikking wat vir hierdie soort toerusting beskikbaar is. Daar moet op gelet word dat dit nie nodig is om die gewone

necessary to make the usual space provision in front of the switch-board for circuit-breaker handling.

SEE FIG. 7

Whilst the price of the vacuum interrupters is still relatively high, it is clearly demonstrated that this design of metalclad switchgear has optimised the resources involved at a time when both labour and material prices are rising astronomically.

The design, which is of modular form, can accommodate a second isolator on the feeder side when required for special circuits, surge arresters, capacitors for transient voltage attenuation, dry-type voltage transformers and is immediately adaptable for dry-type cable joints. Fig. 8 shows a cable box terminated with "Raychem" heat shrinkable materials.

SEE FIG. 8

It is considered that the incorporation of accessories is as important aspect of this range of equipment because where transient-voltage control may be required it can be provided as part of a "package deal" where the manufacturer evaluates any problems which may exist and incorporates in the metalclad design such equipment as may be necessary, avoiding the need for additional cable joints on site.

The range covers 400 amp through to 3000 amp circuit breakers, and up to 500 MVA 11kV/13.8kV short-circuit ratings, and Fig. 9 shows a side view of the interrupter chamber of a 1600 amp, 500 MVA design.

These designs have been developed to introduce a new concept of switching device via a vehicle of tried and tested techniques and components. There is no doubt that more designs have faltered because of mechanical innovation which has been inadequately proved and has had little, if any, bearing upon the circuit breakers interrupting capability.

5.3 New Developments at Higher Voltages

Distribution systems in many parts of the World operate at 20/24kV and Fig. 10 shows a 24kV vacuum interrupter circuit breaker being prepared for short circuit test. For the reason previously outlined, this range of equipment will continue to take the form of the fixed circuit breaker concept, though we can expect to see variations to suit the higher voltage techniques involved, particularly when the design is extended to 33kV. A typical outline drawing of 24kV duplicate busbar switchboard is shown in Fig. 11 indicating the compact dimensions which have been achieved whilst retaining complete independence and access to the separate busbar sections.

SEE FIG. 11

This is the latest design in a series of developments aimed at widening the application of vacuum interrupters and taking advantage of their higher voltage capabilities. Perhaps the most important aspect in modern terms is that equipment must have compact dimensions but density of components immediately results in problems of accessibility. This new arrangement therefore incorporates a feature of a removable circuit breaker, though based upon the premise of low maintenance and high reliability. The maximum simplicity has been aimed for, by eliminating many of the features normally required for a device needing more frequent access, and yet maintaining the standards of safety expected from a modern design.

SEE FIG. 12

It had previously been thought that 33kV switchgear would not be available until 1980 but present progress indicates that provided the supply industry is in a receptive mood, that equipment could be available at a much earlier date, and clearly the 24kV design illustrated can be up-rated to fulfill these requirements. Typical dimensions are appended to Fig. 11.

To date, therefore, we have seen the evolution and introduction of a new form of circuit breaker which has many virtues and advantages which will be dealt with later in this paper. It offers the operational requirements of feeder earthing and interlocking in line with British Electricity Supply Industry Spec. ESI 41-5 which in many ways characterises the basic design.

5.4 Horizontally Isolated Circuit Breakers

However, in many areas of the World these practices are not mandatory, particularly where currently, horizontally-isolated circuit breakers are used. A design based upon the concept of horizontal isolation is particularly suited for high-density switchboard arrangements for Power Station Auxiliaries and industrial application, with special reference to steelworks, oilrefining rigs and similar industries, where frequent switching duties and the need for oil-free equipment justify a high capital expenditure that would normally require the specification of air circuit breakers.

This arrangement is eminently suitable for high levels of short-circuit currents at voltages of 3.3/6.6kV and possibly up to 12kV, including circuit breakers up to 2000/3000 amp, in a double tiered arrangement, (see Fig. 12). Circuit breakers are now available up to 44 kA for this application and of course equipment dimensions are considerably reduced from those required for the equivalent rated air-mag-

ruimte aan die voorkant van die skakelbord vir die hantering van die stroombreker te laat nie.

SIEN FIG. 7.

Tersyf die prys van die vakuum-onderbrekers nou betreklik hoog is, is dit baie duidelik dat hierdie ontwerp van metaal-omhulde skakel-tuig die optimumbenutting van beskikbare hulprone verteenwoordig in 'n tyd wanneer die pryse van sowel materiaal as arbeid astronomies styg.

Die ontwerp, wat in die vorm van 'n module is, kan 'n tweede isolator aan die voeder-kant huisves indien dit vir spesiale stroombane, stuwingsleiers, kapasitors vir oorgangs-spanningsverswakkers en droë-tipe spanningstransformators benodig word, en is onmiddellik aanpasbaar vir die droë-tipe kabelasse. Fig. 8 toon 'n kabelkas wat met "Raychem" hittebestendige materiaal afgeheg is.

SIEN FIG. 8.

Die mening word gehuldig dat die invoeging van toebehore 'n belangrike aspek van hierdie reeks toerusting is, omdat, waar die beheer van oorgangs-spanning nodig is, dit verskak kan word as 'n gedeelte van 'n omvattende "pakket", waar die vervaardigers enige probleme wat mag bestaan, evalueer en die toerusting wat nodig mag wees, in die metaal-omhulde ontwerp insluit en dusdoende die nodigheid van bykomstige kabelasse op die perseel uitsakel.

Die reeks dek stroombrekers van 400 ampere en by 200 ampere, en kortsluitingsaanslag van tot 500 MVA 11kV/13.8kV, en fig. 9 toon 'n syaansig van die onderbrekerkamer van 'n 1600 amp, 500 MVA-ontwerp.

Hierdie ontwerp is ontwikkel om 'n nuwe konsep van 'n skakeltoestel via 'n medium van beproefde tegnieke en bestanddele in te voer. Dit ly geen twyfel nie dat meer ontwerpe gefaal het minstens meganiese afsnykings wat nie voldoende getoets is nie en dat dit van 'n peen invalop op die onderbrekervermoë van die stroombrekers gehad het.

5.3 Nuwe ontwikkelinge teen hoër spannings

Distribusiestelsels in baie dele van die wêreld werk teen 20/24kV en fig. 10 toon 'n 24kV-vakuum-stroombreker wat 'n kortsluitings-toets voorberei word. Om die reeds genoemde redes sal hierdie reeks toerusting nou steeds die vorm van die vaste stroombreker aanneem, alhoewel variasies verwag kan word om die hoër spannings-tegnieke wat betrokke is, te pas, veral wanneer die ontwerp na 33kV uitgebrei word. 'n Tipiese buitelysteekening van 'n 24kV dubbelstam-skakelbord word in fig. 11 aangegee. Hierop word die kompakte afmetings wat verkry is sonder om algehele onafhanklikheid en toegang tot die aparte geleidingsstamafdelings prys te gee, aangetoon.

SIEN FIG. 11.

Dit is di ontwerp in 'n reeks ontwikkelings wat daarop gemik is om die aanwendingsgebied van vakuum-onderbrekers te verbreed en om voorsiening te maak vir hul spanningsvermoëns. Die belangrikste aspek, in moderne terme uitgedruk, is miskien dat die toerusting kompakte afmetings moet hê, dog die digtheid van die komponente bymekaar lei onmiddellik tot die probleem van toeganklikheid. Hierdie nuwe rangskikking hou dus die eienkap van 'n verwyderbare stroombreker in, wat terselfdertyd hoogs betroubaar is en maklik om in stand te hou. 'n Maksimumgraad van eenvoud is die doelwit, wat bereik word deur die uitsakking van baie van die eienkappe wat normaalweg nodig is vir 'n toestel waartoe daar dikwels toegang verkry moet word, tersyf die veiligheidsstandaarde wat van 'n moderne ontwerp verwag word, terselfdertyd behoue bly.

SIEN FIG. 12.

Daar is vroeër verwag dat 33kV-skakeltoeg nie voor 1980 beskikbaar sou wees nie, dog die huidige vordering dui daarop dat, mits die voorsieningswyerheid in 'n ontvanklike bui is, daardie toerusting op 'n veel vroeër datum beskikbaar kan wees, en dit is duidelik dat die 24kV-ontwerp hoër aangeslag kan word om aan hierdie vereistes te voldoen. Tipiese afmetinge word by fig. 11 aangegee.

Tot dusver het ons dus die ewolusie en die invoering gesien van 'n nuwe vorm van stroombreker met talryke voordele en deugde, wat later in hierdie referaat behandel sal word. Dit bied die werksvereistes van voeder-aarding en grendeling ooreenkomstig die Britse Elektriesiteitsvoorsieningswyerheid se spesifikasie ESI 41-5, wat in baie opsigte kenmerkend van die basiese ontwerp is.

5.4 Horizontaal-geïsoleerde stroombrekers

In baie dele van die wêreld is hierdie gebreke egter nie verpligtend nie, veral waar horisontaal-geïsoleerde stroombrekers tans gebruik word. 'n Ontwerp wat op die begrip van 'n horisontale isolasie gebaseer is, is besonder geskik vir hoër-digtheid skakelbord vir kragtentrake-hulpstakke en nywerheids-installasies, veral staalwerke, oliebreie en soortgelyke nywerheids-vestigings, waar herhaalde skakeling en die behoefte aan olie-vrye toerusting, hoe kapitale uitgawe geregdig, waar lugstroombrekers normaalweg die aangewese ding sou wees.

Hierdie rangskikking is ideaal geskik vir hoe vlakke kortsluitingstrome teen spannings van 3.3/6.6kV en moontlik so hoog soos 12kV, met inbegrip van stroombrekers tot by 2000/3000 ampere, in dubbele reë persanskik (sien fig. 12). Stroombrekers van tot 44kA vir hierdie gebruik is nou beskikbaar en die afmetinge daarvan is veel kleiner as dié van vergelykbare lug-magnetiese stroombrekers. Mens begin werklik die voordele wat hierdie tipe toerusting bied, waardeur. Toetastasie-

netic circuit breakers. One really begins to appreciate the advantages to be gained from this form of equipment. Test-Station results indicate a very easy performance, in dealing with asymmetrical short circuits and high making-current peaks. Fuse-protected contactors for motor-control circuits are also included in a multi-tier stack.

6.0 APPLICATIONS

6.1 Substation Design

Vacuum circuit breakers can be applied quite readily to almost all switching applications, and indeed it is only in those cases where other forms of circuit breaker require special considerations that vacuum circuit breakers need to be given further thought.

If the situation demands oil-free switchgear for example, the vacuum circuit breaker can be applied in the same way as oil circuit breakers, with perhaps the reservation that when switching small transformers of unknown impulse level, or air insulated construction, that it would be prudent to apply small surge absorbers to prevent over-voltages which may arise from interrupting the very low magnetising currents - a problem not confined to vacuum circuit breakers.

Examples of usage for oil-free equipment have been in rigs associated with the Oil Industry where the vacuum circuit breakers have been enclosed in a Power Generating Package. The equipment is particularly suited to industrial substations and for network substations in high load density commercial buildings where it is desirable to locate the HV supply near to the load centre at some intermediate floor levels and avoid any fire risk.

It is characteristic of vacuum switchgear that it is almost completely free from any mechanical reaction when interrupting shortcircuit currents and on high ratings this can reduce considerably the cost of substation construction and enable them to be located on gantries or building levels not normally suited to the dynamic loads of some equipments. Due to the lightweight construction, multipanel assemblies can be despatched from the factory reducing site installation costs. Because of the absence of switch oil and gaseous by-products, fire and explosion risks are eliminated and no carbon dioxide fire-fighting equipment or fire walls are therefore required and personnel safety is correspondingly enhanced. Battery requirements are also at an absolute minimum because of the low-energy solenoids.

6.2 Circuit Considerations

For frequent switching duties of arc furnaces and other HV loads the vacuum circuit breaker is admirably suited because of its freedom from attention, particularly low contact erosion of the contact system. This aspect is expanded in the section on Reliability.

Auto-reclosing comes into the same category and high speed tripping (18 m.s.) of vacuum circuit breakers can be provided to reduce damage at the source of the fault and to improve grading with slow blowing HV fuses (Ref. 1).

Control of HV motors has been thoroughly investigated including conditions of light load, full load and run-up/stall with such phenomena as recurrent voltage escalations. These tests have been the subject of an earlier paper (Ref. 1) on the subject and indicate the excellent performance obtained from these devices and that any overvoltages can be taken into consideration. Vacuum circuit breakers augment the fused contactor for the smaller HP motors by covering a range of performance normally only associated with air-circuit breakers.

