VERRIGTINGS 1972
Deel 1

Tegniese Vergadering

25 en 26 MEI, 1972

Kempton Park

Die Vereniging van Munisipale Elektrisiteits-ondernemings van Suid-Afrika

PROCEEDINGS 1972
Volume 1

Technical Meeting

25th and 26th MAY, 1972

Kempton Park

The Association of Municipal Electricity Undertakings of South Africa

TECHNICAL MEETING 1972

HOLIDAY INN, JAN SMUTS, KEMPTON PARK

PRELIMINARY AGENDA AND PROGRAMME

Thursday, 25th May, 1972

9.00 a.m.	Opening of the Meetinig.
9.15 a.m.	Paperette on: "New developments in the field of insulating materials."
9.45 a.m.	Discussion.
10.30 a.m.	Refreshment Interval.
11.00 a.m.	Members Forum—Affiliates Session.
12.30 p.m.	Luncheon Adjournment.
2.00 p.m.	Reports of representatives and sub-committees.
3.00 p.m.	Refreshment Interval.
3.30 p.m.	Members Forum—Natal Branch Session.
5.00 p.m.	Adjournment.
Evening	Informal Reception.

Friday, 26th May, 1972.

9.00 a.m.	Paperette on "New streetlighting developments."
9.30 a.m.	Discussion.
10.30 a.m.	Refreshment Interval.
11.00 a.m.	Members Forum — Highveld Branch Session.
12.30 p.m.	Luncheon Adjournment.
2.00 p.m.	Paperette by S.A.B.S. on Standards.
2.30 p.m.	Discussion.
3.00 p.m.	Refreshment Interval.
3.30 p.m.	Members Forum—Good Hope and Cape Eastern Branch Session.
5.00 p.m.	Adjournment.

TEGNIESE VERGADERING 1972

HOLIDAY INN, JAN SMUTS, KEMPTON PARK

VOORLOPIGE SAKELYS EN PROGRAM

Donderdag 25 Mei 1972

9.00 vm.	Opening van vergadering.
9.15 vm.	Referaatjie insake „Nuwe ontwikkelinge op die gebied van isoneermateriale"
9.45 vm.	Bespreking.
10.30 vm.	Verversingspouse.
11.00 vm.	Ledeforum—Geaffileerders se sitting.
12.30 nm.	Verdaging vir middagete.
2.00 nm.	Verslae van verteenwoordigers en subkomitees.
3.00 nm.	Verversingspouse.
3.30 nm.	Ledeforum—Nataltak se sitting.
5.00 nm.	Verdaging.
Aand	Informele Onthaal.

Vrydag, 26 Mei 1972

9.00 vm.	Referaatjie insake „Nuwe ontwikkelinge met betrekking tot straatverligting"
9.30 vm.	Bespreking.
10.30 vm.	Verversingspouse.
11.00 vm.	Ledeforum—Hoëveldtak se sitting.
12.30 nm.	Verdaging vir middagete.
2.00 nm.	Referaatjie deur S.A.B.S. insake Standaarde.
2.30 nm.	Bespreking.
3.00 nm.	Verversingspouse.
3.30 nm.	Ledeforum — Goeie Hooptak en Oos-Kaaplandtak se sitting.
5.00 nm.	Verdaging.

NATIONAL ELECTRICAL ENGINEERING RESEARCH INSTITUTE

RECENT DEVELOPMENTS IN THE FIELD OF ELECTRICAL INSULATION

By A. J. Eriksson, M.Sc.(Eng.), Pr.Eng., A.M.I.E.E., Grad. S.A.I.E.E., Senior Research Officer, National Electrical Engineering Research Institute, (C.S.I.R.).

1. Introduction.

Electrical insulation is a complex and wide-embracing topic requiring the study and application of several disciplines of science and engineering.

In fact, it has been said (1) that electrical insulation is a necessary evil, in that, when one considers the function of insulating materials in an electrical circuit, one finds that these materials provide mechanical support of the conductive elements of the circuit, but simultaneously impair the electrical performance of the circuit, which would operate much more efficiently if it could be supported by other means.

One may say then, that one of the major objectives of developments in this field has been to improve the performance, or to minimise the deleterious effect of the insulating materials present in electrical systems. This may be for example, in the form of reduced losses, increased electric strengths, increased tempeature ratings, etc.

It is generally accepted (1) that when considering a material as a potential insulant, the material properties should be considered in the following sequence of importance :—

1. Mechanical properties;
2. Thermal properties;
3. Environmental properties;
4. Electrical properties.
5. Economic aspects.

It is only when the material is capable of maintaining a certain physical intergrity, (be it solid, liquid or gaseous), under all the physical conditions of its service environment, that the electrical properties become of importance.

Thus in considering the developments that have taken place in the field of electrical insulation during the past decade, these factors should be borne in mind when assessing any new materials or insulating systems. (Some of the varied applications and requirements of insulating materials are indicated in Table 1)

During the past decade, electrical insulation, in common with many other branches of engineering has seen an increasing sophistication in the application of new materials, (many of them synthetic), and refined assessment and measurement techniques. For example, in power cable and capacitor systems the field has become dominated by the increasing use of low loss polymeric materials, in place of the less efficient oilpaper dielectrics.

Similar developments have taken place in rotating machines, where the newest and largest pieces of equipment, with almost no exception, are now insulated with systems employing mica paper bonded with epoxy resins, providing higher electric stresses with lower losses and better thermal characteristics. The very high temperature and voltage rated polyamide films are making vast inroads into the insulation domain of lower voltage motors and particularly traction motors, and have been very successful.

The field of switch-gear and outdoor insulation has seen the introduction of sulphur hexafluoride insulation systems over the full voltage range and in fact, space restrictions in urban areas have led to the construction of completely metal-clad SF_6 insulated E.H.V. substations — usually indoors. The use of cast expoxy resins for bushings and lower voltage switchgear has found much favour, and recently also there has been the introduction of track-resistant cycloaliphatic resins for outdoor insulation systems.

Due to the very large scope of this field, it will only be possible in this paper to consider a few of these developments in more detail. In fact, a comprehensive review of electrical insulation was given some years ago by Harvey,(2) who covered the insulation of motors, switchgear and transformers in detail. Accordingly, in this paper it is proposed to discuss developments in the power cable field more fully, followed by mention of the work on capacitors. Thereafter consideration will be given to the testing and assessment of insulation systems and some of the work of the C.S.I.R. in this field will also be discussed.

2. Cables.

Despite the considerable success of oil-paper insulated cables for many years, during recent times there has been an ever-increasing change-over to the use of polymeric insulated cables — particularly in Europe and in the U.S.A.

Of course, butyl rubber has been in use as a cable material for over 20 years, but recently the field has become dominated by the application of polyethylene. Cable designs employing plastic or elastomeric materials offer many advantages; freedom from compound drainage, greater robustness and ease of handling, reduced weight — and the non-hygroscopic nature of many of these materials simplifies jointing and terminating techniques. In addition, polyethylene, particularly when in the cross-linked form, has very

low loss characteristics and good electrical and thermal ratings. (Table 2 shows a comparison of some common material properties with those of polyethylene). (3,4, 5,6)

Table 2. Comparison of Cable Insulating Materials.

Insulating material or system	Loss Tangent Tan δ	Dielectric Constant at 50 Hz	AC Breakdown volts kV/mm	Max. Temp. for continuous Loading	Max. Temp. for short circuit
Oil-paper	0,003	3,5	40 - 50	80°C	160°C
Butyl Rubber	0,002	3,5 - 5,0	25 - 30	80°C	230°C
Polyethylene	0,0004	2,3	40 - 50	75°C	120°C
Cross-linked Polyethylene	0,0004	2,3	40 - 50	90°C	250°C

2.1. **Physical properties of polyethylene.**

Linear polyethylene has a planar zig-zag backbone structure of carbon atom chains, with hydrogen atoms in planes perpendicular to the carbon chains. In practice, a certain amount of side branching is present, (dependent on the density of the polyethylene), which influences the softening temperatures and the melt flow index. The structure may be represented ideally as :—

$$-CH_2-CH_2-CH(-CH_2)-CH_2-CH_2-CH_2-CH_2-$$

(side branch)

Electrically, polyethylene has extremely good properties. It has a very low loss factor, high dielectric strength, high impulse withstand voltage, and is not susceptible to moisture. Stabilisers and anti-oxidants are generally introduced to increase the resistance to discharge and ultra-violet degradation, and to improve thermal stability.

Low density polyethylene, despite its relatively low maximum permissible conductor temperature of 75°C, is found in power cables from 600 volts up to as high as 66 kV, (6) and occasionally even 138 kV. However, it is cross-linked polyethylene that is really making vast inroads into the oil-paper cable domain. In this material organic peroxides or vacuum irradiation techniques are used to bring about cross-linking between adjacent molecular chains. This material retains all the good electrical properties of polyethylene, but has the additional advantage of being a thermo-set material with considerable mechanical strength even at elevated temperatures, and has no true melting point, or susceptibility to thermal or environmental cracking.

During the last decade, cross-linked polyethylene has been used very extensively, particularly in the U.S.A. and to a lesser extent in Europe up to about 66 kV in power cables.

Cross-linked polyethylene cables have particular economic advantage over oil-paper insulated cables at high voltage and power ratings, but it has also been found in costing studies carried out in Australia (3) for example, that at the relatively low voltages of 11 kV and 22 kV definite economic benefits can be obtained from the use of polyethylene. (Figure 1).

More recently, design and prototype studies have been successfully completed on cross-linked polyethylene cables for 225-250 kV both in France and Japan, and short lengths of cable at these voltages have been in service for some years. It is confidently expected that as time progresses cross-linked polyethylene cables will dominate the power cable field more and more.

2.2. **Manufacturing technique.**

To avoid high electrical stress concentration in the vicinity of cable conductors due to unevenesses on the stranded conductor surface, a semi-conductive equipotential layer is placed over the conductor surface. In addition it is important that this conducting layer be intimately bonded to the polyethylene insulation. Apart from this, in order to control the potential gradient across the insulation, use is also made of a semi-conductive shield over the insulation. It is important also that throughout the life of the cable, the bonds between the insulant and these two screens be maintained in order to prevent partial discharge processes.

The more successful manufacturing techniques make use of a special extrusion head which is fed by two extruders, one applying a semi-conducting (carbon black loaded) polyethylene formulation, and the other larger extruder, apply-

ing the main insulation. Polyethylene is divided into two parts in the head, the first forming the thin annular layer about the conductor; the dielectric layer follows, and then the outer layer of semi-conducting material is applied. In practice the three layers come together in a sandwich before they are drawn onto the conductor under a slight vacuum.

In this way the insulation has the two electrode surfaces firmly bonded to it, and the possibility of impurities or voids being present then, or during load cycling, is largely eliminated.

Throughout this process, cleanliness is vitally important in order to avoid the inclusion of any particles in the body of the insulant, and indeed extrusion in the larger very high voltage cables is virtually carried out under "clean room" conditions.

Figure 2 shows a typical single-core polyethylene cable construction.

2.3. Discharge problems and test techniques.

Polyethylene as a material, is relatively susceptible to electrical discharge degradation, although cross-linked polyethylene (particularly when certain voltage stabilisers are added), has a much higher resistance.

This susceptibility is the reason for the stringent requirements for cleanliness and intimate bonding referred to earlier. In the vicinity of a void or particle inclusion, local stress intensification may be so high that local breakdown occurs, leading to erosion of the material in a process known as "treeing." This eroded channel may progress through the material fairly rapidly if the stresses are maintained, leading finally to complete breakdown of the insulation. Figures 3 and 4 show typical voids between semiconducting screen and insulation and particle inclusions, while Figure 5 shows a breakdown channel caused by discharge erosion.

Accordingly, in the polyethylene cable field, as well as in other branches of insulation engineering, extensive use is made of an assessment procedure known as partial discharge testing. (7, 8).

Figure 6 shows a schematic of a typical partial discharge measurement circuit. A variable voltage discharge-free H.V. source is used to apply 50 Hz voltage to the sample under test. A discharge-free blocking capacitor, in series with a tuned circuit, couples out any high-frequency discharge pulses that occur in the sample, via a high gain amplifier to an oscilloscope, where the pulses are displayed and measured on a 50 Hz elliptical time base. Figure 7).

Thus, by slowly increasing the voltage applied to the specimen, one can note the voltage at which discharges within the sample first occur. Thereafter, the discharge amplitude at any particular voltage can also be measured.

Normally in testing cables, use is made of a continuous scanning method of measurement as shown in figure 8, where the unscreened cable passes through a H.V. electrode immersed in liquid. This technique has limited sensitivity due to the electrical interference normally present in an industrial environment, and is restricted to tests on unscreened cables.

As described earlier however, most good quality polyethylene cable is manufactured in a three layer extrusion process, and accordingly a scanning system applicable to screened cables is required. One suitable method developed by Kreuger (8) makes use of a balanced bridge circuit (Figure 9), thereby also providing increased sensitivity due to the elimination of interference effects. Here, the cable passes through a set of four wheels, the outer two being earthed, and wheels A and B being connected to earth via resistors. When voltage is applied to the conductor, these two resistors, together with the cable capacitances, form a simple balanced bridge circuit, whose balance is momentarily upset whenever a discharge pulse occurs.

2.4 The role of overcharge testing in polyethylene cables.

In international circles, this is a topic of some controversy at present. (7, 9). The dangers lie largely in the duration of current equipment overvoltage tests, as well as in the overvoltage levels.

Although a polyethylene cable insulation systems may be of sufficiently high quality to ensure good service performance and transient overvoltage withstand capability, (polyethylene has a high impulse voltage withstand), the duration of an overvoltage pressure test may be sufficient to permit the onset of partial discharges and the commencement of erosion. (7). Then, although the cable may well have passed the overvoltage test satisfactorily and gone into service, due to the erosion that has taken place, the discharge inception voltage may be lower than the working voltage, and the consequent continuous discharge degradation will lead to cable failure fairly rapidly.

It is agreed (9) that a limited a.c. overvoltage test is necessary in polyethylene cables since it will detect the presence of any gross defects or flaws in the insulation, but it is strongly recommended that these tests be combined with partial discharge tests. A more realistic test procedure may be to carry out a 5 minute a.c. overvoltage test at a level within the range 1,5 - 2,0 times the phase-to-earth working voltage. This test should be supplemented by partial discharge tests carried out at normal phase voltage, before and after, the pressure tests, and at working voltage the cable should be partial discharge free—at sensitivities of the order of 0,1 - 1,0 p C. Should an impulse test be required, this should be carried out on sample lengths, and should again be combined with partial discharge measurements. Visual examination of cable samples can also be very informative.

In summary, one may say that the problems encountered in the manufacture and test of polyethylene cables up to reasonably high voltages have largely been overcome. The use of cross-linked polyethylene provides cables of very high quality with many advantages over oil-paper and other insulation systems, and it is certainly expected that polyethylene cables will dominate the field, particularly in the low and medium-high voltage ranges, as has already occurred in many parts of the world.

2.5. The use of gaseous and mixed dielectrics in Cables.

Before leaving the cable field, brief mention should be made of some other developments and novel insulation techniques.

As mentioned earlier, cross-linked polyethylene is susceptible to partial discharge degradation in small voids. Some interesting results of developments making use of insulating liquids, or gases together with a polyethylene dielectric, particularly for high-stress applications, have been published.

For example, in Japan, (10) satisfactory service experience has been obtained with a layer or film of silicone oil in the void between the stranded conductor and the insulation in cables of the 66-110 kV class. Figure 10 shows the results of impulse tests made on an experimental sample of cable using this type of construction. It has been found that with this technique, operating stresses within the cable of the order of 18 - 25 kV/mm are permissable, compared with the normal working stresses in polyethylene of the order of 10-12 kV/mm.

In Holland, (11) similar experiments are being carried out with polyethylene cables pressurised with SF6 gas at pressures of the order of 3 to 5 atmospheres. It was found here that in cables of good quality, (i.e. partial discharge free), the improvements gained are mimimal, but in the case of cables of inferior quality, significant benefits can be obtained. It is recommended as a useful technique in the case of cables whose service performance is poor—however, it should only be thought of as a compromise measure, the final solution lying in improved extrusion techniques.

An alternative approach to the use of polyethylene in cables is being investigated in England (12), where a lapped polyethylene cable, also pressurised with SF6, is being developed. Cable samples are built up from polyethylene tapes, having thicknesses of the order of 0,1mm, but being graded to provide suitable impulse withstand capabilities. Semi-conducting tapes are used on the core to provide an equipotential boundary, and the cables are pressurised with SF6 or nitrogen, or a mixture of both. Metallised Melinex foil electrodes are used to construct capacitively graded cable terminations, and, using these techniques, impulse breakdown stresses of the order of 100 - 150 kV/mm have been achieved in a design for a 275 kV system voltage.

Japanese studies (13, 14) have obtained similar impulse strength results, as well as ac discharge inception stresses of the order of 20kV/mm in a similar cable construction using SF6 pressures of about 5 atmospheres.

It is possible that, if the problems in extruding high integrity polyethylene cables for power transmission at voltages of the order of 500 kV are found to be considerable, this type of lapped and pressurised construction may prove a successful alternative, avoiding the problems of voids and inclusions in the solid dielectrics, but retaining the low loss and good voltage and thermal characteristics of polyethylene.

Finally, for underground EHV power cables with ratings of the order of 2500 MVA, fundamental studies are in hand in both Japan (14) and the United Kingdom on the development of compressed gas cables. Here, the presence of solid dielectric has been minimised, and is restricted to conductor supporting spacers at intervals along the cable — the bulk dielectric medium being again SF6 at pressures of the order of 5 atmospheres. This type of construction has several advantages over conventional EHV cable systems, namely:—

(a) Excellent voltage characteristics — ac working stresses of the order of 15 kV/mm being possible,

(b) Very large current capacity due to the low charging currents, negligible dielectric loss, and superior cooling effect.

This technique has interesting possibilities for high density urban areas where large transmission capacities per unit circuit may be required, and is a logical extension to the development of metal-clad SF6 insulated indoor substations.

3. **Power Capacitors.**

Considering briefly the developments that have taken place in this field, it is found that although impregnated paper dielectric systems have been in use for many years, there is now general agreement (15) that further significant improvements and reductions in loss using paper, cannot readily be obtained.

Paper is electrically a polar material: it exhibits losses which are essentially characteristic of the cellulose molecule, and these cannot be reduced by further processes of material purification.

Consequently, the size of currently used impregnated paper capacitors is largely determined by thermal factors, and the only practicable means of reducing capacitor sizes is to employ a dielectric material of lower loss angle, thereby permitting higher stresses in the insulation without increased heat generation.

Thus, as in the case of cables, the domination of the field by impregnated paper systems is rapidly being reduced by the increasing use of polymeric materials.

Of the many plastics available during development, consideration was given to the following materials which are available in thin film form:—

Polystyrene

Polyethylene

Polypropylene

Polycarbonate

Polysulphone

Desirable material properties sought for in potential capacitor dielectrics include:—

Low cost per unit volume.

High electric strength.

Low dielectric loss.

Compatibility with impregnant.

High mechanical strength.

Uniformity, and freedom from particle inclusions.

Suitable temperature characteristics.

Of the available materials, polystyrene and polycarbonate have found some application, but by far the most successful has been polypropylene.

The mechanical and electrical properties of this material in film form are enhanced by a process of two-directional stretching during manufacture, producing what is termed biaxially-orientated polypropylene film.

Film is readily produced at thicknesses down to 10 μm with excellent quality, and provided sufficient care has been taken, is free from conducting particles and weak spots. Polypropylene has a high electrical strength, and dielectric loss is approximately ten times less than that of oil-impregnated paper. (16) (Figure 11). The material is compatible at working temperatures up to about 95°C with the askarels normally used for impregnation, (usually trichlorodiphenyl), and has minimal effect on the impregnant, provided the polypropylene is free from ionic impurities.

The first commercially available designs making use of polypropylene, (17,18) have favoured a composite dielectric, where sheets of polypropylene have been combined with layers of capacitor grade kraft paper tissue acting as a wick for the impregnant. In order to take advantage of the high stress characteristics of the polymer film, the film and paper layer structures are arranged so that the gradient in the paper is of the order of 15 V/μm, and in the film, of the order of 45 V/μm.

The decrease in energy loss with this type of mixed dielectric has been considerable, (Fig.12), and reductions in size and weight of about 30% (17) compared to all-paper capacitors of equivalent rating have been achieved.

However, in many quarters, it is felt that the continued use of paper in these capacitors represents only a compromise approach, (16) and much effort is being directed toward the development of impregnated plastic film capacitors. Some promising results have been obtained at the Electrical Research Association Laboratories in England where this work has been in progress for

some ten years. (15) Using polypropylene films 12,5 pm thick with 6 μm aluminium foil electrodes and trichlorodipheynyl as impregnant, working stresses of more than 50 V(rms)/μm at 50 Hz have been achieved, resulting in reductions in size by a factor of the order of 3.

In order to obtain successful impregnation of the smooth plastic films, vacuum impregnation is essential, and it was found that using this technique, it still took several days for all the residual air bubbles trapped in the winding to escape. (Figure 13).

Roughening the polypropylene film improved the impregnation rates but reduced the electrical strength of the film considerably.

Provided both the film and the impregnant are free from particulate matter and impurities the predominant mechanism of detorioration and failure of these new capacitors is expected to be by internal discharge process. (15) Breakdown of the impregnant in regions of high electric field, such as within the vicinity of foil edges, results in the formation of gas bubbles and consequent discharge degradation of the impregnant. This emphasises the requirement that the impregnant be thoroughly degassed.

Figure 13 gives an impression of the magnitudes of discharge inception stresses possible in a fully impregnated capacitor, and it is important in service that such capacitors be subjected to a minimum of voltage surges in excess of the discharge inception levels.

Although in the case of paper capacitors, discharge detection techniques have been applied for some time, the dangers of discharge deterioration in the new film capacitors are much greater (due to the greatly increased stresses), and it is of prime importance that partial discharge measurements be included in any routine or type testing of these capacitors.

3.1. Future developments.

It is generally accepted that the mixed dielectric structure (17,18) although it provides many advantages in comparison to all-paper capacitors, is at best only an interim approach. As development of the polymer film capacitors develops, and the technique is extended to wider films, (at present it has been limited to widths of the order of 40 mm), it is expected that these capacitors will gradually replace all mixed and impregnated paper systems.

For the lower voltage ranges it will be necessary to develop high quality films of less than 10 μm thickness. The benefits from this would also extend to the high voltage range and in addition, the use of vacuum metallised electrodes offers considerable promise of further reductions in power capacitor sizes.

4. Materials and system evaluation.

The satisfactory performance of any electrical equipment depends on the quality of its insulation, and in particular the retention of that quality during service.

With the increasing sophiscation of insulation techniques, the adoption of synthetic materials, and their application under strigent conditions of electric stress and temperature, it is becoming very important that potential new materials and systems be evaluated comprehensively, with a view to achieving reliable service performance.

To this end, a comprehensive battery of material evaluation test procedures has been evolved by the various national and international standards organisations such as the British Standards Institution (BSI), the International Electrotecnical Commission (IEC), the South African Bureau of Standards (SABS), Verband Deutscher Elecktrotechniker (VDE), and the American Society for Testing and Materials (ASTM), (2). Of these, the ASTM and the IEC procedures are perhaps the most wide ranging, embodying thermal, mechanical, electrical, and environmental characteristics.

Once a basic material has been evaluated and found suitable for a particular application, its behaviour when applied to a specific insulating system, (probably in combination with other materials), has to be assessed under service conditions. In order to predict service performance and life of insulating systems, use is frequently made of accelerated life testing procedures. Life acceleration may be brought about by various methods, which include (often in combination), increased electrical stressing, higher temperatures, repetitive mechanical stressing, and the use of higher electrical frequencies. In the case of external insulation, chemical degradation may also have to be simulated in the form of pollutants or the presense of ultra-violet radiation.

Finally, when a satisfactory system has been developed and is commercially manufactured in the form of an item of electrical equipment, this is usually required to undergo routine or type testing before acceptance. These tests are normally prescribed in the form of equipment

specifications drawn up by the various standards organisations, but today there is a tendency toward a re-orientation of the emphasis of these tests.

