# PROCEEDINGS of the 35th CONVENTION

OF THE

## ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS OF SOUTHERN AFRICA

(FOUNDED 1915)

HELD AT

## LIVINGSTONE

## 1st to 4th MAY, 1961

# VERRIGTINGS van die 35ste KONVENSIE

VAN DIE

## VERENIGING VAN MUNISIPALE ELEKTRISITEITS-ONDERNEMINGS VAN SUIDELIKE AFRIKA

(GESTIG 1915)

GEHOU TE

## LIVINGSTONE

## 1 tot 4 MEI, 1961

# VERRIGTINGS van die 35ste KONVENSIE

VAN DIE

## VERENIGING VAN MUNISIPALE ELEKTRISITEITS-ONDERNEMINGS VAN SUIDELIKE AFRIKA

(GESTIG 1915)

GEHOU TE

## LIVINGSTONE

## 1 tot 4 MEI, 1961

# PROCEEDINGS of the 35th CONVENTION

OF THE

## ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS OF SOUTHERN AFRICA

(FOUNDED 1915)

HELD AT

## LIVINGSTONE

## 1st to 4th MAY, 1961

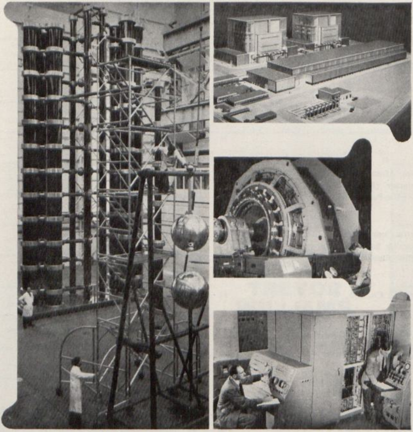
## CONTENTS/INHOUD



## PAPERS/REFERATE:

## LIST OF ADVERTISERS

## LYS VAN ADVERTEERDERS



# PERSONAL INDEX
# PERSOONLIKE INHOUD

EXECUTIVE COMMITEE 1961/1962.

*Front Row*: R. W. Kane (Johannesburg), Clr. R. H. Main (Johannesburg), P. A. Giles (East London), C. Lombard (Germiston) President, R. M. O. Simpson (Durban), Clr. J. Northcote (East London), Clr. W. Nagle (Durban), Clr. J. Paintin (Germiston).

*Second Row*: W. Beesley (Livingstone), Clr. W. Meyer (Welkom), G. J. Muller (Bloemfontein), R. G. Ewing (Secretary), Clr. J. J. Hoffman (Krugersdorp), J. L. van der Walt (Krugersdorp), J. E. Mitchell (Salisbury), J. C. Downey (Springs).

*Third Row*: Clr. D. R. Meyer (Springs), Clr. P. van der Linde (Bloemfontein), J. C. Waddy (Pietermaritzburg), M. P. P. Clarke (Somerset East), Clr. W. T. M. Mills (Salisbury).

*Back Row*: Clr. R. Brown (Livingstone), Clr. W. J. Peters (Cape Town), R. W. Barton (Welkom), C. G. Downie (Cape Town).

# PRESIDENT 1961/62

MR. C. LOMBARD.

Die VERENIGING van MUNISIPALE ELEKTRISITEITSONDERNEMINGS van SUIDELIKE AFRIKA

## EXECUTIVE COUNCIL/UITVOERENDE RAAD 1961/62

*President:*
C. Lombard (Germiston)

*Vice-President/Vise-President:*
P. A. Giles (East London)

*Immediate Past Presidents/Voormalige Presidente:*
R. M. O. Simpson (Durban)
R. W. Kane (Johannesburg)

*Engineer Members/Ingenieur Lede:*

| | | |
|---|---|---|
| C. G. Downie (Cape Town) | J. E. Mitchell (Salisbury) | G. J. Muller (Bloemfontein) |
| J. L. van der Walt (Krugersdorp) | J. C. Downey (Springs) | R. W. Barton (Welkom) |

*Cities or Towns Represented/Stede of Dorpe Verteenwoordig:*

| | | | | |
|---|---|---|---|---|
| Johannesburg | Cape Town | Salisbury | Bloemfontein | Springs |
| Durban | Krugersdorp | Welkom | East London | Germiston |

*Chairmen of Regional Branches/Voorsitters van Streektakke:*

Natal: J. C. Waddy (Pietermaritzburg) (to 2nd October, 1961).
W. Rush (Vryheid) (from 2nd October, 1961).

Cape Eastern: M. P. P. Clarke (Somerset East) (to 6th October, 1961).
G. R. Beard (Grahamstown) (from 6th October, 1961).

*Secretaries/Sekretarisse:*
Davidson & Ewing (Pty.) Ltd.
P.O. Box 7462, Johannesburg.

## SUB-COMMITTEES/ONDER-KOMITEES:

| | |
|---|---|
| *Papers/Verhandelings* | C. Lombard (President), P. A. Giles (Vice-President), R. M. O. Simpson, R. W. Kane (Past Presidents) and the President anticipated to be elected in 1963. |
| *Finance/Finansiële* | R. W. Kane (Convenor), J. C. Downey. |
| *Recommendations Committee for new Electrical Commodities/Aanbevelings oor Nuwe Elektriese Toerustings* | J. L. van der Walt (Convenor), J. C. Downey. |
| *Rights of Supply—Industrial Consumers/Regte van Voorsiening—Industriële Verbruikers* | C. Lombard (Convenor), D. J. Hugo, J. C. Downey, P. A. Giles. |
| *Non-European Supplies Committee/Nie-Blanke Voorsiening Komitee* | R. W. Kane, J. E. Mitchell. |

*Representatives/Verteenwoordigers:*

| | |
|---|---|
| *Electrical Wiremen's Registration Board/Raad vir Registrasie van Draadwerkers* | R. W. Kane |
| *Wiring Regulations Committee/Bedrading Regulasies Komitee* | J. C. Downey, J. L. van der Walt (Alternate). |
| *S.A. Bureau of Standards/S.A. Buro van Standaarde* | J. C. Downey, C. Lombard (Alternate). |
| *S.A. National Committee of the International Electrotechnical Commission/S.A. Nationale Komitee van die Internasionale Elektrotegniese Kommissie* | D. J. Hugo, J. Wilson (Alternate). |
| *S.A.I.E.E. Committee to revise the Code of Practice for Overhead Lines for conditions prevailing in South Africa* | C. Lombard, J. L. van der Walt (Alternate). |

## PAST OFFICERS AND MEMBERS OF COUNCIL:
## OUD-AMPTENARE EN LEDE VAN RAAD:

| | *Past Presidents/Oud-Presidente:* | *Secretary and Treasurer/Sekretaris en Tesourier:* |
|---|---|---|
| 1915-17 | J. H. Dobson, Johannesburg* | F. T. Stokes; E. T. Price |
| 1917-19 | J. Roberts, Durban* | E. Poole* |
| 1919-20 | B. Sankey, Port Elizabeth* | E. Poole* |
| 1920-22 | T. C. W. Dod, Pretoria* | L. L. Horrell* |
| 1922-24 | G. H. Swingler, Cape Town* | H. A. Eastman |
| 1924-26 | J. Roberts, Durban* | E. Poole* |
| 1926-27 | B. Sankey, Johannesburg* | R. G. Tresise |
| 1927-29 | J. M. Lambe, East London* | P. Adkins |
| 1929-31 | R. Macauley, Bloemfontein* | E. Poole* |
| 1931-33 | L. L. Horrel, Pretoria* | E. Poole* |
| 1933-34 | L. F. Bickell, Port Elizabeth* | F. A. P. Perrow |
| 1934-35 | A. R. Metelerkamp, Bulawayo* | E. Poole* |
| 1935-36 | G. G. Ewer, Pietermaritzburg | E. Poole* |
| 1936-37 | A. Rodwell, Johannesburg* | E. Poole* |
| 1937-38 | J. H. Gyles, Durban* | E. Poole* |
| 1938-39 | H. A. Eastman, Cape Town | E. Poole* |
| 1939-44 | I. J. Nicholas, Umtata | E. Poole until Dec., 1940* |
| 1944-45 | A. Rodwell, Johannesburg* | L. L. Horrell, Jan., 1941* |
| 1945-46 | J. S. Clinton, Salisbury<br>J. W. Phillips, Bulawayo | L. L. Horrell*<br>L. L. Horrell to Nov., 1945* |
| 1946-47 | G. J. Muller, Bloemfontein | A. T. Taylor, Dec., 1945* |
| 1947-48 | C. Kinsman, Durban | A. T. Taylor* |
| 1948-49 | A. Foden, East London | A. T. Taylor* |
| 1949-50 | D. A. Bradley, Port Elizabeth | A. T. Taylor* |
| 1950-51 | C. R. Hallé, Pietermaritzburg | A. T. Taylor* |
| 1951-52 | J. C. Downey, Springs | A. T. Taylor* |
| 1952-53 | A. R. Sibson, Bulawayo | A. T. Taylor* |
| 1953-54 | J. C. Fraser, Johannesburg | A. T. Taylor* |
| 1954-55 | G. J. Muller, Bloemfontein | A. T. Taylor* |
| 1955-56 | D. J. Hugo, Pretoria | A. T. Taylor to 30th June, 1955* |
| 1956-57 | J. E. Mitchell, Salisbury | Arthur Tingey, Ewing & Co., 1st July, 1955.<br>Davidson & Ewing (Pty.) Ltd., 1st July, 1956. |
| 1957-58 | J. L. van der Walt, Krugersdorp | Davidson & Ewing (Pty.) Ltd. |
| 1958-59 | C. G. Downie, Cape Town | Davidson & Ewing (Pty.) Ltd. |
| 1959-60 | R. W. Kane, Johannesburg | Davidson & Ewing (Pty.) Ltd. |
| 1960-61 | R. M. O. Simpson, Durban | Davidson & Ewing (Pty.) Ltd. |