Low energy solenoid mechanisms have been used to give maximum flexibility in the control of the circuit breakers, but spring and motor-wound springs are available on some designs.

7.0 OPERATIONAL ASPECTS

7.1 Integral Earthing

Uniformity of operational procedure in high voltage networks is extremely important to the operating engineer and any new design must therefore offer the essential facilities.

In the fixed circuit breaker design, integral earthing of the feeder is provided by an interlocked isolator to disconnect from the busbars and which enables the feeder to be connected to earth via the vacuum circuit breaker, therefore utilising the proven making capacity of the device.

The following is the recommended procedure for earthing to achieve maximum operational safety and reduce the likelihood of supply interruptions. Fig. 13 illustrates the recommended operational sequence.

SEE FIG. 13

SEQUENCE OF OPERATIONS FOR EARTHING

(a) ISOLATE

When the circuit breaker has been opened, the isolator can be opened to provide full safety clearances to the busbars. The feeder cable to be earthed should be isolated at the remote end.

(b) TEST

Even though the circuit breaker has the capacity to "make" on to a fault, it is preferable to test the circuit first to prove that it is de-

resultate dui op baie gladde werking wanneer asimmetriese kortsluitings en hoë maakstroomspitse betrokke is. Sekeringsbeskermede kontaktoors vir motories-beheerde stroombane word ook in die veelvakkige stapelings ingesluit.

6.0 GEBRUIKE

6.1 Substasie-ontwerp

Vakuum-stroombrekers kan maklik vir alle skakelingsoperasies aangewend word en dit is in werklikheid slegs in daardie gevalle waar ander so ree stroombreker spesiale oorweging verdien dat vakuum-ontbrekers buite rekening gelaat kan word.

Wanneer die situasie by olie-vrye skakeluitjre vereis, kan die vakuum-ontbreker op dieselfde wyse as olie-stroombrekers gebruik word, met miskien die voorbehoud dat, wanneer klein transformators met 'n onbekende impulslevel of lug-geïsoleerde konstruksie, geskakel moet word, dit gerade sal wees om klein stuwingsabsorbers aan te wend om oorspannings wat uit die onderbreking van die baie lae magnetiese strome mag ontstaan, te voorkom. Dit is 'n probleem wat nie tot vakuum-ontbrekers beperk is nie.

Voorbeelde van die gebruik van olie-vrye toerusting is in olie-boortorings waar die vakuum-ontbrekers in 'n krag-opwekkingspakket ingesluit is. Die toerusting is besonder geskik vir nywerheidsustasies en vir bennetingsustasies in handelsgebied met 'n hoë vragdigtheid waar dit wenslik is om die hoëspanningsoewer naby die vragmiddel-punt op sommige tussenvoerlakkte te plaas om enige brandgevaar te verhoed.

Dit is tipies van vakuum-skakeluitjre dat dit byna heeltemal vry van enige meganiese reaksie is wanneer kortsluitingstrome-ontbrek word, en by hoë aanslae kan die konstruksiekoste van substasies hierdeur aansienlik vermindre word, wat dit moontlik maak om hulle op stellings of op bouvalke wat normaalweg nie vir die dinamiese vragte van sommige soorte toerusting geskik is nie, te plaas. Weens die ligte konstruksie kan veelpanelige monterings direk vanaf die fabriek gestuur word, met 'n besparing van monteringskoste op die perseel. Weens die afwesigheid van skakel-olie en gasagtige nee-produkte word die risiko van brand en ontplofings uitgeskakel. Geen koolstofdioksied-brandblussers of brandwonde dust benodig nie en die veiligheids van die perseel word dienooreenkomstig verhoed. Batterybehoefes word ook tot 'n minimum beperk as gevolg van die lae energiebehoefes van die solenoiede.

6.2 Stroombaanbehoefes

Die vakuum-ontbreker is uitnemend geskik vir die talryke skakelings wat deur boog-ontde en ander HS-vragte vereis word, vanweë die feit dat dit so min aandag nodig het, veral wat betref die lae kontak-erosie van die kontakstel. Hieroor meer in die afdeling oor Betroubaarheid.

Outomatiese hersluiting val in dieselfde kategorie en hoë-spoedklinking (18 m.s.) van vakuum-ontbrekers kan bewerkstellig word om beskadiging by die omsprong van die fout uit te skakel en om die gradering met stadig-smeltende HS-sekerings te verbeter (Verw. 1).

Die beheer van HS-motore is deeglik ondersoek, met inbegrip van toestandse soos ligte vrag, volle vrag en versnelling/stilstand en met verskynsels soos herhalende spannings-stygings. Hierdie toets is vroeër in 'n referaat oor die onderwerp behandel (Verw. 1) en gee 'n aanduiding van die uitstekende prestasies wat met hierdie toestelle behaal is, sowel as van die feit dat enige oorspannings wat voorgekom het, in aanmerking geneem moet word. Vakuum-ontbrekers val die gesekerde kontaktoors by kleiner HS-motore aan deurdad hulle 'n werksreks dek wat normaalweg slegs met lug-stroombrekers gassoneer word.

Lae-energie-solenoeide-meganismes is al gebruik om maksimum-huighartheid in die beheer van die stroombrekers te verseker, dog handgelaide sowel as motories gelaide veermeganismes is in sommige ontwerpe beskikbaar.

7.0 BEDRYFS-ASPEKTE

7.1 Integrale Aarding

Eenvormigheid van bedryf-prosedures in hoëspanningsnetwerke is van die uiterste belang vir die toesighoudende ingenieur en elke nuwe ontwerp moet dus die noodsaaklike fasiliteite aanhuldig.

In die ontwerp van die vaste stroombreker word integrale aarding verskaf deur middel van 'n gegredende isolator wat die geleidingsde dekonnekteer en wat dit moontlik maak om die voerder via die vakuum-ontbreker na aarde te konnekteer en sodanig die hewese maak-vermoë van die toestel te benut.

Die aanbevole aardingprosedure om maksimum bedryfsveiligheid te verseker en die moontlikheid van toewer-ontbrekings te vermindre, volg hieronder Fig. 13 toon die aanbevole bedryfsvolgorde.

SIEN FIG. 13.

VOLGORDE VAN AARDINGSSTAPPE

(a) ISOLEER

Wanneer die stroombreker oop is, kan die isolator opgemaak word om volle veiligheidsruimtes vir die geleidingsde te verskaf. Die voerderkabel wat geaard moet word, moet by sy verste punt geïsoleer word.

(b) TOETS

Athowel die stroombreker vermoë het om in die teenwoordigheid van 'n fout te sluit, is dit gerade om eers die stroombaan te toets

energised, prior to earthing. A padlocked test point is provided.

(c) EARTH

The circuit can now be earthed by closing first the earth switch and then the circuit breaker. Only at this stage can access be gained to the interrupter compartment.

(d) SAFETY EARTH

If it is necessary to carry out any work in the interrupter compartment, a safety earth can be bolted to the test point to safeguard against any possible re-energising from the remote end of the cable.

BUSBAR EARTHING

Normally this would be achieved, utilising a similar procedure to that above, for a bussection switch, where it is possible to earth either set of busbars.

ALTERNATIVELY - the safety earth referred to above may be left in position and the vacuum circuit breaker reclosed after the isolator has been closed to the service position.

The isolator is provided with an off position which enables the circuit breaker to be checked - operated without the necessity of energising the main circuit - a facility for which "jumper connections" are normally required for most isolatable circuit breakers.

7.2 Operational Requirements

Interlocked test points are provided in the vacuum interrupter chamber, to enable test connections to be made to the circuit once it has been earthed via the vacuum circuit breaker (in line with the practice normally used in oil switches). Additionally this point can be used for the provision of a "working earth" to retain the circuit breaker at earth potential once the integral earth is removed. The same point provides for current injection through the main cable and the current transformers, and for "phasing-out" between adjacent panels when voltage transformer spouts are not available.

The newer 24kV design incorporates some refinements in the following respects:-

- 1) The arrangement of the isolator not only provides a safeworking isolating distance, but completely segregates the switching chamber from the busbar chamber to facilitate breaker removal.
- 2) It offers an improvement over many existing designs of horizontally isolated equipment at this voltage by providing integral earthing of all cables and connected equipments, such as CT's and VT's, by using the faultmaking capacity of the vacuum circuit breaker.
- 3) This equipment offers the user a choice of operating mechanisms for the circuit breaker from a range of springs and solenoid devices. Designs based upon horizontal isolation will follow the usual conventions, though feeder earthing is more readily attainable as a standard feature than the busbar facility. This fortunately is a little used feature involving fault-making capacity, particularly in industrial networks and installations where within the plant it is more practical to check isolation and certainly more prudent in view of the short-circuit powers involved. Isolation is provided within the housing and a handling track is provided for access for detailed inspection of the circuit breaker.

8.0 RELIABILITY AND MAINTENANCE

8.1 Product Integrity

Much has been written concerning freedom from maintenance, which must be developed as a long term attribute of any modern switching equipment. This can be established by development testing of the interrupters, mechanical and electrical endurance tests of the equipment, including an assessment of the attention which may be required.

Reliability is the capability of the equipment to fulfill its design function with or without maintenance. It is of course of the greatest significance that the interrupter is a completely sealed unit of known capabilities; manufactured and checked under the most rigorous conditions associated with any form of modern technology, and undoubtedly setting new standards for any form of HV switchgear.

8.2 Non-Maintainable Aspects

The principles on which vacuum switchgear have been based are to utilise existing knowledge and experience in component design and above all to simplify the mechanical content of moving components. The present concept of the fixed circuit breaker makes a material contribution to meeting these demands and specific items of equipment consolidate the maintainable parts outside the HV enclosure. The basic linkage is non-maintainable with compression springs, and the in-built features ensure that throughout the entire life of the contacts, adequate contact pressure is automatically maintained. Through-current and rated breaking current tests have proved the effectiveness of this arrangement at the reduced spring pressure associated with maximum wear.

tenende te bewys dat dit ontwerp is voordat dit geaard word. 'n Toetspunt wat toegesluit kan word, word voorsien.

(c) AARDE

Die stroombaan kan nou geaard word deur eers die aardskakelaar en dan die stroombreker te sluit. Dit is eers in hierdie stadium dat toegang tot die stroombrekerkamer verkry kan word.

(d) VEILIGHEIDSAARDING

Indien dit nodig is om in die stroombrekerkamer te werk, kan 'n veiligheidsaardverbinding aan die toetspunt vasgebou word om die installasie teen die moontlike herbevestiging vanaf die verste punt van die kabel te beveilig.

GELEISTAM-AARDING

Normaalweg word dit bewerkstellig deur dieselfde proses soos hierbo beskryf vir 'n stamskeikakelaar, waar dit moontlik is om die een of die ander stel geleistamme te aard.

ALTERNATIEWELIK - kan die veiligheidsaarde waarna hierbo verwys is, in posisie gelaat en die vakuüm-ontbreker weer toegemaak word nadat die isolator in die diemissieposisie gesluit is.

Die isolator is toegerus met 'n "af"-posisie wat dit moontlik maak om die stroombreker vir kontrole-doelendes te laat werk sonder om die hoof-stroombaan te bekrag - iets waarvoor oorbrug-aansluitings normaalweg in die geval van die meeste isoleerbare stroombrekers nodig is.

7.2 Bedryfsvereistes

Gegreindele toetspunte word in die vakuüm-ontbrekerkamer voorsien om dit moontlik te maak om toets-aansluitings na die stroombaan te maak nadat dit via die vakuüm-ontbreker geaard is (soos wat normaalweg by olie-skakelaars gesoen word). Hierdie punt kan ook gebruik word vir die daarstelling van 'n "werkende aarde" tenende die stroombreker vir aard-potensiaal te hou nadat die integrale aarde verwyder is. Hierdie punt maak ook voorsiening vir stroom-invoering deur die buskabel en die stroomtransformators en vir "uitfasering" tussen aanliggende panele wanneer spanningstransformatorite nie beskikbaar is nie.