As discussed earlier, when considering overvoltage testing of cables, much reliance has been placed in the past on potentially destructive long-term (one to fifteen minute), pressure tests at power frequency. However, as mentioned above, in the more advanced insulation systems, these tests can be potentially degrading, leading to a substantial reduction in insulation life. Apart from this, an ac overvoltage test can be misleading on its own, as it does not provide sufficient information on the insulation condition. (7)

Nowadays, a substantial variety of pontentially non-destructive tests and measurement procedures are available for dielectric assessment, (19) and application of certain of these procedures together with limited ac over-voltage and impulse tests if necessary, (dependent on the type of equipment being tested), can be very informative. Certain of these procedures are shown in Figure 11.

Foremost amongst the methods now in use are the partial discharge measurement techniques described earlier. (7,8) These have application to virtually all forms of electrical power equipment, including switchgear, bushings transformers, capacitors, cables and even rotating machinery, and are particularly important where synthetic materials are involved.

A similar measurement technique, but one which provides additional information particularly about the severity of discharges, is the dielectric loss measurement, using an instrument termed a Dielectric Loss Analyser. (20) This employs a form of balanced bridge circuit (Figure 15) to provide an oscillographic loop trace display the area of which is related to the energy content of the discharges. (Figure 16). This technique is especially useful for assessing the condition of high voltage motor and generator insulation.

The use of the Schering Bridge for the measurement of insulation loss tangent has long been popular, (19) and has found ready application in the testing of insulation for motors, cables, capacitors and bushings. It is particularly informative if measurements are made over the full range of working voltage for the specific item of equipment. (Figure 17).

Direct current measurements of insulation resistance as a function of voltage have found favour in the U.S.A. (21) These techniques too, can provide very useful information on the basic insulation condition, especially when the effects of moisture are being considered. The measurement of insulation resistance has almost become a tradition in the form of "Megger" tests, but these can be very misleading if insufficient care is taken. At any particular voltage, insulation resistance is a function of the time for which the voltage is applied (21) (Figure 18), and during the first ten minutes of a test can vary by a factor as great as 8 - 10. This property, which is a consequence of dielectric absorption, is made use of during drying out procedures on high voltage motors and generators, where the ratio of the ten-minute to the one-minute insulation resistance (termed polarisation index), is a useful indication of the state of dryness of the insulation. (2) (Figure 19).

4.1. Assessment of insulation condition during service.

In the past, routine maintainence tests on insulation have normally been restricted to measurements of insulation resistance — usually with a "Megger". However, as pointed out above, resistance measurements can be meaningless unless the duration of the voltage application is noted and consistently practised.

The Power Electrical Engineering Division of the National Electrical Engineering Research Institute of the CSIR has recently started an insulation research section as a service to the electrical supply and manufacturing industry, with the prime objectives of the assessment of both basic insulation materials and also insulation systems in service.

With regard to the latter, recent advanced measurement procedures have been applied to the assessment of the comparative condition of insulation in service, with the object of developing techniques for ultimately anticipating equipment failures, but also to discover what approaches may be used to best advantage to improve such insulation systems in order to avoid breakdown.

One of the difficulties of the newer techniques is that in some cases insufficient information is available concerning the severity of some of the parameter levels obtained in these measurements, and this provides a parallel objective for the CSIR work.

For the present, this work has been confined to assessments of the condition of the insulation of high voltage motors in service. (22) In an effort to obviate the difficulties mentioned above,

the CSIR procedure consists of the application of a group of about six different tests to the stator insulation of a motor. Each test result is then assigned a merit mark lying between 1 and 10, dependent on the magnitude of the test results in relation to a scale such as is shown in Table 3. The merit marks for each test are then combined into a mean merit percentage for a particular machine, and this provides comparative assessments for a group of machines. At present this procedure is repeated at approximately annual intervals on a group of 19 high voltage motors, and Figure 20 shows the changes that have occurred in this group over a period of two years.

It is found (22) that the insulation of a motor shows an improvement in condition during approximately the first 3 years of service, and thereafter deterioration is evident. This initial improvement is probably related to the long term curing processes taking place in the insulation system which is usually some form of mica, bonded with shellac or epoxy resins. (23) Prediction of imminent failure is not yet possible, due to the short duration of this work to date, but already it is possible to observe increased rates of deterioration in certain machines which must then be considered as suspect.

As this work progresses it is expected that certain of these test procedures will be applied to assessments of the insulation condition of other items of electrical equipment during service, and it is hoped that gradually some of these tests will be incorporated into routine equipment preventative maintainance tests by equipment users.

5. Conclusion.

The field of electrical insulation has undergone much development during the past decade. Dominating this development has been the emergence of improved insulating materials — mostly synthetic — and many of which are being embodied into sophisticated insulation systems which are gradually replacing the older more traditional systems.

Indicative of these trends has been the success of cross-linked polyethylene as power cable insulation particularly at medium voltages, — previously the domain of oil-impregnated paper systems, and a review has been presented of developments in this field, as well as in the field of power capacitors, where great improvements have been achieved using other polymeric materials.

Consequential to the increasing sophistication of insulating materials and techniques, has been the evolution of refined and more sensitive measurement and assessment techniques, and a brief resumé has also been given of some of the developments in this field.

These assessment techniques are finding application also to the assessment of insulation quality in service — a field of increasing importance, now that the newer materials are being used under conditions of increased electrical, mechanical, and thermal stressing, and mention has been made of some of the CSIR work in this field — a field which is gradually expected to develop in South Africa as the newer materials are brought more into service.

Acknowledgments.

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22. ERIKSSON, A. Assessment of the condition of high voltage motor stator insulation. CSIR Contract Report C/ELEK/6. December 1971.

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Table 3. MARKING SCHEME FOR ASSESSMENT OF INSULATION CONDITION.

RANGE OF MERIT MARKS.

Merit Mark	Discharge Magnitude at Vph. C/F	Discharge Energy at Vph. Joules/cycle x10—3	Tan δ at Vph.	Tan δ "Tip-up" x10—3	Dispersion factor	One Minute Disorption Current mA/VF
1	> 5.00	> 50.0	> 0.08	> 15.0	> 0.23	> 4.0
2	3.3 — 4.99	25 — 49.99	0.06 — 0.079	10 — 14.9	0.175 — 0.229	3:5 — 4.0
3	2.5 — 3.29	15 — 24.99	0.04 — 0.059	7 — 9.9	0.148 — 0.1749	3.0 — 3.49
4	1.9 — 2.49	10 — 14.99	0.03 — 0.039	5 — 6.9	0.124 — 0.1479	2.5 — 2.99
5	1.4 — 1.89	7 — 9.99	0.025 — 0.029	4 — 4.9	0.11 — 0.1239	2.0 — 2.49
6	1.0 — 1.39	5 — 6.99	0.0225 — 0.0249	3 — 3.9	0.09 — 0.0109	1.5 — 1.99
7	0.6 — 0.99	3.5 — 4.99	0.02 — 0.02249	2 — 2.9	0.078 — 0.089	1.0 — 1.49
8	0.3 — 0.59	1.75 — 3.499	0.015 — 0.019	1.5 — 1.9	0.068 — 0.0779	0.5 — 0.99
9	0.15 — 0.29	1.0 — 1.749	0.010 — 0.0149	1.0 — 1.49	0.059 — 0.0679	0.25 — 0.49
10	0 — 0.149	0 — 00.99	0 — 0.009	0 — 0.99	0 — 0.0589	0 — 0.249

Table 1. FUNCTIONS AND APPLICATIONS OF INSULATING MATERIALS.

The relative importance of the various properties for the different applications is indicated by (1) primary, (2) secondary, (3) tertiary.

Equipment Property	High Voltage	Medium Voltage	Low Voltage	High Temperature	High Frequency
Low tan δ	1	2	3	1	1
High electric strength	1	2	3	2	2
Track resistance	1	1	1	1	1
High mechanical strength	1	1	2	1	2
Good thermal transfer characteristic	1	1	2	1	1
Resistance to thermal degradation	1	1	2	1	1
Moisture resistance	Usually sealed	1	2		1
Cost of material processing	3		1	3	3
Type of Equipment	Bushings, cables, capacitors, transformers, switchgear for supertension systems	Generators, Machines, control gear, Distribution equipment and cables.	FHP motors, Domestic equipment and wiring, capacitors	Aircraft, Aerospace Nuclear, Furnace controls	Radio, Radar, and Telecommunication equipment, R.F. heaters.
Insulation systems used	Self-healing systems, i.e. oil/paper, gases with High pressure spacers or polymer film, Vacuum	Viscous oilpaper, Polymeris and elastomeris, Micaceous resin/glass laminates and mouldings	Polymers, elastomers, varnishes, moulding and casting resins, laminates.	Silicones, PTFE, PTFE/glass Polyimide, ceramics, mica.	Low loss polymers, resins, ceramics, glasses, vacuum.

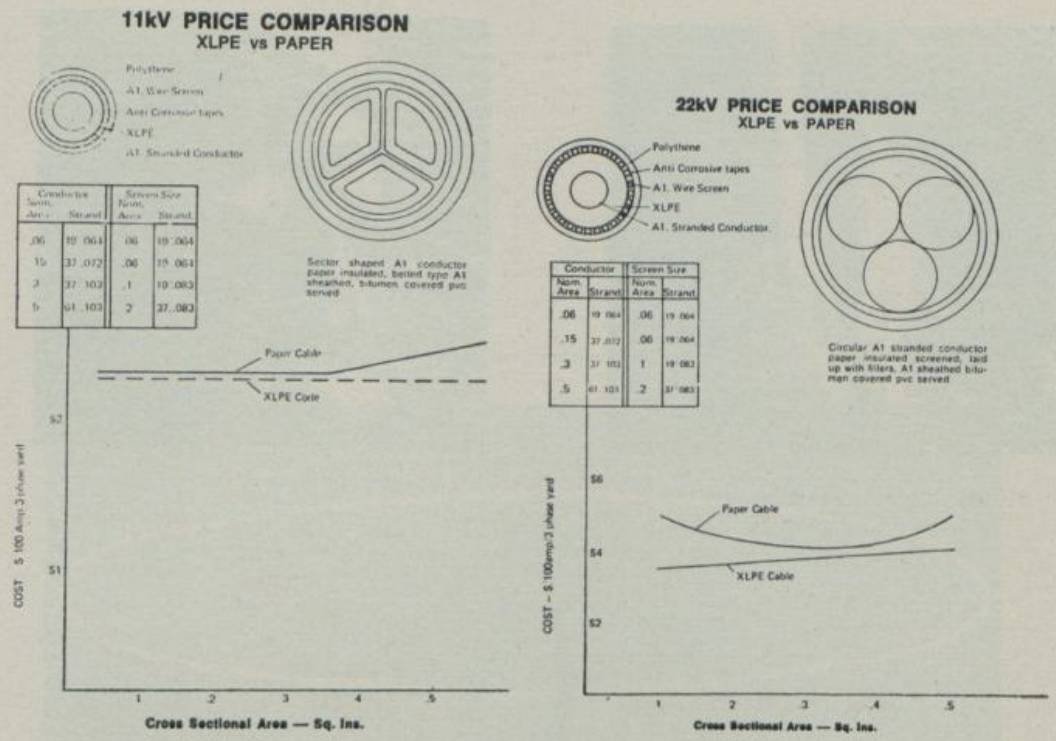

FIGURE 1: Cost comparisons between cross-linked polyethylene and paper insulated power cables

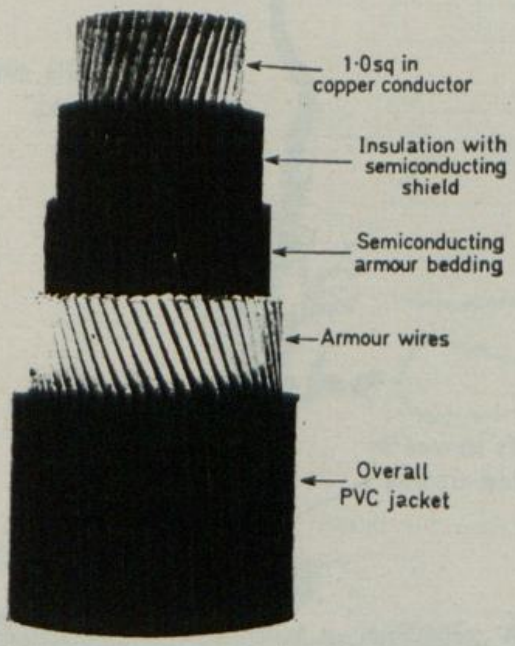

FIGURE 2: 11 kV single core polyethylene cable

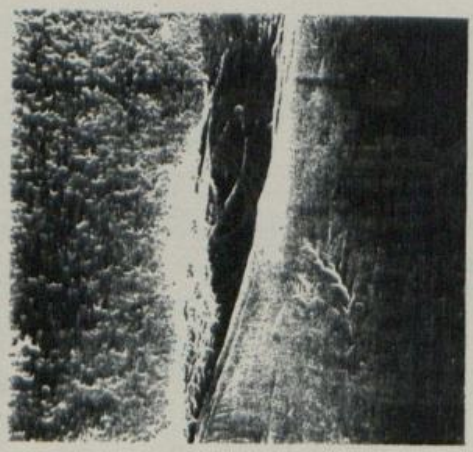

FIGURE 3: Void between screen and insulation in polyethylene cable

FIGURE 4: Particle inclusion between screen and insulation in polyethylene cable

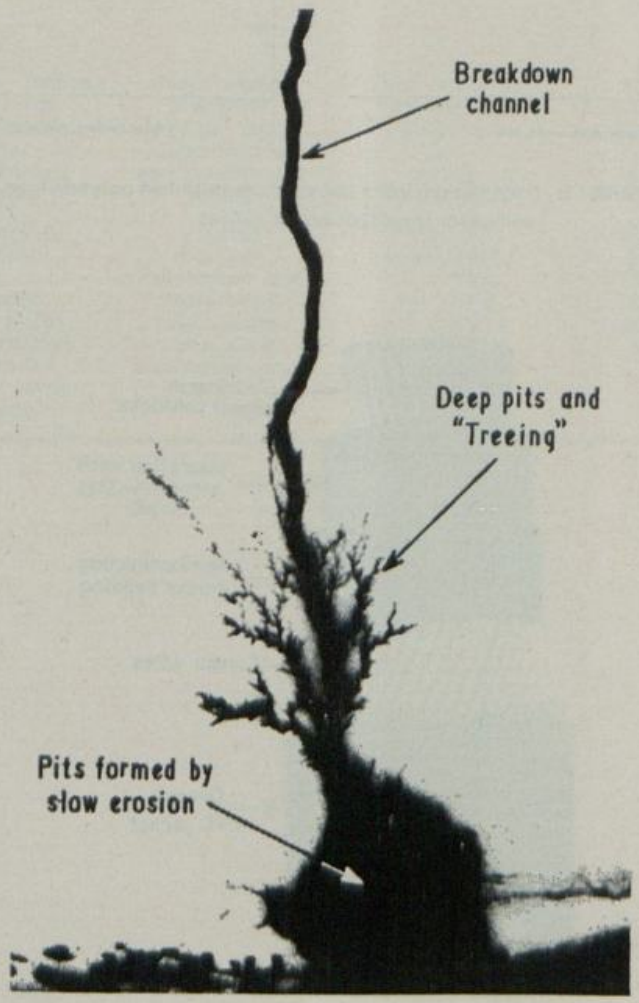

FIGURE 5: Breakdown in polyethylene due to discharge erosion

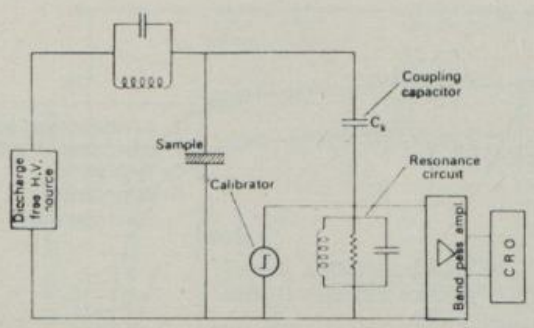

FIGURE 6: Basic partial discharge measurement circuit

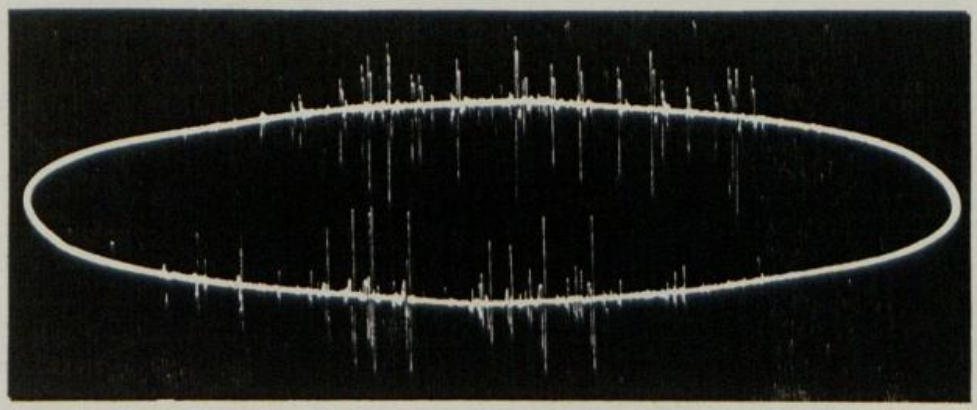

FIGURE 7: Typical discharge detector display

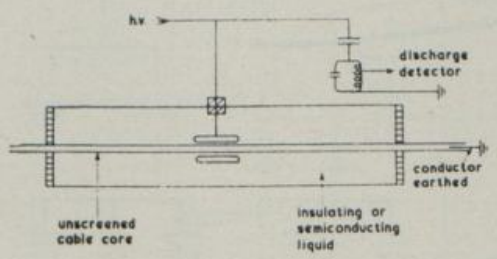

FIGURE 8: Discharge scanning method for unscreened cable

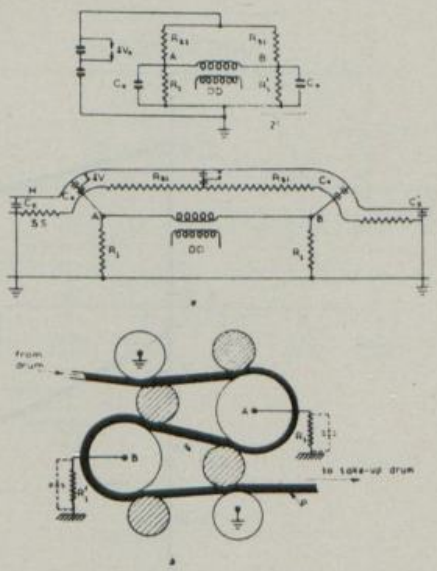

FIGURE 9: Kreuger bridge scanning system

a Equivalent circuits

$$Z' = \frac{R_1'}{1 + j\omega C_x R_1'}$$

$$R_1 = R_{s1} + R_{s1}'$$

$C_x C_x'$ = capacitance of cable core on either side of test circuit

H H.V. conductor

SS Semiconducting screen

DD Discharge detector

b Arrangement of test wheels

Conductor is at h.v.

P Plastic core with semiconducting screen

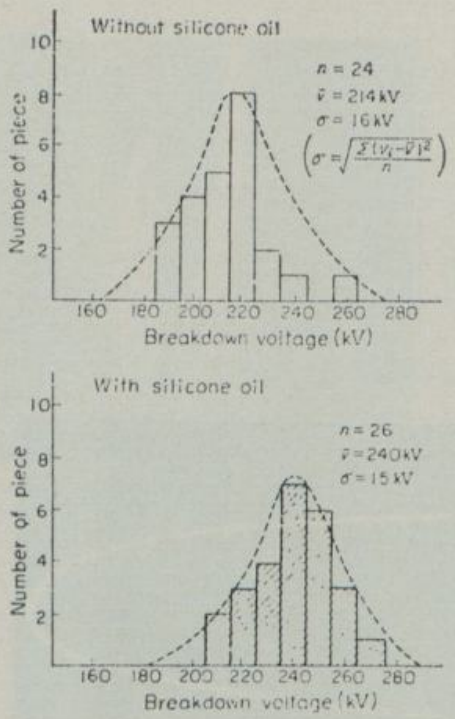

FIGURE 10: Histograms of breakdown voltages in sample polyethylene cables showing the effect of silicone oil filling

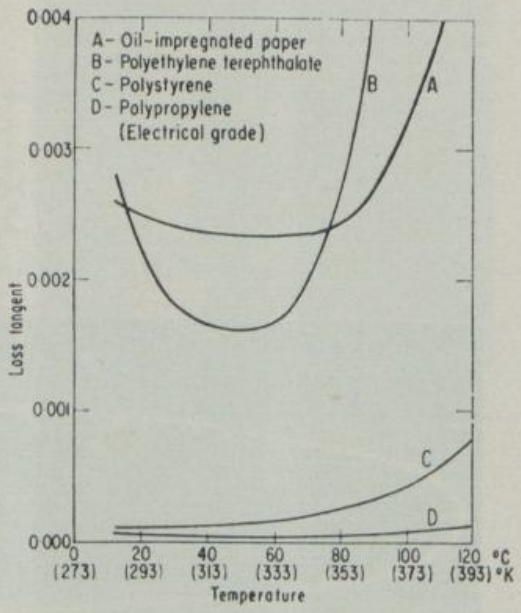

FIGURE 11: Loss characteristics of various polymer film materials at 50 Hz

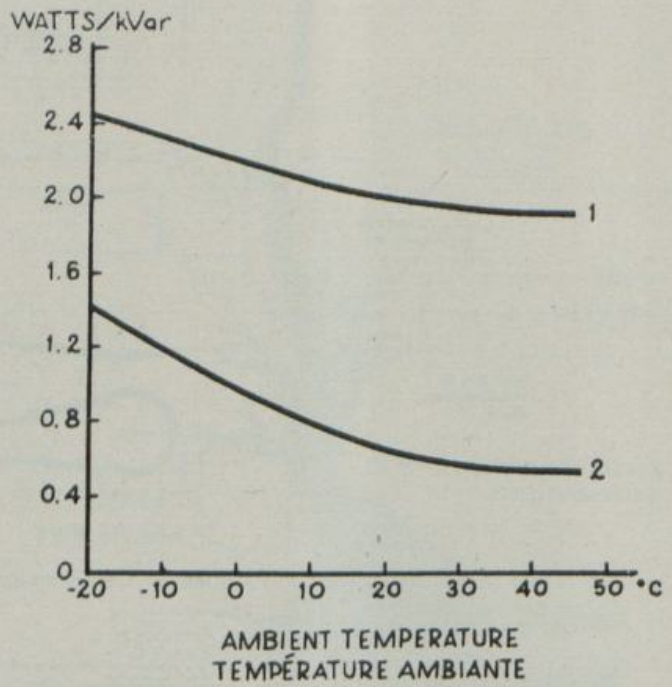

FIGURE 12: Variation of total energy losses in 100 kVar capacitors with ambient temperature.
1. Low density paper askarel
2. Composite polypropylene-paper, askarel

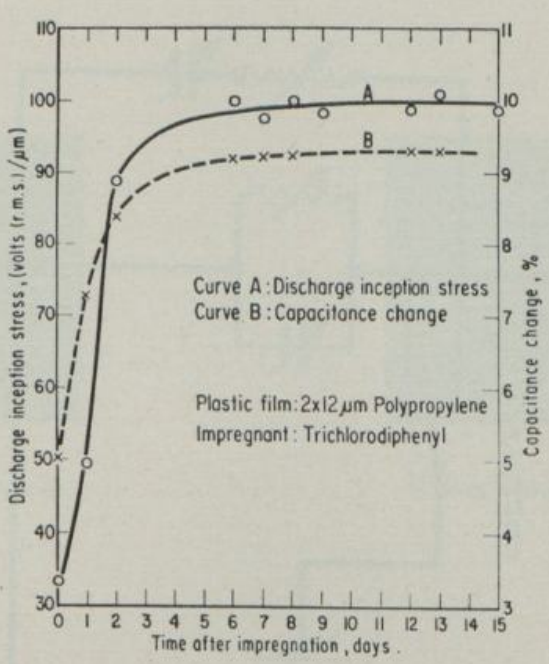

FIGURE 13: Changes in discharge inception stress and capacitance with time after impregnation of plastic film