*Deceased/Oorlede**

*All correspondence to be addressed to:*
THE SECRETARIES
DAVIDSON & EWING (Pty.) LTD.
P.O. BOX 7462, JOHANNESBURG
Telegrams and Cables: "Minute" Tel.: 835-7286

*Rig alle korrespondensie aan:*
DIE SEKRETARISSE
DAVIDSON & EWING (Pty.) Ltd.
POSBUS 7462, JOHANNESBURG
Telegramme: „Minute" Tel.: 835-7286

## LIST OF MEMBERS/LYS VAN LEDE 30-6-61

### HONORARY MEMBERS/ERE-LEDE

1957 (1944) Bradley, D. A., 9, Target Kloof Road, Port Elizabeth (Past President).
1960 Castelyn, F. J. C., 1a Arboretum Avenue, Bloemfontein.
1951 (1922) Eastman, H. A., Torwood, Parel Vallei, Somerset West, C.P.
1958 (1931) Ewer, Col. G. G., 174, Edmonds Road, Durban (Past President).
1960 Davies, L. P., 49, Union Street, Springs.
1955 (1944) Fraser, J. C., 26, Grace Road, Mountain View, Johannesburg (Past President).
1958 (1938) Foden, A., 4, Hardy Road, Selborne, East London (Past President).
1958 (1944) Hallé, C. R., P.O. Box 399, Pietermaritzburg (Past President).
1954 (1938) Kinsman, C., 7, Highgate Place, Durban North (Past President).
1956 (1939) Milton, W. H., c/o. Electricity Supply Commission, P.O. Box 1091, Johannesburg.
1956 Jaffray, A. Morton (Alderman), 8, Fairbridge Avenue, Salisbury.
1945 (1924) Rodwell, A. T., "Miranda," Oxford Road, Parktown, Johannesburg (Past President).
1956 Young, C. E. K., 6, Lexdon Circle, Pietermaritzburg.

### COUNCIL MEMBERS/RAADSLEDE

1946 (1917) Aliwal North, C.P., Municipality, P.O. Box 46.
1948 (1934) Alberton, Tvl., Municipality, P.O. Box 4.
1948 Barberton, Tvl., Municipality, P.O. Box 33.
1935 (1926) Beaufort West, C.P., Municipality, P.O. Box 9.
1935 (1917) Benoni, Tvl., Municipality, P.O. Box 45.
1950 (1919) Bethal, Tvl., Municipality, P.O. Box 3.
1944 (1915) Bethlehem, O.F.S. Municipality, P.O. Box 130.
1939 (1917) Bloemfontein, O.F.S., City Council, P.O. Box 288.
1936 (1915) Boksburg, Tvl., Town Council, P.O. Box 215.
1945 (1927) Brandfort, O.F.S., Municipality, P.O. Box 13.
1938 (1927) Bulawayo, S.R., City Council, P.O. Box 591.
1947 Butterworth, Transkei, Municipality, P.O. Box 36.
1948 Brakpan, Tvl., Town Council, P.O. Box 15.
1948 Brits, Tvl., Town Council, P.O. Box 106.
1949 Bothaville, O.F.S., Municipality, P.O. Box 12.
1937 Burgersdorp, C.P., Municipality, P.O. Box 13.
1935 (1915) Cape Town, C.P., City Council, P.O. Box 298.
1935 (1916) Cradock, C.P., Municipality, P.O. Box 24.
1949 Ceres, C.P., Municipality, P.O. Box 44.
1960 Carletonville, Tvl., Municipality, P.O. Box 3.
1953 (1933) De Aar, C.P., Municipality, P.O. Box 42.
1946 Delmas, Tvl., Village Council, P.O. Box 6.
1935 (1915) Durban, Natal, City Council, P.O. Box 147.
1953 Dewetsdorp, O.F.S., Municipality, P.O. Box 13.
1935 (1919) East London, C.P., City Council, P.O. Box 134.
1936 (1916) Ermelo, Tvl., Municipality, P.O. Box 48.
1935 Eshowe, Zululand, Town Board, P.O. Box 37.
1948 Edenvale, Tvl., Town Council, P.O. Box 25.
1952 Estcourt, Natal, Borough, P.O. Box 15.
1957 Empangeni, Natal, Town Board, P.O. Box 2.
1935 (1927) Fort Beaufort, C.P., Municipality, P.O. Box 36.
1936 (1934) Gatooma, S.R., Municipality, P.O. Box 114.
1936 (1924) Grahamstown, C.P., City Council, P.O. Box 176.
1947 (1915) Greytown, Natal, Borough, P.O. Box 71.
1935 (1934) Graaff-Reinet, C.P., Municipality, P.O. Box 71.
1952 Germiston, Tvl., City Council, P.O. Box 145.
1948 (1915) Harrismith, O.F.S., Municipality, P.O. Box 43.

1949 Heidelberg, Tvl., Municipality, P.O. Box 201.
1959 Hermanus, C.P., Municipality, P.O. Box 20.

1935 (1915) Johannesburg, Tvl., City Council, P.O. Box 1049.

1952 Kempton Park, Tvl., Municipality, P.O. Box 13.
1935 (1917) Kimberley, C.P., City Council, P.O. Box 194.
1935 (1916) Klerksdorp, Tvl., Municipality, P.O. Box 160.
1935 (1934) Kokstad, E.G., Municipality, P.O. Box 8.
1951 Komgha, C.P., Municipality, P.O. Box 21.
1945 (1916) Kroonstad, O.F.S., Municipality, P.O. Box 302.
1935 (1917) Krugersdorp, Tvl., Town Council, P.O. Box 94.
1954 Kenhardt, C.P., Municipality, P.O. Box 15.
1960 Knysna, C.P., Municipality, P.O. Box 21.

1935 (1915) Ladysmith, Natal, Borough, P.O. Box 29.
1945 Louis Trichardt, Tvl., Municipality, P.O. Box 96.
1948 Livingstone, N.R., Municipality, P.O. Box 29.
1937 (1927) Ladybrand, O.F.S., Municipality, P.O. Box 64.
1959 Lydenburg, Tvl., Municipality, P.O. Box 61.

1935 (1926) Mafeking, Bech'd., Municipality, P.O. Box 42.
1935 Matatiele, E.G., Municipality, P.O. Box 35.
1939 (1929) Middelburg, C.P., Municipality P.O. Box 55.
1935 (1926) Middelburg, Tvl., Municipality, P.O. Box 14.
1954 (1929) Mossel Bay, Municipality, P.O. Box 25.

1945 Nelspruit, Tvl., Municipality, P.O. Box 45.
1948 (1915) Newcastle, Natal, Borough, P.O. Box 21.
1944 N'Dola, N.R., Municipality, P.O. Box 197.
1936 Nigel, Tvl., Municipality, P.O. Box 23.

1948 Odendaalsrus, O.F.S., Municipality, P.O. Box 21.
1959 Orkney, Tvl., Health Committee, P.O. Box 34.
1944 (1915) Oudtshoorn, C.P., Municipality, P.O. Box 255.

1935 (1926) Paarl, C.P., Municipality, P.O. Box 12.
1935 (1920) Pietersburg, Tvl., Municipality, P.O. Box 111.
1935 (1915) Pietermaritzburg, Natal City Council, P.O. Box 321.
1936 Piet Retief, Tvl., Municipality, P.O. Box 23.
1936 (1934) Port Alfred, C.P., Municipality, P.O. Box 13.
1935 (1915) Port Elizabeth, C.P., City Council, P.O. Box 116.
1936 Port Shepstone, Natal, Borough, P.O. Box 5.
1948 (1915) Potchefstroom, Tvl., Municipality, P.O. Box 113.
1944 Potgietersrust, Tvl., Municipality, P.O. Box 34.
1935 (1915) Pretoria, Tvl., City Council, P.O. Box 440.
1951 Parys, O.F.S., Municipality, P.O. Box 39.
1953 Postmasburg, C.P., Municipality, P.O. Box 5.
1959 Peri-Urban Areas Health Board, P.O. Box 1341, Pretoria.

1935 (1915) Queenstown, C.P., Municipality, P.O. Box 113.
1948 Que Que, S.R., Municipality, P.O. Box 15.

1935 (1929) Randfontein, Tvl., Municipality, P.O. Box 139.
1935 (1929) Robertson, C.P., Municipality, P.O. Box 52.
1935 (1926) Roodepoort-Maraisburg, Tvl., Municipality, P.O. Box 217, Roodepoort.
1944 (1920) Rustenburg, Tvl., Municipality, P.O. Box 16.
1956 Riversdale, C.P., Municipality, P.O. Box 29.
1957 Rouxville, O.F.S., Municipality, P.O. Box 8.

1935 (1926) Salisbury, S.R., City Council, P.O. Box 990.
1956 Sasolburg, O.F.S., Village Board, P.O. Box 60.
1935 (1916) Somerseat East, C.P., Municipality, P.O. Box 21.
1935 (1916) Springs, Tvl., Town Council, P.O. Box 45.
1935 (1931) Springfontein, O.F.S., Municipality, P.O. Box 10.
Stanger, Natal, Borough, P.O. Box 72.
1938 (1916) Stellenbosch, C.P., Municipality, P.O. Box 17.
1948 (1927) Somerset West, C.P., Municipality, P.O. Box 19.
1935 (1915) Standerton, Tvl., Municipality, P.O. Box 66.
1959 Stilfontein, Tvl., Health Committee, P.O. Box 20.
1959 Stutterheim, C.P. Municipality, P.O. Box 2.

1959 (1927) Tarkastad, C.P., Municipality.
1949 The Strand, C.P., Municipality, P.O. Box 3.
1957 Tzaneen, Tvl., Village Board, P.O. Box 24.