Die jongste 24kV-ontwerp bevat die volgende nuwigheide:-

- 1) Die plasing van die isolator maak nie alleen voorsiening vir 'n veilige isoler-afstand nie, dog skei ook die skakelkamer heeltemal van die geleistamkamer tenende die verwydering van die stroombreker te vergemaklik.
- 2) Dit bied 'n verbetering oor verskeie bestaende ontwerpe van horisontaalgeïsoleerde toerusting by hierdie stroomspanning deur die voorsiening van die integrale aarding van alle kabelle en aangeslote toerusting soos bv. stroom- en spanningstransformators, deur gebruik te maak van die foutsluitende vermoë van die vakuüm-ontbreker.
- 3) Hierdie toerusting bied aan die gebruiker 'n keuse van bedryfs-meganisme vir die stroombreker uit 'n reeks veer- en solenoïedemeganisme.

Ontwerpe wat op horisontale isolasie gebaseer is, sal die konvensionele patroon volg, alhoewel die aarding van voerders makliker as 'n standaard-eienskap verwenlik kan word as die aarding van geleistamme. Hierdie eienskap kan word as die vermoë om foutsluiting te bewerkstellig, insluit, word gelukkig baie min gebruik, veral in nywerheidsnetwerke en installasies, waar dit meer prakties en sekerlik ook meer verstandig is, met die oog op die kortsluitingskragte wat daarby betrokke is. Isolاسie word binne die omhulsel toevoeging en 'n hanteertrouk word voorsien vir toegang tot die stroombreker vir gedetailleerde inspeksiedoeleindes.

8.0 BETROUBAARHEID EN INSTANDHOUDING

8.1 Integriteit van die Produk

Daar is al baie geskryf oor die vryheid van instandhoudingsprosedure, wat as 'n langtermyn-eienskap van moderne skakeltoeg ontwikkel behoort te word. Dit kan tot stand gebring word deur die ontwikkelingstoetsing van die ontbrekers en deur meganiese en elektriese uithouoetsing van die toerusting, met inbegrip van 'n skatting van die mate van aandag wat nodig sal wees.

Betroubaarheid is die vermoë van die toerusting om sy ontwerp-funksie te verrig met of sonder instandhouding. Dit is natuurlik baie belangrik dat die ontbreker 'n heeltemal verskeie eenheid met bekende vermoëns moet wees. Dit is om'er die mees veelseidende toestand vervaardig en getoets word, met die toepassing van elke vorm van moderne tegnologie, en moet ongetyfeld nuwe standaarde vir alle vorms van HS-skakeltoeg daarsel.

8.2 Nie-instandhoubare Aspekte

Die beginsels waarop die ontwerp van vakuüm-skakeltoeg gebaseer is, is om die bestaande kennis en ondervinding van die ontwerp van die komponente te gebruik en om, in die eerste plek, die meganiese inhoud van die bewegende komponente te vereenvoudig. Die huidige begrip van die vaste stroombreker lewer 'n wesentlike bydrae tot die vervulling van hierdie beoefes en spesifieke onderdele van die toerusting dien om die instandhoubare dele buite die HS-omhulsel te konsolideer. Die basiese koppeling, met sy ingeboude veer, is nie-instandhoubaar, terwyl die ingeboude eienskappe verskerk dat gegonsame kontakdrukking dwarsdeur die lewensduur van die kontakte outomaties volgebou word. Deurstroum- en aangeslane breekstroomtoets het die doeltreffendheid van hierdie bestel teen die verminderde veer-drukking wat met maksimum-slytasie gepaard gaan, bewys.

Contact erosion has been thoroughly investigated in the course of extended short circuit testing and it can be related to the total arc energy integrated over the life of the interrupters. The graph, Fig. 14, shows a number of breaking operations at various levels of current for a 250 MVA/11kV circuit breaker of the type used for frequent switching duty. Each design incorporates a feature in the mechanism linkage to show what degree of wear has taken place, in order that the end-of-life condition can be recognised and in view of the fact that no intermediate life adjustment is required, maximum utilisation is obtained from the equipment. It has been found on test that this condition is in no way critical as on most other forms of circuit breaker.

SEE FIG. 14

8.3 Mechanisms etc.

The operating mechanism has been designed to match the characteristics of the vacuum interrupter and is therefore a short-stroke, low-energy device, with low wear and long life capability. Auxiliary contacts, contactors and mechanisms are also accessible for inspection and lubrication without the need for access to the circuit-breaker chamber. These provisions account for the high reliability of this design of equipment, which is backed up by an extensive programme of research and development.

Extended endurance tests are a fundamental aspect of the development of this equipment, not only for the basic mechanical linkages, but also for the vacuum interrupters. It is essential to establish by co-ordinated testing that the combination of all these components will give the reliability claimed for each separate component. This is well illustrated in the absence of contact bounce on closing to reduce contact erosion and on freedom from rebound on opening to enhance the life of the bellows.

9.0 CONCLUSIONS

Clearly the vacuum circuit breaker now commands its own position in high voltage industrial distribution networks, and whilst it is not expected to replace all other forms of circuit breaker, it can be seen that it can offer many advantages to the user when it is thoughtfully applied and evaluated in the total concept of providing circuit breaker substations.

Ref. 1 CIRE 1975 paper - "Recent Progress in the Development and Application of Vacuum Switchgear" by T.V. Armstrong, G. Auton, J. Fisher, W.L. Passant and H.S. Wood.

Kontak-erosie is deeglik ondersoek in die loop van uitgebreide kortsluitingstoetses en dit kan in verband gebring word met die totale boogenergie, geïntegreer oor die lewensduur van die onderbrekers. Die grafiek, fig. 14, toon 'n aantal breek-operasies teen verskillende stroomvlakke vir 'n 250 MVA/11kV-stroombreker van die soort wat vir herhaalde skakelings gebruik word. Elke ontwerp het 'n eienskap in die meganiese koppeling wat aantoon hoeveel slytasie plaasgevind het, sodat die einde van die lewensduur bepaal kan word, en, aangesien geen tussentydse lewensaanspassing nodig is nie, word die maksimumbenutting van die toerusting verkry. Toetses het bewys dat hierdie toestand geensins kritiek is, soos wat met die meeste ander soorte stroombreker die geval is nie.

SIEN FIG. 14.

8.3 Meganisme ens.

Die bedryfsmeganisme is ontwerp om by die eienskappe van die vakuumonderbreker aan te pas en dit is dus 'n toestel met 'n kort slag, lae energieverbruik, lae slytasie en 'n lang lewensduur. Hulpkontakte, kontaktoetsers en meganismes is ook toeganklik vir inspeksie en smering, sonder dat daar toegang tot die stroombreker-kamer verkry hoef te word. Hierdie faktore is verantwoordelik vir die hoë betroubaarheid van hierdie toerusting, wat gerugsteun word deur 'n uitgebreide navorsings- en ontwikkelingsprogram.

Langdurige uithou-toetses is 'n fundamentele aspek van die ontwikkeling van hierdie toerusting, nie net ten opsigte van die basiese meganiese koppelings nie, maar ook ten opsigte van die vakuumonderbrekers. Dit is noodsaaklik dat daar, by wyse van gekoördineerde toetses, vasgestel word dat die kombinasie van al hierdie komponente die betroubaarheid wat daar vir elke afsonderlike komponent opeis word, sal waarborg. Dit word duidelik geïllustreer deur die afwesigheid van kontaktspringing by sluiting om kontak-erosie te verminder en deur die vryheid van terugspringing by die oopmaak, wat op sy beurt die lewensduur van die konsertina verleng.

9.0 GEVOLGTREKKINGS

Dit is duidelik dat die vakuum-onderbreker nou sy eie plek in hoogspanningsnetwerke in nyrhedede inneem, en, alhoewel daar nie verwag word dat dit alle ander vorms van stroombreker sal vervang nie, is dit duidelik dat dit aan die verbruiker baie voordele bied as dit sinvol aangewend en in die totale opset van die voorsiening van stroombrekersubstansies geëvalueer word.

Verw. 1 CIRE 1975-referaat: "Onlangse Vordering in die ontwikkeling en aanwending van vakuum-skakeluitg" deur T.V. Armstrong, G. Auton, J. Fisher, W.L. Passant en H.S. Wood.



A group of the delegates listening attentively to one of the speakers.

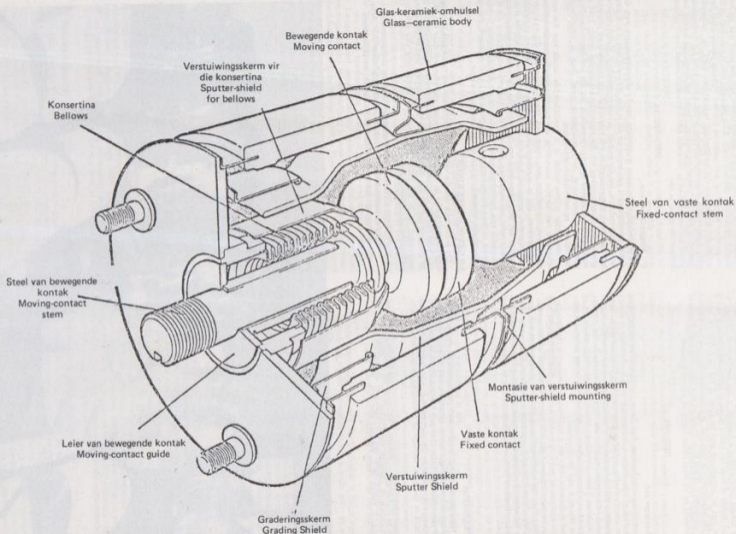


FIG. 1 BINNE-AANSIG VAN TIPIESE VAKUUM-ONDERBREKER
INTERIOR VIEW OF TYPICAL VACUUM INTERRUPTER

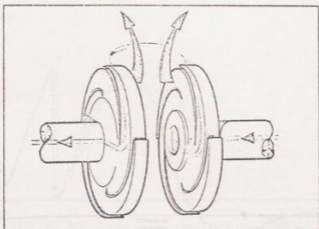


FIG. 2 TYPICAL CONTACT CONFIGURATION TO PROMOTE RAPID ARC MOVEMENT OVER THE CONTACT SURFACE
 TIPIESE KONTAK-KONFIGURASIE OM VINNIGE BOOGBEWEGING OOR DIE KONTAKOPPERVLAKTE TE BEVORDER

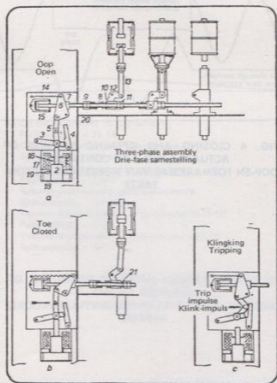


FIG. 3 CLOSING SYSTEM ADOPTED FOR VACUUM CIRCUIT BREAKER
 TOEMAAKSTELSEL VIR VAKUUM-STROOMONDERBREKER

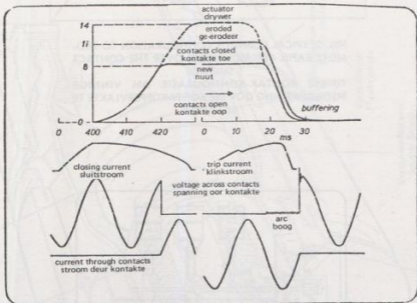
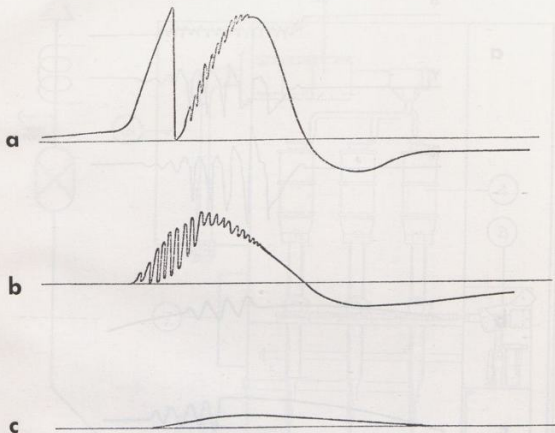
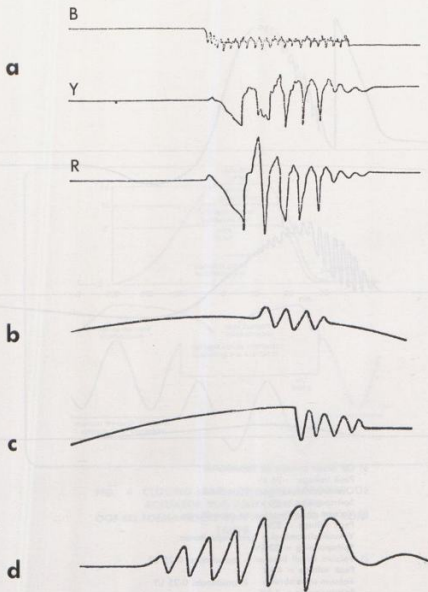