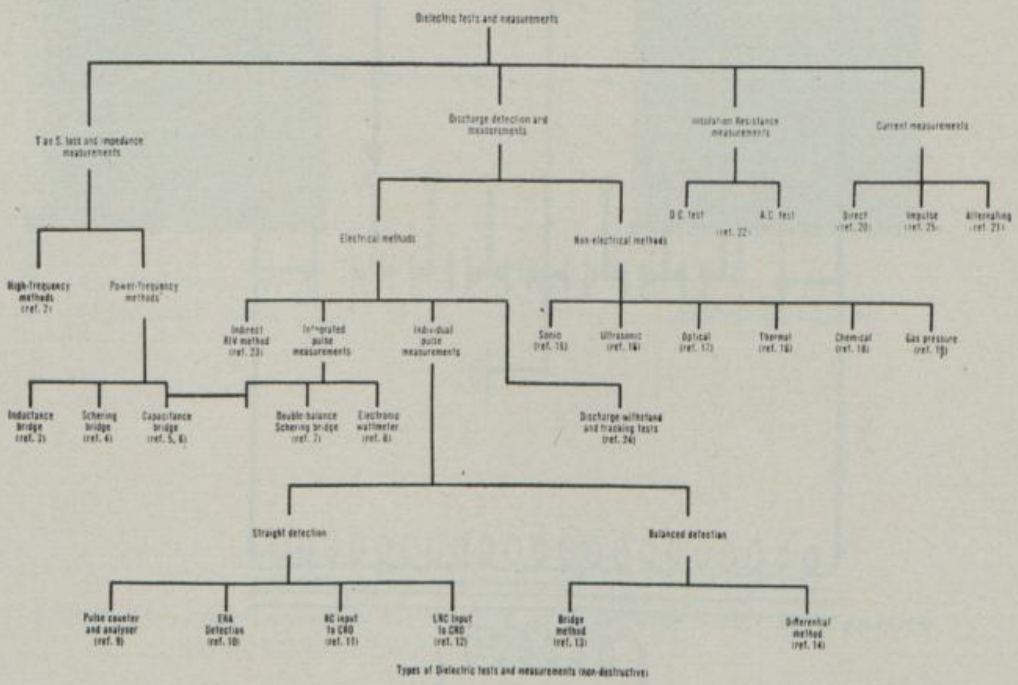

FIGURE 14: Types of non-destructive dielectric tests and measurement procedures

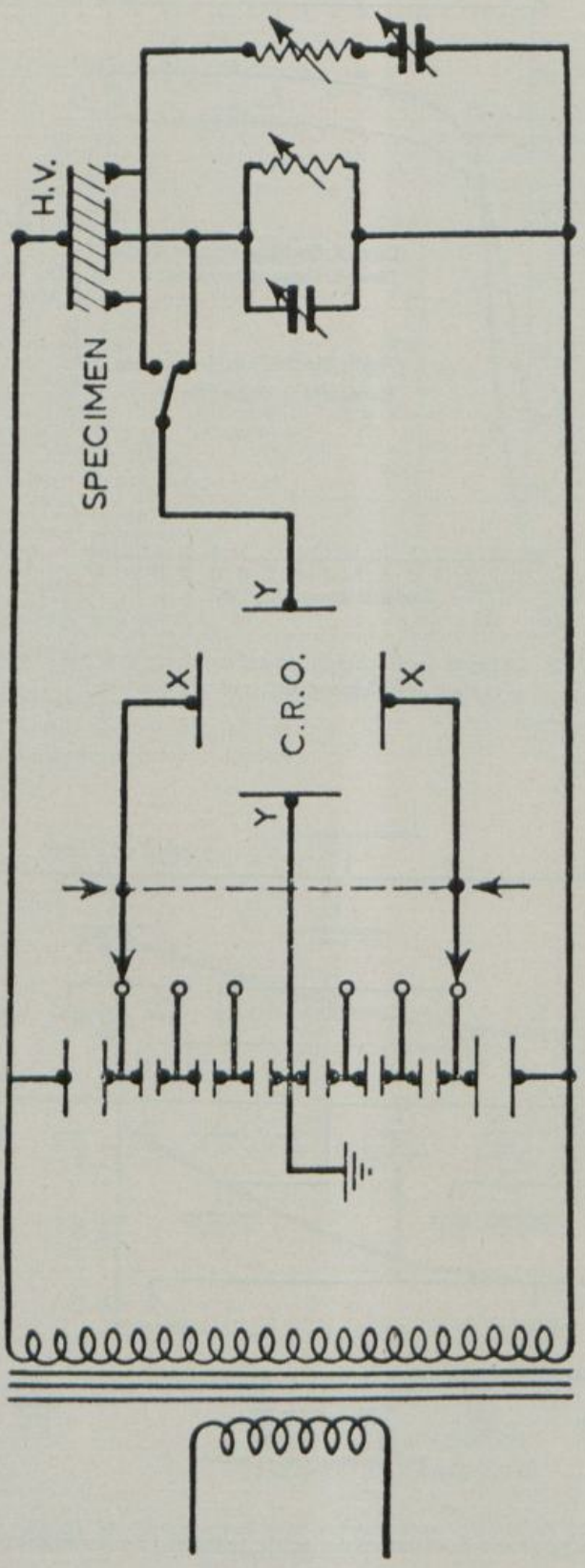

FIGURE 15: Dielectric loss analyser basic circuit

Negible discharging

Moderate discharging

General porosity
Many small voids

One large cavity

FIGURE 16: Loop displays of different 16 KV micaceous stator bar insulation tested unrestrained at working stress

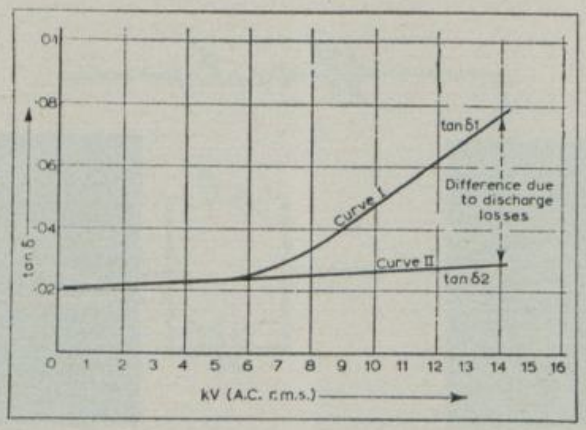

FIGURE 17: Schering bridge triple balance
Curve I : Schering bridge balanced with tuned detector
Curve II: Schering bridge balanced with c.r.o.

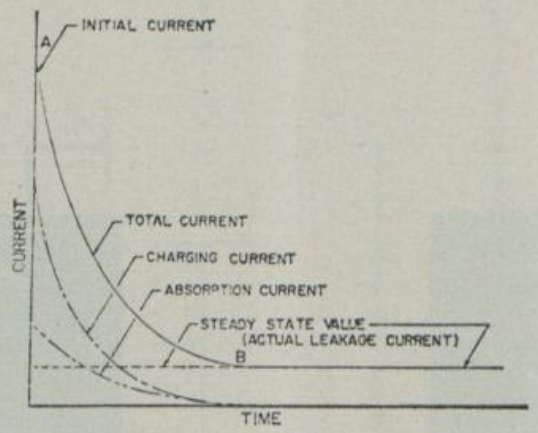

FIGURE 18: Current versus time in a dc high-potential test

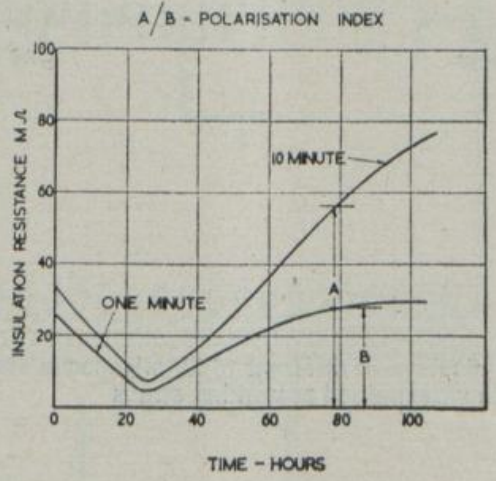

FIGURE 19: Typical polarization index curves

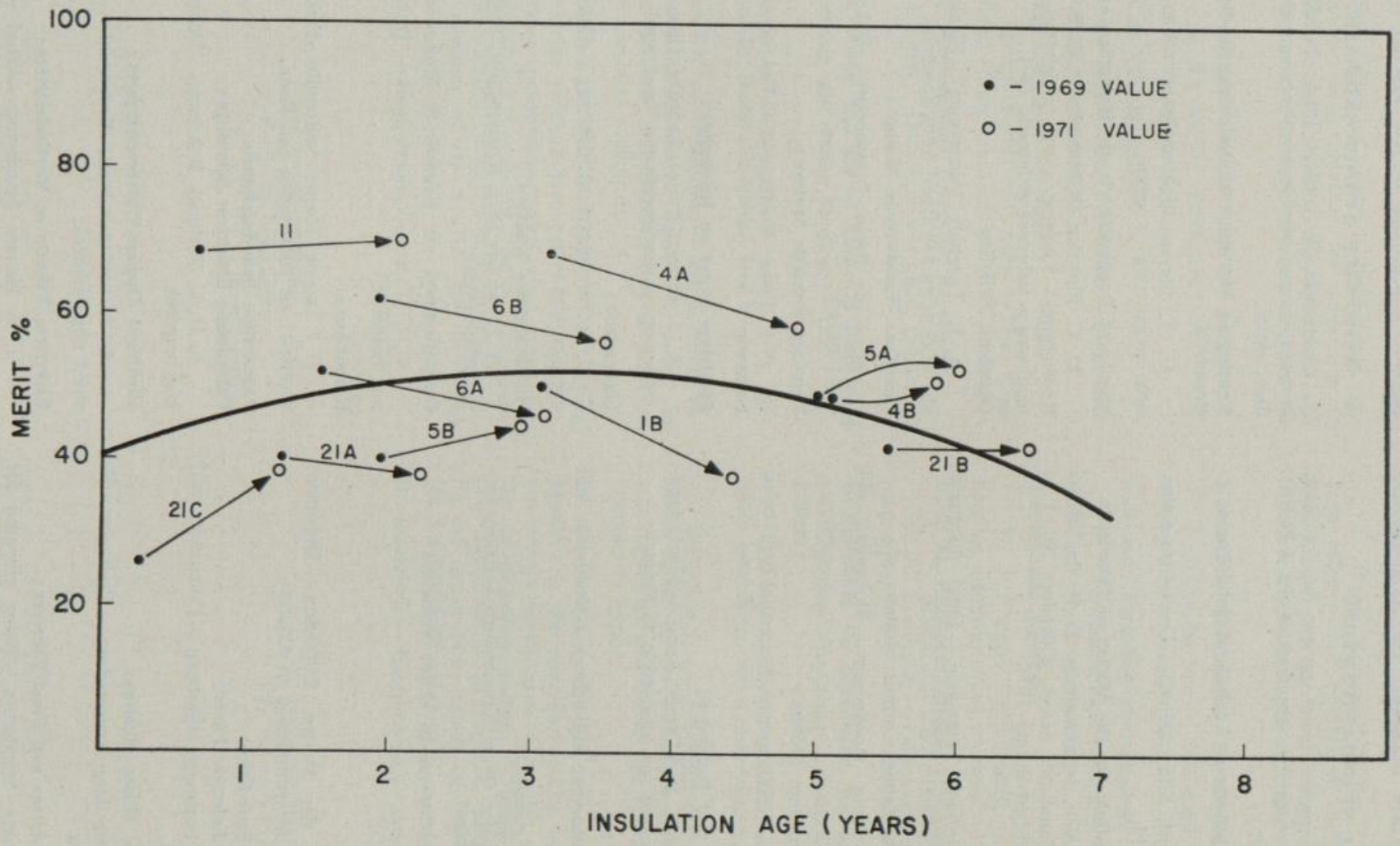

FIGURE 20: Merit mark change from 1969 – 1971 for rewound machines

SOUTH AFRICAN BUREAU OF STANDARDS

A. NATIONAL STANDARDISATION

During the period under review the following committees, on which representatives of the A.M.E.U. serve, were active :

Sampling and Methods of Analysis of Solid Fuels :

G. T. Stevens, Johannesburg — Committee active, two meetings held.

Standard Regulations for the Wiring of Premises :

D. C. Plowden, Johannesburg; E. E. de Villiers Rustenburg — Committee active, addendum No. 1 to regulations published during 1971.

Public Lighting :

A. F. Turnbull, Vereniging — Final document being prepared for submission to Council.

Single-phase Alternating Current Motors :

H. J. de Bruin, Roodepoort — Document still being discussed.

Three-phase Induction Motors :

P. J. Botes, Roodepoort — Document still being discussed.

Electric Stoves and Hotplates :

W. J. Cronje, Peri-Urban Areas — Final document being prepared for submission to Council.

Light Dimmers :

J. E. Heydenrych, Middleburg — Document still under discussion.

Heat Resisting Cables :

A. J. van der Berg, Krugersdorp — Being prepared for comment.

Storage Batteries for use in Motor Vehicles :

G. C. Theron, Vanderbijlpark — Document still being discussed.

Contactors :

F. J. van der Merwe, Stilfontein — Document being prepared for submission to Council.

Cartridge type Fuse-links
Cartridge type Eelectric Fuses :

A. H. L. Fortman, Boksburg — Documents still being discussed.

Electric Storage Water Heaters :

A. J. van der Berg, Krugersdorp — Document still under discussion.

Electric Refrigerators and Food Freezers :

G. B. Heunis, Standerton — Being prepared for comment.

SUID-AFRIKAANSE BURO VIR STANDAARDE

A. NASIONALE STANDAARDISASIE

Gedurende die verslagtydperk was die volgende komitees waarop verteenwoordigers van die V.M.E.O. dien, aktief :

Keuring en Metodes van Ontleiding van Soliede Brandstof :

G. T. Stevens, Johannesburg — Komitee aktief, twee vergaderings is gehou.

Standaard Regulasies vir die Bedrading van Persele :

D. C. Plowden, Johannesburg; E. E. de Villiers Rustenburg — Komitee aktief, addendum No. 1. tot regulasies gepubliseer gedurende 1971.

Openbare Beligting :

A. F. Turnbull, Vereeniging — Finale dokument vir voorlegging aan Raad word voorberei.

Enkelfase Wisselstroom Motore :

H. J. de Bruin, Roodepoort — Dokument word nog bespreek.

Drie-fase Induksie Motore :

P. J. Botes, Roodepoort — Dokument word nog bespreek.

Elektriese Stowe en Kookplate :

W. J. Cronje, Buite- Stedelike Gebiede — Finale dokument vir voorlegging aan Raad word voorberei.

Ligdempers :

J. E. Heydenrych, Middelburg — Dokument word nog bespreek.

Hittebestaande Kabels :

A. J. van der Berg, Krugersdorp—Word voorberei vir kommentaar.

Opgaarbatterye vir Gebruik in Motorvoertuie :

G. C. Theron, Vanderbijlpark — Dokument word nog bespreek.

Kontaktors :

F. J. van der Merwe, Stilfontein—Dokument word voorberei vir voorlegging aan Raad.

Patroontipe Sekeringskabels :
Patroontipe Elektriese Sekerings :

A. H. L. Fortman, Boksburg — Dokumente word nog bespreek.

Elektriese Opgaar-Waterverwarmers :

A. J. van der Berg, Krugersdorp — Dokument word nog bespreek.

Elektriese Yskaste en Voedselvriesers :

G. B. Heunis, Standerton — Word voorberei vir kommentaar.

Conductors for Overhead Electrical Transmission Lines :

D. Briers, Kroonstad — Part 1, dealing with copper conductors, being prepared for submission to Council. Parts 2 and 3, dealing with aluminium and steelcored aluminium conductors, being prepared for comment.

Core Balance Earth Leakage Protection Units :

F. J. van der Merwe Stilfontein — First committee document being prepared.

Moulded Case Circuitbreakers :

F. J. van der Merwe, Stilfontein — First committee document being prepared.

Co-ordinating Committee on Noise :

W. J. Cronje, Peri-Urban Areas — First Committee document being prepared.

Colour and Mono-chrome Television Receivers :

J. A. Loubser — Document still under discussion.

Installation, Wiring and use of Electrical Equipment in Anaesthetising and similar locations — COP :

L. Futcher, Kempton Park — Document still under dsicussion. Being sub-divided into four parts.

The S.A.B.S. was exceptionally active during the past year and the Association again had to call on the help of numerous engineer members in order to man all the technical committees.

The question of the establishment of working committees in the different branches of the A.M.E.U. to discuss those specifications under review which are of prime importance to municipal electrical engineers, are being investigated. I wish to thank Mr Middlecote and other members of the S.A.B.S. for their kind assistance.

P. J. BOTES,
Convener.

D. C. PLOWDEN,
E. E. de VILLIERS
Representatives.

Geleiers vir Bogrondse Elektriese Verspreidingslyne :

D. Briers, Kroonstad — Deel 1 wat handel oor koper geleiers word voorberei vir voorlegging aan Raad Dele 2 en 3 wat handel oor aluminium en staalkern aluminium geleiers word voorberei vir kommentaar

Kernbalans Aardlekkasie Beveiligingseenhede :

F. J. van der Merwe, Stilfontein — Eerste komitee dokument word voorberei.

Gevormde Omhulsel Stroombrekers :

F. J. van der Merwe, Stilfontein — Eerste komitee dokument word voorberei.

Ko-ordinasie Komitee :

W. J. Cronje, Buite-Stedelike Gebiede — Eerste komitee dokument word voorberei.

Kleur en Eenkleur Televisie Ontvangstoestelle :

J. A. Loubscher — Dokument nog steeds onder bespreking.

Gebruikskode vir Installering, Bedrading en Gebruik van Elektriese Toerusting in Narkose en Soortgelyke Lokale :

L. Futcher, Kempton Park — Dokument nog onder bespreking. Word onderverdeel in vier afdelings.

Die S.A.B.S. was gedurende die afgelope jaar besonder aktief en die Vereniging moes die hulp van talle ingenieurslede inroep ten einde al die tegniese komitees te beman.

Die kwessie van die daarstelling van werke**komitees in die onderskeie takke van die V.M.E.O.** om daardie spesifikasies wat onder hersiening is, en van buitengewone belang vir munisipale elektrotegniese ingenieurs is, te bespreek, word nog ondersoek. Ek wil graag Mnr. Middlecote en ander lede van die S.A.B.S. bedank vir hulle vriendelike bystand.

P. J. BOTES,
Sameroeper.

D. C. PLOWDEN,
E. E. de VILLIERS
Verteenwoordigers.

TRAINING OF TECHNICAL STAFF

A memorandum from the Sub-Committee appointed to investigate the training of technical staff for electricity supply authorities has been considered by the Executive Council, who adopted the following recommendations :

(a) That the U.M.E. be requested to approve of the appointment by the A.M.E.U. of a special committee, to investigate the feasibility, methods of financing and the introduction of suitable supplementary practical training facilities and the method of obtaining contributions from local authorities who cannot provide this facility individually; also to co-operate on these lines with private industrial concerns similarly placed.

(b) To investigate the introduction of adult training schemes on a national basis on the lines set out in Annexure B to this memorandum.

(c) That an approach be made to the various Provincial Education Departments, with the full backing of the U.M.E., with the view of obtaining their full support for publicising the value of the Engineering Technician Sandwich Course Training available at the Country's Colleges for Advanced Technical Education.

(d) That all supply Authorities agree to the designation of the semi-professional group of Engineers, i.e., those holding the qualifications of National Technical Diploma and National Diploma for Technicians being that of "Engineering Technician".

(e) That the Committee also investigate through the Professional Engineers Council the avenue by which certain categories can achieve professioinal status.

A copy of this memorandum together with the Executive Council's resolutions quoted above was referred to the United Municipal Executive of South Africa, who replied on the 1st September, 1971, as follows :

"The contents of the memorandum which was forwarded with your letter of the 15th April, 1971, were noted with interest at a meeting of the United Municipal Executive on the 19th-20th August, 1971.

The Executive approves in principle the appointment by your Association of an investigating commi'tee as outlined in the memorandum, and

OPLEIDING VAN TEGNIESE PERSONEEL

'n Memorandum van die Sub-Komitee wat aangestel is om die opleiding van tegniese personeel vir elektrisiteitsvoorsieningsowerhede te ondersoek, is deur die Uitvoerende Raad oorweeg, wat die volgende aanbevelings gedoen het :

(a) Dat die Verenigde Munisipale Bestuur van Suid-Afrika versoek word om goedkeuring te gee tot die aanstelling deur die V.M.E.O. van 'n spesiale Komitee om ondersoek in te stel aangaande die doenlikheid, metodes van finansering en die daarstelling van geskikte aanvullende praktiese opleidingsfasiliteite en die metode om bydraes van plaaslike owerhede wat nie individueel dié fasiliteite kan voorsien nie te bekom; ook om op dieselfde wyse met private industrieële instansies wat in soortgelyke omstandighede verkeer, saam te werk.

(b) Om ondersoek in te stel aangaande die invoering van volwasse opleidingskemas op 'n nasionale grondslag volgens die laidrade in Bylae B tot die Memorandum, uiteengesit.

(c) Dat die verskillende Provinsiale Onderwysdepartemente, met die volle steun van die Verenigde Munisipale Bestuur van Suid-Afrika, genade word met die doel om hulle volle steun te verkry vir reklame oor die waarde van die stapelkursusse vir ingenieurstegniese, wat beskikbaar is by die land se Tegniese Kolleges vir Gevorderde Tegniese Onderwyse.

(d) Dat alle Voorsieningsowerhede instem oor die ampsbenaming van die half-professionele groep ingenieurs, naamlik diegene wat die kwalifikasie van Nasionale Tegniese Diploma en Nasionale Diploma vir Tegnici het, naamlik die ampsbenaming van „Ingenieurstegnikus".

(e) Dat die Komitee ook, deur die Raad van Professionele Ingenieurs, sal ondersoek instel aangaande die kanale waardeur sekere groepe professionéle status kan verkry.

'n Afskrif van die Memorandum, tesame met die Uitvoerende Raad se besluite, soos hierbo aangehaal, was verwys na die Verenigde Munisipale Bestuur van Suid-Afrika, wat as volg geantwoord het op 1 September 1971 :

"Die inhoud van die memorandum wat aangestuur is met u brief van 15 April 1971, is met belangstelling kennis van geneem op 'n vergadering van die Verenigde Munisipale Bestuur van Suid-Afrika gehou op 19-20 Augustus 1971.

Die Bestuur keur die aanstelling van 'n kommissie van ondersoek deur u vereniging soos aangedui in die memorandum in prinsiep goed, en

in doing so it suggests that you should seek the co-operation of the Department of National Education and invite the Department to be represented on the committee",

To enable further progress to be made, and before discussion with the Department of National Education, it was considered necessary to have some indication of the numbers of trainees likely to be involved in the various categories and also of the extent to which local authorities might be able to support provision of training facilities. To obtain this information a questionnaire has been sent to all Engineer Members and Associate Members with a return date fixed as the 29th February, 1972.

In the meanwhile the project has been discussed briefly with the Deputy Director (Technology) of the Witwatersrand College for Advanced Technical Education, who showed keen interest and willingness to assist where possible.

D. C. PLOWDEN
Convener.

sodoende stel dit voor dat u die samewerking van die Departement van Nasionale Onderwys sal soek en die Departement sal uitnooi om op die komitee verteenwoordig te wees".

Ten einde verdere vordering te kan maak, en voor bespreking met die Departement van Nasionale Onderwys, word die nodig geag om 'n idee te kry van die waarskynlike getal kwakelinge in die verskeie groepe asook van die mate waartoe plaaslike owerhede instaat mag wees om voorsiening van opleidingsfasiliteite te ondersteun. Ten einde hierdie inligting te verkry, is 'n vraelys gestuur aan al die Ingenieurslede en Assosiassielede, met die keerdatum vasgestel op 29 Februarie 1972.

Intussen is die skema kortliks bespreek met die Adjunk Direkteur (Tegnologie) van die Witwatersrand Kollege vir Gevorderde Tegniese Onderwys, wat 'n lewendige belangstelling en gewilligheid om te help waar moontlik, getoon het.