1936 (1920) Uitenhage, C.P., Municipality, P.O. Box 45.
1936 (1927) Umtata, Tembuland, Municipality, P.O. Box 57.
1935 (1927) Umtali, S.R., Municipality, P.O. Box 121.

1960 Vanderbijlpark, Tvl., Municipality, P.O. Box 3.
1949 Ventersdorp, Tvl., Municipality, P.O. Box 15.
1935 Vereeniging, Tvl., Municipality, P.O. Box 35.
1955 Virginia, O.F.S., Village Board of Management, P.O. Box 156.
1947 (1929) Vrede, O.F.S., Municipality, P.O. Box 155.
1935 Vryburg, C.P., Municipality, P.O. 35.
1948 (1920) Vryheid, Natal, Borough, P.O. Box 57.

1960 White River, E. Tvl., Village Council, P.O. Box 2.

1935 (1934) Walmer, C.P., Municipality, P.O. Box 5010, Walmer.
1955 Warmbaths, Tvl., Municipality, P.O. Box 48.
1956 Wellington, C.P., Municipality, P.O. Box 12.
1953 Welkom, O.F.S., Village Board, P.O. Box 708.
1953 Westonaria, Tvl., Municipality, P.O. Box 19.
1946 Willowmore, C.P., Municipality, P.O. Box 15.
1944 (1919) Winburg, O.F.S., Municipality, P.O. Box 26.
1945 (1924) Windhoek, S.W.A., Municipality, P.O. Box 59.
1955 (1927) Witbank, Tvl., Municipality, P.O. Box 3.
1936 (1922) Worcester, C.P., Municipality, P.O. Box 37.
1960 Walvis Bay, Village Council, P.O. Box 2.

Dates in brackets initial membership as or by Engineer. Membership not necessarily continuous.

## ENGINEER MEMBERS/INGENIEUR-LEDE

1949 Asselbergs, P. C., Town and Elec. Eng., P.O. Box 21, Empangeni, Natal.
1947 Aalbers, G., Municipal Electrical Engineer, P.O. Box 12, Wellington, C.P.
1939 Adams, C. H., Municipal Electrical Engineer, P.O. Box 19, Somerset West, C.P.

1960 Bozyczko, W., Municipal Electrical Engineer, P.O. Box 25, Edenvale, Tvl.
1959 Beard, G. R., City Electrical Engineer, P.O. Box 176, Grahamstown, C.P.
1948 Barratt, V. E. O., Municipal Electrical Engineer, P.O. Box 113, Queenstown, C.P.
1948 Barton, R. W., Electrical Engineer, P.O. Box 708, Welkom, O.F.S.
1957 Beesley, W., Town Electrical Engineer, P.O. Box 29, Livingstone, N.R.
1956 Benson, T., Town Electrical Engineer, P.O. Box 35, Matatiele, E.G.
1957 Booysen, L., Town and Electrical Engineer, P.O. Box 155, Vrede, O.F.S.
1949 Brown, D. D., Municipal Electrical Engineer, P.O. Box 217, Roodepoort, Tvl.
1956 Bellingan, G. F., Town Electrical Engineer, P.O. Box 59, Windhoek, S.W.A.
1959 Botes, P. J., Assistant Electrical Engineer, P.O. Box 217, Roodepoort, Tvl.
1959 Billington Eales, A., Town Electrical Engineer, P.O. Box 2, Stutterheim, C.P.
1960 Boshoff, J. J., Electrical Engineer, P.O. Box 44, Ceres, C.P.

1955 Clarke, M. P. P., Municipal Electrical Engineer, P.O. Box 21, Somerset East, C.P.
1948 Cherry, J. R., Municipal Electrical Engineer, P.O. Box 139, Randfontein, Tvl.
1954 Coetzee, F. J., Electrical Engineer, P.O. Box 21, Evaton, Tvl.
1947 Cowley, B. W., Municipal Electrical Engineer, P.O. Box 33, Barberton, Tvl.
1946 Craig, J. S., Borough Electrical Engineer, P.O. Box 21, Newcastle, Natal.

1950 Dreyer, L., Municipal Electrical Engineer, P.O. Box 19, Westonaria, Tvl.
1957 Dunstan, R. S., Deputy City Electrical Engineer, P.O. Box 369, Port Elizabeth, C.P.
1956 Dawson, J. D., Municipal Electrical Engineer, P.O. Box 45, Uitenhage.
1955 De Villiers, E. E., Municipal Electrical Engineer, P.O. Box 3, Carletonville, Tvl.
1954 De Villiers, S. de V., Municipal Electrical Engineer, P.O. Box 52, Robertson, C.P.
1945 De Wet, D. P., Municipal Electrical Engineer, P.O. Box 15, Willowmore, C.P.
1944 Downey, J. C., Town Electrical Engineer, P.O. Box 45, Springs, Tvl. (Past President).
1947 Downie, C. G., City Electrical Engineer, P.O. Box 82, Cape Town, C.P. (Past President).
1957 Dreyer, H. C., Assistant Electrical Engineer, P.O. Box 94, Krugersdorp, Tvl.
1959 Durr, H. R., Electrical Engineer, Peri-Urban Areas Health Board, P.O. Box 1341, Pretoria, Tvl.

1950 Erikson, J. G. F., Borough Electrical Engineer, P.O. Box 15, Estcourt, Natal.

1944 Fisher, K. M., Municipal Electrical Engineer, P.O. Box 551, Bethlehem, O.F.S.
1952 Futcher, L., Municipal Electrical Engineer, P.O. Box 13, Kempton Park, Tvl.
1957 Fohren, H., Borough Electrical Engineer, P.O. Box 37, Eshowe, Zululand.
1961 Frantz, A. C. T., Assistant City Electrical Engineer, P.O. Box 82, Cape Town.

1945 Gericke, J. M., Municipal Electrical Engineer, P.O. Box 99, Klerksdorp.
1939 Giles, P.A., City Electrical Engineer, P.O. Box 529, East London, C.P.
1936 Grandin, P.C., Municipal Electrical Engineer, P.O. Box 114, Gatooma, S.R.
1960 Gresse, U. B., Town Electrical Engineer, P.O. Box 45, Nelspruit, Tvl.
1944 Gripper, H. J., Municipal Electrical Engineer, P.O. Box 21, Knysna, C.P.

1954 Hafele, C. F., Deputy City Electrical Engineer, P.O. Box 288, Bloemfontein, O.F.S.
1953 Haig-Smith, D., Municipal Electrical Engineer, P.O. Box 55, Middelburg, C.P.
1949 Halliday, K. W. J., Municipal Electrical Engineer, P.O. Box 5, Port Shepstone, Natal.
1927 Harvey, A. Q., Town Electrical Engineer, Warmbaths, Tvl.
1949 Hattingh, J. D., Municipal Electrical Engineer, P.O. Box 8, Rouxville, O.F.S.
1953 Hatwich, A. H. J., Town and Electrical Engineer, P.O. Box 13, Dewetsdorp, O.F.S.
1953 Heunis, G. B., Town and Electrical Engineer, P.O. Box 66, Standerton, Tvl.
1956 Hobbs, I. L., Town Electrical Engineer, P.O. Box 156, Virginia, O.F.S.
1938 Hugo, D. J., City Electrical Engineer, P.O. Box 423, Pretoria, Tvl. (Past President).

1944 Inglis, J. I., Town Electrical and Water Engineer, P.O. Box 111, Pietersburg, Tvl.

1933 Jones, G. E. H., Municipal Electrical Engineer, P.O. Box 42, Mafeking, Bechuanaland.
1959 Jooste, R. K., Municipal Electrical Engineer, P.O. Box 255, Oudtshoorn.

1946 Kane, R. W., General Manager, Electricity Department, P.O. Box 699, Johannesburg (Past President).
1949 Kirberger, M. N., Town Engineer, P.O. Box 3, Bethal, Tvl.
1949 Kruger, M. J. C., Municipal Electrical Engineer, P.O. Box 13, Port Alfred, C.P.
1959 Koeslag, H. J., Electrical Engineer, P.O. Box 29, Riversdale, C.P.

1931 Lategan, J. F., Town Electrical Engineer, P.O. Box 17, Stellenbosch, C.P.
1953 Lees, D., Town Electrical Engineer, P.O. Box 45, Benoni, Tvl.
1944 Leishman, R., Deputy General Manager, Electricity Department, P.O. Box 699, Johannesburg.
1956 Lewis, L., Town Electrical Engineer, P.O. Box 25, Mossel Bay, C.P.
1947 Lombard, C., City Electrical Engineer, P.O. Box 145, Germiston, Tvl. (President).
1944 Lotter, G. A., Town Electrical Engineer, P.O. Box 96, Louis Trichardt, Tvl.
1955 Lynch, E. C., Assistant City Electrical Engineer, P.O. Box 73, Salisbury, S.R.

1953 Macques, J. A., Municipal Electrical Engineer, P.O. Box 42, De Aar, C.P.
1948 McIntyre, H. A., Asst. Town Elec. Eng., P.O. Box 35, Vereeniging.
1948 Mathews, J. A., City Electrical Engineer, P.O. Box 194, Kimberley, C.P.
1945 Meintjies, P. A., Municipal Electrical Engineer, P.O. Box 16, Rustenburg, Tvl.
1948 Mitchell, J. E., City Electrical Engineer, P.O. Box 73, Salisbury, S.R. (Past President).
1929 Mocke, T. M., Town and Electrical Engineer, P.O. Box 23, Piet Retief, Tvl.
1934 Muller, G. J., City and Electrical Engineer, P.O. Box 288, Bloemfontein, O.F.S. (Past President).
1954 McNeil, J. L., Borough Electrical Engineer, P.O. Box 72, Stanger, Natal.
1952 Millen, T. J., Town and Electrical Engineer, P.O. Box 24, Tzaneen, Tvl.