FIG. 4 CLOSING AND OPENING STROKES OF ACTUATOR ROD AND CONTACTS
 OOP-EN TOEMAAKSLAE VAN WERKSTANG EN KON-
 TAKTE



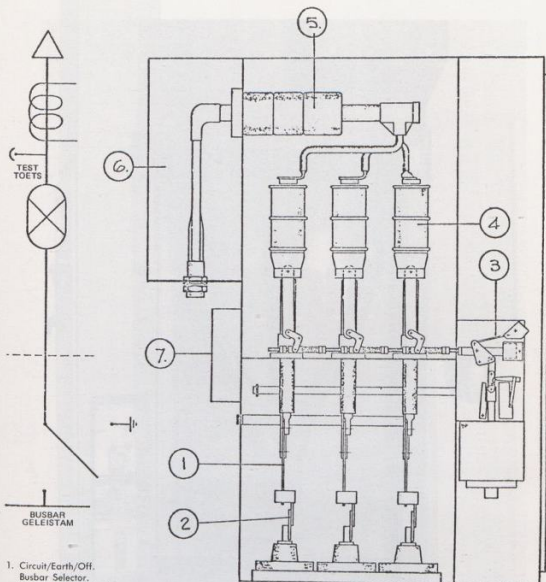
- a) Oil circuit breaker no capacitance.
Peak voltage = 26 kV.
Olie-stroombreker geen kapasitansie.
Spitsspanning = 26 kV.
- b) Vacuum circuit breaker no capacitance.
Peak voltage = 22 kV.
Vakuum-stroombreker geen kapasitansie.
Spitsspanning = 22 kV.
- c) Vacuum circuit breaker - capacitance; 0.25 UF.
Peak voltage = 4 kV.
Vakuum-stroombreker - kapasitansie: 0.25 UF.
Spitsspanning = 4 kV.

**FIG. 5 CURRENT CHOPPING CHARACTERISTICS OF
CIRCUIT BREAKERS
STROOMAFKAPPINGSEIENSKAPPE VAN STROOM-
BREKERS**



- (a) Closing transient.
Toemaak-oorgang.
- (b) Opening transient - normal speed.
Oopmaak-oorgang - normale spoed.
- (c) Opening transient - stalled rotor.
Oopmaak-oorgang - stilstaande rotor.
- (d) Discharge of stored energy.
Ontlading van bergede energie.

FIG. 6 MOTOR SWITCHING CHARACTERISTICS OF VACUUM C.B.'s.
MOTORIESE SKAKEL-EIENSKAPPE VAN VAKUUM-STROOMBREKERS



1. Circuit/Earth/Off.
Busbar Selector.
Stroombaan/Aarde/Af.
Geleistam Kieser.
2. Busbars.
Geleistamme.
3. Solenoid Operated Mechanism.
Meganisme deur solenoiede gewerk.
4. Vacuum Interruptors.
Vakuum-stroombrekers.
5. Current Transformers.
Stroomtransformators.
6. Cable Box.
Kabelkas.
7. Multicore Cable Box.
Veelkern-kabelkas.

UNIT EENHEID	WIDTH mm WYDTE mm	HEIGHT mm HOOGTE mm	DEPTH mm DIEPTE mm
630A 250M.V.A.	460	1730	990
1250A 250M.V.A.	560	1830	1170
2000A 500M.V.A.	560	1930	1330

**FIG. 7 ARRANGEMENT AND PRINCIPLE DIMENSIONS
OF TYPE FV VACUUM SWITCHGEAR
RANGSIKKING EN HOOF-AFMETINGS VAN TIPE FV-
VAKUUM SKAKELTUIG**

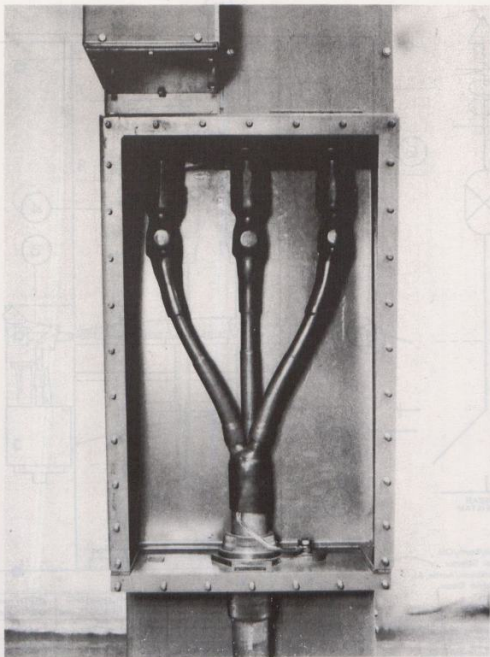


FIG. 8 CABLE BOX SHOWING TYPICAL HEAT SHRINKABLE JOINTS (RAYCHEM)
KABELKAS MET TIPIESE HITTE-KRIMPBARE LASSE (RAYCHEM)

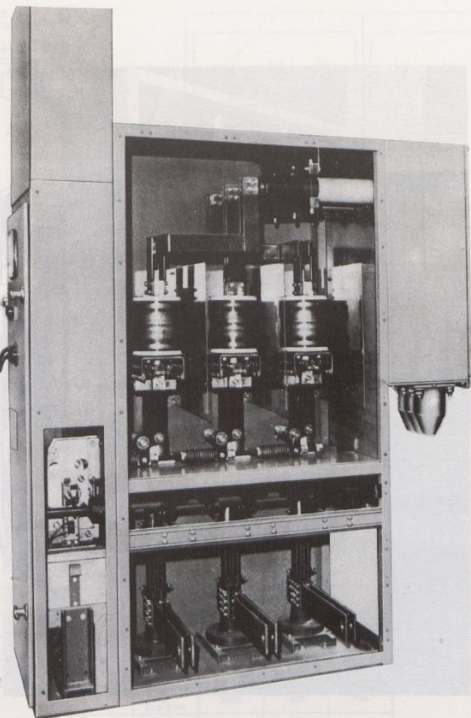


FIG. 9 SIDE VIEW OF TYPE FV VACUUM CIRCUIT
BREAKER UNIT 500 MVA.
SY-AANSIG VAN TIPE FV VAKUUM-ONDERBREKER-
EENHEID 500 MVA

FIG. 11 ARRANGEMENT VAN APPROXIMATE WINDING
EXPOSURE RANGE OF VACUUM SWITCHGEAR
BANDWIDTH BY MANIPULATED SPINNING VAN
OM FV-REKEL VAKUUM-SKAKELTUIG

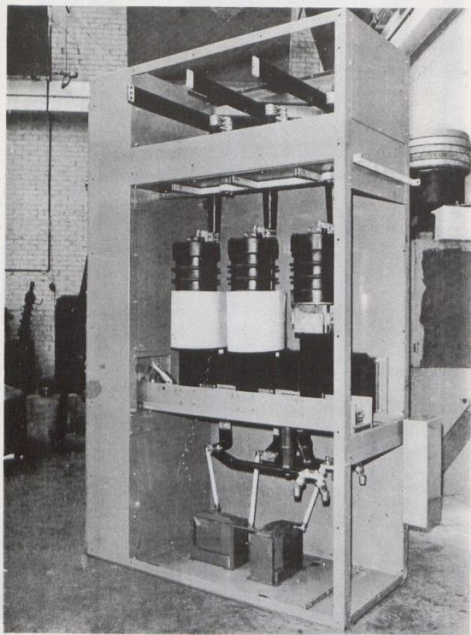
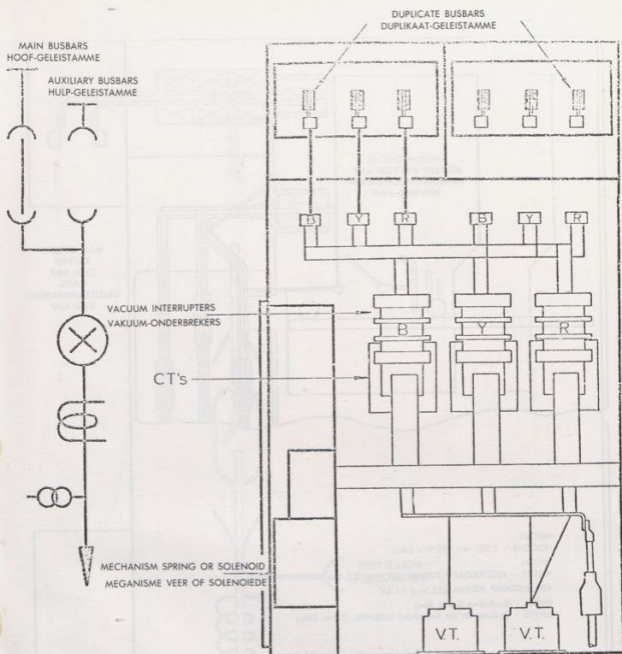
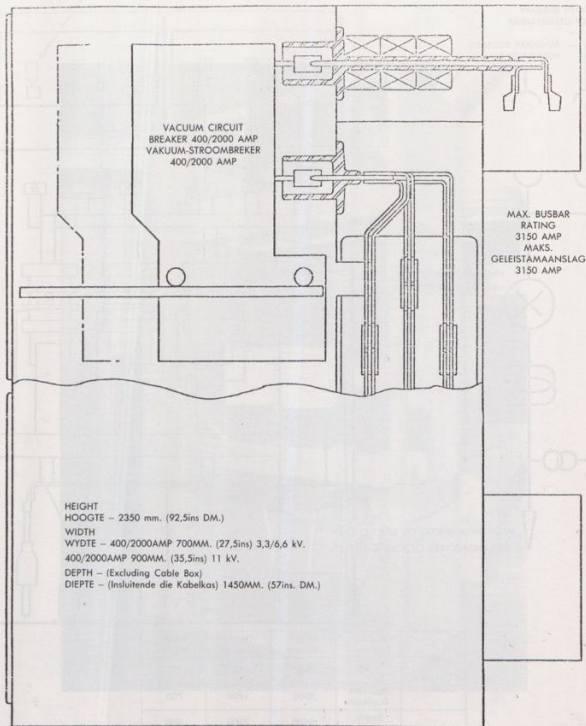


FIG. 10 SIDE VIEW OF 24 kV VACUUM CIRCUIT
BREAKER UNIT.
SY-AANSIG VAN 24kV VAKUUM-STROOMBREKER-
EENHEID



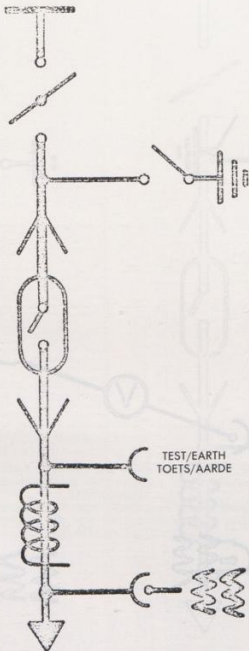
V	Busbars Stamme	Height Hoogte	Depth Diepte	Width Wydte
17.5/24KV 100MVA	Single Enkel	2600	1600	700
	Duplicate Duplikaat	3000	1600	700
30/36 KV 1500 MYA	Single Enkel	3500	2500	900
	Duplicate Duplikaat	4100	2500	900

FIG. 11 ARRANGEMENT AND APPROXIMATE DIMENSIONS OF FVT RANGE OF VACUUM SWITCHGEAR
RANGSKIKKING EN BENADERDE AFMETINGS VAN DIE FVT-REEKS VAKUUM-SKAKELTIIG



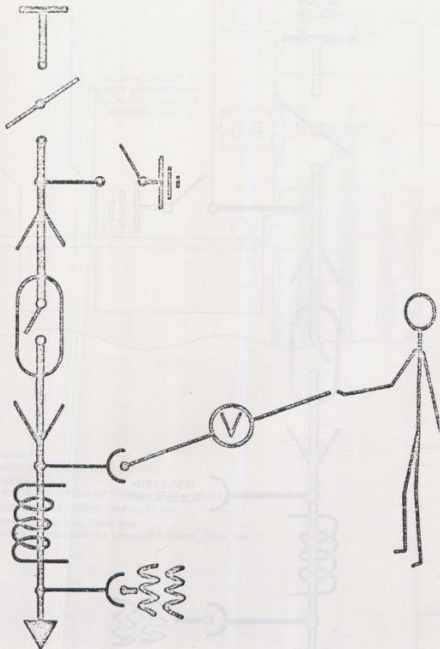
**FIG. 12 HORIZONTALLY ISOLATED VACUUM CIRCUIT BREAKER TWO TIER CONSTRUCTION RATINGS UP TO 500 MVA, 6.6/11kV (250MVA 3.3kV)
 HORIZONTAL-GEISOLEERDE VAKUUM-STROOMBREKER TWEELAAG-KONSTRUKSIE AANSLAE TOT BY 500MVA, 6.6/11kV (250MVA 3.3kV)**