D. C. PLOWDEN,
Sameroeper,

CO-ORDINATING COMMITTEE FOR HIGH-VOLTAGE RESEARCH AND TESTING FACILITIES

The sixth meeting of the Committee was held at the C.S.I.R., Pretoria, on Friday, 8th October, 1971, and the following are the main points arising from the proceedings :

(1) Co-operative Research

The need for co-operative research was discussed particularly where the topics were beyond the field of specialised co-ordinators, Mr Anderson listed the co-operative research projects at present in operation, namely :

(a) Apollo 400 kV Recording Station;

(b) Olifantsfontein Surge Recording Station;

(c) RWB Project on Rotating Machine Insulation;

(d) Municipality of Durban 33 kV Transmission Line Project;

(e) S.A.R. Project on Traction Motor Insulation.

(2) Lightning Research in South Africa

Mr Anderson described the progress made during the past year at the three C.S.I.R. Institutes working in this field. He also mentioned that the C.I.G.R.E. Working Group during their recent meeting in Lugano had emphasised the importance of studying some of the more fundamental lightning parameters in various parts of the world.

Mr van Wyk reported on the recent C.S.I.R. internal discussions concerning lighting research in South Africa.

(3) Corona Research

Professor Heymann reported that at present the main emphasis of the work on corona was on the radio noise aspects and he described the progress made on the two projects in operation.

(4) Earthing

In the absence of Mr Middlecote, Professor Hellawell said that there was little to report at this stage. A circular to a number of interested persons and organisations indicated support for the study of earthing problems and recommendations had been made for the sub-division of the subject.

(5) Insulation and Internal Discharges

Professor Hellawell's report under this heading

KO-ORDINERINGSKOMITEE VIR HOOGSPANNINGSNAVORSING EN TOETSFASILITEITE

Die sesde vergadering van die Komitee is by die W.N.N.R., Pretoria gehou op Vrydag, 8 Oktober 1971 en die volgende is die belangrikste onderwerpe wat uit die verhandelinge voortgevloei het :

(1) Ko-operatiewe Navorsing :

Die behoefte vir ko-operatiewe navorsing is besprcek in besonder waar die onderwerpe buite die bestek van gespesialisseerde samewerkers geval het. Mnr Anderson het die huidige ko-operatiewe navorsingsprojekte opgenoem as volg :

(a) 400 kV Apolloregistreerstasie;

(b) Stuwingsregistreerstasie te Olifantsfontein;

(s) Randwaterraadprojek oor isolasie van roterende masjiene;

(d) 33 kV transmissielynprojek van die Durbanse Munisipaliteit;

(e) S.A.S. se projek oor traksiemotorisolasie.

(2) Weerlignavorsing in Suid-Afrika

Mnr. Anderson het die vordering wat gedurende die afgelope jaar gemaak is by die W.N.N.R. instituut, werksaam in die verband, beskryf. Hy het ook gemeld dat C.I.G.R.E. Werkgroep, gedurende hulle onlangse vergadering in Lugano, die belangrikheid van die studie van sommige van die meer fundamentele weerligparameters op verskillende plekke van die wereld, beklemtoon het.

Mnr. van Wyk het verslag gedoen omtrent die onlangse W.N.N.R. interne besprekings aangaande weerlignavorsing in Suid-Afrika.

(3) Koronanavorsing

Professor Heymann het verslag gedoen dat op die oomblik die klem van die werk oor korona veral val op die radiosteuringsaspekte en hy het die vordering aan die twee projekte waaraan gewerk word, beskryf.

(4) Aarding

By die afwesigheid van Mnr. Middlecote het Professor Hellawell gesê, dat daar weinig is om oor verslag te doen op hierdie tydstip. 'n Omsendbrief aan 'n aantal belangstellende persone en instansies het ondersteuning vir die studie van aardingsprobleme aangedui en aanbevelings is gedoen vir die onderverdeling van die onderwerp.

(5) Isolasiemateriaal en Interne Ontladings

Professor Hellawell se verslag onder hierdie hoof

was given in two sections. The first dealt with the formation and first meeting of a Working Group under his chairmanship. At this meeting it was found that for the time being the main concern of the Group would be with the problems of rotating machine insulation. In the second part of his report he described the progress under various insulation projects.

During the discussion that followed his report, several members of the Committee suggested that Professor Hellawell's Working Group should not restrict themselves to machine insulation alone but should also concern themselves with the problems of transformer and cable insulations.

(6) External Insulation and Pollution

Professor Hellawell reported on behalf of Mr van Alphen on the formation of a Working Group in this field under the auspices of the S.A.B.S. Progress is being made with the establishment of exposure stations at various locations in the country, and willingness to jointly co-operate in these projects was expressed by Escom, S.A.B.S. Col. Webster of Cape Town University and Mr Barnard on behalf of the A.M.E.U.

(7) Progress Reports on Research Projects

Reports were submitted on the following research projects :

(a) Apollo 400 kV Recording Station;

(b) Silverton 11 kV Surge Recording Station;

(c) The Olifantsfontein SAR Surge Recording Station;

(d) Fault Recording and Reporting;

(e) Escom National EHV Research Centre;

(f) High Voltage Research Facilities for the C.S.I.R.

(8) Proposals for New Research Projects.

Mr Anderson said at the previous meeting it had been suggested that there were a number of user organisations such as the A.M.E.U. who did not undertake research but were in a position to make recommendations on research requirements and it was proposed therefore, in future high voltage schedules, would make provision for suggested research projects.

Mr Barnard said that this question had been included in a circular to the A.M.E.U. members and it appeared that in general problems were experienced with insulation at 11 kV levels.

is in twee dele gegee. Die eerste het gehandel oor die instelling en eerste vergadering van 'n werksgroep onder sy voorsitterskap. Op die vergadering is dit bevind dat die groep tans hoofsaaklik met isolasie probleme in verband met roterende masjiene gemoeid sal wees. In die tweede deel van sy verslag het hy die vordering in verskillende isoleringsprojekte beskryf.

Gedurende die bespreking wat op sy verslag gevolg het, het verskeie lede van die Komitee voorgestel dat Professor Hellawell se Werksgroep hulleself nie sal beperk tot majienisolasie alleenlik nie, maar hulleself ook sal bemoei met transformator en kabelisoleering.

(6) Eksterne Isolasie en Besoedeling

Professor Hellawell het namens Mnr. van Alphen verslag gedoen oor die samestelling van'n werksgroep in dié gebied onder beskerming van die S.A.B.S. Vordering word gemaak met die oprigting van blootstellingsterreine op verskillende plekke in die land en gewilligheid om gesamentlik saam te werk aan die projekte is uitgespreek deur Evkom, S.A.B.S. Kol. Webster van die Kaapstadse Universiteit en Mnr. Barnard namens die V.M.E.O.

(7) Vorderingsverslae oor Navorsingsprojekte

Verslae is ingedien oor die volgende navorsingsprojekte :

(a) 400 kV Apolloregisteerstasie;

(b) Die Silver onse 11 kV stuwingsregistreerstasie;

(c) Die S.A.S. se stuwingsfegistreerstasie te Olifantsfontein;

(d) Foutregistrasie en foutmeedeling;

(e) Die Nasionale Evkom Ekstrahoëspannings navorsingsentrum;

(f) Hoogspanningsfasiliteite vir die W.N.N.R.

(8) Voorstelle vir Nuwe Navorsingsprojekte

Mnr. Anderson het gesê, dat daar op 'n vorige vergadering voorgestel is dat daar 'n aantal verbruiksorgnisasies is soos byvoorbeeld die V.M.E.O., wat nie self navorsingswerk onderneem nie maar wat instaat is om aanbevelings te maak aangaande navorsingsbenodighede en dit was gevolglik voorgestel dat in die toekoms voorsiening gemaak word in die skedules vir navorsingsprojekte wat aan die hand gedoen word.

Mnr. Barnard het gesê dat die vraag ingesluit was in 'n omsendbrief aan die V.M.E.O. lede en dit het geblyk dat, oor die algemeen, probleme ondervind word met isolasie op 11 kV gebiede.

(9) General

It was agreed that the Committee would continue to meet once per year formally in October when the Co-ordinators would present their report and once informally in approximately April each year. It was further agreed that these informal meetings should be held at various locations around South Africa. A full report could be given on one of the research projects presently in hand. The Chairman suggested that the next meeting be an informal one and it was agreed that it would be held in April-May 1972, probably at a venue in Cape Town.

(10) Summary of Schedules.

(a) Schedule 1

(i) Basic research in progress — 19 projects

(ii) Applied research and testing in progress — 21 projects.

(iii) Research and testing planned — 12 projects.

(iv) Proposed future research and testing — 25 projects.

(v) Research completed during 1970/71 — 17 projects.

(vi) Co-operative research projects — 6 projects.

(b) Schedule 2

High Voltage Facilities at the Universities of the Witwatersrand, Pretoria, Cape Town and Natal, C.S.I.R., S.A.B.S., ESCOM, S.A.R. and A.M. E.U. were updated.

(c) Schedule 3

Seventeen additional publications were added to the list of publications, theses and reports.

D. C. PLOWDEN,
Representative.

(9) Algemeen

Daar is saamgestem dat die Komitee sal voortgaan om een maal per jaar, in Oktober formeel saam te kom, wanneer die ko-ordineerders hulle verslag sal voorlê, en eenmaal informeel rondom April elke jaar. Daar is verder saamgestem dat hierdie informele vergaderings op verskillende plekke oor Suid-Afrika gehou behoort te word. 'n Volle verslag kan dan gedoen word oor een van die navorsingsprojekte op hande. Die Voorsitter het voorgestel dat die volgende vergadering 'n informele een sal wees en daar is saamgestem dat dit in April-Mei 1972 gehou sal word, waarskynlik in 'n bymekaarkomplek te Kaapstad.

(10) Opsomming von Bylaes

(a) Bylae 1

(i) Lopende basiese navorsing — 19 projekte.

(ii) Lopende toegepasde navorsing en toetse — 21 projekte.

(iii) Navorsing en toetse beplan — 12 projekte

(iv) Voorgestelde toekomstige navorsing en toetse — 25 projekte.

(v) Navorsing voltooi gedurende 1970/71 — 17 projekte.

(vi) Ko-operatiewe navorsingsprojekte — 6 projekte.

(b) Bylae 2

Hoogspanningsfasiliteite by die Universiteite van die Witwatersrand, Pretoria, Kaapstad en Natal, W.N.N.R., S.A.B.S., Evkom, S.A.S. en V.M.E.O. is op datum gebring.

(c) Bylae 3

Sewentien bykomstige publikasies is toegevoeg tot die lys van publikasies, tesisse en rapporte.

D. C. PLOWDEN
Verteenwoordiger.

REPORT OF THE RECOMMENDATIONS COMMITTEE FOR NEW ELECTRICAL COMMODITIES

It may be useful to members to describe briefly the composition and function of the Committee :

A.M.E.U. : R. W. Barton (Chairman) and E. de C. Pretorius.

Johannesburg Electricity Department : D. C. Plowden.

S.A.I.E.E. : J. T. Williams and R. A. Leigh.

Escom : J. W. Barnard and R. A. Forbes.

S.A. Association of Consulting Engineers : R. Everatt.

S.A.B.S.: J. V. Grant and B. C. Lawrence.

Electrical Engineering and Allied Industries Association : J. A. Morrison

Electrical Contractors Association : M. Jochelson and F. A. Michael.

Department of Posts and Telegraphs : A. F. W. Eggers.

Secretaries : Davidson and Ewing (Pty.) Ltd.

The function of the Committee is to consider new electrical commodities for which there is no S.A.B.S. specification and to advise A.M.E.U. members regarding their suitability for use.

Such consideration is based on a detailed description, inspection of samples, tests conducted by the S.A.B.S. or other responsible organisation, and practical experience of the commodity.

The responsibility of deciding whether the commodity may be used in an area rests on the individual City or Town Electrical Engineer, who is invited to make use of the Committee's findings as circularised to all members.

In the case of a commodity for which a S.A.B.S. specification exists, the onus lies with the individual Engineer to permit its use only if it complies with such specification.

It should be noted that portable appliances do not fall within the scope of the Committee.

During the year 1971 no less than five meetings were held, at which 31 commodities were considered, of which 24 were recommended for use, indicating that the Committee continues to serve a useful purpose.

A newcomer welcomed to its ranks was the Department of Posts and Telegraphs, represented by Mr A. F. W. Eggers, since an increasing number of items are being received which are of interest to the Department, such as power skirtings with provision for telephone cables.

Thanks are due to the members of the Committee for their valuable work on our behalf and also the S.A. Bureau of Standards for carrying out the necessary tests with a special word of appreciation for Miss Elaine Brewin representing the Secretaries.

R. W. BARTON,
Convener.

REPORT ON S.A.N.C.I. CONGRESS 1971

The Eighteenth Annual General Meeting and Congress of S.A.N.C.I. was held in the Library Hall, East London, from the 26th to the 28th April, 1971.

The theme of the Congress was "Lighting, today and tomorrow". It was opened by His Worship the Mayor of East London, Councillor David Lazarus, J.P., M.P.C., who, in a witty speech which, incidentally, he wrote himself, expressed the appreciation of all local authorities for the invaluable work being performed by S.A.N.C.I.

Presidential Report :

In his Presidential Report, Dr W. Rennhackkamp said that the lighting industry had now become well established in the Republic, being a nearly R50 000 000 industry. The intergration of air conditioning and artifical lighting and the intergration of daylighting with artificial lighting were aspects receiving a lot of attention.

Streetlighting developments were considerable and would undoubtedly result in a reduction of the road accident rate and a reduction in crime, particularly in the Bantu areas.

The advent of television would present a great challenge to our members since lighting both in studios and out-of-doors would have to be properly designed, for both intensity and colour.

Dealing with the work of the many active subcommittees the President said that copies of the guides for rugby and soccer field lighting are available to members on request. The final draft of the second part of the code for Street and Highway Lighting, covering such aspects as roundabouts, complex interchanges, on and off ramps, etc., had been accepted by the main committee and was being edited to be distributed for comments. The code committee had decided to proceed with the drafting of a clause on tunnel lighting.

Dealing with Code of Practice on Interior Lighting, the first of part one on recommended levels of illumination, glare prediction, etc., was nearing completion, after which work on the second part of the code, concerning daylight, would commence.

In the international field S.A.N.C.I. were active on numerous C.I.E. sub-committees and a substantial delegation would attend the C.I.E. session in Barcelona in September 1971.

Executive Committee :

Three engineer-members of the A.M.E.U. were

VERSLAG OOR S.A.N.K.V.—KONGRES 1971

Die agtiende Algemene Jaarvergadering en Kongres van die S.A.N.K.V. is in die Biblioteeksaal, Oos-Londen, gehou vanaf 26 tot 28 April 1971.

Die tema van die kongres was "Verligting, vandag en môre." Dit is geopen deur Sy Agbare die Burgemeester van Oos Londen, Raadslid David Lazarus V.R., L.P.R. In 'n luimige toespraak, wat hy terloops self geskryf het, het die waardevolle werk van alle plaaslike owerhede vir die waardevolle werk wat deur die S.A.N.K.V. gedoen word, uitgespreek.

Presidentsrede:

In sy Presidentsrede het Dr. W. Rennhackkamp gesê dat die verligtingsnywerheid nou goed gevestig geraak het en reeds byna 'n R50 000 000 nywerheid geword het. Die integrasie van lugversorging en kunsmatige verligting en die integrasie van daglig met kunsmatige verligting is aspekte wat 'n groot mate van aandag geniet.

Straatligontwikkelinge is van aansienlike omvang en sal ongetwyfeld veel bydra tot die vermindering van padongelukke sowel as 'n afname in misdaad, veral in die Bantoegebiede.

Die koms van beeldradio sal 'n groot uitdaging vir ons lede inhou, aangesien verligting, sowel in ateljees as buitemuurs, behoorlik ontwerp sal moet word vir sowel intensiteit as kleur.

Toe hy die werk van die talryke aktiewe subkomitees behandel het, het die President gesê dat afskrifte van die handleidings vir die verligting van rugby- en sokkervelde op versoek aan lede beskikbaar gestel kan word. Die finale konsep van die tweede gedeelte van die kode vir die verligting van strate en hoofpaaie, wat sulke aspekte soos verkeersirkels, ingewikkelde wisselaars, op- en afritte ens. dek, is deur die hoofkomitee aanvaar en word tans geredigeer met die oog op die verspreiding daarvan vir kommentaar. Die kodekomitee het besluit om voort te gaan met die opstelling van 'n kode vir die verligting van tonnels.

In verband met die gebruikskode vir binnenshuis verligting, sê hy dat die eerste gedeelte van Deel Een in verband met aanbevole verligtingspeile, die voorspelling van skittering ens. tans voltooiing nader, waarna die werk aan die tweede gedeelte van die kode, wat met daglig te doen het, sal begin.

Op internasionale gebied is die S.A.N.K.V. bedrywig in talryke C.I.E.-subkomitees en 'n sterk afvaardiging sal die C.I.E.-sitting in Barcelona in September 1971 bywoon.

Uitvoerende Komitee:

Drie ingenieurlede van die V.M.E.O. is tot Uit-

elected to the Executive Committee, in the persons of Mr J. von Ahlften and, as country members, Messrs K. Robson and R. W. Barton.

Papers :

The following papers, all of high quality, were presented :

1. The Lighting of Museums and Historical Buildings.

The paper by Mr J. B. Harris, one of the two guest speakers from overseas, traced the development of museum lighting, from the early gas burners to the present day flourescent tubes of various colours. This development accompanied the change in the conception of museums as mere repositories to cultural centres, where presentation could well involve intergration of light, sound and movement. A thorny problem arises from the fact that many exhibits, paintings, for instances, are damaged by light intensities exceeding 20 lux.

2...Stage Lighting in the New Nico Malan Theatre Complex.

In this paper Mr A. H. Haak described the stage lighting equipment in the new Nico Malan Theatre in Cape Town. It is the most modern and versatile equipment available and offers infinitely variable lighting. The lighting programme of a complete opera can be pre-set on punch cards, with over-riding manual control by the operator if necessary. Short-term storage systems which can register 40 settings simultaneously are used during rehearsals to permit quick changes. In the opera house there are 200 dimable circuits rated at 1100 kV, while the drama theatre has 160 circuits rated at 900 kV.

3. New Lamps for Old.

Mr D. W. Young surveyed the development of lamps during the past 100 years which led to the description of the modern lamps of today and how they operate, with an indication of how lamps can evolve into the light sauces of the next decade and later.

4. Lighting Design Development in Western Europe.

Mr F. Drijver, the other guest speaker from overseas direct in a philosophical style with the development of lighting design in Western Europe, especially in its relation to architecture and people. While showing that technology had outstripped management, he saw hope for the future in that the emphais was moving towards quality of lighting rather than quantity.

voerende Komitee verkies, te wete mnr. J. von Ahlften en mnre. K. Robson en R.W. Barton as plattelandse lede.

Referate :

Die volgende referate, wat almal van hoë gehalte was,, is gelewer:—

1. „Die Verligting van Museums en Historiese Geboue."

Die referaat deur mnr. J. B. Harris, een van die twee gassprekers van oorsee, het 'n oorsig gegee van die verligting van museumgeboue, vanaf die vroeë gasbranders tot by die hedendaagse fluoresserende buise van verskillende kleure. Hierdie ontwikkeling gaan gepaard met die verandering van die konsepsie van museums as blote bewaarplekke tot kultuursentrums, waar die voorstellings gebruik kan maak van die integrasie van lig, klank en beweging. 'n Moeilike probleem spruit voort uit die feit dat baie uitstallings, soos bv. skilderye, beskadig kan word deur lig-intensiteite van meer as 20 lux.

2. „Verhoogverligting in die nuwe Nico Malan-Teaterkompleks."

In hierdie referaat het mnr. A. H. Haak 'n beskrywing gegee van die verhoog-verligtingstoerusting in die nuwe Nico Malan-teater in Kaapstad. Dit is die mees moderne en veelsydige toerusting wat beskikbaar is en bied 'n oneindige variasie van verligting. Die verligtingsprogram van 'n hele opera kan vooraf op ponskaarte aangebring word, met handbeheer deur die operateur indien nodig. Korttermyn-bergingstelsels wat 40 toneelskikkings gelyktydig kan registreer. word gedurende repetisies gebruik om vinnige veranderinge moontlik te maak. In die operahuis is daar 200 verdofbare stroombane van 1100 K.W., terwyl die drama-teater 160 stroombane met 'n aanslag van 900 K.W. het.

3. „Nuwe Lampe vir Oues"

Mnr. D. W. Young het 'n oorsig gegee van die ontwikkeling van lampe gedurende die afgelope 100 jaar, wat gelei het tot 'n beskrywing van die moderne lampe van vandag, met 'n aanduiding van hoe lampe kan ontwikkel in die ligbronne van die volgende dekade en later.

4. „Die Ontwikkeling van Verligtingsontwerp in Wes-Europa"

Mnr F. Drijver, die ander gesspreker van oorsee, het op filosofiese wyse 'n oorsig gegee van die ontwikkeling van verligtingsontwerp in Wes-Europa, veral in sy verhouding tot argitektuur en mense. Terwyl hy bewys het dat die tegnologie die bestuurswese verbygestreef het, het hy nogtans hoop vir die toekoms gesien in die feit dat die klem besig was om te verskuif

5. Die Algemene Verligting van 'n Teater vir die Uitvoerende Kunste.

In this very practical paper, Mr H. B. Grobler surveyed the general lighting requirements of a theatre, that is lighting of the auditorium, foyers, dressing rooms, passages and other functional areas. Suggestions were made regarding lighting fittings and circuits and illumination levels were established.

6. Motorway Lighting in a Coastal City.

Mr K. G. Robson, City Electrical Engineer of East London, in a paper of great interest to municipal electrical engineers, reported on the lighting of motorways already completed and under construction in East London at an estimated cost of R20 million and reviewed problems encountered in a coastal city with severe climatic and corrosion conditions. The need of standard specifications for luminares was emphasised. Problems of non-standard light sources of the mercury halide and high pressure sodium types were examined. Statistical data and information on installation operating and maintenance costs of motorway lighting installations in East London were supplied.

7. The Optometrist and Lighting Today.

Mr D. K. Turnbull defined optometry as the profession which deals specifically with the correction of visual problems, particularly in the healthy person. The full scope of optometry was briefly explained. Illumination, as understood by the optometrist, was discussed. Finally, the topic "stereopsis and illumination" was used as an example of common ground between the illumination engineer and the optometrist.

8. Spatial and Directional Illumination in Theory Practice.

Mr J. C. Krause emphasised the importance of taking account of the spatial and directional properties of lighting design particularly as far as modelling is concerned.

The theory of spatial and directional lighting was briefly reviewed and a short description was given of instruments developed for measuring these quantities.

9. The International Spectroradiametric comparison of Flourescent Lamps.

By Mr C. J. Kok and Dr M. C. Boshoff.

The work discussed forms part of an international programme for the intercomparison of fluorescent and mercury arc lamps. A description was given of the vanaf die hoeveelheid van verligting na die gehalte daarvan.

5. „Die Algemene verligting van 'n Teater vir die Uitvoerende Kunste"

In hierdie baie praktiese referaat het mnr H. B. Grobler 'n oorsig gegee van die algemene verligtingsbehoeftes van 'n teater, d.w.s. die verligting van die ouditorium, die portale, kleedkamers, gange en ander funksionele gebiede. Wenke is aan die hand gedoen in verband met ligtoebehore en stroombane en verligtingspeile is daargestel.

6. „Snelwegverligting in 'n Kusstad."

Mnr K. G. Robson, Elektrotegniese Stadsingenieur van Oos-Londen, het in 'n referaat wat vir munisipale elektrotegniese ingenieurs van groot belang was, verslag gedoen oor die verligting van snelweë wat reeds in Oos-londen voltooi of in aanbou is teen 'n beraamde koste van R20 miljoen en het 'n oorsig gegee van die probleme wat in 'n kusstad met strawwe klimaats- en verweringstoestande ondervind word. Daar is nadruk gelê op die noodsaaklikheid van Standaardspesifikasies vir armature. Daar is ondersoek ingestel na die probleme van nie-standaard-ligbronne van die kwik-halide en hoëdruk natriumtipes. Statistiese gegewens is gegee en inligting verstrek in verband met die installasie-, werking- en instandhoudingskoste van snelweg-verligtingsinstallasies in Oos-Londen.

7. „Die Oogkundige en Verligting Vandag."