1955 Nobbs, D. M., City Electrical Engineer, P.O. Box 369, Port Elizabeth.

1953 Odendaal, M. W., Town Electrical Engineer, P.O. Box 4, Alberton, Tvl.

1957 Paull, R. A., Municipal Electrical Engineer, P.O. Box 57, Umtata, Tembuland.
1952 Potgieter, N. A., Municipal Electrical Engineer, P.O. Box 106, Brits, Tvl.
1951 Pretorius, D. R., Town Electrical Engineer, P.O. Box 39, Parys, O.F.S.
1952 Pretorius, E. de C., Electrical Engineer, P.O. Box 113, Potchefstroom.
1960 Pretorius, J. W., Assistant Electrical Engineer, P.O. Box 23, Nigel.

1957 Rautenbach, G. F., Electrical Engineer, P.O. Box 99, Klerksdorp.
1946 Redman, R. H., Deputy City Electrical Engineer, P.O. Box 1803, Bulawayo, S.R.
1927 Relihan, H. J., Municipal Electrical Engineer, P.O. Box 12, Paarl, C.P.
1948 Reyneke, G. M., Town Electrical Engineer, P.O. Box 26, Winburg, O.F.S.
1954 Ross, J. W., Municipal Electrical Engineer, P.O. Box 34, Potgietersrust, Tvl.
1934 Rossler, A., Municipal Electrical Engineer, P.O. Box 24, Cradock, C.P.
1935 Rossler, W., Town Electrical Engineer, P.O. Box 302, Kroonstad, O.F.S.
1944 Rush, W., Borough Electrical Engineer, P.O. Box 57, Vryheid, Natal.

1935 Sibson, A. R., City Electrical Engineer, P.O. Box 1803, Bulawayo, S.R. (Past President).
1954 Simpson, A. C., Municipal Electrical Engineer, P.O. Box 5010, Walmer, C.P.
1953 Simpson, R. M. O., City Electrical Engineer, P.O. Box 147, Durban, Natal (Past President).
1946 Sims, C. N., Municipal Electrical Engineer, P.O. Box 3, The Strand, C.P.

1937 Smith, E. L., Municipal Electrical Engineer, P.O. Box 215, Boksburg, Tvl.
1934 Stevens, F., Borough Electrical Engineer, P.O. Box 29, Ladysmith, Natal.
1956 Sulter, F. J., Assistant Electrical Engineer, P.O. Box 145, Germiston, Tvl.

1947 Thackwray, W. G., Town Electrical Engineer, P.O. Box 8, Kokstad, E.G.
1945 Theron, W. C., Municipal Electrical Engineer, P.O. Box 37, Worcester, C.P.
1946 Theron, G. C., Town Electrical Engineer, P.O. Box 3, Vanderbijlpark, Tvl.
1931 Turner, H. T., Town and Electrical Engineer, P.O. 121, Umtali, S.R.
1950 Turnbull, A. F., Town and Electrical Engineer, P.O. Box 35, Vereeniging, Tvl.

1955 Van der Merwe, F. J., Municipal Electrical Engineer, P.O. Box 20, Stilfontein, Tvl.
1959 Van Heerden, B. G., Mun. Elec. Eng., P.O. Box 48, Ermelo, Tvl.
1957 Van Heerden, W. J. B., Elect. Eng., Orkney Health Committee, P.O. Box 201, Heidelberg, Tvl.
1956 Van Meerdervoort, J. K. L., Pompe, Town Electrical Engineer, P.O. Box 43, Harrismith, O.F.S.
1949 Van der Walt, J. L., Town Electrical Engineer, P.O. Box 94, Krugersdorp, Tvl. (Past President).
1945 Vergottini, P. L., Municipal Electrical Engineer, P.O. Box 15, Brakpan, Tvl.
1951 Verschoor, D. R., Town and Electrical Engineer, P.O. Box 36, Fort Beaufort, C.P.
1955 Vorster, P. J., Municipal Electrical Engineer, P.O. Box 3, Witbank, Tvl.
1957 Von Ahlfton, J. K., Town Electrical Engineer, P.O. Box 60, Sasolburg, Tvl.

1954 Waddy, J. C., City Electrical Engineer, P.O. Box 399, Pietermaritzburg, Natal.
1952 Waldron, F. R., Municipal Electrical Engineer, P.O. Box 86, Walvis Bay.
1952 Ward, H. V., Borough Engineer, P.O. Box 71, Greytown, Natal.
1952 Williams, A. H., Assistant Electrical Engineer, P.O. Box 45, Springs, Tvl.
1938 Wilson, J., Assistant City Electrical Engineer, P.O. Box 423, Pretoria, Tvl.
1948 Woolridge, W. E. L., Town Electrical Engineer, P.O. Box 24, Harding, Natal.
1961 Wiehahn, G. D., Town Engineer, P.O. Box 551, Bethlehem, O.F.S.

1956 Yodaiken, J., Municipal Electrical Engineer, P.O. Box 115, Que Que, S.R.

1959 Zausmer, H., Municipal Electrical Engineer, P.O. Box 20, Hermanus.

## ASSOCIATES/GEASSOSIEERDERS:

1959 Bester, J. H., Town Electrician, P.O. Box 15, Ventersdorp, Tvl.

1959 Carpenter, B. F., Town Electrical Engineer, P.O. Box 206, Aliwal North, C.P.

1960 Flint, V. G., Acting Electrical Engineer, P.O. Box 14, Middelburg, Tvl.

1960 Greef, J. J., Town Electrician, P.O. Box 2, White River.

1959 Jordaan, J. H., Municipal Electrical Engineer, P.O. Box 35, Vryburg, C.P.

1959 Laas, C. P., Electrical Engineer, P.O. Box 15, Kenhardt.
1959 Lochner, J. van S., Town Electrical Engineer, P.O. Box 64, Ladybrand, O.F.S.

1956 McNamara A. B., Electrical Engineer, P.O. Box 21, Komgha.

1959 Ross, M. J., Town Electrical Engineer, P.O. Box 13, Brandfort, O.F.S.

1959 Schoombee, G. T. van W., Town Electrical Engineer, P.O. Box 61, Lydenburg, Tvl.

## ASSOCIATE MEMBERS/VERBONDE LEDE:

1946 Andrew, W. M., c/o. E.S.C., P.O. Box 667, East London, C.P.
1951 Attridge, W. H., P.O. Box 463, Tsumeb, S.W. Africa.

1944 Burton, C. R., 54, Memorial Road, Kimberley, C.P.
1952 Bailey, R. V., P.O. Box 255, Oudtshoorn, C.P.
1956 Barnard, F. J. W., c/o. Electricity Supply Commission, P.O. Box 12, Springs.

1933 Campbell, P.O. Box 3, Impendhle, Natal.
1929 Clinton, J. S., P.O. Box 4648, Johannesburg (Past President).
1948 Conradie, D. J.. R., P.O. Box 1009, Bloemfontein, O.F.S.

1951 Dalton, G. A., 111, Eckstein Street East, Observatory Extension, Johannesburg, Tvl.
1934 Dawson, C., Electricity Supply Commission, P.O. Box 2408, Durban.
1948 De Wit, T., P.O. Box 44, Brits, Tvl.

1960 Ford, W. P., P.O. Box 40, Lusaka, N.R.

1960 Gill, G. B., Zululand Electrical Utility Co. (Pty.) Ltd., P.O. Box 29, Gingindhlovu, Natal.

1936 Heasman, G. G., P.O. Box 77, Fort Victoria, S.R.

1949 Lutsch, W. J. F. S., c/o. Faculty of Engineering, University of Stellenbosch, C.P.

1960 McGibbon, J., P.O. Box 92, Carletonville, Tvl.
1926 Marchand, B., P.O. Box 223, Witbank, Tvl.
1946 Mole, E. W., P.O. Box 106, Saxonwold, Johannesburg.
1926 Muller, H. M. S., P.O. Box 112, Upington, C.P.
1961 Magowan, J. M., Southern Rhodesia Electricity Supply Commission, P.O. Box 377, Salisbury.

1927 Nicholas, I. J., P.O. Box 185, Dordrecht (Past President).

1959 Petersen, G. R., Federal Power Board, P.O. Box 630, Salisbury.
1934 Phillips, J. W., P.O. Box 1731, Bulawayo, S.R.

1953 Rothman, J. L., P.O. Box 606, Kimberley.

1927 Simpson, H. G., Engineering Department, Searles Ltd., Great Brak River, C.P.

1931 Wright, G. R. E., P.O. Box 465, Benoni, Tvl.
1947 Williams, J. T., P.O. Box 1617, Pretoria, Tvl.
1946 Wylie, R. J. S., c/o. E.S.C., Rand Undertaking, P.O. Box 103, Germiston, Tvl.

1957 Zeederberg, T. D. 96, Olive Road, Valhalla, Pretoria.

## AFFILIATES/GEAFFILEERDES:

1959 AEG South Africa (Pty.) Ltd., P.O. Box 10264, Johannesburg.
1957 Aberdare Cables (Africa) Ltd., P.O. Box 494, Port Elizabeth.
1957 Adams, Symes & Partners, P.O. Box 1498, Johannesburg.
1957 African Cables Ltd., P.O. Box 9909, Johannesburg.
1959 African Explosives & Chemical Industries, Ltd., P.O. Box 1122, Johannesburg.
1957 Allenwest S.A. (Pty.) Ltd., P.O. Box 6168, Johannesburg.
1957 Alcan Aluminium Co. of S.A. Ltd., P.O. Box 2430, Johannesburg.
1957 Arthur Trevor Williams (Pty.) Ltd., P.O. Box 2873, Johannesburg.
1959 Asea Electric (Pty.) Ltd., P.O. Box 691, Pretoria.
1957 Aycliffe Cables Ltd., Hargreaves Works, Main Road, Eastleigh, Edenvale.
1960 African Lamps (Pty.) Ltd., P.O. Box 75, Industria.
1960 Associated Electrical Industries C.A. (Pvt.) Ltd., P.O. Box 1979, Salisbury, S.R.
1960 Associated Electrical Industries (Pty.) Ltd., P.O. Box 7755, Johannesburg.