ISOLATE
ISOLEER



TEST/EARTH
TOETS/AARDE

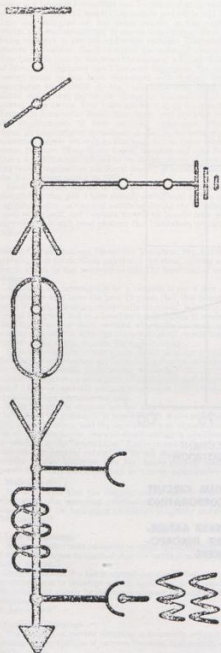
TEST
TOETS



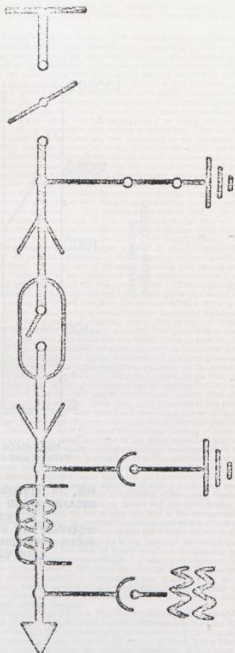
PART B (OF4) FIG 13

b

EARTH
AARDE



SAFETY EARTH
VEILIGHEIDS-AARDE



PART C (OF 4) FIG 13

c

PART D (OF 4) FIG 13

d

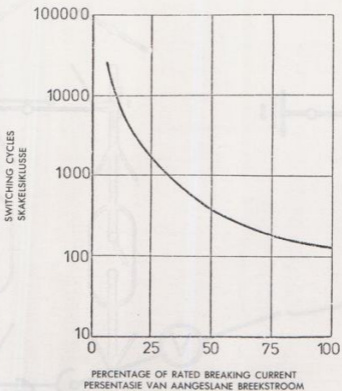


FIG. 14 PERFORMANCE OF VACUUM CIRCUIT BREAKER RATED 250MVA/11kV INCORPORATING V.I.L. INTERRUPTORS
WERKING VAN VAKUUM-STROOMBREKER AANGESLAAN TEEN 250MVA/11kV MET DIE INKORPORASIE VAN V.I.L.-ONDERBREKERS

Mr. J. Birtles (Affiliate): Mr. President, Gentlemen, when the President invited me to introduce the author of this paper, two points somehow escaped his notice. Firstly, although I knew of Geoff Auton being employed by the same organisation I have never met him. In fact we met for the first time on Tuesday night at this Hotel. Secondly, I discovered that as a Lancastrian I had to introduce to the meeting a Yorkshireman. Some of you may remember that way back in history there was a war between Lancashire and Yorkshire that turned into the War of the Roses. The red rose for Lancashire and white rose for Yorkshire. This war still goes on, but today mainly on the rugby fields, the cricket and football pitches. In recent times this emblem of this war is being changed to the red and white turbans! Like many of the Engineers in England, Geoff obtained his technical education on a part time basis. In time he achieved the status of a Fellow of the Institution of Electrical Engineers and Chartered Engineers. For something over twenty years he has been associated with design, development of switchgear up to 33kV, As the Companies with which he was associated during that period are classed as Competitors, I am not mentioning their names. Five years ago he took up his present position as Technical Director of Brush Switchgear and has been responsible for the developments in new switching techniques. Hence his very thorough knowledge of the subject covered by his present paper. He has presented papers not only in England, but in many other parts of the world. Belgium, Hong Kong, Lagos, Karakas and even Peking to mention a few. His contributions to the development of vacuum switching has been recognised by the Royal Society of London who awarded him the S.G. Brown medal in 1975.

Geoff described himself as married "with a number of children". He also likes to play golf. I have already assimilated quite a lot of interesting information on vacuum switching during the two days that I have spent with Geoff, and I believe we will all benefit from what he has to say today. It is with great pleasure that I introduce to you all, Mr. Geoff Auton.

Mr. D.C. Palser (Cape Town): Mr. President, Mr. Auton is to be congratulated on an excellent paper and the clear, concise and able manner in which he has initiated us into the mysteries of vacuum circuit breakers!

Although arc interruption in a vacuum is not a new concept, it is nevertheless only over the past 15 years that this principle has been rapidly developed and commercially exploited, largely in America, the United Kingdom and to a lesser extent in Japan. It would appear that the stage has now been reached where the vacuum breaker is becoming competitive with the conventional oil circuit breaker and, for certain applications, is even the logical choice.

I do not think that there is any doubt that the vacuum breaker is definitely overall technically superior to conventional circuit breakers for 11kV distribution applications. As far as I can see the only factor militating against its more general acceptance and adoption is that of price. I believe currently vacuum breakers at 11kV are about 20% more expensive than conventional gear.

Even though the vacuum breaker may be more expensive on, say, a 11kV, 250MVA system, it is possible that if one considers the overall cost of a substation, and the capitalised cost of maintenance over the life of the installation, the cost disadvantage is significantly reduced. In referring to the "overall cost" I have in mind, for instance, the fact that vacuum breaker substations do not require Co² installations and employ smaller batteries. Can Mr. Auton perhaps elaborate in this question of costs and economics in a more quantitative manner?

1. Maintenance:

If one accepts that the vacuum bottle itself is maintenance free, what about the operating mechanism? Surely this requires regular maintenance? Or, because of its relative simplicity and short stroke, is this minimal?

2. Loss of vacuum:

Are any routine tests necessary to verify the integrity of the vacuum? If not, how can one be assured that the bottle is not leaking and slowly losing vacuum?

I understand that if a bottle should completely lose vacuum and then be called upon to interrupt a fault equivalent to its maximum rating, the bottle will merely be destroyed without any explosion or hazard to personnel. Is this correct?

3. Current Chopping:

The problem of current chopping is frequently referred to when discussing the capabilities of vacuum breakers. Is this really a problem today?

I understand that current chopping can be minimised by correct design and choice of contact material. Is this correct? What levels of current chopping are currently being achieved?

I believe modern designs chop less than 5 amp. Is this so? To safeguard against current chopping do you advocate the installation of surge divertors?

4. Pole Mounted Auto Recloser:

Is a pole mounted, auto reclosing vacuum breaker commercially available yet for 11kV overhead distribution systems? If not, is any development work currently being undertaken in this direction and, if so, when do you envisage such a recloser becoming commercially available?

5. Market Penetration:

And, finally, one last question.

Has any serious effort been made to significantly reduce the cost of vacuum switchgear in an attempt to increase sales volume and market penetration?

This should be possible since, I believe, the prices of vacuum bottles are very volume sensitive. This marketing technique of cutting prices to increase sales volume has been successfully exploited before, notably by the motor industry in this country. Thank you Mr. President.

Mr. G. Auton Thank you very much Mr. Palser for your contribution. Mr. Palser has asked a very comprehensive series of questions touching upon points which I am sure would be of interest to most of your colleagues at the Conference. Prices, as you say have been quoted in the last two years which have been in the order of between 15 - 20% higher. I think that is a very reasonable picture in line with both, my Company's pricing policy and also, that price which the market was prepared to pay, for the enhanced performance of this circuit breaker. I would like to couple this sort of answer with a point further down in your contribution where you are saying, have we made serious attempts to reduce these costs. Our answer is indeed yes. There is clear evidence that Manufacturers are now beginning to see the fruits of their efforts from the amount of money which we ploughed into new tooling and getting this circuit breaker set up into being a competitive device. I do see an encouraging sign that the vacuum interruptor is perhaps more sensitive to volume than the switchgear and we are seeing a growth in the number of interruptors manufactured during each period and for the first time, the Manufacturer moving away from making a loss on each interruptor, so that the prices are starting to come right.

We can now say that 15 - 20% was the price that we used to pay for vacuum circuit breakers and in this competitive market you will be paying less than that on subsequent purchases. A lot does depend upon how you reline your thinking to the use of a new circuit breaker. Currently the co-author of another paper in the U.K. which is specifically aimed at the detached appraisal of that suggested by your question, the economics, the total cost of running, operating and owning substations, it may not yet have appeared in your technical papers, but a new word has been coined for this study called "Technoteology". This is the study of these aspects and I can freely quote that one of our biggest users in the United Kingdom has perhaps failed to take in all the advantages of using vacuum circuit breakers because he readily admits that he has a policy of standard sub-station design: of using a standard size battery, of having a standard floor plan with a given amount of area, it always embodies reinforced floors to take the dynamic loadings of the oil circuit breakers operating on maximum duty. So what he is saying is "I am highly delighted with the performances of the circuit breaker." He was the gentleman who gave me the statistics on the reduced maintenance costs. What he is saying in the total picture at the moment he has gained some of the advantages but he really has not cashed in on the total aspect of sub-station design. That then Gentlemen, will depend very much upon your approach to the philosophy of the design. Mr. Palser mentioned the savings one would make if you have the type of installation where you would otherwise require a Co² installation, and other fire-proof precautions. Looking at these in the complete picture; these are some of the many areas and they are spelt out in my paper, where a real saving can be made and these are just a visible in South Africa as anywhere else. The maintenance of the mechanism; will of course you rightly identify this area; there is little point in having a circuit breaker which has got an indefinite life if you can not at least go some way to matching it with a mechanism and I tend to look upon this in a picture of reliability of the circuit breaker, because the mechanism is a moving device and the short stroke, to which you referred, and the low energy required in the springs under the solenoid has enabled us to contrive a mechanism which, where the movement of the links is over a short radius and which turn over a very short arc and together it all adds up to the fact that we can produce a mechanism with a low level of stress in all its components and design the bearing surfaces accordingly. Lubrication is necessary, but of course the fundamental difference between the circuit breaker with which I associate myself, is that lubrication, preferably by an oil mist spray, can be applied to the mechanism just by opening the control cubicle door at the front and there is no need to have access to the high voltage chamber.

The integrity of the vacuum. The fundamental research work which goes into the manufacture of the vacuum interruptor is of such a high level of technology that by making two measurements of the vacuum at distinct periods of time, let us say 30 days or 60 days, it is a Manufacturer's technique when the vacuum interruptor is complete to measure the level of pressure in the interruptor at the finalisation of the manufacturing processes. It is then put into store for a period of 30 days or 60 days, and then it is retrieved and the vacuum is again measured using a magnetron with a very fine and accurate measurement equipment, and if he can detect any change in the pressure and hopefully at the very least one does not have any change, but assuming that there is a marginal rise in the pressure then that represents the unknown rate of leakage and by a very straight-forward computation he can determine whether that rate of leakage would degrade the vacuum to an unacceptable level in say less than 25 years. Those that may have any element of doubt can be detected in the manufacturing stage and of course that really is at a time which might well be six or nine months before your gentlemen would ever see the circuit breaker. During this

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time it would be shipped into our factory; it will be incorporated in the switchgear and we would do a 28kV applied AC voltage test, and then in another period of weeks or months depending upon where the equipment is going to, it would be installed and commissioned and another final high voltage test would be done, so I think we can be reasonably sure that provided the interruptors have gone safely through their principle area of hazard that is firstly the initial manufacture and secondly the time when they have been handled in our own factory and incorporated into the switchgear and once they get that far they really are not at risk to any form of damage, so the answer to your question is no I do not think there is going to be any real need and usage to date has not called for frequency HV tests to establish whether the vacuum is still there. What I do believe, as with all equipment of this basic type of switchgear, that once the equipment has been installed I think it is always prudent whether oil switchgear or vacuum switchgear that it is wise after about 12 months from installation to examine the equipment to check that nothing has been overlooked during the commissioning tests and I do know that until we gain competence that a number of my users elsewhere are taking the opportunity to do an applied voltage test, but again this after 12 months, is what I think will become the final acid test for the vacuum, and we will come to accept this as being an item of high reliability.