Dr. D. K. Turnbull het die oogkunde gedefinieer as die professie wat hom spesifiek besig hou met die regstelliing van gesigsprobleme, veral by gesonde persone. Die volle omvang van die optometrie is kortliks verduidelik. Verligting, soos dit deur die oogkundige verstaan word, is bespreek. In die laaste plek is die onderwerp „Stereoptiese gesigvermoë en verligting" gebruik as 'n voorbeeld van die gemeenskaplike terrein van die verligtingsingenieur en die oogkundige.

8. „Ruimtelike en Rigtingsverligting in Teorie en Praktyk."

Mnr J. C. Krause het nadruk gelê op die belangrikheid daarvan om die ruimtelike en rigtingseienskappe van verligtingsontwerp in aanmerking te neem, veral sover dit modellering betref.

Die teorie van ruimtelike en rigtingsverligting is kortliks in oënskou geneem en 'n kort beskrywing is gegee van die instrumente wat reeds ontwikkel is om hierdie hoeveelhede te meet.

9. „Die Internasionale Vergelyking van die Spektrale Straling van Fluoresserende Lampe."

Deur mnr. C. J. Kok en M. C. Boshoff.

Die werk wat bespreek is, vorm deel van 'n internasionale program vir die vergelyking van fluoresserende en kwikbooglampe. 'n Beskrywing is gegee

apparatus and method used to measure the spectral irradiance of three 4ft 40 watt. fluorescent lamps against three tungsten element quartz-iodine. Standard Measurements were made at 5 nm. intervals from 300 nm. to 800 nm. at a temperature of 25 + – 0.5°C. Chromaticities were calculated from the spectroradiometric data and the electrical characteristics of the lamps were also measured. The results were to be discussed at the 1971 C.I.E. meeting.

Discussion Groups :

An innovation at this Congress was the holding of two discussion groups in which all delegates were encouraged to participate. The first dealt with standards of quality in locally manufactured fittings, under the chairmanship of Mr R. Yates, and resulted in an approach to the A.M.E.U. regarding the need for a S.A. Standard Specification for street lighting fittings. The second, under the chairmanship of M. L. Vorster, had as its topic "Quality rather than quantity control in lighting."

Once again the usual high standards of authors and proceedings were in evidence at this very successful congress.

R. W. BARTON,
Representive.

van die apparaat en die metode wat gebruik is om die spektrale straling van drie 4 vt.-fluoresserende lampa van 40 watt te meet teen drie kwartsjoduimlampe met tungsten-elemente. Standaardmetings is geneem met 5 nm.-tussenposes van 300nm. tot 800 nm. teen 'n temperatuur van 25 + –0,5°C. Kleurgehaltes is vanaf die spektrale stralingsgegewens bereken en die elektriese eienskappe van die lampe is ook gemeet. Die resultate sou by die C.I.E.-vergadering van 1971 bespreek word.

Besprekingsgroepe :

'n Nuwigheid by hierdie kongres was die hou van twee besprekingsgroepe waaraan al die afgevaardigdes aangemoedig is om deel te neem. Die eerste een het gehandel oor gehaltestandaarde in plaaslik vervaardigde toebehoere onder die voorsitterskap van mnr R. Yates en het tot gevolg gehad dat die V.M.E.O. genader is met betrekking tot die noodsaaklikheid vir 'n Suid-Afrikaanse standaardspesifikasie vir straatlig-armature. Die tweede, onder voorsitterskap van mnr L. Vorster, het gehandel oor die onderwerp "Gehalte- liewer as hoeveelheidsbeheer in verligting."

Die gewone hoë standaard van referente en verrigtinge is weer eens by hierdie baie suksesvolle kongres gehandhaaf.

R. W. BARTON,
Verteenwoordiger.

REPORT ON THE WORLD ENERGY CONFERENCE

Paraphrasing the words of its Secretary-General, "the World Energy Conference is the sole non-governmental organisation concerned with all energy disciplines and with the means of production, transportation, transformation and utilization of energy in all its aspects, representing National Committees from 67 countries and enjoying consultative status with the Economic and Social Council of the United Nations."

The following bodies are represented on the South African National Committee:—

Electricity Supply Commission
The Association of Municipal Electricity Undertakings.
Atomic Energy Board
Chamber of Mines
Department of Mines
Fuel Research Institute
Council for Scientific and Industrial Research
South African Institute of Electrical Engineers
South African Institute of Mechanical Engineers
South African Railways
Department of Labour
South African Coal, Oil and Gas Corporation Limited
Department of Planning

The South African Committee on Large Dams has observer status.

The Annual Meeting of the South African National Committee was held at Escom Centre, Johannesburg, on the 18th February, 1972, under the Chairmanship of Dr. R. L. Straszacker. The following were amongst the numerous matters discussed:—

Eighth Plenary Meeting: This was held in Bucharest during June, 1972. As visas were not forthcoming for South African citizens, we were not represented. However, it is understood that the three technical papers sponsored by members of the South African National Committee will appear in the proceedings.

The theme of this meeting was "Improving the Utilization of Energy, with Special Reference to Complex Uses." Two-hundred and thirty-four papers were presented. A copy of the "Summary of the Proceedings" is available for perusal. An interesting

VERSLAG OOR DIE WERELDKONGRES INSAKE ENERGIE.

In die woorde van sy Sekretaris-General is „die Wêreldkongres insake Energie die enigste nie-regeringsorganisasie belas met die onderwerping van energie en met die wyse waarop energie in al sy aspekte geproduseer, vervoer, getransformeer en gebruik word, met verteenwoordiging van Nasionale Komitees uit 67 lande en wat oorlegplegende status by die Ekonomiese en Sosiale Raad van die Verenigde Volke geniet."

Die volgende liggame is in die Suid-Afrikaanse Nasionale Komitee verteenwoordig:—

Elektrisiteitsvoorsieningskommissie
Die Vereniging van Munisipale Elektrisiteitsondernemings.
Die Atoomkragraad
Die Kamer van Mynwese
Die Departement van Mynwese
Die Brandstofnavorsingsinstituut
Die Wetenskaplike en Nywerheidsnavorsingsraad
Die S.A. Instituut van Elektrotegniese Ingenieurs.
Die S.A. Instituut van Meganiese Ingenieurs
Die S.A. Spoorweë
Die Departement van Arbeid.
Die S.A. Steenkool-, Olie- en Gaskorporasie Beperk.
Die Departement van Beplanning

Die S.A. Komitee insake Groot Damme geniet die status van waarnemer.

Die Jaarvergadering van die S.A. Nasionale Komitee is in die Evkomsentrum, Johannesburg, op 18 Februarie 1972 onder voorsitterskap van Dr. R. L. Straszacker gehou. Die talryke sake wat bespreek is, het die volgende ingesluit:—

Agtste Raadplegende Vergadering: Hierdie vergadering is gedurende Junie 1971 in Boekarest gehou. Aangesien visums nie vir Suir-Afrikeense burgers beskikbaar was nie, was ons nie verteenwoordig nie. Daar is egter rede om te glo dat die drie tegniese referate wat deur lede van die S.A. Nasionale Komitee geborg is, in die notule van die verrigtinge sal verskyn.

Die tema van hierdie vergadering was „Die Verbetering van die gebruik van Energie, met spesiale verwysing na komplekse gebruike." Tweehonderd vier-en-dertig referate is voorgedra. 'n Afskrif van die „Opsomming van die Verrigtinge" is beskikbaar

item which emerged was the estimate that in the year 2000 energy consumption will exceed 20,000 million tons coal equivalent, which is three times the 1970 figure, while electric energy consumption will increase to more than six times the 1970 figure and will exceed 30,000 TWh. The question of pollution was always prominent and it seems likely that this factor will ultimately limit development.

Future Meetings: The next meeting of the International Executive Council will be held in Wairakei, New Zealand from the 19th to 21st September, 1972 Dr. Straszacker and Mr. Jan H. Smith of Escom will represent the South African National Committee.

The Ninth World Energy Conference will take place in Detroit, U.S.A. from the 22nd to the 27th September, 1974.

Survey of Energy Resources: The Department of Planning, as from this meeting, represented on the South African National Committee will undertake a study of the consumption of and the future demand for energy in its various forms, and will institute a survey of all our energy resources.

The results will be used in the formation of an energy policy for the Republic.

Conservation of the Environment: The World Energy Conference is giving considerable attention to the pollution of land, air and water arising from energy production plants. It is expected that a comprehensive report will be submitted to the United Nations as a contribution to the 1972 Conference on Human Environment.

It is already noted that the energy industries are taking a responsible attitude towards the effects of their operations on the environment and are doing a great deal to minimise any adverse effects. A sense of proportion is necessary in assessing the value of marginal improvements in relation to the cost of achieving them.

Increase in Subscriptions: As the result of rising costs, including an increase in the annual fee payable to the Central Office of the World Energy Conference by the South African National Committee, from 133 to 400 pounds sterling, it has been found necessary to raise the subscriptions payable by the constituent bodies. The annual contribution due from the Association of Municipal Electricity Undertakings has been fixed at R50, being an increase of R10.

R. W. BARTON,
Representative.

ter insae. 'n Interessante saak wat na vore gekom het, was die beraming dat kragverbruik in die jaar 2 000 die ekwiwalent van 20 000 miljoen ton steenkool te bowe sal gaan, wat drie keer die syfer vir 1970 is, terwyl die gebruik van elektriese energie sal toeneem tot meer as ses keer die syfer vir 1970 en 30 000 TWh te bowe sal gaan. Die kwessie van besoedeling het steeds na vore getree en dit wou voorkom asof hierdie faktor uiteindelik ontwikkeling aan bande sal lê.

Toekomstige Vergaderings: Die volgende vergadering van die Internasionale Uitvoerende Raad sal vanaf 19 tot 21 September 1972 in Wairakei, Nieu-Seeland gehou word. Dr. Straszacker en mnr. Jan H. Smith van Evkom sal die Suid-Afrikaanse Nasionale Komitee verteenwoordig.

Die negende Wêreldkongres insake Energie sal vanaf 22 tot 27 September 1974 in Detroit, V.S.A. gehou word.

Opname van Energie-Hulpbronne: Die Departement Beplanning, wat vanaf hierdie vergadering in die Suid-Afrikaanse Nasionale Komitee verteenwoordig is, sal 'n studie-projek onderneem van die verbruik van en die toekomstige aanvraag vir energie in sy verskillende vorme, en sal ondersoek instel na al ons energie-hulpbronne.

Die resultate sal gebruik word vir die formulering van 'n energie-beleid vir die Republiek.

Bewaring van die Omgewig: Die Wêreldkongres insake Energie gee 'n aansienlike mate van aandag aan die besoedeling van grond, lug en water wat uit die gebruik van energie-produserende installasies voortspruit. Daar word verwag dat 'n omvattende verslag aan die Verenigde Volke voorgelê sal word as 'n bydrae tot die 1972-Konvensie insake die Menslike Omgewing.

Dit is reeds opmerklik dat die energie-nywerhede 'n verantwoordelike houding ten opsigte van die uitwerking van hulle bedrywighede op die omgewing inslaan en dat hulle baie doen om enige naderlige bygevolge sover moontlik te verminder. 'n Sin vir verhoudinge is nodig om die waarde van marginale verbeteringe aan te slaan in verhouding tot die koste daarvan om dit te bereik.

Verhoging van Ledegelde: As gevolg van stygende kostes, insluitende 'n verhoging van die jaarlikse gelde wat deur die Suid-Afrikaanse Nasionale Komitee aan die Sentrale Kantoor van die Wêreldkongres insake Energie betaalbaar is vanaf 133 tot 400 pond sterling, is dit nodig gevind om ook die ledegelde van die samestellende liggame te verhoog.

Die jaarlikse bydrae wat deur die Vereniging van Munisipale Elektrisiteitsondernemings betaalbaar is, is op R50 vasgestel, wat 'n verhoging van R10 verteenwoordig.

R. W. BARTON,
Verteenwoordiger.

REVISION OF THE STANDARD REGULATIONS FOR THE WIRING OF PREMISES

The Executive Council once again nominated Messrs. D. C. Plowden (Johannesburg) and E. E. de Villiers (Rustenburg) to represent the A.M.E.U. on the S.A.B.S. Committee charged with the revision of the Regulations.

Since the conference in Cape Town (October 1971) the Committee had no further meetings, but Working Group 1 of the South African Technical Committee of Technical Committee No. 64 (Electrical Installations of Buildings) of the International Electrotechnical Commission had met to consider the I.E.C. documents which were to be discussed at the meeting of TC.64 in London (Britain).

To date of this report no further details of resolutions taken at meetings of TC.64 have been advised, neither has notice of any further meeting of this S.A.B.S. Committee been received.

Should further developments of consequence occur, such will be elucidated verbally at the Technical Meeting in May, 1972.

E. E. de VILLIERS,
Representative.

HERSIENING VAN STANDAARD REGULASIES VIR DIE BEDRADING VAN PERSELE

Die Uitvoerende Raad het weerens Mnre. D. C. Plowden (Johannesburg) en E. E. de Villiers (Rustenburg) benoem om die V.M.E.O. te verteenwoordig op die S.A.B.S.-komitee belas met die hersiening van die Regulasies.

Sedert die kongres in Kaapstad (Oktober 1971) het die Komitee nog nie weer byeengekom nie, maar het Werkgroep 1 van die Suid-Afrikaanse Tegniese Komitee Nr. 64 (Elektriese Installasies van Geboue) van die Internasionale Elektrotegniese Kommissie vergader vir verdere oorweging van die I.E.K.-dokumente wat tydens die vergadering van TK.64 in Londen (Brittanje) bespreek sou word.

Tot op datum van hierdie verslag is nog geen besonderhede verneem van besluite wat op die vergaderings van TK.64 in Londen geneem is nie en geen kennis van enige vergadering van hierdie S.A.B.S.-komitee ontvang nie.

Indien enige verwikkelinge van belang intussen voorkom kan sodanig tydens die Tegniese Vergadering in Mei 1972 mondelings toegelig word.

E. E. de VILLIERS,
Verteenwoordiger.

COMMON SERVICE FACILITIES.

"Final report on Common Service Facilities:

The subjoined letter dated 11th February, 1972 was received from the U.M.E.:—

"The code of practice for the simultaneous installation of Post Office and Municipal service cables, as forwarded with your letter dated 3rd November, 1971, received the approval of the United Municipal Executive of South Africa at a meeting held on the 1st - 3rd February, 1972.

In approving the code the U.M.E. noted particularly that it is to form the basis of negotiations between the Department of Posts and Telegraphs and individual local authorities in whose areas the installation of common service facilities may be considered. It is recognised that conditions vary between local authorities and it may not be practicable in all cases to carry out the provisions of the code.

The Provincial Municipal Associations are being advised by my office of the approval of the code and they are requested to bring it to the notice of the local authorities in their areas.

The code of practice referred to in the letter was made available to members of the A.M.E.U. at the convention held at Cape Town in October, 1971.

The A.M.E.U. subcommittee which consisted of Messrs. Frantz, Simpson and Theron expresses the hope that the code of practice will assist members in negotiating future schemes with the department of Posts and Telegraphs."

G. C. THERON,
Representative.

GEMEENSKAPLIKE DIENSGERIEWE.

„Finale verslag oor Gemeenskaplike Diensgeriewe :

Die hieronder aangehaalde brief, gedateer 11 Februarie 1972, is van die V.M.B. ontvang :—

„Die gebruikskode vir die gelyktydige installasie van Poskantoor- en Munisipale dienskabels, soos aangestuur saam met u brief van 3 November 1971, is deur die Verenigde Munisipale Bestuur op sy vergadering gehou op 1 - 3 Februarie 1972 goedgekeur.

By sy goedkeuring van die kode het die V.M.B. in die besonder daarvan kennis geneem dat dit bedoel is om die grondslag te vorm van onderhandelinge tussen die Departement van Pos- en Telegraafwese en endiwiduele plaaslik besture in wie se gebiede die installasie van gemenskaplike diensgeriewe oorweeg mag word. Daar word toegegee dat toestande van die een plaaslike bestuur na die ander mag wissel en dat dit nie in alle gevalle moontlik mag wees om die bepalinge van die kode toe te pas nie.

Die Provinsiale Munisipale Verenigings word deur my kantoor van die goedkeuring van die kode in kennis gestel en hulle word versoek om die onder die aandag van die plaaslike besture in hul gebiede te bring.'

Die gebruikskode waarna in die brief verwys word is tydens die konvensie wat in Oktober 1971 in Kaapstad gehou is, aan lede van die V.M.E.O. beskikbaar gestel.

Die V.M.E.O.-subkomitee, wat bestaan het uit mnre. Frantz, Simpson en Theron spreek die hoop uit dat die gebruikskode vir lede tot hulp sal wees en hul onderhandelinge in verband met toekomstige skemas met die Departement van Pos- en Telegraafwese."

G. C. THERON,
Verteenwoordiger.

C.S.I.R. ADVISORY COMMITTEE FOR ELECTRICAL ENGINEERING

Before reporting on the work of this Institute, I wish to place the Association's appreciation on record for the work done and interest shown by Mr G. C. Theron as the A.M.E.U.'s representative on this Committee over the past few years. We have become accustomed to the efficient and concise reports submitted by Mr Theron as the A.M.E.U.'s representative on various committees and wish to thank him for the valuable work done on the Association's behalf. I trust that the new representatives will be able to follow up the good work done so far.

This Committee is under the Chairmanship of the Vice-President of the C.S.I.R. and meets once a year in October when the work done by this Institute is reviewed, first in the various laboratories and later by way of the Annual reports and proposed research programme for the following year.

For general interest the following annual reports of the Institute's Divisions are reviewed :

1. Power Electrical Engineering Division.
2. Electronic Instrumentation Division.
3. Solid State Electronics Division.
4. Automatic Division.
5. Special Problems Division.
6. Applied Electronics Division.

As reported to the Association at its 1971 Convention in Cape Town, Mr J. D. N. van Wyk has been appointed as Director of the National Electrical Engineering Research Institute as constituted above.

The Power Electrical Engineering Division which is of special interest to electricity supply undertakings is under the leadership of Mr R. B. Anderson and is primarily concerned with all the aspects associated with research in electrical power engineering including earthing, thermal and electrical soil resistivity, lightning protection, surge voltages on high voltage systems, insulation co-ordination and high voltage laboratories.

Of particular interest was the report on the visit to a number of research laboratories concerned with the fields of electrical insulation and high voltage technology in the U.K. and in Europe.

In the field of insulating materials, the use of

DIE W.N.N.R. SE ADVIESKOMITEE INSAKE ELEKTROTEGNIESE INGENIEURSWESE

Voordat ek oor die werk van hierdie Instituut verslag doen, wil ek graag die Vereniging se waardering boekstaaf vir die werk gedoen en die belangstelling getoon deur mnr G. C. Theron as die V.M.E.O. se verteenwoordiger in hierdie Komitee die afgelope paar jaar. Ons het gewoond geraak aan die doeltreffende en pittige verslae wat deur mnr. Theron as die V.M.E.O. se verteenwoordiger in verskillende komitees ingedien is en wil hom graag bedank vir die waardevolle werk wat hy namens die Vereniging verrig het. Ek vertrou dat die nuwe verteenwordigers in staat sal wees om die goeie werk wat tot dusver is, op te volg.

Hierdie Komitee staan onder voorsitterskap van die Vise-President van die W.N.N.R. en vergader eenkeer per jaar in Oktober, by welke geleentheid die werk van hierdie Instituut in oënskou geneem word, eers in die verskillende laboratoriums en later by wyse van die jaarverslae en die voorgestelde navorsingsprogram vir die volgende jaar.

Vir algemene inligting word die volgende jaarverslae van die Instituut se afdelings in oënskou geneem :

1. Die Afdeling Krag-ingenieurswese (Elektrotegnies)
2. Die Afdeling Elektroniese Instrumentasie.
3. Die Afdeling Elektronika van die Vaste Toestand.
4. Die Afdeling Outomatisasie.
5. Die Afdeling Spesiale Probleme.
6. Die Afdeling Toegepaste Elektronika.

Soos op die 1971-konvensie te Kaapstad aan die Vereniging gerapporteer, is mnr J. D. N. van Wyk aangestel as Direkteur van die Nasionale Instituut vir Narvorsing na die Elektrotegniese Ingenieurswese, saamgestel soos hierbo uiteengesit.

Die Afdeling Kra-ingenieurswese (Elektrognies) wat vir elektrisiteitsvoorsieningsondernemings van spesiale belang is, staan onder die leierskap van mnr R. B. Anderson en hou homself primêr besig met al die aspekte wat in verband staan met narvorsing na die elektriese krag-ingenieurswese, met inbegrip van aarding, termiese en e ktriese weerstand van die grond, beskerming teen w erlig, stuspannings op hoogspannings-stelsels, die o-ordinasie van isolasie en hoogspanningslaboratoriums.

Van besondere belang was die verslag oor 'n besoek aan 'n aantal navorsingslaboratoriums wat hulself besig hou met elektriese isolasie en hoogspanningstegnologie in die Verenigde Koninkryk en Europa.

Op die gebied van isoleermateriale kom die ge-

synthetics, such as polymers, arachlors epoxies, etc., is becoming more and more prevalent — permitting the design and construction of insulation systems of increasing compactness at higher stress levels than before. With this has come the need for a better understanding of the processes affecting the life of electrical insulation which has led to a whole field of research into accelerated life tests and non-destructive measurement procedures. Foremost amongst these is the partial discharge measurement technique.

Many of the new polymeric insulating materials are susceptible to partial discharge damage and the present day policy of routine equipment acceptance tests based on "pressure tests" carried out at multiplied over voltage levels can be very damaging and can lead to greatly reduced equipment service lives. The growing development is therefore in the use of potentially non-destructive test methods based on partial discharge measurements. This matter should receive priority in the research programme to provide local industry with the facilities for sophisticated measurement and assessment techniques as well as guidance in the application of new materials especially from South African source.

Work in this Division is however still seriously being hampered by a shortage of sufficient senior research personnel with the necessary experience to cover all the aspects of the research programme.

The work of the other Divisions is mainly concerned with research in specialised fields for defence purposes, medical electronics, computer technology and instrumentation.

J. VON AHLFTEN
Representative.

bruik van sintetiese stowwe soos byvoorbeeld polimeer, arachlor, epoksie ens. meer en meer voor, wat tot gevolg het dat isolasiestelsels van toenemende kompaktheid teen hoër spanningspeile as voorheen gebou kan word. Gepaard hiermee gaan die behoefde aan 'n beter begrip van die prosesse wat die lewensduur van elektriese isolasie affekteer, en dit het op sy beurt gelei tot 'n hele navorsing na versnelde lewensduurtoetse en nie-vernietigende metingsprosedures. Die belangrikste van laasgenoemde is die tegniek vir die meting van gedeeltelike ontlading.

Baie van die nuwe polimeriese isolosiemateriale is onderhewig aan skade deur gedeeltelike ontlading en die hedendaagse beleid van roetine-aanvaardingstoetse vir toerusting wat gebaseer is op „drukkingstoetse" wat teen vermeningvuldigde oorspanningspeile uitgevoer word, kan groot skade veroorsaak en kan lei tot die grootliks verminderde lewensduur van toerusting. Die groeiende neiging is dus in die rigting van die gebruik van potensieel nie-vernietigende toetsmetodes wat op die meting van gedeeltelike ontlading gebaseer is. Hierdie saak behoort voorkkeur te geniet in die navorsingsprogram teneinde die plaaslike nywerheid te voorsien van die geriewe vir gesofistikeerde metings- en aanslagtegnieke, sowel as van leiding ten opsigte van die gebruik van nuwe materiale, veral van Suid-Afrikaanse oorsprong.

Die Werk in hierdie Afdeling word egter nog ernstig in die wiele gery deur 'n tekort aan voldoende senior navorsingspersoneel met die nodige ondervinding om al die aspekte van die navorsingsprogram te dek.

Die werk van die ander Afdelings het hoofsaaklik te doen met navorsing op gespesialiseerde gebiede vir verdedigingsdoeleindes, mediese elektronika, rekenaartegnologie en instrumentasie."

J. VON AHLFTEN,
Verteenwoordiger.

ANNUAL REPORT 1971
ELECTRICAL WIREMEN'S REGISTRATION BOARD

The Board was constituted as follows for 1971 :

Chairman : Mr J. G. Wannenburg.