1957 Babcock & Wilcox of Africa Ltd., P.O. Box 545, Vereeniging, Tvl.
1957 Brian Colquhoun & Partners (Rhodesia), Floor Five, Century House, Baker Ave., Salisbury, S.R.
1957 British General Electric Co. of C.A. (Pvt.), Ltd., P.O. Box 845, Salisbury, S.R.
1957 British General Electric Co. Ltd., P.O. Box 2406, Johannesburg.
1959 British Insulated Callender's Cables S.A. Ltd., P.O. Box 2827, Johannesburg.
1957 Burgun (Pty.) Ltd., A. M., P.O. Box 132, Jeppestown.

1957 Caltex (Africa) Ltd., P.O. Box 714, Cape Town.
1957 Chloride Electrical Storage Co. S.A. (Pty.) Ltd., P.O. Box 7508, Johannesburg.
1957 C.M.B. Engineering Co. (Pty.) Ltd., P.O. Box 55, Denver, Johannesburg.
1959 Construction Electric Co. (Pty.) Ltd., P.O. Box 10100, Johannesburg.
1959 Contactor (Pty.) Ltd., Zuider Paarl, C.P.
1957 Crompton Parkinson S.A. (Pty.) Ltd., P.O. Box 4236, Johannesburg.

1957 Davidson & Co. (Africa) (Pty.) Ltd., P.O. Box 180, Springs, Tvl.
1957 Dowson & Dobson Ltd., P.O. Box 7764, Johannesburg.
1959 Ian Drewett, P.O. Box 35, Johannesburg.

1959 Electrical Contractors' Association (South Africa), P.O. Box 11359, Johannesburg.
1957 Enfield Cables (S.A.) Ltd., P.O. Box 5289, Johannesburg.
1959 English Electric Co. (C.A.) (Pvt.) Ltd., P.O. Box 2191, Salisbury.
1957 English Electric Co. S.A. Ltd., P.O. Box 2387, Johannesburg.

1957 First Electric Corp. of S.A., P.O. Box 3961, Johannesburg.
1957 F. W. J. Electrical Industries Ltd., P.O. Box 58, Alberton, Tvl.

1958 George Kent S.A. (Pty.) Ltd., P.O. Box 7396, Johannesburg.
1957 General Motors South Africa (Pty.) Ltd., P.O. Box 1137, Port Elizabeth.
1957 W. T. Glover & Co. Ltd., c/o. W. G. Harlow, 202 Bordeaux, Sea Point, Cape Town.
1957 E. Green & Son S.A. (Pty.) Ltd., 406 Barclays Bank Buildings, Kruis Street, Johannesburg.

1959 Henley-Simplex Africa (Pty.) Ltd., P.O. Box 100, Jeppe, Johannesburg.
1957 Heinemann Electric (S.A.) Ltd., 1 Long Street, Booysens, Johannesburg.
1957 Hopkinsons S.A. (Pty.) Ltd., P.O. Box 11029, Johannesburg.
1957 James Howden & Co., Africa (Pty.) Ltd., P.O. Box 11139, Johannesburg.
1957 Hubert Davies & Co. Ltd., P.O. Box 1386, Johannesburg.
1960 Hawker Siddeley Brush (Southern Africa) Ltd., P.O. Box 75, Booysens, Tvl.

1957 International Combustion Africa Ltd., P.O. Box 5981, Johannesburg.

1957 John Thompson (S.A.) (Pty.) Ltd., P.O. Box 3570, Johannesburg.
1957 Johnson & Phillips S.A. (Pty.) Ltd., P.O. Box 552, Germiston.
1957 R. T. Jones, Esq., 43, The Avenue, Orchards, Johannesburg.

1957 G. H. Langler & Co. Ltd., P.O. Box 3762, Johannesburg.

1957 Dr. J. K. Marais, P.O. Box 8006, Johannesburg.
1957 Mr. G. H. Marais, P.O. Box 1789, Pretoria.
1957 Harold Marthinusen & Co. (Pty.) Ltd., P.O. Box 469, Johannesburg.
1957 L. H. Marthinusen Ltd., P.O. Box 64, Denver, Tvl.
1957 Merz & McLellan, P.O. Box 11578, Johannesburg.
1957 Mine Elect. (Pvt.) Ltd., P.O. Box 2356, Salisbury, S.R.
1959 Mitchell Engineering Group S.A. (Pty.) Ltd., 63 Harrison Street, Johannesburg.
1959 Mouchel & Partners, L. G., P.O. Box 9732, Johannesburg.

1959 N.V. Nederlandsche Kabelfabrieken Ltd., P.O. Box 3513, Cape Town.

1957 C. A. Parsons (Rhodesia) Ltd., P.O. Box 550, Bulawayo, S.R.
1957 C. A. Parsons & Co. (S.A.) (Pty.) Ltd., P.O. Box 3425, Johannesburg.
1959 Patrick Murray (Pty.) Ltd., P.O. Box 1541, Durban.

1957 Reunert & Lenz Ltd., P.O. Box 92, Johannesburg.
1957 A. Reyrolle & Co. Ltd., P.O. Box 9677, Johannesburg.
1960 A. Reyrolle & Co. (Rhodesia) Ltd., P.O. Box 1975, Salisbury.
1957 Rice & Diethelm Ltd., P.O. Box 930, Johannesburg.

1957 Samuel Osborn S.A. (Pty.) Ltd., P.O. Box 19, Denver.
1957 Scottish Cables (S.A.) Ltd., P.O. Box 2882, Johannesburg.
1957 Shell Co. of S.A. Ltd., P.O. Box 2231, Cape Town.
1958 Siemens Edison Swan (Pty.) Ltd., P.O. Box 7404, Johannesburg.
1957 Standard Telephones & Cables Ltd., P.O. Box 4687, Johannesburg.
1957 Stamcor (Pty.) Ltd., P.O. Box 6107, Johannesburg.
1957 Stewards & Lloyds of S.A. Ltd., P.O. Box 1195, Johannesburg.
1957 S.A. General Electric Co. Ltd., P.O. Box 1905, Johannesburg.
1957 S. A. Philips (Pty.) Ltd., P.O. Box 7703, Johannesburg.
1957 Superconcrete Pipes (Pty.) Ltd., P.O. Box 92, Roodepoort, Tvl.
1957 Switchcraft (Pty.) Ltd., P.O. Box 6444, Johannesburg.
1960 South Wales Electric (Pty.) Ltd., P.O. Box 2180, Johannesburg.
1957 Southern African Cable Makers Association, P.O. Box 2258, Johannesburg.
1960 Siemens S.A. (Pty.) Ltd., P.O. Box 4583, Johannesburg.

1957 Union Steel Corporation S.A. Ltd., P.O. Box 48, Vereeniging, Tvl.

1957 Wilson & Herd (Pty.) Ltd., P.O. Box 3093, Johannesburg.
1957 Wright Anderson (S.A.) Ltd., P.O. Box 5057, Boksburg.

1957 Yarrow Africa (Pty.) Ltd., P.O. Box 619, Johannesburg.
1959 Yorkshire Transformers (S.A.) (Pty.) Ltd., P.O. Box 44, Paarden Eiland, C.P.

## LIST OF MEMBERS, COUNCIL MEMBERS AND VISITORS ATTENDING THE 35th ANNUAL CONVENTION OF THE ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS

## LYS VAN LEDE, RAADSLEDE EN BESOEKERS—35ste JAARLIKSE KONVENSIE VAN DIE VERENIGING VAN MUNISIPALE ELEKTRISITEITSONDERNEMINGS

### COUNCIL AND ENGINEER MEMBERS
### RAADS EN INGENIEURSLEDE

ALIWAL NORTH: McCusker, Cr. Dr. V. V.; Carpenter, B. F.

BENONI: Korsman, Cr. N. C.; Lees, D.

BETHLEHEM: Wiehahn, G. D.

BLOEMFONTEIN: van der Linde, Cr. P.; Muller, G. J.

BOKSBURG: de Bruin, Cr. D. S.; Smith, E. L.

BRAKPAN: Oberholzer, Cr. L. R. F.; van de Pol, Cr. R. E.; Vergottini, P. L.

BRITS: Bodenstein, Cr. J. C.; Potgieter, N. A.

BULAWAYO: Dold, Cr. A. C.; Sibson, A. R.

CAPE TOWN: Peters, Cr. W. J.; Downie, C. G.

CARLETONVILLE: Kriek, Cr. C. J.; de Villiers, E. E.

CRADOCK: Rossler, A.

DURBAN: Nagle, Cr. W.; Simpson, R. M. O.

EAST LONDON. Northcote, Cr. J. D.; Giles, P. A.

EDENVALE: Archer, Cr. R. R.; Bozyczko, W.

ERMELO: de Bruin, Cr. J.; van Heerden, B. G.

ESTCOURT: Erikson, J. G. F.

GERMISTON: Paintin, Cr. J. R.; Lombard, C.

HEIDELBERG: Mentz, Cr. Dr. F. E.; van Heerden, W. J.

JOHANNESBURG: Main, Cr. R. H.; Kane, R. W.

KEMPTON PARK: de Klerk, Cr. F. S.; Futcher, L.

KIMBERLEY: Gray, C.; Mathews, J. A.

KLERKSDORP: Brady, Cr. A. V. G.; Gericke, J. M.

KNYSNA: Gripper, H. J.

KROONSTAD: Rossler. W.

KRUGERSDORP: Hoffman, Cr. J. J.; van der Walt, J. L.

LADYSMITH: Gailey, Cr. Mrs. R.; Stevens, F.