Current Chopping: I have referred to it in the paper; your information is basically correct that the chopping levels are at, or slightly below 5 amps, particularly for the copper chromium alloys used in the series of interruptors manufactured by VIL. Current chopping need not always be the total criterion and therefore there are other successful interruptors available which have got slightly higher chopping currents. I think the important thing is that if we have a special application that the manufacturer's literature is consulted or he is approached because there is no mystery in current chopping. Oil circuit breakers have been chopping currents for many, many years and it is one of the things about our research that in looking at vacuum circuit breakers in this last 5 years, we are astounded, perhaps you would be, as to what we found out in the way of the chopping current statistics of all circuit breakers and we have been getting away with it; we have not even noticed it for this last 20 years, so it is not a problem and I think it is a fair claim that we have a very full understanding of the problem. If we have an application such as a packaged sub-station, if we are doing a packaged sub-station to put into a high fire risk environment and we are using a dry type transformer with a vacuum circuit breaker, certainly there, because it is well known that the impulse level of dry type transformers is not really comparable with that of oil filled transformers, we would recommend the use of some surge suppression for a transformer the most effective way is to incorporate some small capacitors. Surge divertors are really the answer for suppressing current chopping voltages, and this need not be an additional burden to be put on the designer of the sub-station. These capacitors would be supplied as an integral part of the switchgear in very much the same way as a voltage transformer would be, provided if such were required.

Pole mounted reclosers: My Company does not operate in the field of pole mounted reclosers, but I do know that a proto-type has been made by a U.K. company who by sheer coincidence happened to make a lot of oil filled pole mounted reclosers. I would perhaps conclude, I see no reason why they would have technical problems, none whatsoever. I conclude that perhaps their economics are not right. Thank you.

Terotechnology is a combination of Management, Financial Engineering and other practices applied to physical assets in pursuit of economic life cycle costs. Its practice is concerned with the specification and design for reliability and maintainability of plant, machinery, equipment, buildings and structures, with their installation, commissioning, maintenance, modification and replacement and with feed back information on design, performance and costs.

Mr. W. Barnard (Johannesburg): Mr. President / Mr. Auton, This paper is being presented at a very opportune time as far as Johannesburg is concerned. The difficulty in obtaining ground in the Central Business District of Johannesburg has forced us to the development of major substations integrated with commercial office and shopping centres.

This has introduced a new major factor in substation design of fire-risk and the use of non-inflammable distribution equipment. The vacuum interrupter appears to be a solution, but there are certain aspects on which we would like some assurance.

1. Maintenance.

One of the most striking features of the vacuum interrupter appears to be it's maintenance and trouble free life. It would seem that the life of the vacuum interrupter will be determined firstly by the life of the contacts and secondly by the life of the vacuum. Can the author indicate how these two parameters can be monitored and if the interrupters can be repaired or if they must be replaced if abnormal contact wear or loss of vacuum take place. Also what would the consequences be of a vacuum interrupter operating under fault conditions if the vacuum has deteriorated.

2. Over-voltages

One of the early draw-backs of the vacuum-interrupter was it's disposition to cause surge over-voltages by current chopping.

Although the author states that by the use of special contact materials surges due to current chopping have been reduced to value

equivalent to those for oil circuit breakers; he nevertheless suggests that surge absorbers may be necessary to protect certain types of plant.

To reduce the fire-risk in substations dry-type of transformers are being considered which according to the author may require surge absorbers. To date we have not found this necessary with the use of oil circuit breakers.

3. Vacuum Contactors

The author has clearly differentiated between the design characteristics of vacuum contactors and vacuum interrupters but it would be interesting to hear if an interrupter could not be developed for both duties.

At the Johannesburg Diepsloot sewerage pumping station vacuum interrupters have been used for 12 months to control the switching of the 6,6kV 976 HP pump motors.

These contactors have a 50 MVA fault rating and are backed up by 250 MVA HRC Fuses and operate at an average 2 times/day.

I think this is rather a neat way of having the best of both worlds and consider this application could be extended in some instances to installations where otherwise interrupters would be used.

4. SF6 Switchgear

To the engineer who is not an expert on switchgear it would appear that SF6 switchgear would have most of the advantages of vacuum interrupters and some of the disadvantages, viz. ease of maintaining gas pressure, accessible for repair or renewal of contacts, a softer break thus avoiding current chopping and surge voltages and yet not necessarily more bulky than vacuum gear.

I would like to thank the author for the interesting and valuable information he has given on vacuum interrupters, but would appreciate if possible some comparison with SF6 switchgear.

Mr. P.J. Botes (Roodepoort): Probably the most important point to be considered with vacuum switchgear is the change in operating techniques. The writing appears to be on the wall for the classical drawout truck clearly and unambiguously isolates the cable.

This, therefore, means a proliferation of interlocks or a change in the standard of operators. The latter which is unfortunately not possible. It is maintained that tests which have been carried out show that the interrupter will not shatter should it fail to clear a fault of (for e.g. greater severity than it's capacity). The vacuum bottle may be damaged and the vacuum destroyed. The bottle becomes "conducting" but this is not obvious to the operator.

The operation sequence as mentioned by Mr. Auton, therefore, becomes essential and so does the provision of a set of testing sticks to the operators.

The earthing of the cable is achieved through the interrupter. Tripping must, therefore, be inhibited while the earth switch is in service. Perusal of the arrangements shown in Figure 7 of the paper will show that it is not possible to "phase in" the cable after repair, should a ring feed be involved. This limits the application to radial feeders or feeders where alternate types of gear are available on the other end for phasing.

The existing switchgear manufacturing industry is very much "bulk-oil" orientated and high local contents are usually quoted. This will no longer be the case with vacuum as the volume will probably never warrant the establishment of a "bottle making" industry. A loss in foreign exchange to the country will, therefore, proliferate. What is the possibility, however, of manufacturing the "bottles" locally?

Visibility of the positions of the links in the chamber, particularly the remote phase could well be improved, as it is essential. The low level bushbars might prove to be troublesome should flooding be expected.

The above comments make it clear that some further research work on the development of the panels is possible and when the same experience exists on vacuum as on oil, excellent results can be expected.

Mr. President as regards the interrupter a few questions please. I was given to understand that the equipment on the high voltage range the interrupter emits X-rays?

How serious is this?

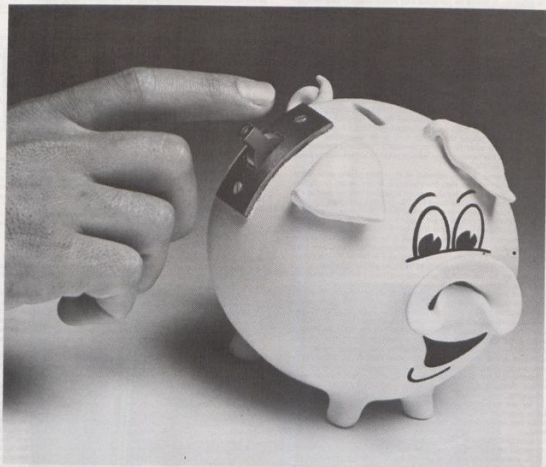
The use of this gear as a load breaker instead of an oil circuit breaker in the higher voltage ranges is being advocated in certain quarters. This means that one has to rely on backup breakers and the inhibiting of the tripping of the load breakers when a fault occurs.

Information of such a system will be of great interest to us when consideration is given to the high cost of oil circuit breakers at higher voltage levels.

Mr. President I must also add my thanks to Mr. Auton for a very interesting paper.

A paper which I have enjoyed tremendously.

Mr. G. Auton Mr. Barnard, you have raised the question of integrated sub-stations in the environment in which you spoke of and sort out some further thoughts on the fire hazard, then in particular the consequence of an interrupter failing, that is having to interrupt short circuit current at a time when the vacuum may for some reason not be there. The in-test which you are all interested in; let me try and set the background to this. Firstly, we set up the interruption in the test station, and did a 13kA short circuit and secondly, to contrive the breaker to open on this fault with a hole purposely drilled in to allow the air to be there. Now normally on a healthy system that is well graded, if one breaker fails to clear then according to what the grading is it might be pilot wire protection giving a rapid clearance; it might be back-up pro-



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indeed they exist, and on an equipment like this which has been purpose made and will be subjected to specific voltages then we can give a very specific answer.

And my answer is with this, the levels of radiation measured with the equipment closed up with all its normal coverplates in place, are not measurable on the outside of the unit. If we open the front access door and then measure at the level of the door, there again is nil radiation this is on account of a distance that we are now standing from the interruptor and probably the worst case is if you are doing any exploration on a unit in the workshop and you have taken off one of the side covers then you have the possibility of getting much closer to the unit. Using instruments measuring in millirads, which is the unit in which we measure x ray generation, we have a value of .5 of a millirad and this will exist for say one minute for a test voltage. To quote the Government regulation, a safe dosage is considered to be point, 75 of a millirad for 2000 hours. So again, to put the thing into perspective, x-rays are there but all we get is .5 of a millirad for one minute, but in the voltage range that we are operating it does not represent a health hazard.

Lead Breakers: Finally, I believe you asked me about lead breakers, while inhibiting the trips of these devices under fault conditions to enable fault clearance this to be carried out by a circuit breaker. This I think Mr. Botes, is a very fascinating possibility, we have been giving some thought to this for some time. It is capable of being developed. It does have an application to distribution networks, I believe again a change in operating philosophy is required if we are to follow this technique. I hope on some later occasion perhaps if we do develop the idea to discuss it again, it does have possibilities.

Thank you.

Mr. R.W. Blower (Affiliate): Good afternoon Gentlemen, I am very conscious of the fact that the afternoon is progressing and although it is a fascinating subject there is a limit to what one can say about it. Although you have a no-advertising rule, I think you could add some weight to what I have to say if I remark that I am a Director of that other Company that makes vacuum switchgear in the United Kingdom and also a Director of the Company who makes the bottles.

Perhaps if I could deal first of all with the actual interruptor itself and this question which has been raised about leakage. The process of manufacture is a very sophisticated one, after the components have been manufactured, they are assembled in a clean room. This is a bit like operating theatres; it is supplied with filtered air which actually filters out influenza virus to keep the standard of cleanliness absolutely at the top level. When the actual interruptors have been baked and evacuated and all the welding operations are completed, they are given a test for the degree of vacuum and are then recorded in respect of each and every vacuum interruptor. The interruptors then have to go through a sequence of what we call conditioning tests which are in effect a series of short circuit and voltage tests which condition the surface of the contacts to make sure they will undergo all the operations that Mr. Auton has been talking about. Then when that is complete they are given a second measurement of their vacuum and we normally would expect that vacuum to improve, the effect of all the arcing which is going on inside the interruptor will be to have exercise, a sort of getting effect and mop up any loose amount of gas that has been left inside. They are then put on the shelf for a month and at the end of that period they are measured once more. Once again we would normally expect them to improve. If to any degree they are worse, then they will be put on one side and given a further month's test and if there is still no sign of improvement then they will be scrapped. In other words I may perhaps elaborate and make a little bit of an issue on what Mr. Auton has said because if there is any sign of leakage developing in the thing then it does not go into service, but I think I must emphasise another point. If you consider the size of these things and imagine how long it really would take for the vacuum to be replaced by air through any physically capable size of hole, you will realise it actually is a very short period. We do not visualise and up to now have no experience, of conditions where vacuum will gradually get worse. That is the reason why it has been put on the shelf for a month. That period will demonstrate any possible signs of a catastrophic leakage. Question of repairs being mentioned, well I think from what I have already described about the manufacture of the bottle, I do not want to dwell on it this afternoon, but there is no doubt about it, any attempt of repair would be more expensive than to make a new one.

Let us go on to the second point, because it was raised the question if in fact South Africa went down this road and I recommend you do so, perhaps there will be a loss of foreign exchange because a fairly expensive part of equipment, whoever tries to manufacture it here, will have to be imported and there may not be a case for South Africa to set up manufacture. Now this is a point that a considerable amount of thought will have to be devoted to, because there is not really scope in the World for a large number of manufacturers of vacuum interruptors. It is a high cost investment business and it is a business where, in order to lower the cost of the actual component, that is the vacuum interruptor, down to sensible levels you have to have volume. Something of a mass production operation although it is a highly sophisticated process industry really. It is by investment and by elimination of human error that we can get the yield and the high quality of the interruptors which is necessary to safeguard the industry and to provide the facilities that the switchgear manufacturer requires. So it largely depends on how many interruptors the South African market wants as to whether this is a viable operation. It is only perhaps to the westion of

the switchgear itself, operational facilities, certainly as far as the U.K. manufacturers are concerned on the switchgear side, it has been our intention or our objective to simplify but in no way to reduce these standards of safety and security in operation of this equipment and as far as the earthing to the circuit breaker is concerned, perhaps I could just comment one thing here and answer possibly the last contributor to the discussion, it is certainly in our case usual for when the isolator or selector is put into the earth position prior to carrying out an earthing operation via the circuit breaker, the auxiliary switches associated with that, are disconnected and actually trip. It is possible of course to carry out an operation which mechanically locks the manual trip so that when you carry out your earthing operation, if there is any fault on the system, then it will not be that circuit breaker that trips out and in order to release it you would have to physically unlock the manual tripping arrangements before you could do so.