Members : Messrs J. M. Fraser, F. Leemans, A. H. M. Drysdale, J. K. von Ahlften.

In an advisory capacity, Mr Hare of the Central Organisation for Trade Testing, Olifantsfontein, attended all the meetings of the Board.

MEETINGS OF THE BOARD AND APPLICATION FOR REGISTRATION.

The Electrical Wiremen's Registration Board held 13 meetings during 1971 and considered applications in respect of 1542 persons. Of these applicants 1520 were accepted for the prescribed examinations or were exempted therefrom in part or in full. The Board also granted provisional registration certificates or approved the renewal of such certificates in respect of 2040 applicants.

During 1970 the Board launched a drive to register unlicenced wiremen and took steps to try and ensure that wiring work is not performed by unlicenced persons. As a temporary concession the Board decided to exempt artisans with long experience from the written examination, grant them provisional registration and require them to pass the practical test only to qualify for full registration. The termination date of the concession was agreed upon as 31st January, 1972.

This concession resulted in a sharp increase in the number of provisional registration certificates issued as well as increases in the number of practical examinations arranged and full registration certificates granted, while the number of candidates for the written examinations decreased slightly. During 1971, 1027 provisional registration certificates were issued as against 465 during 1969.

PROVISIONAL REGISTRATION CERTIFICATES GRANTED :

Year	Number
1966	355
1967	371
1968	386
1969	465
1970	702
1971	1 027

JAARVERSLAG VIR 1971
REGISTRASIERAAD VIR ELEKTROTEGNIESE DRAADWERKERS

Die Raad vir 1971 was as volg saamgestel :

Voorsitter : Mnr J. G. Wannenburg.

Lede : Mnre . M. Fraser, F. Leemans, A. H. M. Drysdale, J. K. von Ahlften.

Mnr Hare van die Sentrale Organisasie vir Ambagstoetse, Olifantsfontein, het die vergaderings van die Raad in 'n raadgewende hoedanigheid bygewoon.

VERGADERINGS VAN DIE RAAD EN AANSOEKE VIR REGISTRASIE :

Die Registrasieraad vir Elektrotegniese Draadwerkers het gedurende 1971 13 vergaderings gehou en oorweging verleen aan 1542 nuwe aansoeke vir registrasie. Hiervan is 1520 of tot die eksamens toegelaat of geheel of gedeeltelik daarvan vrygestel. Die Raad het ook voorlopige registrasie-sertifikate of die hernuwing van sulke sertifikate ten opsigte van 2040 applikante toegestaan.

Gedurende 1970 het die Raad 'n veldtog geloods om alle ongelisenseerde draadwerkers te laat registreer en stappe probeer neem om te verseker dat draadwerk nie deur ongelisenseerde persone onderneem word nie. As 'n tydelike toegewing het die Raad besluit om ambagsmanne met jarelange ondervinding vry te stel van die geskrewe eksamens en voorlopige registrasie toe te staan en slegs vereis dat hulle die praktiese toetse moet slaag om te kwalifiseer vir volle registrasie. Daar is besluit dat die keerdatum van hierdie toegewing die 31 Januarie 1972 sal wees.

Die gevolg van hierdie toegewing was 'n skerp toename in die aantal voorlopige registrasie-sertifikate wat uitgereik is sowel as 'n toename in die aantal praktiese eksamens wat gereël is en volle registrasies wat toegestaan is met 'n geringe afname in die aantal kandidate vir die geskrewe eksamens.

Gedurende 1971 is 1027 voorlopige registrasie-sertifikate uitgereik teenoor 465 in 1969.

VOORLOPIGE REGISTRASIE-SERTIFIKATE UITGEREIK :

Jaar	Aantal
1966	355
1967	371
1968	386
1969	465
1970	702
1971	1 027

(In terms of the Act a provisional registration certificate can be issued for a period of six months and can be renewed for three further periods of six months. A second provisional registration certificate cannot be issued).

EXAMINATIONS :

Three written examinations were held at 46 examination centres and 1 334 candidates were entered. The results were as follows :—

Part 1. (On the Standard Regulations for the Wiring of Premises).

Failed	324
Passed	221

Part 2. (On Electrical Theory).

Failed	282
Passed	87
Absentees	420
Total	1 334

A number of candidates who, for various reasons, were unable to undergo or pass the written examinations, were allowed to undergo oral examinations.

During the year under review 243 practical examinations were held in the eight principal centres. Test arrangements were made in respect of 2 257 candidates of which 496 passed, 1 396 failed and 365 were absent.

Of the 1 396 who failed a number of candidates passed in certain tasks of the tests, but they failed the tests as a whole due to not obtaining 60% for each individual task.

The abovementioned totals of 1 334 and 2 257 include candidates who failed in previous years.

REGISTRATION CERTIFICATES :

Particulars of registration certificates issued since the Act came into operation are reflected hereunder :

REGISTRATION CERTIFICATES ISSUED

Year	To Applicants exempted from the examinations	To applicants who passed the examinations during 1971 or in previous years	Totals
1946—1966	2 617	6 937	9 554
1967	34	218	252

(Volgens die Wet kan 'n voorlopige registrasie-sertifikaat vir ses maande uitgereik word en daarna vir drie verdere periodes van ses maande hernu word. 'n Tweede voorlopige registrasie-sertifikaat kan nie uitgereik word nie).

EKSAMENS :

Die geskrewe eksamens is by 46 eksamensentra gehou 1 334 kandidate was daarvoor ingeskryf. Die uitslae was as volg :

Deel 1. (Bedradingsregulasies).

Druip	324
Slaag	221

Deel 2. (Elektriese Teorie).

Druip	282
Slaag	87
Afwesig	420
Totaal	1 334

'n Aantal kandidate wat om verskillende redes nie die skriftelike eksamens kon afle of slaag nie, is toegelaat om mondelikse eksamens te ondergaan.

Gedurende die verslagjaar is 243 praktiese eksamens in die agt vernaamste sentra gehou. Toetsreëlings is tenopsigte van 2257 kandidate getref van wie 496 geslaag het en 365 was afwesig. Van die 1396 wat gedruip het, het 'n hele aantal in sommige van die take geslaag maar die toets as geheel gedruip deur nie 60% in die individuele take te behaal nie.

Die bogenoemde totale van 1 334 en 2 257 sluit kandidate in wat in die vorige jaar gedruip het.

REGISTRASIE-SERTIFIKATE :

Besonderhede van registrasie-sertifikate wat sedert die inwerkingtreding van die Wet uitgereik is word hieronder weergegee :

REGISTRASIE-SERTIFIKATE UITGEREIK

Jaar	Aan applikante wat van die eksamens vrygestel is	Aan applikante wat gedurende 1970 of in vorige jare in die eksamens geslaag het	Totaal
1946—1966	2 617	6 937	9 554
1967	34	218	252

1968	50	169	219
1970	89	371	460
1971	133	460	593
TOTALS	2 997	8 448	11 445

PROPOSED AMENDMENTS TO THE ACT:

The revision of the Act is at present under consideration and the Secretary for Labour requested our Association by a letter dated 29th December, 1971, to submit any proposals in this connection.

The Secretaries requested by a circular letter dated 7th January 1972 to all Engineer Members of the Executive Council for information, discussion and comment by not later than 4th February, 1972 on any proposed amendments to the Act.

Unfortunately it must be reported that the reaction was disapppointing but the few proposals received plus those of your representative and of the Highveld Branch taken at its meeting in July 1970 have been submitted to the Secretary of Labour for consideration.

It is anticipated that all the proposals received will be circulated for final comment to all interested parties in due course.

In conclusion I wish to thank the Board for the information provided in this report and for permission to submit it to the meeting.

J. VON AHLFTEN,
Representative.

1968	50	169	219
1970	89	371	460
1971	133	460	593
TOTALE	2 997	8 448	11 445

VOORGESTELDE WYSIGINGS AAN DIE WET:

Die hersiening van die Wet is tans onder oorweging en het die Sekretaris vir Arbeid in 'n brief dateer 29 Desember 1971 ons Vereniging versoek om voorstelle in die verband in te dien.

Die Sekretarisse het by wyse van 'n omsendbrief dateer 7 Januarie 1972 lede van die Uitvoerende Raad versoek om inligting, bespreking en kommentaar, maar nie later as 4 Februarie 1972, oor enige voorstelle vir wysigings aan die Wet te lewer.

Ongelukkig moet verslag gedoen word dat die reaksie teleurstellend was maar die paar voorstelle wat ontvang is tesame met die van u verteenwoordiger asook van die Hoëveld Tak geneem tydens sy vergadering van Julie 1970, is aan die Sekretaris vir Arbeid voorgelê vir oorweging.

Dit word verwag dat alle voorstelle wat ingedien is mettertyd uitgestuur sal word vir finale kommentaar aan alle belanghebbende instansies.

Ten slotte wil ek graag die Raad bedank vir die inligting wat in hierdie verslag vervat is, sowel as vir die nodige toestemming om dit aan die Vergadering voor te lê.

J. VON AHLFTEN,
Verteenwoordiger.

THE RESPONSIBILITIES OF THE POWER SUPPLY ENGINEER AS REGARDS FORMULATION OF STANDARD SPECIFICATIONS

By A. A. Middlecote, Pr. Eng., B.Sc. (Elec. Eng.)

1. GENERAL.

The recent monetary crisis, as well as many other associated events, has again drawn attention to the intense competition on the international market. Only countries capable of producing quality products have chance of equitable world trade and consequent continued increase in their standard of living. The Republic of South Africa has many natural resources which promise a healthy industrial development but these may be squandered unless we realize the need for the manufacture of products of the level of quality dictated by the international market. You might ask whether this concerns the electricity supply engineer; it is surely the industrialist's responsibility? However it requires but little analysis to realize that the user and the buyer of products in any country have an important function in establishing the level of quality of products manufactured in that country. Should this level be much different from that required on the international market, the local manufacturers are likely to suffer as regards possible export and the country consequently as regards balance of payments. To achieve an acceptable quality level co-operation between manufacturer and user is necessary and this is best brought about in the discussions of a committee appointed to work on a standard specification. A sincere effort must be made to set that level of quali y for any product **which is in the best interests of the country.** The manufacturer must give requisite quality and reliability at a reasonable price so as to help the power supply authority to provide a **reliable** electricity supply for industry at a reasonable price, and the supply authority must help establish a quality level that will give the manufacturer the long production runs that enable him to take advantage of the classic unit cost-volume relationship and to compete on the international market. The benefits of selling on the international market will feed back to the power supply authority because of the strong resultant national economy and the sound local industry demanding an ever increasing electricity supply.

There is a further requirement on the part of the power supply engineer. This is the need to discard unreasonable parochialism or provincialism since a narrow outlook can only harm the overall national economy. Each part of a country, whether it is village, city or province, must act and react on the other parts to produce a whole that is better than the sum of the parts. The power supply authority must take a whole view which includes the field of manufacture, installation, maintenance and export potential of a product and also the requiremen's of the different parts of the country. It was Professor R. Kapp who stated in the third Charles Le Maistre Memorial Lecture of the International Electrotechnical Commission in 1957 : "If engineers did not take the whole world of reality into consideration, with all its faults and blemishes, if they did not hospitably **welcome** to their debates all relevant facts, including the troublesome ones, the regretable ones, the ones that contradict their most cherished convictions, they would be as far from reaching agreement among themselves as are the philosophers." Thus it is that the power supply engineer must attend a specification meeting with an open mind prepared to examine fairly all relevant facts.

2. QUALITY SPECIFICATIONS.

2.1 ECONOMIC POWER SUPPLIES. Arthur M. Wellington once said : "To define it rudely but not ineptly, engineering is the art of doing that **well** with one dollar which any bungler can do with two — **after a fashion."** One must note the underlined words. This means that the power supply engineer must supply energy at a much lower cost than the bungler — but it must be a good reliable supply and not one "after a fashion." Energy is a component of manufacture and its cost has an important effect on the cost of the product manufactured. But it is useless to offer the industrialist a cheap power supply if he has to experience frequent power failures and consequent disruption of his production line.

While overall sound design of a reticulation is the foundation of satisfactory electricity supply, the cost and the reliability are largely dependent on the manufactured components used in its construction. These components must be capable of giving satisfactory and reliable service, must keep maintenance costs down and losses to an economic minimum, and must have a low initial cost. In short they must be quality products.

2.2 QUALITY.

2.2.1 **Definition.** What exactly do we mean when in specification work we refer to quality in a product? To many, quality is par excellence, a standard which may be industrially unattainable in an economic sense. This concept is dangerously wrong. Quality in the true sense is a whole concept and should preferably be thought of as total quality. Parts which make for total quality are:

(a) Fitness for purpose;

(b) reliability, maintainability and replaceability;

(c) running costs including cost of losses;

(d) ease of operation as determined by ergonomics;

(e) appearance; and

(f) cost of manufacture.

It is in fact the balancing of all costs against the other requirements that ultimately sets the desired level of quality in a product. This can be seen in Figure 1. Here the benefits of quality and the cost of quality are plotted against quality level. At zero quality the costs will have a positive value which is termed "Fixed costs of quality." The benefits for this quality are xero. When the level rises above zero quality. there is a region between zero and A where costs are in excess of benefits. No manufacturer would wish to remain in this region. However, above A benefits begin to exceed costs; C is the level for maximum profit and can be regarded as the optimal quality level. The profits of quality levels B and D are equal and although the costs at D are higher the returns and the market potential are greater at D. It is obviously uneconomical to increase the quality level above E. This theoretical consideration is considerably affected by standardization, since if particular quality levels are standardized, the cost relationship is changed by the benefit of the consequent longer production runs.

2.2.2 **Total Quality Control.** Quality is built into a product during the whole process of manufacture—from the formulation of the specification to the delivery of the properly packaged and transported article. This building-in involves designers, engineers, operators, production supervisors, and inspection and testing staff and is named total quality control. Total quality control is generally accepted as having nine parts. These are:

a) Market research;

b) specification production;

c) design;

d) buying of materials and components;

e) manufacturing engineering;

f) production;

g) inspection and testing;

h) packaging and transportation; and

i) installation and instructions.

The circle of activity of total quality control is given in Figure 2. This paper is concerned only wiith specification production, but before one can successfully contribute towards the formulation of a satisfactory specification the value of the whole circle of activity must be appreciated. In fact it is now internationally accepted that standard specifications should be drawn up with their implementation by means of quality control always borne in mind.
The other parts of total quality control form the basis of the standardization mark scheme of the South African Bureau of Standards which seeks to ensure consistent production of articles to the quality levels laid down in the specification formulated by the committee on which, among others, power supply engineers make their useful contribution.

However this is a very interesting but long story and would justify a paper to itself. But time certainly will not allow of its discussion in this paper.

2.3 SPECIFICATIONS AND STANDARD SPECIFICATIONS

2.3.1 **Definitions.** The most important phase of standardization is the formulation of specifications and in particular standard specifications. It is perhaps advisable to highlight the differences between these two terms.

The Standards Act made sure that the difference between a specification and a standard specification was clear by defining the two as follows:

a) A specification means a description of any commodity by reference to its nature, qualities, strength, purity, composition, quantity, dimensions, weight, grade, durability, origin, age or other characteristics, or of the material or substance from or with which any commodity may be manufactured, produced, processed or treated, or of the manner in which this may be done.

b) A standard specification means a specification which is the subject of a notice published in terms of section fourteen and declaring any mark to be a standardization mark in respect of any commodity or the manufacture, production, processing or treatment of any commodity.

In effect the fact that a specification has been made a standard specification by the abovementioned declaration means that the specification has been accepted by the country as its national standard specification and all in the country are expected to accept the standard specificatioin as the description of the commodity they wish to buy or sell.

An international standard specification is a specification that has been accepted inter-

nationally and one would expect all in the world to accept such a specification as the descriptioin of the product they wish to buy or sell.

2.3.2 **Prerequisites of the specification. Specifications** must in the first place be expressed in clear, explicit **unambiguous language** since they are required to be bases of legal agreements. In the second they must preferably give performance requirements since these allow the use of the latest materials and the application of the latest trends in process, which might not be possible should the description be merely the specification of the exact material and its dimensions.

While a private organization can produce its own specifications by suitable liaison between the marketing and the technical departments, many organizations lack suitable specialized staff for this function. Furthermore quality production should be based on a true national opinion or, even more important, on international opinion, since a healthy strong industry must expand initially from its parochial market to the market of the whole country and finally to the world market. The Bureau of Standards is in a position to produce standards of quality and performance which satisfy all these requirements since it is a national body and a member of internatiónal standards organizations and has the necessary specialized engineers and technologists to cover all the different branches of industry.

2.3.3 **Committees.** All national standard specifications are prepared, not by the Bureau officials themselves but by a committee fully representative of manufacturers, distributors, consumers, consultants, and professional institutions. In this way it is ensured that a truly national specification which will give value for money results. The Bureau itself makes a major contribution by presenting to the committee vital information regarding test work on the commodities, national statistics, specialist technological opinion, and (most important of all) international opinion. At present the participation by the Bureau in such international standardization work is not restricted to Bureau personnel only; members of industry and commerce also attend, thus ensuring that our participation in the international field is truly representative of the country. Recently the AMEU itself sponsored a delegate to represent the power supply industry.

Obtaining agreement on such a difficult question as the national standard of quality is as one can appreciate no easy task and requires a full understanding by all members of the committee of the meaning of expressions such as quality, value, simplification, reliability, maintainability, etc. It also requires skill and patience on the part of the Bureau staff responsible for the piloting of the standard through its different stages to ensure that their enthusiasm for the great job of standardization is infused into every member of commerce and industry with whom they come in contact so that the latter might make their rightful contribution towards the work in hand.

3. THE POWER SUPPLY ENGINEERS AND SPECIFICATION COMMITTEES

3.1 **GENERAL.** In most committees dealing with specifications for electrical equipment it is the power supply engineer who is expected to make the most important contribution from the point of view of the consumer. While it has been stressed that he must approach the meeting with an open mind, prepared to appreciate the whole problem, there are nevertheless certain areas in which he can provide specialist opinion and help. It would be interesting to see what these areas are.

3.2 AREAS OF POWER SUPPLY ENGINEERS' SPECIAL CONTRIBUTION

3.2.1 **Clarity and Logic.** At all times the specification must be examined for clarity and logic; it must be a clear, concise working document which has a real meaning for the power supply engineer. The pitfall of specifying impracticable requirements or tests that are impracticable, expensive, or time-consuming must be avoided since these can adversely affect costs without significantly adding to the value or quality.

3.2.2 **Total Cost.** It has been pointed out that the cost of a product in relation to its quality level is important but it is the effective total cost that must be considered, and not only the primary cost. This effective cost could be the sum of the primary cost and the capitalized costs of maintenance, replacements and losses The supply engineer is in a unique position to examine these factors and ensure that the resultant specification has in fact considered all the cost factors that should be balanced against the quality level to be specified.

3.2.3 **Reliability.** Since reliability of supply is so important to the supply engineer, it is he who

should always take its importance into consideration. Basic reliability van be included in the performance requirements laid down in the specifications, particularly through the medium of simulated life tests, impulse tests, environmental tests and the specifying of physical properties of materials. However overall reliability is a statistical problem based on the level of quality assurance during manufacture. This cannot normally be included in a specification but is covered by inspection schemes and in particular the standardization mark scheme which can reduce statistical probability of failure through laying down quality control requirements. Nevertheless these statistical probabilities of failure stress one fundamental rule in the drawing up of specifications—to avoid unnecessary features or additions to a product since these will decrease its reliability by increasing the probability of failure of the product.

3.2.4 **Simplification.** Apart from helping increased reliability, simplification helps considerably to reduce overall costs and should be applied wherever possible. Simplification itself refers to the process whereby the interests of all concerned are brought together with a view to reducing unnecessary variety of articles or commodities for one and the same purpose. Standards activities which lead to simplification —that is fewer models, easier assembly, replaceability, greater production—contribute greatly to our ability to take advantage of the unit cost-volume relationship. Standardizing on dimensions, on tolerances, and on the characteristics of purchased materials is a familiar contribution. So is the work which reduces the variation between component parts and subassemblies and permits of flexible interchange. This is of particular value to the supply engineer as regards ease and cost of maintenance or replacement.

3.2.5 **Safety.** Safety is most important and is always being highlighted publically sometimes with an undue display of emotionalism. But safety costs money and consequently safety requirements are the most difficult to set down when formulating specifications. The level of safety has to be carefully and responsibly assessed against increase in cost. Fortunately international work in this field is helpful; nevertheless it is in this field that the supply engineer can bring to the specification important experience as regards probable faults or hazardous conditions.

4. EXAMPLES OF ELECTRICAL PRODUCTS

4.1 With the general directives enumerated above in mind, it might be interesting to consider a few examples of typical electrical products and indicate how the power supply engineer can help in establishing a good sound specification for the the products concerned.

4.2 FIXED ELECTRIC STORAGE WATER HEATERS

4.2.1 **Power Supply Engineer's Interests.** The engineer has a moral obligation not only towards the purchaser of such an appliance for whom he should ensure quality and value but also towards his undertaking since in many cases the characteristics of water heaters have an important bearing on peak loads and any associated off-peak heating of the supply system. Basically the supply engineer has an interest in safety (not only electrical but also hydraulic), life, total effective costs, and peak load contribution.

4.2.2 **Life.** While the life of a product is established mainly by defining acceptable materials, processes, and tests, it must be appreciated that life will also depend upon environmental conditions —particularly the nature and quality of the local water supply. Here the supply engineer can help establish the average quality of water throughout the Republic so that the requirements for standard heaters may be set. Special requirements can then be set for those areas having hard, dezincifying, or corrosive waters since it would be nationally uneconomic in most cases to require all heaters to be suitable for these special conditions. An additional responsibility for the supply engineer burdened with unduly corrosive water would be to help ensure that heaters sold in his area have the special requirements defined.

4.2.3 **Total Effective Costs.** The basic cost of a heater is determined by the requirements designed to give an adequate life. However there is a cost for thermally insulating the heater so as to prevent excess heat losses. Naturally the lower the losses the greater the cost. Figure 3 attached gives typical values of cost of insulation and annual cost of losses (calculated at 1c per unit) against the standing loss in watts. The present standard loss of a 135 litre heater is 115 watts, at which value the annual cost of losses is approximately equal to the cost for insulation (R10). A "cheaper" heater having twice the standing loss (230 watts) would be R6,30 cheaper but the annual cost of losses

would be increased by R10. At first sight the advertised cost of the cheaper article would appear attractive but over 10 years the purchaser would pay an extra R100 on his electricity account. This indicates the need to establish true overall costs which are the primary costs plus the capitalized cost of losses. Careful consideration could probably establish an even better "standard" standing loss. Figure 3 also shows the change in overall diameter with change in standing loss. An increased space requirement also represents a hidden loss since a too large heater might take up useful space and will certainly increase transport costs. From this point of view a limitation on dimensions might be useful.

4.2.4 **Peak Load.** A water heater in which the water is just being kept at the requisite temperature without any draw-off, and which has standing loss of say 230 watts would, under the control of a thermostat, be switched on for 0.47 hours and then remain off for 3.4 hours when the water will have cooled sufficiently to again switch on the thermostat. With a standing loss of 115 watts, the times would change to 0.40 hours on and 6.80 hours off.

If a uniform distribution of initial switching-on times is accepted, it could be calculated that for 1 000 heaters each having 2 kW heating elements the peak loads would be 244 kW for heaters with a standing loss of 230 wts and only 112 kW for heaters with a standing loss of 115 watts. For a town with 10 000 heaters the figure would be 2,44 MW and 1,12 MW respectively. Since such a town could have a peak load of about 25 MVA, the reduction of 1 MW is very significant. In practice with water being drawn off the figure would probably not be so impressive but this theoretical analysis does indicate a further advantage in making a careful selection of the "standard" standing loss. It is again in this field that the supply engineer can help select a value which is in the best national interest.

4.3 MOULDED CASE CIRCUIT BREAKERS.

4.3.1 There are many features of this very important component of electrical installations that have to be considered but perhaps three can be mentioned here.

4.3.2 **Interrupting Capacity.** It is essential that the number of categories of interrupting capacities is kept to a minimum. It is also desirable that these line up with international requirements since this is a field in which the Republic has already entered the export trade. But the categories selected must be realistic and it is the basic responsibility of the supply engineer to ensure that he is not paying for unnecessarily high rupturing capacities. His experience of typical short circuit current value on installations in practice can be most valuable.