LOUIS TRICHARDT: van der Berg, Cr. C. J.; Lotter, G. A.

LIVINGSTONE: Brown, Cr. R.; Beesley, W.; The Mayor of Livingstone.

MAFEKING: Cronje, Cr. S. C.; Jones, G. E. H.

NEWCASTLE: van Kampen, Cr. C.; Craig, J. S.

NDOLA: Watt, Cr. T. C.; Steele, E. E.

ORKNEY: Ceronio, Cr. A. J.; Rattey, W. P.

PARYS: Pretorius D. R.

PIETERSBURG: Inglis, J. I.

PIETERMARITZBURG: Franklin, Cr. Col. H. C., Waddy, J. C.

PORT ELIZABETH: Erasmus, Cr. J. C. K.; Murray Nobbs, D.

POTCHEFSTROOM: Theron, Cr. J. G.; Calderbank, Cr. H. W. H.; Pretorius, E. de C.

POTGIETERSRUST: Ross, J. W.

PRETORIA: Blignaut, Cr. P. G. C.; Wilson, J.; Knobel, F. L.

PERI-URBAN AREAS HEALTH BOARD: Geldenhuys, Cr. S. J. J. van V.; Muller, B. Durr, H. A.

QUEENSTOWN: Barratt, V. E. O.

QUE QUE: Newton, Cr. F.; Yodaiken, J.

RANDFONTEIN: Jordaan, Cr. D. G.; Cherry, J. R.

ROODEPOORT: Hugo, Cr. H. J.; Brown, D. D.

RUSTENBURG: Malan, Cr. S. F.; Meintjies, P. A.

SALISBURY: Mills, Cr. W. T. M.; Broder, E.; Mitchell, J. E.

SASOLBURG: de Jong, Cr. S.; von Ahlften, J. K.

SOMERSET EAST: Selley, Cr. A. G.; Clarke, M. P. P.

SPRINGS: Meyer, Cr. D. R.; Terblanche, Cr. D. J.; Downey, J. C.

SOMERSET WEST: Adams, C. H.

STILFONTEIN: van der Merwe, Cr. F. J.; Barnard, Cr. S. S.; de Villiers, G. S.

STANDERTON: de Lang, Cr. M. A.; Heunis, G. B.

TZANEEN: Millen, T. J.

UITENHAGE: Hultzer, Cr. J. S.; Dawson, J. D.

UMTATA: Nelson, Cr. C. W.; Paull, R. A.

UMTALI: Gammon, Cr. F.; Turner, H. T.

VANDERBIJL PARK: van Rooyen, Cr. J. M.; Theron, G. C.

VEREENIGING: Oliver, Cr. R. W.; Turnbull, A. F.

VIRGINIA: van Niekerk, Cr. S. J. L.; Hobbs, I. L.

VENTERSDORP: Bester, J. H.

VRYHEID: Rush, W.

WARMBATHS: Meininger, Cr. L. J.; Harvey, A. Q.

WELKOM: Meyer, Cr. W. F.; Barton, R. W.

WITBANK: Vorster, P. J.

WESTONARIA: Dreyer, L.

## OTHER MEMBERS

Clinton, J. S. (Associate Member), Johannesburg.

Dalton, G. A. (Associate Member), Johannesburg.

Eastman, H. A. (Honorary Member), Somerset West.

Ford, W. P.—Central Electricity Corporation, Ltd. (Associate Member), Lusaka.

Milton, W. H. (Honorary Member), Johannesburg.

Muller, H. M. S. (Associate Member), Upington.

Peterson, G. R. (Associate Member), Salisbury.

## A.M.E.U. OFFICIALS

R. G. Ewing (Representing the Secretaries), Johannesburg.

Mrs. J. Woods (Minute Clerk), Livingstone.

Mrs. H. G. Simms (Convention Proceedings Clerk), Johannesburg.

## AFFILIATES

Aberdare Cables (Africa) Ltd., J. F. A. van der Linden, G. Yuill, Johannesburg.

African Cables Limited, R. W. Lord, V. H. Woods, Johannesburg.

Arthur Trevor Williams (Pty.) Ltd., J. A. Barnett, J. T. Williams, Johannesburg.

Asea Electric S.A. (Pty.) Ltd., V. F. Checketts, F. Frank, Pretoria.

Associated Electrical Industries C.A. (Pvt.) Ltd., C. J. Close, Salisbury.

Associated Electrical Industries S.A. (Pty.) Ltd., D. W. Stanley, S. McCracken, Johannesburg.

Aycliffe Cables Ltd., C. A. Rist, Johannesburg.

Babcock & Wilcox of Africa Ltd., H. Doughty, H. J. Kroon, Vereeniging.

British Insulated Callender's Cables S.A. (Pty.) Ltd., W. J. G. Emery, N. R. Price, A. W. Allen, Johannesburg.

Burgun (Pty.) Ltd., A. M., G. Gerber, Johannesburg.

Caltex Africa Ltd., A. E. Cooper, Salisbury.

Chloride Electrical Storage Co. S.A. (Pty.) Ltd., A. C. Tilley, P. M. Duggan, N. D. Jones, Johannesburg. H. Wood, A. Coman, Salisbury.

C.M.B. Engineering Co. (Pty.) Ltd., F. W. de Zeeuw, Denver, Tvl.

Contactor (Pty.) Ltd., D. A. Anderson, R. K. Eaton, D. M. Castle, Zuider Paarl.

Crompton Parkinson S.A. (Pty.) Ltd., E. Bird, Johannesburg.

Ian Drewett, I. H. M. Drewett, H. McLachlan, Johannesburg.

Electrical Contractors' Association (South Africa), S. Revow, Johannesburg.

Enfield Cables S.A. (Pty.) Ltd., A. E. Torrance, P. P. Miles, Johannesburg.

English Electric Co. (C.A.) (Pvt.) Ltd., A. E. O'Dowd, Salisbury.

English Electric Co. S.A. Ltd., K. Druce, Johannesburg.

First Electric Corp. of S.A. Ltd., L. G. Axe, Johannesburg.

F. W. J. Electrical Industries Ltd., G. R. Hain, Alberton.

Glover & Co. Ltd., W. T., W. G. Harlow, Sea Point.

George Kent S.A. (Pty.) Ltd., H. B. Hichens, Johannesburg.

Heinemann Electric S.A. Ltd., G. A. Dalton, Johannesburg.

Henley Simplex Africa (Pty.) Ltd., J. A. Morrison, G. Hyde, Johannesburg, J. D. Johnson, Stoke-on-Trent, England.

Hopkinsons S.A. (Pty.) Ltd., E. C. Enfield, W. G. van Aswegan, Johannesburg.

John Thompson S.A. (Pty.) Ltd., D. Eaton, Johannesburg.

Johnson & Phillips S.A. (Pty.) Ltd., E. W. Dixon, D. S. Shorten, R. F. Slater, Germiston.

Marais, Mr. G. H., Pretoria.

Marthinusen & Co. (Pty.) Ltd., Harold, G. Roeske, Johannesburg.

Merz & McLellan, C. E. R. Langford, T. R. J. Bishop, Johannesburg. T. K. A. Douglas, H. G. Hampson, Salisbury.

Mine-Elect (Private) Ltd., T. A. Laxton, R. Jackson, Salisbury.

N.V. Nederlandsche Kabelfabrieken Ltd., G. H. van Harten, Cape Town.

Parsons (Rhodesia) Ltd., C. A., I. S. L. Clunas, Salisbury.

Parsons & Co. S.A. (Pty.) Ltd., C. A., H. M. Rochester, T. R. Strawson, Johannesburg.

Reunert & Lenz Ltd., T. C. Marsh, T. K. Adams, E. J. McKechnie, Johannesburg.

Reyrolle & Co. Ltd., A., W. J. Gibbons, R. H. Rollema, Johannesburg.

Reyrolle & Co. Ltd., A., N. Kirschner, Salisbury.

Rice & Diethelm Ltd., N. Raban, Salisbury.

Scottish Cables S.A. Ltd., D. G. Sutherland, Pietermaritzburg. A. C. Grant, Johannesburg. K. N. Weeden, Bulawayo.

Siemens Edison Swan (Pty.) Ltd., E. B. Sidney, M. C. W. Miller, Johannesburg.

Standard Telephones and Cables Ltd., R. Oxley, Boksburg.

Stewarts & Lloyds of S.A. Ltd., R. N. Nevin, Johannesburg.

South Wales Electric (Pty.) Ltd., C. L. de Beer, Johannesburg. H. Seabrook, Salisbury.

Superconcrete Pipes S.A. Ltd., A. R. Nel, Roodepoort.

Switchcraft (Pty.) Ltd., M. Froling, Johannesburg.

Shell South Africa (Pty.) Ltd., J. Evans, Cape Town.

Union Steel Corp. S.A., T. N. D. Griffin, Vereeniging.

Wilson & Herd, W. M. Herd, Johannesburg.

## VISITORS

Anderson, J. P. South African Railways, Johannesburg.

Axe, L. G., S.A. Institute of Electrical Engineers, Johannesburg.

Beaton, J. J., Ministry of Works, Salisbury.

Calothi, I. G., Livingstone.

Cassidy, C. S., Public Works Department, Maseru.

Cuthbert, P. G. Part-time Secretary, Victoria Falls Electricity Board, Livingstone.

Dalton, E. Inspector of Factories (Engineering), Windhoek.

Dickenson, C. R., Regional Controller, N. Rhodesia, Federal Ministry of Posts, Livingstone.

Drewett, I. H. M., Institution of Certificated Mechanical & Electrical Engineers, Johannesburg.

Herrmann, G., Southern Rhodesia Department of Engineering and Construction, Salisbury.

Innis, Col. H., Southern Rhodesia Department of Engineering and Construction, Salisbury.