Mr. P.R. Rosen (Affiliate): Mr. President, Gentlemen, first of all I would like to congratulate Mr. Auton on his fine delivery of a very good paper. There are two questions I would like to raise. The first one in the paper in the first paragraph 5.1 refers to vertically isolated switchgear designs and in particular to the integral earthing facility achieved by relocation of the circuit breaker and states which allow system development and operation to reach new standards of safety and reliability. The bulk oil circuit breaker, because of its construction, completely encloses moving conducting parts of a circuit breaker in oil, which is an excellent insulating medium. The only open terminals of modern bulk oil circuit breaker panels are enclosed by orifices with the present knowledge of insulator design and with present materials these are virtually trouble free. The vacuum interruptor is an open terminal device which cannot be enclosed with insulation except with some considerable cost. However, if access to vacuum interruptors is adequate and convenient for insulation maintenance this need not result in reduced insulation security but may mean more frequent maintenance is necessary. Busbar and current transformer compartments of some modern oil circuit breaker designs contain no moving parts and can be completely covered with insulation. Vacuum circuit breaker panel designs of the type illustrated incorporate isolators in the busbar compartments and in some cases the current transformer compartment would not only inhibit an enclosed insulation design but also introduce moving contacts and linkages into these compartments. Does this not suggest that with the vacuum circuit breaker panels illustrated insulation security is reduced or alternatively the frequency of insulation maintenance must be increased compared with modern oil circuit breaker panels. If this is so, can this be justified as part of the price that has to be paid for the provision of an enclosure of lowest possible cost, to offset the high price of the vacuum circuit breakers.

The second question I would like to ask is on a further statement made in the paper, that there is no doubt that more designs are faulted because a mechanical innovation which has been inadequately proved and which has little if any bearing on a circuit breaker's interrupting ability that is in 5.2 last paragraph last sentence.

This requires some further explanation from the author. The impression is given that circuit breakers' interrupting capability is the only criterion of a good design. With present modes of operation practices earthing, testing and maintenance facilities together with a high level of insulation security are also most essential considerations in panel design and it is usually in these areas where innovation or in other words design, plays its part in meeting those requirements economically.

Thank you.

Mr. G. Auton Thank you Mr. Rosen for those points reminding us really of the sort of very excellent background that we have of so many tens, indeed hundreds of thousands of oil circuit breakers. I do not take serious issue in the way that you presented your information, but I think that what I would probably like to say is that what has been a general philosophy in trying to launch a new vacuum circuit breaker has really been to take a very thoroughly evaluated switching device and puts it into an environment where it can be operated, as Mr. Blower said, with nothing whatsoever to degrade the operating safety in standards of the equipment. But yet to get it launched without some of the points that I referred to in my paper I accept your observation that we have a more air insulated and correspondingly not as many encapsulated components than is currently available in practically all modern oil circuit breakers. What I do believe is that these equipments adequately fulfil the requirements as re the national specifications standard of impulse level and other considerations. I think having achieved a launching pad for this device that time will not be far away when we are able to overhaul this situation. Let me remind you that it is not many years ago really, since oil circuit breakers were built into metal clad cubicles with series isolators and some of the many other things that you have just currently referred to. I hope that we shall make progress and ultimately combine what might be a higher degree of insulation integrity. The fully encapsulated vacuum circuit breaker is certainly more feasible than the fully encapsulated oil circuit breaker. Statistics in relationship to mechanical failures - that remark of mine in the papers were very well founded because if I were to quote a very good friend of mine in the CEBG in London who is responsible for running a national fault reporting scheme, he says that the number of circuit breakers which fail as circuit breaker is inconsequential.

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tection extending as much as half a second, and the object of this test was to find out how an interruptor would perform and clearly it really has no extinguishing capability whatsoever and as a result you need to determine what are the consequences. I would like you to re-examine in a general sense the type of outcome in a switchgear cubicle that might be something similar to, shall we say, a current transformer chamber explosion or a flashover of insulation because we have only identified that there is no oil there and so that gets rid of a major problem. Now what actually happens in the interruptor is this, that because our contacts are only separating by 8mm then when we do have a 13kA arc it is an extremely low energy arc. The problems of faults in CT chambers on other forms of circuit breakers, take the air circuit breaker for example, here we extend the arc as long as possible and try and build up the resistance of the arc to cut down the current, but there is a fair amount of energy involved in these long arcs. In this instance we have a very short arc and it is contained between these quite massive contacts. The arc energy is low and because it is low then it can be contained within this de-energized glass envelope for quite some period of time, but ultimately the temperature will rise. So really all we have inside is metal vapour pressure plus of course, a quite steeply rising temperature at this time and as the interruptor commences to melt around that stainless steel skirt then we are really getting a quite modest relief of the thermal pressure that is inside. This interruptor was exposed to 13kA for a period just short of one second. Now this will give you an idea, Mr. Barnard, as to the type of failure that we are talking about.

I would expect to see from some of the tests that we have done ourselves in the factory, in our own short circuit test station, that this would be typified by displacing cover plates and leaving a small amount of soot, not the sort of sooty deposits that you get from oil. The contact erosion, I think I could probably be more specific over what is included in the paper on that, and then you might say how did we assess the vacuum interruptor afterwards. We have on record an extended series of tests which I described in conjunction with the graph of contact life this morning and at the end of that the interruptor was evaluated by putting it through all the type tests which are included in IEC 56. From the temperature rise test, the impulse test, the applied voltage test, the over voltage test, all these things were the means of trying to establish that even at the end of this series of tests we still had a very viable switching device and as the contact erosion at that time was only about 20% of the active material then we have possibly got a factor of three times in hand.

To monitor and repair: The only practical way that I can recommend for monitoring this is as I described this morning, firstly, to allow the equipment to have an initial period of service and then after applying a H.T. voltage test, we are satisfied that the performance is still alright then for my part I really feel that service experience and confidence will minimise the real need for a monitor. For repair as far as I am concerned it is expressly excluded. I seek to establish a form of switchgear which has an infinite life, but when we do come to the point that we see contact erosion overtaking it or for some reason it will not withstand its voltage test then I think at that moment in time we have got to have confidence, and hopefully say we have had value for money from it, put it in the dustbin and fit another one.

Over voltages in relationship to dry type substations: Gentlemen, in our research, which we put into the paper, we said that there has been a long and satisfactorily experience of using oil circuit breakers in this duty for dry type transformers. The information shown on Fig 5 is typical. It is not a comparison of my own oil circuit breaker. It is a contribution made by one of my other manufacturing colleagues in the U.K. which they presented for a previous paper, but we have checked it with our own circuit breaker and found it to be very typical. On Fig. 5(a) we have a typical over voltage produced by current chopping with an air circuit breaker and (b) a very similar magnitude from the vacuum breaker. There is one difference which is worth noting and that is that the oil breaker current chops somewhat spasmodically and therefore it might produce 26kV, 3 or 4 times, it might miss and might produce much lower voltages. The vacuum breaker is somewhat more predictable see 5B and produces something of the order of 20 to 22kV on most occasions and that is why we say that if we are using the vacuum breaker on a dry type transformer with this knowledge we would apply 3 phase capacitors of about 0.25 mFarad on the circuit breaker terminals connected in somewhat like we would connect an ordinary voltage transformer and the Trace 5 C shows you then the effect the capacitor has on attenuating the peak voltage. The first part it occurs where 22kV is shown on (b) this is the voltage resulting directly from the action of current chopping. The energy being taken out of the current wave and appearing as a voltage and therefore if you see 4kV on Trace C that is the subdud transient voltage and the 50 cycle wave shown below the line on (b) would then go on to rise up to a peak on an 11kV system of about 9kV to earth which is a normal peak voltage, but now it has suppressed the transient voltage and this we would confidently apply to any breakers controlling equipment which was in any way sensitive. 20/22kV is not going to be harmful to a 6kV dry type transformer as an infrequent incident, but it would be prudent if we were likely to subject it to frequent switching then to apply the capacitors.

The combination of contactors and fuses: This is adopted by the manufacturers of contactors if they have plant or distribution transformers included on a switchboard. To acknowledge your point that ultimately the available fuse sizes will become the practical limitation to this sort of combination, because not only does the fuse combination in

itself presents a limit but the higher the nominal rating of the fuse the higher is the let-through current and then of course with a higher let-through current you need a more substantial switching device. At this moment your are somewhat inhibited, because we are just on the threshold of finding an economical 11kV device of the 50MVA capability, and you will not have long to wait.

SF₆ Circuit Breakers: To overcome the disadvantages of the vacuum circuit breakers, I have looked at the SF₆, it is a very similar mode of switching. From an effectiveness point of view you can if you have studied it get a good circuit breaker; there are a number of limitations. The problem is not vastly different, possibly the most important thing is that for the vacuum device with the butt contact, indicated in my paper that we can operate with something in the order of 750 watts on the closing coil of the circuit breaker, because all that the coil has to do is to close the circuit breaker. The extinguishing of the arc shall we say comes free, this is because it is the way an arc performs in vacuum. But with SF₆ the only satisfactory way that has been established so far is either by using a separate compressor to pressurise the gas or from more modern development the so called, single pressure device where you have a circuit breaker element which is substantially like an over-grown bicycle pump and you use the compression of the piston to compress the gas and extinguish the arc. So now your mechanism has to be capable of not only making the contacts on closing but has also to store enough spring energy to be able to drive the, what I call the bicycle pump, to provide enough pressure to blow out the arc during an opening operation, and I am firmly convinced that whereas it can be an effective circuit breaker it does not lend itself in any way to what I believe to be the simplicity and the reliability that we can achieve with a vacuum interruptor. I hope this has covered the points which Mr. Barnard raised.

Gentlemen, Mr Botes

Operating Techniques: You refer, along with so many other fans and colleagues, to this question of the operating techniques of the isolatable and fixed circuit breaker. To put it clearly, there will be for sometime divergent views. You have indicated that we really cannot change the operatives, but we look upon it as part of our responsibility, to ensure this we try and achieve the same degree of uniformity. We all recognise that even at this moment in time there are so many makes of equipment which all fall into the isolatable category, and there is so very, very little real standardization achieved, and for very obvious reasons if we are buying equipment in a worldwide market competitively then there will be this diversity.

Phasing Out: I would refer you to Figure 7 in my paper. It is not obvious from that figure, I must admit, and omitted to touch on this in detail. Figure 7 shows a division panel to the right hand side of the interruptor marked with a number 4. That division panel can either be removable or it can be hinged and interlocked according to what your operating practices, with the cover access open, then indeed you do have access to the 3 terminals shown above the interruptor marked 4. Now, for phasing out simply by taking the voltage reference, should we say of Panel 1, with the circuit breaker closed which actually gives you a busbar reference and then open the adjacent panel which would be your feeder having an unknown voltage reference on it and by using your phase sticks then between the appropriate phases, phasing out can be safely carried out under those circumstances.

Local Manufacture: At this moment of time there is some substance in what you say, but an enormous amount of money has been put into production already and we have an adequacy of supply within the world. How long this will continue to exist is difficult to forecast, it is quite feasible if we see the growth of a patent that might emerge and if there were to be the wholesale acceptance of this type of switchgear, then industrialists in South Africa will see that there is a demanding product like this then I am quite sure they will look seriously at the possibility of local manufacture.

Low Level Busbars: There was comment regarding the low level of connections in the unit that I have been describing to you and perhaps this has been amplified by what I understand was a rather high level flood that you had recently and I am sure that in the art which we all practice of substation design one of the essential things that we do is look to establish our substation above known flood levels and perhaps every now and again we shall be caught out until we see perhaps a later generation of switchgear and it is a few years away yet but I think the type of switchgear that we have got is ultimately eminently suitable for fully encapsulating in epoxy resin in the fullness of time this type of gear is capable of being developed into one which will indeed be surmountable if needs be.