4.3.3 **Temperature Rise.** There has been, and probably will for some time be, contention regarding the temperature rise of terminals of breakers and contactors. Naturally a high temperature rise usually allows for a lower cost because of savings in material. On the other hand a high temperature rise can, in association with the maximum temperature allowed on cables connected to such apparatus lead to difficulty when breakers or contactors are replaced since the insulation on the cable might be disturbed. Feed-back of practical experience in this regard can come only from supply engineers. Again a problem of cost and reliability is involved.

4.3.4 **Environmental Conditions.** Breakers have sometimes to operate in difficult environments. Coastal engineers have the problem of moist salt-laden air, while factory engineers contend with either dusty or explosive atmospheres. Here again it is usually uneconomic to expect standard breakers to be suitable for operation in such unusual environments. The answer will then be either special classes of breakers or the acceptance that standard breakers must be housed or situated in a suitable enclosure.
The first approach is only reasonable if the consequent demand is sufficient to give good production runs and consequent reasonable costs. In most cases the second approach is the best. This is again a fine exercise in logic. One can find a parallel case in a low-cost consumable commodity such as dry batteries used in professional electronic equipment as well as in torches and domestic radios. These are prone to leakage of electrolyte if discharged beyond their limit. Such leakage could ruin the equipment they are housed in. Dry cells with a high degree of immunity from leakage can be built but only at much higher cost. An alternative, and possibly more reasonable approach would be to design equipment using such batteries with a suitable battery compartment which prevents leakage from spreading to the vital parts of the equipment. This could be done at a much lower effective cost. In essence this means that when two or more types of equipment are used in combination the design of all parts of the combination or system should be carefully considered when the specification for any one part is drawn up.

4.4 STORAGE BATTERIES.

4.4.1 **Life.** The storage battery is a good example of a product in which the tests to establish the probable life have to be very carefully considered. Life is dependent in the first place on the life of the plates themselves which after certain duty cycles will deteriorate until they are no longer capable of functioning correctly. A test can be devised to simulate this. Life is also dependent on the strength of the casing which could deteriorate under vibration, temperature cycling and shock. Again a test can be devised to simulate this. However the two tests should be such as to give approximately the same life since it would be uneconomic to demand, or pay attention to, long life as indicated by cycling tests if the life as determined by mechanical tests on the casing is much shorter.

4.4.2 **Changing Conditions.** In the case of storage batteries changes in operating conditions have required changes in life tests. Originally storage batteries operated under service conditions where they were charged over a certain period and then discharged. This called for a deep cycling life test. However with the advent of the modern voltage regulator and the changes on the automobile itself, a situation was reached where batteries were almost continuously in a state of being fully charged. In fact in most cases they become overcharged. This condition required a change in the type of life tests applied which now become an overcharge life test. It is only by using the experience of the user and the feed-back of information regarding typical failures that the specification can be kept abreast of such changes.

4.5 EARTH LEAKAGE UNITS.

So much has been said about earth leakage units at A.M.E.U. gatherings that there is little further to be said. Nevertheless these previous discussions indicate how important a contribution the supply engineer can make to the specification meeting proceedings. What has been done by supply engineers in the past has enabled the Republic to make outstanding contributions to the discussions on an international level. At present overseas bodies are tending to line up with the requirements set by South Africa.

Particular fields have been the investigation of spurious tripping, and inherent earth leakage currents on installations and the consequent level of tripping. The vacillating international values seem to be settling down around 20 milliamp as the threshold of tripping—the value which we now have. However, the supply engineer must continue his efforts in this field to help establish even more logical values. In this regard records of his experiences are most valuable.

4.6 DISTRIBUTION TRANSFORMERS

4.6.1 **Need for Effecting Savings.** The recent meetings to revise the standard specification for distribution transformers have indicated many areas in which considerable savings can be effected. Thinking nationally, when one realizes that approximately six million rand is spent on distribution transformers per year, a reduction in costs of 10% can represent a saving of R600 000 per year. This is well worth aiming at, provided of course costs elsewhere are not increased, i.e. costs due to losses, maintenance, and replacements. A reduction of 10% can easily be effected by application of simplification. The following points are of interest.

4.6.2 **Tapping Switches.** At present tapping switches increase the cost of small distribution transformers by about 7% and of larger ones by about 3%. If the standard transformers did not have tapping switches, further streamlining might lead to a reduction of 8% and 6% respectively. The reliability of the transformer will be increased because of the reduction of components and because a tapped winding is mechanically weaker. On the other hand it must be assessed whether a tapping switch is necessary. This can be done only by the supply engineer with an open mind.

4.6.3 **Standard Bushings.** Standard bushings as with other standardized components used on transformers result in lower costs, greater reliability, and easier and cheaper maintenance. However the use of standard bushings depends on a preferred method of mounting of the transformer core and bushings, i.e. core suspended from lid with top bushing entry or side entry of bushing.

4.6.4 **Conservator.** The supply engineer must consider whether on smaller transformers the additional cost of 3% to 4% for a conservator is justified.

4.6.5 **Mounting of Core.** A current debate is centered in the problem whether the transformer core and winding should not be suspended from the lid of the transformer. There are assembly advantages to this method, saving in space, and possible saving in costs. The disadvantages claimed are the need to lift the whole assembly (consequently heavy lifting gear must be made available) when making a cursury examination

or replacing damaged insulator bushings. The counter argument is that to be effective any examination must be of the whole winding though it is conceded that the claim regarding replacement of bushings is legitimate. This debate is one that deserves attention since the correct solution to this problem must have many advantages for both supply engineer and manufacturer. Certainly careful consideration of the standard specification for distribution transformers promises saving in costs and increase in reliability.

5. RECORDS

In these deliberations one must appreciate that much of the good the supply engineer can bring to a specification meeting is based on his experience. In most cases this is best illustrated by means of records where one usually deals with figures or measurements. Lord Kelvin said: "I often say that when you can measure what you are speaking about and express it in numbers you know something about it, but when you cannot measure it, when you cannot express it in numbers your knowledge is of a meagre and unsatisfactory kind."

Here I would not recommend the irresponsible keeping of records at great cost and to no purpose but it is felt that the keeping of sensible records of operation of a supply system will always help the supply engineer contribute vital information.

"By experience we find out a shorter way by a long wandering—learning teacheth more in one year than experience in twenty."

It is in the standard specification that one can learn in a few days the experience of many years thus reflecting the most advanced level of technology. But this experience must include, in the case of electrical equipment, that of the supply engineer.

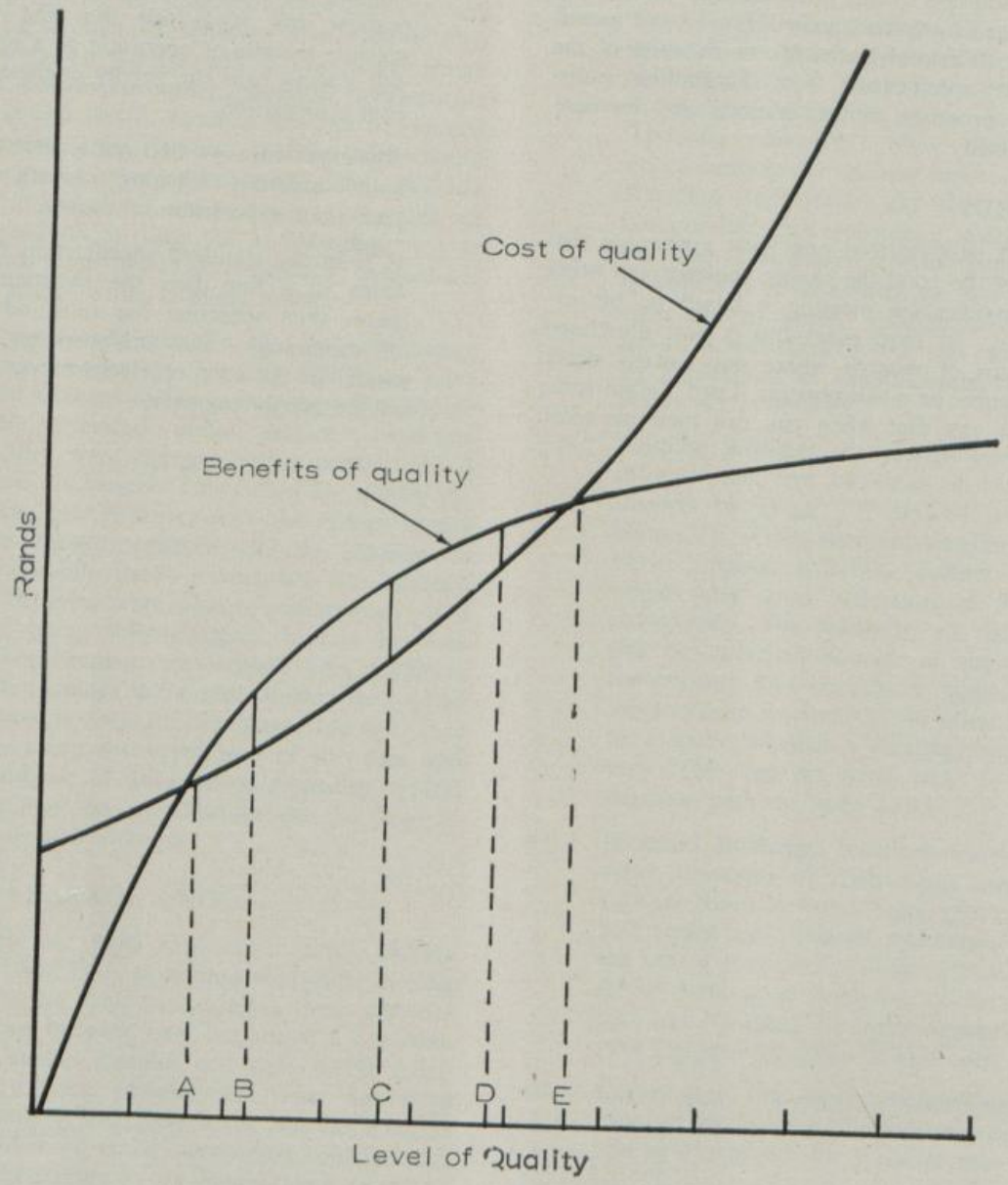
Cost of quality
Benefits of quality
Rands
A
B
C
D
E
Level of Quality

Figure 1

Total Quality Control

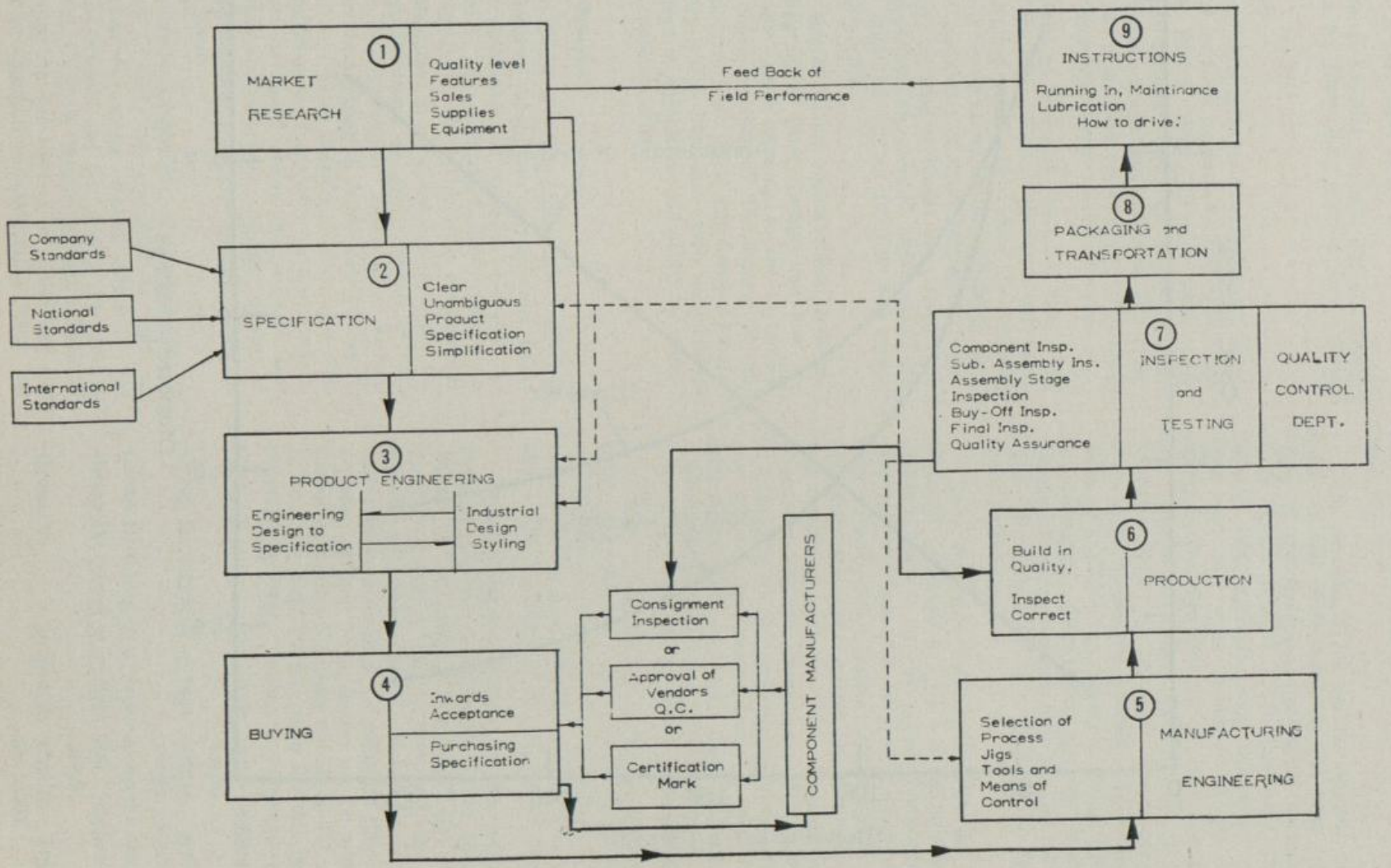

FIGURE 2

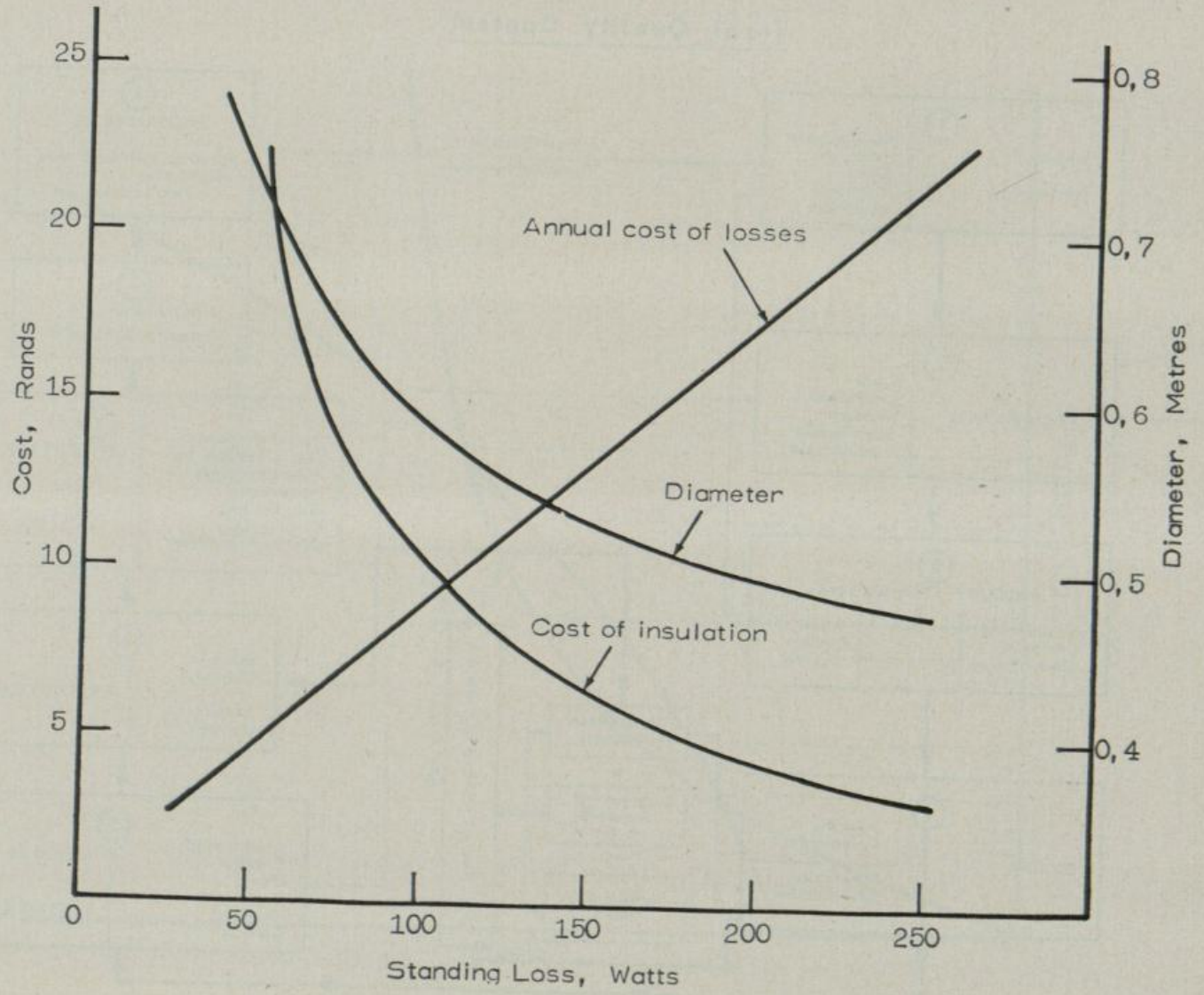
25
20
15
10
5
0
50
100
150
200
250
Cost, Rands
Standing Loss, Watts
Annual cost of losses
Diameter
Cost of insulation
0,8
0,7
0,6
0,5
0,4
Diameter, Metres

Figure 3

S.A.B.S. 098 PLUS 5

(A review of Street Lighting over the past five years)
By R. S. Yates, M. Illum. E.S., M.A.P.L.E., C.G.I.A.

1. Introduction.

Exactly five years ago, the S.A. Bureau of Standards published its Code of Practice (098 - 1967) for Public Lighting, Part 1, "The Lighting of Streets and Highways." It is therefore opportune to review progress in street lighting design and equipment over these past five years and to ascertain what has been developed here and how overseas practices have influenced us.

The principles of providing "high and even road brightness" as the basis of street lighting design have remained unchanged since 1931 when the original British Standard Specifications for street lighting were published. The techniques of street lighting are however continually changing as design of roadways are improved, road surfaces are changed, higher speeds are permitted and improved lighting materials and equipment become available.

How are South African manufacturers and engineers matching up to these changes and how do we compare with other countries as far as quality in street lighting is concerned? The issuing of our own code of practice was a great step forward for the lighting industry and in five years much should have been learnt about its application and effects by manufacturers and engineers alike.

2. Codes of Practice.

Numerous Codes of Practice have been published in various countries during the last 40 years based on experience combined with research. National experience, thinking or preferences have resulted in differing prescriptions. The C.I.E. (the international body on illumination) in an attempt to reconcile the varying viewpoints drawn up and published in 1965 its Document No. 12 entitled "International Recommendations for the Lighting of Public Thoroughfares". This document was never intended to serve as a code in itself but rather as the framework on which national codes could be based, taking into account local needs, condition and economic structure. It was on these recommendations that the S.A.B.S. Code of Practice was based.

The Committee responsible for publication of this document (E.3.3.1) has continued to work on recommendations for street lighting situations not covered in the original and last year at the general meeting of the C.I.E. in Barcelona final version of recommendations for the lighting of motorways and of tunnels were approved for publication. Work has also been proceeding on revising the original Document 12.

The reaction of the various member nations of C.I.E. to the recommendation has been interesting. Many of the European Continental countries and South Africa adopted C.I.E. Document 12 as the basis of their national codes. Britain on the other hand had, two years previously, issued a revised edition of B.S. CP 1004 and in 1964 a specification, No. 1788 on street lanterns. CP 1004 is based on principles similar to the C.I.E. but is expressed in terms of the installation geometry and luminaire light output. BS 1788 covers luminaire design, both optical and mechanical. Shortly after the issue of the British recommendations, Australia drew up and published its Code CA.19, based to a large extent on the British recommendations.

The "American Standard Practice for Roadway Lighting" published in 1963 is based on average illumination and not on road surface luminance, i.e. the principal of "high and even road brightness". The large refractor bowls popular in the United States do not, with most light sources provide light distribution complying with the C.I.E. recommendations. It is peculiar that the Americans send a representative to practically all the meetings of Committee E.3.3.1 and approve their recommendations but make little attempt to adopt, or apply them, due probably to commercial considerations. Japan followed American practice in its recommendations, published in 1967.

Work is proceeding on the re-drafting of the C.I.E. document 12. The changes proposed include classification of road surfaces according to reflection characteristics, new methods of specifying uniformity and a new formula for the calculation of glare.

Road luminance depends on the reflecting characteristics of the road surface. These characteristics depend on "the degree of brightness", (Q_o) i.e. whether the road surface is light or dark and "the degree of specular reflection", ($\mathcal{R}$) i.e. the extent to which the road surface deviates in its reflection properties from a perfect diffuser. These factors can be measured and special equipment has been developed (1) to do this. It has been proposed that road surfaces be classified according to their values as follows :—

Group I	$\mathcal{R} < 0{,}22$	very diffuse asphalt roads.
Group II	$0{,}22 \leqslant \mathcal{R} < 0{,}33$	diffuse asphalt and rough concrete roads.
Group III	$0{,}33 \leqslant \mathcal{R} < 0{,}44$	moderate texture roads
Group IV	$0{,}44 \leqslant \mathcal{R} < 0{,}55$	fine surface texture roads.
Group V	$\mathcal{R} \geqslant 0{,}55$	smooth asphalt and tar roads.

Average road surface luminance $\bar{L}$ can be calculated from this formula :

$$\bar{L} = \eta_L \frac{\Phi}{W \cdot S}$$

Where η_L is the luminance yield for a given luminaire with a road surface of average luminance factor q_o and specular factor s and a given observer position (as shown in fig. 1).

Φ is the luminous flux from the lamp.

W is the width of the road.

S is the spacing.

To assist designers one manufacturer now publishes iso-luminance diagram for each luminaire based on four representative types of road surfaces :

Asphalt with white aggregates	($q_o = 0{,}105$ $s = 0{,}23$)
Concrete	($q_o = 0{,}101$ $s = 0{,}29$)
Non-skid rock asphalt	($q_o = 0{,}066$ $s = 0\,36$)
Smooth asphalt	($q_o = 0{,}66$ $s = 0{,}60$)

The uniformity of luminance over the complete road surface must also be defined. Proposals have been submitted but these are still being considered. The important aspect of luminance is however, that it should change slowly without any significant variations in the rate change.

The restrictions proposed on the amount of glare in an installation are limited to discomfort glare on the principle that disability glare is negligible if discomfort glare is bearable (3). Following extensive experimentation by de Boer and Schreuber (4) the proposed formula for the calculation of disability glare is :

$$G = 13{,}82 - 3{,}31 \operatorname{Log} I_{80} + 0{,}97 \operatorname{Log} \bar{L} + 4{,}41 \operatorname{Log} h'$$
$$+ 0{,}65 \operatorname{Log}\left\{\frac{I_{80}}{I_{88}} - 0{,}9\right\} + \operatorname{Log} F - 1{,}46 \operatorname{Log} p + K$$

where G=a number on a glare scale ranging from G=1 for "unbearable" glare to G=9 for "unnoticeable" glare.

I_{80} = Luminaire intensity in candelas at 80° from the downward vertical.

I_{88} = Luminaire intensity in candelas at 88° from the downward vertical.

I = Average road luminance in candelas per sq.m

h = Difference in height between observer's eyes and luminaire in metres.

F = Flashed area in sq. metres of luminaire as seen at 80°.

p = number of luminaires per kilometre.