Jackson, A., Provincial Administration of the Cape of Good Hope, Cape Town.

Kane, R. W., S.A. Institution of Mechanical Engineers, Johannesburg.

Kraft, Mrs. K., Editor, S.A. Electrical Review and Power Magazine, Johannesburg.

L'Ange, G. W. R., Ministry of Works, Salisbury.

le Page, W. C., Chief Electrical Adviser, Ministry of Transport, Lusaka.

Middlecote, A. A., South African Bureau of Standards, Pretoria.

Milton, W. H., Electricity Supply Commission, Johannesburg.

Molyneux, G. C., Chief Electrical Engineer, Rhodesian Railways, Bulawayo.

Olds, W. H., President, Municipal Association of N. Rhodesia and Nyasaland, Livingstone.

O'Mahoney, B. M. E., District Engineer, Rhodesia Railways, Livingstone.

Peterson, G. R., Federal Power Board, Salisbury.

Pretorius, W., Parys.

Rabb, M. G., Livingstone.

Raisbeck, C. N., Ministry of Power, Salisbury.

West, J. H., Ministry of Power, Salisbury.

## LADIES

Adams, Mrs. C. H., Somerset West.
Allen, Miss O. M., Johannesburg.
Anderson, Mrs. D. A., Zuider Paarl.
Anderson, Mrs. J. P., Johannesburg.
Axe, Mrs. L. G., Johannesburg.

Beaton, Mrs. J. J., Salisbury.
Beesley, Mrs. W., Livingstone.
Bishop, Mrs. T. R. J., Johannesburg.
Bodenstein, Mrs. J. C., Brits.
Brod, Mrs. E., Salisbury.
Brown, Mrs. R., Livingstone.

Calderbank, Mrs. H. W. J., Potchefstroom.
Checketts, Mrs. V. F., Pretoria.
Clinton, Mrs. J. S., Johannesburg.
Close, Mrs. C. J., Salisbury.
Clunas, Mrs. I S. L., Salisbury.
Colin, Mrs. L. L., Salisbury.
Cuthbert, Mrs. P. G., Livingstone.

Davies, Mrs. L. P., Springs.
de Beer, Mrs. C. L., Johannesburg.
de Lang, Mrs. M. A., Standerton.
Dickenson, Mrs. C. R., Livingstone.
Dixon, Mrs. E. W., Germiston.
Dold, Mrs. A. C., Bulawayo.
Doughty, Mrs. H., Vereeniging.
Douglas, Mrs. T. K. A., Salisbury.
Downey, Mrs. J. C., Springs.
Druce, Mrs. K., Johannesburg.

Eaton, Mrs. R. K., Zuider Paarl.
Emery, Mrs. W. J. G., Johannesburg.
Erasmus, Mrs. J. C. K., Port Elizabeth.
Erikson, Mrs. J. G. F., Estcourt.

Ford, Mrs. W. P., Lusaka.
Frank, Mrs. F., Pretoria.
Franklin, Mrs. H. C., Pietermaritzburg.
Froling, Mrs. M., Johannesburg.

Geldenhuys, Mrs. S. J. J., Pretoria.
Gibbons, Mrs. W. J., Johannesburg.
Giles, Mrs. P. A., East London.
Grant, Mrs. A. C., Johannesburg.

Hain, Mrs. G. R., Alberton.
Harlow, Mrs. W. G., Sea Point.
Heunis, Mrs. G. B., Standerton.
Hichens, Mrs. H. B., Johannesburg.
Hyde, Mrs. G., Johannesburg.

Inglis, Mrs. J. I., Pietersburg.

Jaffray, Mrs. Morton, Salisbury.

Kane, Miss J., Johannesburg.
Kane, Mrs. R. W., Johannesburg.
Kirschner, Mrs. N., Salisbury.
Kroon, Mrs. H. J., Salisbury.

Le Page, Mrs. W. C., Lusaka.
Langford, Mrs. C. E. R., Johannesburg.
L'Ange, Mrs. G. W. R., Salisbury.
Lees, Mrs. D., Benoni.
Lombard, Mrs. C., Germiston.
Lord, Mrs. R. W., Johannesburg.
Lotter, Mrs. G. A., Louis Trichardt.

Main, Mrs. R. H., Johannesburg.
Marais, Mrs. G. H., Pretoria.
Marsh, Mrs. T. C., Johannesburg.
Mathews, Mrs. J. A., Kimberley.
Mayoress of Livingstone.
McCracken, Mrs. S., Johannesburg.
Mentz, Mrs. F. E., Heidelberg.
Meyer, Mrs. W. F., Welkom.
Miles, Mrs. P. P., Johannesburg.
Miller, Mrs. M. C. W., Johannesburg.
Mills, Mrs. W. T. M., Salisbury.
Milton, Mrs. W. H., Johannesburg.
Mitchell, Mrs. J. E., Salisbury.
Molyneux, Mrs. G. C., Bulawayo.
Morrison, Mrs. J. A., Johannesburg.
Morrison, Miss R., Johannesburg.
Muller, Mrs. B., Pretoria.
Muller, Mrs. G. J., Bloemfontein.
Murray-Nobbs, Mrs. D., Port Elizabeth.

Nagle, Mrs. W., Durban.
Nel, Mrs. A. R., Roodepoort.
Newton, Mrs. F., Que Que.

O'Mahoney, Mrs. B. M. E., Livingstone.
Oxley, Mrs. R., Boksburg.

Paull, Mrs. R. A., Umtata.
Potgieter, Mrs. N. A., Brits.
Pretorius, Mrs. D. R., Parys.
Pretorius, Mrs. E. de C., Potchefstroom.

Raban, Mrs. N., Salisbury.
Rabb, Mrs. M. G., Livingstone.
Rist, Mrs. C. A., Johannesburg.
Rochester, Mrs. H. M., Johannesburg.
Roeske, Mrs. G., Johannesburg.
Ross, Mrs. J. W., Potgietersrust.
Rossler, Mrs. A., Cradock.
Rossler, Mrs. W., Kroonstad.

Selley, Mrs. A. G., Somerset East.
Shorten, Mrs. D. S., Germiston.
Sibson, Mrs. A. R., Bulawayo.
Sidney, Mrs. E. B., Johannesburg.
Simpson, Mrs. R. M. O., Durban.
Slater, Mrs. R. F., Germiston.
Stanley, Mrs. D. W., Johannesburg.
Stevens, Mrs. F., Ladysmith.

Theron, Mrs. J. G., Potchefstroom.

van Harten, Mrs. G. H., Cape Town.
van Aswegan, Mrs. W. G., Johannesburg.
van de Pol, Mrs. R. E., Brakpan.
van der Berg, Mrs. C. J., Louis Trichardt.
van Kampen, Mrs. C., Newcastle.

Waddy, Miss, Pietermaritzburg.
Waddy, Mrs. J. C., Pietermaritzburg.
Weeden, Mrs. K. N., Bulawayo.
Williams, Mrs. J. T., Johannesburg.
Woods, Mrs. V. H., Johannesburg.
West, Mrs. J. H., Salisbury.

Yodaiken, Mrs. J., Que Que.

# NOTICE OF 35th ANNUAL CONVENTION

Notice is hereby given that the 35th Annual Convention of the Association will be held in the Victoria Hall, Livingstone, from the 1st May, to the 4th May, 1961, both days inclusive.

DAVIDSON & EWING (PTY.) LTD.

per: R. G. EWING,

*SECRETARIES.*

# AGENDA AND PROGRAMME

SATURDAY, 29th APRIL, 1961.

9.30 a.m.—4.30 p.m.—Meeting of Executive Council — Victoria Falls Hotel.

MONDAY, 1st MAY, 1961.

8.45 a.m.—Registration and Issue of Livingstone Folder.

9.30 a.m.—Welcome to Livingstone by His Worship the Mayor of Livingstone.

Welcome to Convention by the Representative of the City Council of Germiston.

Official Opening of the Convention by the Hon. G. W. R. l'Ange, C.B.E., M.P., Federal Minister of Works.

Election of President.

Venue of next Convention.

Election of Vice-President.

10.45 a.m.—Refreshment Interval.

11.45 a.m.—Apologies and Greetings.

11.30 a.m.—Presentation (Past President's Medal and Certificate).

11.35 a.m.—Election of Executive Council.

11.45 a.m.—Presidential Address.

12.45 p.m.—Luncheon Adjournment.

2.30 p.m.—Paper: "The Kariba Project," by G. R. Peterson, B.A., M.I.E.E., M.I.Mech.E., M.Rhod.I.E.

3.30 p.m.—Refreshments.

4.00 p.m.—Discussion on Paper.

4.45 p.m.—Adjournment.

6.30—7.30 p.m.—Civic Reception.

TUESDAY, 2nd MAY, 1961.

8.45 a.m.—Executive Council Meeting—Victoria Hall, Livingstone.

9.30 a.m.—Convention Resumes.

Communications from Council.

Paper: "Supervisory Remote Control of a Distribution System," by E. Brod, Dipl. Ing., A.M.I.E.E., Electricity Dept., City of Salisbury.

Discussion on Paper.

10.30 a.m.—Tea.

11.00 a.m.—Paper: "The Application of 'Audio-frequency' Remote Control on an Electricity Supply Undertaking's Distribution Network," by J. K. von Ahlften, B.Sc., B.Sc. (Eng.).

Discussion on Paper.

12.30 p.m.—Lunch.

2.30 p.m.—Paper: "The Utilisation of Hydro Electric Power in the Union of South Africa," by C. E. R. Langford, M.I.E.E., M. (S.A.) I.E.E.

3.30 p.m.—Refreshments.

4.00 p.m.—Discussion on Papers.

4.45 p.m.—Adjournment.

8.15 p.m.—Members' Forum.

10.00 p.m.—Refreshments.

WEDNESDAY, 3rd MAY, 1961.