X-Rays: On the subject of X-rays from vacuum interruptions, x-rays are only generated under one particular condition and that is that if you have an open gap in vacuum and you apply a sufficiently high voltage it accelerates the electrons across the gap and on impacting on the conductor at the opposite side it is under these conditions that the x-rays are generated and of course the whole thing requires being examined from a quantitative point of view. The voltage necessary to accelerate them and produce these x-rays is outside the normal voltage that we are operating at. You can marginally enter this voltage range when you are applying test voltages and in the equipment that we are talking about - let us assume it is 10 to 12kV equipment - and we are using a test voltage around about 28 or 30kV. Regulations in most Countries require to stipulate the protective measures to be taken against x-rays if

The whole file is full of statistics of mechanical failures of one form or another, and I know and so many other people know that a lot of those things did come out of unproved innovations. I think it is important that we do look at the co-ordination of this switching device and achieve certainly a comparable mechanical performance. Thank you.

Mr. E de C Pretorius (President): Thank you Mr. Auton. Gentlemen I think you all agree with me that we've had a very interesting paper from Mr Auton. It certainly has evoked a considerable amount of very interesting discussion I don't think everything has been said about, or not the last thing has been said about, vacuum circuit breakers and it appears that Mr Auton will have to come back to South Africa next year and join us at East London so that we can continue discussion on this paper. Mr Auton thank you very much, and I should now like you to join me and show our appreciation to Mr Auton for an excellent paper in the usual manner.

AFSLUITING SESSIE - CLOSING SESSION

Mnr. E De C Pretorius (President): Ek het die dames gevra om by ons aan te sluit en ek versoek hulle dus om so te doen, en ek vra u asseblief om op te staan as hulle inkom.

Ladies very welcome.

Dames en here, ons het verskoning van sy Edele die Agbare Burgemeester. Hy het ongelukkig 'n bestuurskomitee vergadering wat by moet hywoon. Ek hoop dit staan in verband met Mnr de Villiers se salaris wat by verdien definitief 'n verhoging. Nou ons het gekom by die tweede laaste item van ons agenda, soos u sien die laaste item is verversings - die afsluiting sessie.

Soos ek gister gesê het dit is die sesde Tegniese Vergadering. Ons eerste Tegniese Vergadering is presies tien jaar gelede gehou in Bloemfontein waar Mnr de Villiers toe ook die Elektrotegniese Stadsingeneur was. Ek dink by daardie Tegniese Vergadering was daar so iets soos 80 of 100 afgevaardigdes teenwoordig gewees. By hierdie vergadering is daar amper 200 afgevaardigdes en 50 dames. Ek dink dit is 'n rekord. U sal seker met my saamstem dat hierdie vergadering een van die mees suksesvolle vergaderings was wat ons nog ooit gehad het. En dit is te danke aan 'n aantal persone en 'n aantal organisasies wat ek nou graag wil bedank.

Ten eerste, ek kan hom nie sien nie. Raadslid Kobie van Zyl by is ook by die bestuurskomiteevergadering. Nou die gedagte het by Raadslid Kobie van Zyl ontstaan om hierdie Tegniese Vergadering te Rustenburg te hou en by het ons ook namens sy Raad hierna genooi. Aan hom baie dankie.

Dan miskien moet ek hom heel laaste uitsonder, maar ek moes hom heel eerste genoem het Mnr Emil de Villiers. U weet dit is dit nie vir Mnr de Villiers was nie, dan was hierdie vergadering 'n onomuttelike gewees. Dan kan ons maar vergeet her daarvan. Slegs die mense wat al die ondervinding het om so 'n vergadering te reël, 'n organisasie in rat te stel weet dat dit van 'n man ver. Ek dink u sou met my saamstem dat Mnr de Villiers het 'n enorme sukses daarvan gemaak. Ek wil graag hier dat u sament met my ons dankbetuiging aan Mnr Emil de Villiers doen in die gewone manier. Baie dankie Emil, baie dankie my ou vriend.

In sy afwesigheid aan die Edelagbare Burgemeester, Raadslid A.V. Combrink en die Stadsraad van Rustenburg vir hulle gulharige ontvangs en gasvryheid. Ek verwoy veral na die funksie van gisteraand wat ons seker nie maklik sal vergeet nie. Baie van die afgevaardigdes het in daardie tyd na my gekom of gedurende die funksie na my gekom en geesê: "Eugene, jy weet ons was nog nie by so 'n burgelikeonthal gewese nie." Ek stem saam!

Ons wil ten derde die Bestuur van hierdie Hotel, die Safari Hotel, baie hartlik bedank vir die ontvangs. Ons het dit baie geniet. Ons is baie goed behandel en ek wil in besonder uitsonder Mv. Courtney-Clarke. Ek verstaan van Mnr van der Walt dit is nou presies 'n jaar gelede dat Mv Courtney Clarke hier aan bewind gekom het en dit is presies 'n jaar gelede dat Mnr van der Walt reëlings begin tref het. So sy was saam met Mnr van der Walt van die begin af doenig gewees met die reëlings vir ons verblyf hier. Thank you very much.

Ons wil die plaaslike tak van Sanlam, in besonder die Streekbestuurder, Mnr J.T. Hofmeyer, en die Streeksekretaris Mnr A.J.N. Kruger met al sy pragtige helpers bedank. Die mooi dames wat u daar voor gesien het, hulle is almal van Sanlam. Vir hulle hulp, vir al die dokumente en al die bystand voor en tydens die vergadering en ek wil weer verwoy na ons agenda waar gesê word dat Sanlam sal sy plaaslike telediens aan afgevaardigdes kosteloos beskikbaar stel. Baie dankie daarvoor.

Mnr de Villiers se departement, die Elektrotegniese en Meganiese Departement van die Rustenburgse Stadsraad, ook die Departement van die Stadsingeneur en die Klerk van die Raad en veral Mnr Smoek en sy personeel van die Rustenburg Kloof, asook die Departement van Lisensies en Beskerming vir die verkeersreëlings. Ons sê baie dankie aan Mnr Frikkie van Heerden vir al sy hard werk voor en tydens die vergadering en in dieselfde asem wil ons Mnr Doll de Preez, die man

wat die mikrofone en luidsprekers geantee het (ek wil net sê Mnr Doll de Preez is deur ons grootgemaak in Potchefstroom) en Mnr Frans Heystek wat hierd bygestaan het, baie dankie. Baie dankie Mnr Heystek. Gepraat van Potchefstroom. U weet ek het gedink daar is 'n „snag" met hierdie Burgemeester van Rustenburg. Daar is iets wat my nie heeltemal pluis is nie. Die man kan so lekker praat en by lyk my so gewild hier in Rustenburg toe vind ek gisteraand uit dat hy is 'n produk van Potchefstroom.

Ons wil baie dankie sê aan Mv Diana Combrink die Burgemeestersvrou vir die reëlings en aanbieding van die program vir die dames. Ek verstaan hulle was gister uit gewees na Boekenouthoftein, die ou opstal van President Kruger en vandag na die potbekkery en die dames verkeer my dat hulle dit geweldig waardier en dit baie geniet het. Dit was baie interessant gewees. Baie dankie Mvrou! Om net ons dank aan u te betoon Mvrou sal ons graag aan u 'n ruiker oorhandig.

Dan 'n baie belangrike persoon wat 'n baie belangrike aandeel gehad het in die sukses van die damesprogram is Mv. Lydia de Villiers, mnr Emil de Villiers se eggenote. Baie dankie Lydia vir alles wat jy gedoen het en ek dink ek praat ook namens al die dames. Baie, baie dankie. Aan u wil ons ook 'n ruiker oorhandig. Om ons dankbaarheid te betoon.

I should like also to thank and very particularly the President Elect Mr Ken Robson. Ken for everything you've done for me and on my behalf. Thank you very much. It has not gone unnoticed.

To our overseas guest speakers Messrs. Phillip Hartill and Geoff Auton once again thank you very much for very interesting papers.

The two quizmasters Mr Jules van Ahlfen and Mr John Morrison. Thank you very much for your contribution for making this meeting such a great success. En veral aan my goeie vriend Jules. Hy het geweldig baie werk in hierdie forum ingestel.

Aan al die lede en ek sluit in affilientele wat vrae reformuleer het vir die lede forum. Sonder u vrae kon daar nie 'n lede forum gewees het nie. U het die ledeforum gemaak en dan ook die mense wat daaraan deelgeneem het wat die bydraes gelees het. Sonder u deelname sou die vergadering nie 'n sukses gewees het nie alans dit kon nie plaasgevind het nie.

Aan almal wat aan die besprekings deelgeneem het, besprekings van die referate aan u sê ons ook baie dankie.

En aan die man hier op my regterhand, hy is ook my geestelike regterhand, Mnr Bennie van der Walt ons sekretaris. Dames en here aan hom moet u definitief 'n spesiale hard handeklap gee. Baie, baie dankie Bennie.

En dan ten laaste maar beslis die belangrikste en ek sê dit in alle priet, dank aan ons Skepper vir die pragtige omgewing waarin ons hierdie vergadering kon gehou het en die lieflike weer wat ons gehad het. Voor ek finaal afsluit wil Mnr Ken Robson ook 'n paar woorde sê.

Mnr Ken Robson (Aangewese President): Mnr die President, Mvrou Combrink, dames en here, dit is vir my besonder aangenaam om namens u almal wat hierdie vergadering bygewoon het ons innige dank aan u mnr die President oor te dra. Mnr die President vir die bewakende vriendelike manier wat u die vergadering geleid het. Ek kan u versker ons het die twee dae in pragtige Rustenburg ten volle geniet. Dit is ook sonder twyfel dat 'n belangrike punt in die sukses van hierdie sesde Tegniese Vergadering u leienskap is.

Mr President I believe you have succeeded in drawing out from us the problems, the opinions and the fruits of experience of a quite impressive number of enthusiastic and dedicated engineers or so they would seem to be.

We have touched on matters like interruptions of supply, breakdowns of equipment and communications and some of the attributes of a successful chairman are the maintenance throughout the proceedings of lines of communication between yourself and your audience and the creation of a very special kind of relationship with those who listen to you and to make sure that in these lines of communication there are no misunderstandings. These Sir I believe you have achieved admirably.

Now Mr President I believe that you have had no breakdowns in the communication and our relationship have been of a very special kind and this is due to the fact that you are the kind of man you are. What I'm trying to say, I hope in a special kind of way, is that we have appreciated what you have been and what you have done during these two days.

It's been good to have been with you.

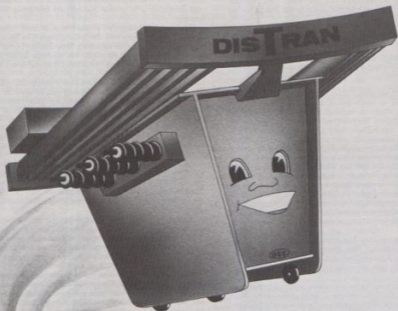
En nogmaals Mnr die President baie dankie vir alles wat u vir ons gedurende die laaste jaar en by hierdie samekoms gedoen het.

Mr E de C Pretorius (President): Ladies and gentlemen it is my sincerest wish that all of you will have a very safe journey back home and I hope to see all of you in East London next year. We have now come to the end of our proceedings and I now declare the Sixth Technical Meeting of the AMEU closed.

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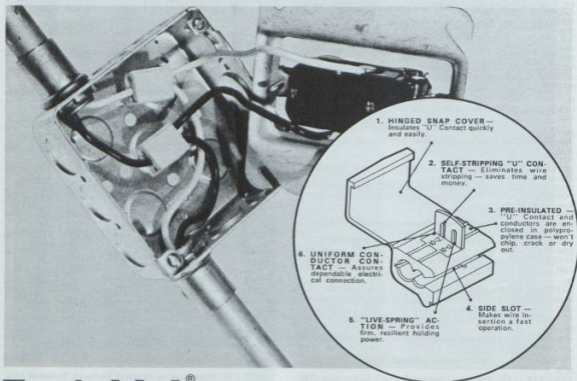
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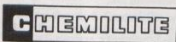
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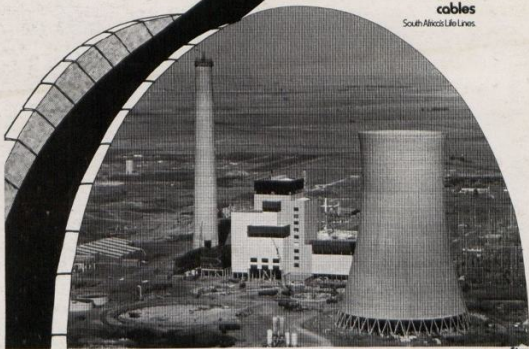
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