K = Colour factor (0 for incandescent, tubular fluorescent and high pressure sodium +0,4 for low pressure sodium and −0,1 for colour corrected mercury)

Although long, the formula is fairly simple to apply. It could be a tedious exercise however to apply it to every type and make of luminaire offered for a lighting scheme, particularly if various layouts are to be considered at the same time. Graphical methods of obtaining the glare number are available and such an exercise is illustrated in fig. 2 (5).

If the above proposals are accepted, the present definitions of luminaire distribution (cut-off, semi-cut-off and non-cut-off) would disappear and the light distribution would be only one factor in the overall design of the installation.

Up until the end of the last World War the fundamental work on street lighting had been done in Britain and all the great names in the lighting world were British. From about 1960, for various reasons the amount of research into street lighting in Britain has markedly declined. At the same time many organisations on the Continent of Europe, particularly in Holland and Germany, have increased their efforts in this field. A tremendous amount of money has been spent on elaborate and imposing laboratories and the influence and leadership in the field of street lighting has swung across to these countries. It was therefore inevitable that the ideas and results of research of Continental members should have had such a strong influence on the recommendations of the C.I.E.

Recently a lot of work has been put into the study of Document 12 by British members with reference to their B.S. code. It has been found that many installations in Britain designed to the code complied with the C.I.E. recommendations with regard to road luminance but fell short of the proposed glare standards. At Barcelona last year serious objections were raised to the proposed revisions by the British members. These objections can be summarised as follows :

1. Carriageway luminance is not a constant factor. The characteristics of any road surface change with wear, repair, moisture, dirt, rubber and oil deposits on it. Thus a lighting installation designed for conditions today can vary considerably within a period of less than 12 months due to wear and within hours due to the presence of rain, dew or other moisture on the surface.

   Any simple method of road surface classification is completely impractical. Road surfaces with the same nominal specifications have been found to have luminance factors varying from 1,8 to 150 immediately after laying.

2. The glare formula is unrealistic for the following reasons :

(a) No account is taken of the luminance of the background to the roadway which is fundamental to the judgement of glare.

(b) Technically identical instal'ations do not yield the same glare mark from the formula.

(c) It is difficult to determine certain values in the formula.

3. The administration of concrete based on the C.I.E. proposals become extremely complex.

4. The design of street lighting installations is becoming too complicated and necessitates a lot of local research into factors such as road surface characteristics. The facilities to do this are not available to the majority of public lighting engineers.

5. The final measurement of the results can only be carried out by means of sophisticated and expensive instruments.

6. The additional expenditure due to the closer spacing of luminaries necessitated by the sharp cut-off angles of continental luminaries cannot always be justified.

An excellent paper on this subject, by Mainwaring (6) was presented to the British Association of Public Lighting Engineers in September 1971.

It is a point of conjecture whether some of the practical difficulties raised by Britain have not also been the reasons why many South African engineers have not given their full support to the S.A.B.S. code. There are many new South African installations of street lightiing which have been designed on illumination levels or by some other preferred method which differs from the recommendations of the S.A.B.S. It would be timely and of great interest and value if all engineers in South Africa dealing with street lighting design were to study the implications of the present S.A.B.S. code in relation to the proposed amendments to C.I.E. Document 12 and in the light of their experience to record their findings.

In the meantime it was decided at Barcelona that all members of C.I.E. would carry out further experiments and investigations into the proposed amendments and try to come to some satisfactory conclusion before the next international meeting in 1975. With the co-operation of authorities in South Africa this country could play a significant part in this work. Perhaps the South African National Committee on Illumination could be the liaison organisation in this survey which could have a great influence on the future of street lighting design in this country.

3. Lighting Equipment.

During the past five years many changes have occurred in the design of light sources, luminaires and other equipment associated with street lighting. It is not possible to cover all these factors in this paper and only possible to comment briefly on some aspects.

(a) Light Sources—The majority of discharge lamps used for street lighting have been with us for a number of years. However, lumen output, lumen maintenance life and colour rendering are being continually improved. Two new light sources which are having a great impact on street lighting design are now coming into more common usage. These are the Metal Halide and High Pressure Sodium lamps. The former has not yet been used to any extent in this country but a number of authorities have installations of the latter. With the use of new equipment there is the inevitable crop of teething troubles. Experience has now shown that lamps from different countries and even from the same manufacturer can have different characteristics. It is therefore not advisable to operate some lamps on the control gear of other manufacturers. Furthermore the effects of over or under voltage on the mains and temperature rise in the luminaires are far more critical than was originally realised. Attempts to use high pressure sodium lamps in luminaires designed for other light sources can also have serious consequences

(b) Luminaires—When the S.A.B.S. Code of Practice was published a number of manufacturers had to change the design of their luminaires or design new units to comply with the requirements expressed in the Code. The results of some of the earlier luminaires manufactured were nearly disastrous mechanically. Most manufacturers failed to install proper test facilities, and incomplete knowledge of the behaviour of some components under the conditions of heat generated by the larger wattage lamps led to most unfortunate results. Since then and following the issue of extremely tight specifications by some authorities, the standard of manufacture, if not the aesthetic appearance of luminaires has greatly improved. Local manufacturers still fall far behind their parent companies and overseas colleagues as far as research into local conditions and materials is concerned. For instance the effects of ultra-violet irradiation and atmospheric conditions on gaskets and plastic materials are not fully known and it looks as if the users will be compelled to conduct their own experiments if reliable information is to be obtained.

Manufacturers are now giving considerably more attention to such factors as ease of install-

ation and maintenance in luminaire design. Quality control does however remain a problem, and whenever a new luminaire is marketed troubles, such as ingress of moisture, incorrect sizes of terminal blocks and poorly fitting bowls seem to be inevitable. For this reason efforts are being made by responsible bodies including some manufacturers to get the S.A.B.S. to draw up a full specification for street lighting luminaires. However appointing a "policeman" is not the whole answer. Acceptance of a quality design and control philosophy by manufacturers is also necessary. The employment of qualified industrial designers by manufacturers to improve the appearance of luminaires is also sorely needed.

New material such as resin impregnated glass fibre and vandal resistant ultra-violet stabilised plastics are now being used very successfully by a few manufacturers thereby overcoming some of the earlier problems of weight and proneness to vandalism. Close (or sometimes regrettably not so close) copying of overseas produced luminaires is giving way to design of optical systems and other components more suitable to the requirements of the local market. Manufacturers are to be congratulated on the stand they are taking in this matter, particularly where in some cases, it has meant a lot of pursuasion to obtain the agreement of their overseas principals.

(c) Control Gear—Practically every type of control equipment for the operation of discharge lamps is now manufactured in South Africa. New companies have come into being and consequent increased competition in quality and price has provided a stimulant to the market. Once again standard specifications for quality of equipment are needed to ensure the standard remains as high as it is at the moment.

Some manufacturers have co-operated extremely well in the development of special control gear to cater for unusual requirements. On one section of Johannesburg's motorway a single phase 400 volt supply has been provided and control gear for operating 180 watt SOX lamps was specially designed and manufactured for this installation. This permitted the use of smaller section cables with a consequent saving in costs.

(d) Poles—Steel is still the most commonly used materail for poles for street lighting in South Africa. Concrete has been used to a lesser extent possibly due to fears of these poles fracturing under impact and causing secondary accidents and injuries. A number of attempts have been made by overseas manufacturers to introduce glass fibre poles into South Africa, but to date they have had little success. Wooden poles are used in some areas with overhead reticulation systems, but non-uniform diameters cause problems with the fixing of brackets and other components. Stainless steel and aluminium poles have not been used, except in a few special areas.

A number of experiments have been conducted overseas into the value of breakaway devices on poles (7) (8). It is obvious that poles do not cause accidents but can be a source of fatality or serious injury when hit by a vehicle.

Much research has been put into reducing the hazard of poles but unfortunately the complete solution to the problem has not yet been found. The severity of damage caused when a vehicle collides with a pole is dependent on the material and mass of the pole, the method of mounting and the speed and mass of the vehicle on impact. Break-away devices and sectional types of poles have proved successful under some circumstances but variations in the speed of impact and size of vehicle have produced unforeseeable results. Futhermore poles, or part of poles, being flung across other traffic lanes can cause secondary accidents involving innocent persons. It is generally agreed for the above reasons, that break-away devices should not be used in the central median of main roads or for mounting heights exceeding 12 metres.

In certain states of Canada and the U.S.A. concrete or direct buried street poles must be mounted at least 9 metres from the edge of motorways. This policy has created tremendous problems with regard to the mechanical design of poles and foundations. Furthermore, the quality of lighting on the roadway is reduced which itself may be the cause of other accidents.

From the local user's point of view there is still too much variation in the design and manufacture of pole components. Door locks differ from one manufacturer to another and some manufacturers offer two or three different designs. As proper security of components behind the doors is essential authorities are compelled to keep an unmanageable array of keys or tools to ensure access to all their poles. In addition there is no uniformity of length and diameters of spigots. It was proposed some years ago by the S.A.B.S. that a specification be drawn up to cover spigot sizes, but this has unfortunately never progressed any further. If and when a luminaire specification is published this could be incorporatd therein and would be a boon to pole and luminaire manufacturers and users alike.

Designs and shapes of poles differ considerably. Although uniformity of design is not advo-

cated here some consideration of the combined aesthetics of pole and luminaire would obviate the peculiar combinations seen in many parts of this country.

4. Lighting Techniques.

Many overseas techniques of lighting have been introduced to South Africa over the past five years. Some have been improved upon and some new techniques have evolved here. Amongst the latter is the axial medium form of lighting using specially designed poles and luminaires. This and other forms are discussed below.

(a) Axial Median Lighting—This form of lighting used mainly for motorways utilises special luminaires mounted over the median between the two carriageways with the luminaires mounted parallel to the axis of the roadway (9). In 1968 the first section of the Johannesburg motorway system was opened and this method of lighting employed. The fittings were specially designed to give the correct light distribution and were mounted on double stem poles. On subsequent sections a single stem pole was used and the long brackets mounted on a pivot so that the stems could be kept vertical and the brackets aligned parallel with the roadway, On long straight sections in industrial areas the same system is used but the luminaires are fastened to a catenary suspension.

The results have been good. The average road luminance obtained initially was 2,5 cd/m^2 (about 50% higher than that recommended in the S.A.B.S. code) with a diversity factor of 2.2.1. The average level of illumination was 35,5 lux giving an illumination to luminaire ratio of 14,8. This indicates surface characteristics closer to "light than "medium" which is usually accepted here for design purposes. Glare is negligible.

(b) High Mast Lighting—The lighting of complex interchanges on motorways becomes extremely complicated if the standard lighting system of 10-12m high poles mounted on the outside of carriageways is used. The forest of poles which would be needed would be unsightly and lighting patterns formed by luminaires incomprehensible. High mast lighting systems become the only solution. High light-output lamps 35 000 to 60 000 lumens, are mounted in clusters on 25-35m poles The number of poles and luminaires is considerably reduced compared with the standard system and the whole area of the interchange is illuminated, instead of only the roadways, thereby giving improved visibility.

All the poles, raising and lowering gear and, recently, luminaire components are now being manufactured locally and quality is comparable with similar equipment overseas. New developments include luminaires with adjustable optical systems to give asymetric light distribution as required to improve the utilisation of the luminous flux.

High mast lighting with floodlights has also been used for area lighting in Bantu townships.

(c) Intermediate Mast Lighting—The lighting of complex junctions and exceptionally wide roads has always been a problem. To enable a motorist to select his path quickly and safely, it is important that he sees the layout as it would appear in daytime. To do this, poles of 15-18m high are mounted in the road islands with clusters of luminaires arranged to give a high level of illumination over the whole area. Multi-lamp luminaires mounted on the sides of the road or back-to-back on the median of a dual-carriageway road provide good lighting where road widths exceed 25 metres.

(d) Low Level Lighting—Where roadways are built on structures it is possible to incorporate the lighting in the ballustrade. Mounting heights are generally in the order of 1m above road levels. Linear light sources such as sodium and fluorescent tubes are generally used mounted parallel to the roadway. Such installations exist in Cape Town Durban and near Howick and have much to recommend them from the aesthetic point of view. The main disadvantages are high initial cost, difficult maintenance and proneness to damage and vandalism. They are impractical from the lighting point of view for roads with more than two lanes.

(e) Tunnel Lighting—No tunnels have yet been lit in this country although one tunnel in Pretoria with lighting is due for opening in the near future. The techniques of providing adequate visibility in tunnels are complicated (10). Unlike normal street lighting tunnels must be lit by day and night and the requirements by day are by far the most stringent. It is important that a driver's eyes be adapted to the low levels of illumination in a tunnel by the time he is past the threshold. To accomplish this screens and/or other devices should be erected at the tunnel approach and particular attention paid to the avoidance of light coloured and high reflecting surfaces at the tunnel entrance. Inside, the levels of illumination must be considerably higher than by night particularly at the start of the transition zone, the area immediately inside the entrance to the tunnel. At dusk, lighting levels in the transition zone are reduced as daylight levels fall. It is unfortunate that tunnels are being built on a number of main roads in South Africa without any allowance for lighting or any

attempt being made to reduce threshold luminances. The sudden shock of plunging into a dark interior from bright sunlight is disconcerting to a driver and is a definite driving hazard.

(f) Residential Road Lighting—Lighting in these areas usually presents a number of problems. By far the greater proportion of roads in any town are residential, or Class B, roads, therefore the total cost of lighting to the recommended standard is high. As the lighting must be adequate to provide good visibility for drivers and pedestrians and be a deterrent against criminal activities, it should be more than a mere token installation. Following extensive investigations in Johannesburg (11) a luminaire distribution has been developed which will meet all the above requirements when mounted at 8m above the roadway at a spacing of 35m. Glare is slightly higher than is proposed by C.I.E. for this class of road, but from a survey taken it was not found to be excessive.

(g) Special Lighting—There comes a time in the life of most public lighting engineers when an architect will approach him with a request for the normal street lighting in front of his new building to be changed to a "more aesthetically suitable" design. Attempts have been made to install specially designed luminaires on the building itself or to manufacture special luminaires and even poles.

Laudable as the idea is from the aesthetic point of view, it is fraught with problems. It is usually impossible to achieve the same luminance distribution as on other stretches of the road and the provision of special supplies off street mains and the maintenance of luminaires often necessitates special equipment and maintenance personnel, and the stocking of non-standard spares.

In areas of civic importance it could however be justifiable but the ingenuity of the engineer and the skills of the architect may frequently be stretched to their limits to obtain a satisfactory soultion.

5. Conclusion.

It is obvious that considerable strides have been made in South Africa, during the past five years in street lighting design and equipment. Standards have improved and it can be said that our lighting engineers are playing a significant part in the fight to reduce road accidents and urban crime.

There still remains however, a lot to be done.

Firstly it is important that the whole country work to one code of practice when designing lighting. There is still too great a variety of luminaires being manufactured and sold which, in a country with a limited market increases costs unnecessarily.

No single authority has complete information on the reflection characteristics of its roads or the equipment to carry out the complicated calculations necessary to design on installation strictly to the C.I.E. recommendations. Therefore if a local code based on these recommendations cannot be applied simply and quickly by any electrical engineer, it is essential that a version is published based on geometric recommendations allied to luminaire distribution. This in no way belittles the value of the theoretical work being done by C.I.E. and lighting laboratories overseas, as this work could be the basis of local research into such aspects as characteristics of local road surfaces and tolerance to glare. From this could come a code acceptable to all in its method of application.

Secondly, if we are to have well designed lighting installations it is essential that we have well designed lighting equipment. Standard specifications are urgently needed to cover the electrical, mechanical and material requirements of luminaires. Manufacturers must also give greater consideration to such aspects as ease of installation, maintenance and aesthetics. Users too must play their part in maintaining records of results they obtain from their designs and from equipment they use, and make this available to manufacturers and other users alike.

Finally the time has now arrived when serious consideration must be given to the creation of a national lighting laboratory either as part of the National Institute for Road Research or as an independent unit sponsored by the manufacturers and users. It is important that research is conducted into the properties of road surfaces and deterioration of materials under local conditions. It is possible that with the high daylight levels of illumination in South Africa tolerance to glare may be higher than in Europe and the requirements for visual performance may differ according to locality and race. These factors can have considerable effect on standards of lighting and so offer ample scope for research.

It is only by applying the correct techniques and using the proper equipment that we can hope to reduce the appalling accident rate on our roads at night.

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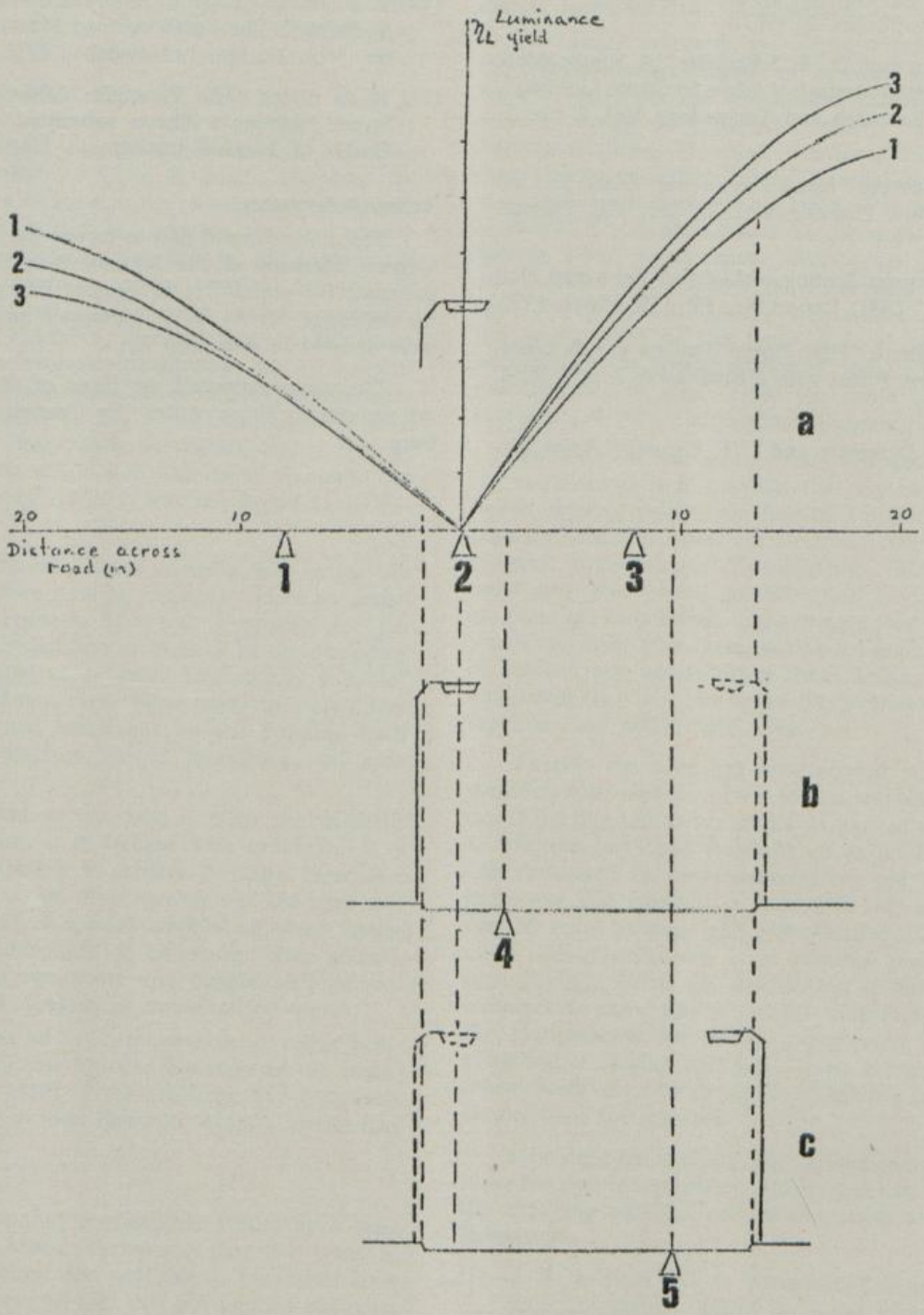

FIGURE 1—Installation design on the basis of dry road surface luminance.

(a) Luminance yield curve for a typical luminaire and road surface showing the three standard observer positions.

(b) Cross section of the road lined up so that the luminaire coincides vertically with the origin of the curves. The full line luminaire in this and (c) is that for which luminaire yield values are being read.

(c) Cross section of road dealing with the second line of luminaires.

4 and 5 Driver's viewing positions for (b) and (c).

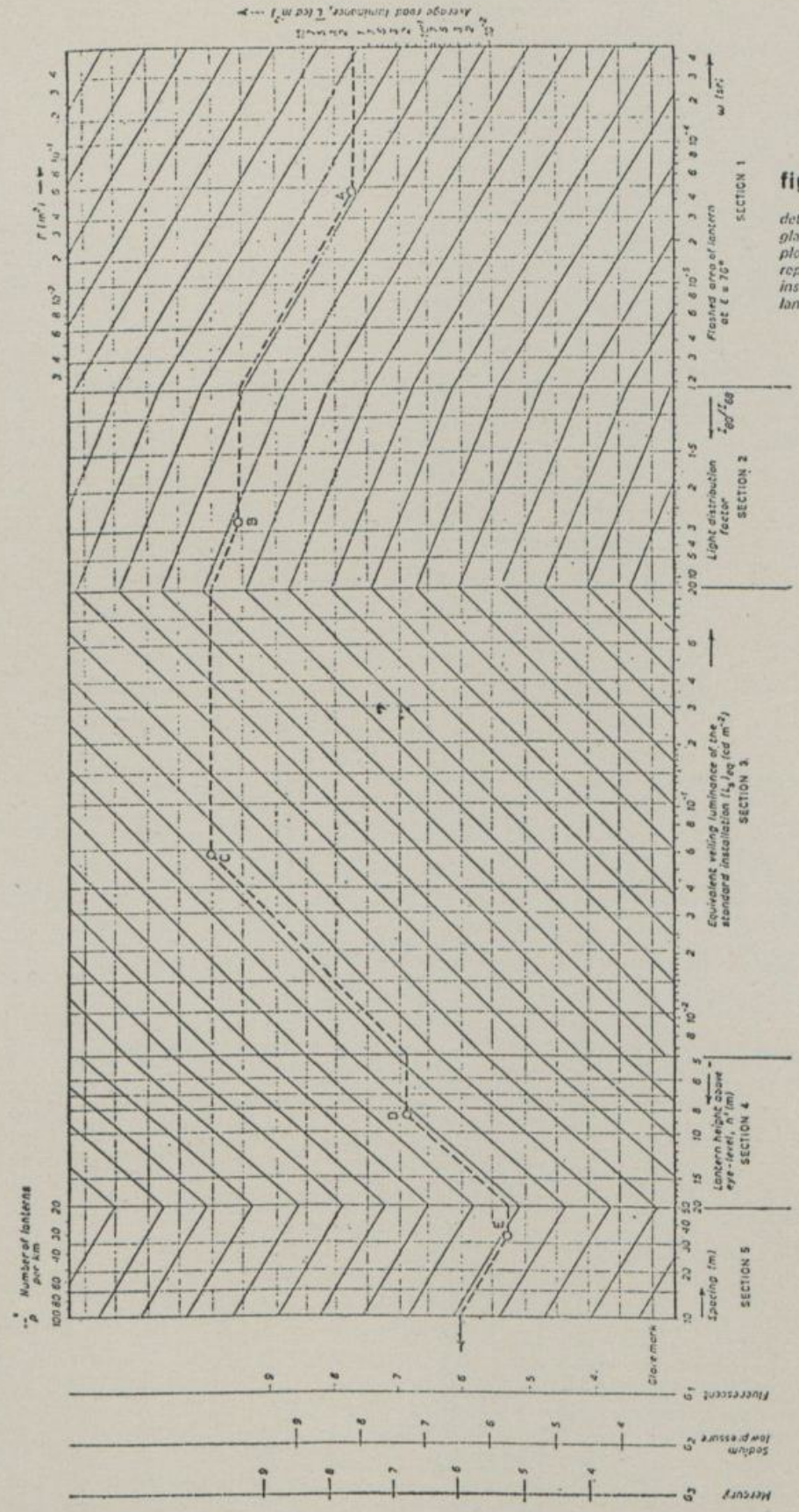

fig 2

Diagram for determining discomfort glare. The example plotted as broken lines represents a normal installation of cut-off lanterns

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