8.30 a.m.—Meeting of Executive Council — Victoria Falls Hotel — if necessary.

Flight to Kariba for those Delegates who have elected to make this trip.

Alternatively —

Trips round Falls and/or Boat Trip. Times to be arranged.

Alternative arrangements will be made for these visits on Friday for those who will be at Kariba on Wednesday.

8.00 p.m.—Theatre Show, Victoria Hall.

THURSDAY, 4th MAY, 1961.

9.30 a.m.—Convention Resumes.

Communications from Council.

# KENNISGEWING VAN DIE 35ste JAARLIKSE KONVENSIE

Hiermee word kennis gegee dat die 35ste Jaarlikse Konvensie van die Vereniging van 1 tot 4 Mei 1961 in die Victoriasaal, Livingstone, gehou sal word.

DAVIDSON & EWING (EDMS.) BPK.

per: R. G. EWING,
*SEKRETARISSE.*

# AGENDA EN PROGRAM

SATERDAG, 29 APRIL 1961.

9.30 vm.—4.30 nm.—Vergadering van Uitvoerende Komitee in die Hotel Victoria Falls.

MAANDAG, 1 MEI 1961.

8.45 vm.—Registrasie en uitreiking van Livingstone-pamflet.

9.30 vm.—Verwelkoming in Livingstone deur Sy Ed. die Burgemeester.
Verwelkoming op Konvensie deur die Verteenwoordiger van die Stadsraad van Germiston.
Amptelike Opening van Konvensie deur Sy Edele G. W. R. l'Ange, C.B.E., L.V., Federale Minister vir Werke.
Verkiesing van President.
Vergaderplek van volgende Konvensie.
Verkiesing van Vise-President.

10.45 vm.—Ververings.

11.15 vm.—Verskonings en groete.

11.30 vm.—Presentasie (Aftredende President se Medalje en Sertifikaat).

11.35 vm.—Verkiesing van Uitvoerende Komitee.

11.45 vm.—President se Rede.

12.45 nm.—Middagete.

2.30 nm.—Referaat: „Die Kariba-projek," deur G. R. Peterson, B.A., M.I.E.E., M.I.Mech.E., M.Rhod.I.E.

3.30 vm.—Verversings.

4.00 nm.—Bespreking van referaat.

4.45 nm.—Verdaging.

6.30—7.30 nm.—Burgerlike Onthaal.

DINSDAG, 2 MEI 1961.

8.45 vm.—Vergadering van Uitvoerende Komitee in die Victoria-saal, Livingstone.

9.30 vm.—Konvensie word hervat.
Berigte van Komitee.
Referaat: „Toesighoudende Afstandsbeheer van 'n Verspreidingsnet," deur E. Brod, Dipl. Ing., A.M.I.E.E., Elektrisiteitsdepartement, Stad Salisbury.
Bespreking van referaat.

10.30 vm.—Tee-pouse.

11.00 vm.—Referaat: „Die Aanwending van ‚Oudio-frekwensie' Afstandsbeheer op 'n Elektrisiteitsonderneming se Verspreidingsnet," deur J. K. von Ahlften, B.Sc., B.Sc. (Ing.).
Bespreking van referaat.

12.30 nm.—Middagete.

2.30 nm.—Referaat: „Die Benutting van Hidro-elektriese Krag in die Unie van Suid-Afrika," deur C. E. R. Langford, M.I.E.E., M.(S.A.)I.E.E.

3.30 nm.—Verversings.

4.00 nm.—Bespreking van referaat.

4.45 nm.—Verdaging.

8.15 nm.—Lede-forum.

10.00 nm.—Verversings.

WOENSDAG, 3 MEI 1961.

8.30 vm.—Vergadering van Uitvoerende Komitee in die Hotel Victoria Falls (as dit nodig is).
Vliegrit na Kariba vir die Afgevaardigdes wat besluit het om hierdie rit te maak.
andersins
Ritte om die Waterval en/of 'n Bootrit. Tyd moet bepaal word.
Alternatiewelike reëlings kan vir hierdie ritte op Vrydag getref word vir diegene wat Woensdag by Kariba was.

8.00 nm.—Teater, Victoria-saal.

Annual Report of Secretaries.
Appointment of Auditors.
Discussion on Reports of Sub-Committees and Representatives.
Discussion on Papers.

10.30 a.m.—Tea.

11.00 a.m.—Continuation of Members' Forum.
Discussion on Paper.

12.30 p.m.—Luncheon Adjournment.

2.30 p.m.—Discussion regarding Papers, Reports, etc.

3.30 p.m.—Tea.

4.00 p.m.—Closing Session.

5.00 p.m.—Meeting of Executive Council — Victoria Falls Hotel.

7.30 p.m.—Informal Break-up Party. (Supper and Dancing at Victoria Falls Hotel).

## LADIES' PROGRAMME

MONDAY, 1st MAY, 1961.

8.45 a.m.—Assemble for Registration, Issue of Livingstone Folder and Official Opening.

10.45 a.m.—Refreshment Interval.

11.45 a.m.—Apologies and Greetings.

11.30 a.m.—Presentation (Past President's Medal and Certificate).

11.45 a.m.—Presidential Address.
Free Afternoon.

6.30 p.m.—7.30 p.m.—Civic Reception.

TUESDAY, 2nd MAY, 1961.

a.m.—Drive and morning tea with the Mayoress.

p.m.—Free afternoon.

8.00 p.m.—Programme of Travel Films to be shown at Victoria Falls Hotel.
Alternatively —
Members' Forum

WEDNESDAY, 3rd MAY, 1961.

Flight to Kariba for those Delegates who have elected to make this trip.

Alternatively —

Trips round Falls and/or Boat Trip.

Times to be arranged.

Alternative arrangements can be made for these visits on Friday for those who will be at Kariba on Wednesday.

8.00 p.m.—Theatre Show, Victoria Hall.

THURSDAY, 4th MAY, 1961.

a.m.—Free morning.

3.30 p.m.—Assemble for Tea and Closing Session.

7.30 p.m.—Informal Break-up Party. (Supper and Dancing at Victoria Falls Hotel.)

DONDERDAG, 4 MEI 1961.

9.30 vm.—Konvensie word hervat.

Berigte van Komitee.

Jaarverslag van Sekretarisse.

Benoeming van Ouditeure.

Besprekings van verslae van Onderkomitees en Verteenwoordigers.

Bespreking van Referate.

10.30 vm.—Teepouse.

11.00 vm.—Moontlike bykomstige Referaat of voortsetting van die Lede-Forum.

Bespreking van referaat.

12.30 nm.—Middagete.

2.30 nm.—Besprekings oor Referate, Verslae e.d.m.

3.30 nm.—Teepouse.

4.00 nm.—Afsluiting.

5.00 nm.—Vergadering van Uitvoerende Komitee —Hotel Victoria Falls.

7.30 nm.—Informele Afskeidsparty. Soepee en Dans by Hotel Victoria Falls.

# PROGRAM VIR DAMES

MAANDAG, 1 MEI 1961.

8.45 vm.—Vergader vir registrasie en uitreiking van Livingstone-pamflet en Amptelike opening.

10.45 vm.—Verversings.

11.15 vm.—Verskonings en groete.

11.30 vm.—Presentasie (Aftredende President se Medalje en Sertifikaat).

11.45 vm.—President se Rede.

Namiddag vry.

6.30 nm.—7.30 nm.—Burgerlike Onthaal.

DINSDAG, 2 MEI 1961.

vm.—Plesierrit en oggendtee saam met Burgermeestersvrou.

nm.—Namiddag vry.

8.00 nm.—Program van Reisfilms by die Hotel Victoria Falls.

Alternatiewelik —

Lede-forum.

WOENSDAG, 3 MEI 1961.

Vliegrit na Kariba vir die Afgevaardigdes wat besluit het om hierdie rit te maak.

Andersins —

Ritte om die Waterval en/of 'n Bootrit. Tyd moet bepaal word.

Alternatiewelike reëlings kan vir hierdie ritte op Vrydag getref word vir diegene wat Woensdag by Kariba was.

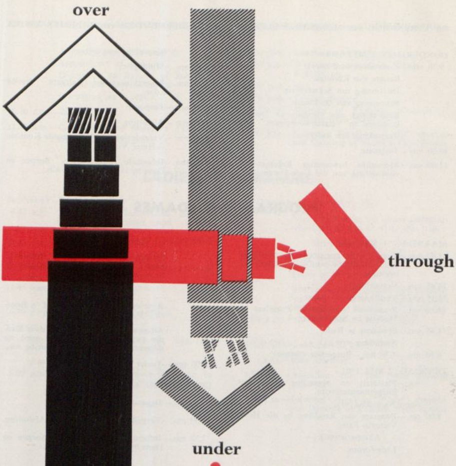
8.00 nm.—Teater, Victoria-saal.

DONDERDAG, 4 MEI 1961.

vm.—Oggend vry.

3.30 nm.—Vergader vir verversings en Afsluiting.

7.30 nm.—Informele Afskeidsparty. (Soepee en Dans by Hotel Victoria Falls.


over
through
under

The Thirty-Fifth Convention of the Association was opened in the Victoria Hall, Livingstone, by the Hon. G. W. R. l'Ange, C.B.E., M.P., Federal Minister of Works, at 9.30 a.m. on Monday, 1st May, 1961.

Attendance at the Convention was as follows:—65 Councils represented by 52 Councillors and 67 Engineers and Associates; 2 Honorary Members (not representing Councils or Affiliates); 5 Associate Members; 83 representatives of 50 Affiliates; 26 Visitors (representing Government Departments, Public Utilities and other organisations); 115 Ladies; 3 A.M.E.U. Officials—a total of 353 persons.

# FIRST DAY

MR. R. M. O. SIMPSON, President, Durban: Good morning ladies and gentlemen. I hope I find I find you all well at the start of this convention. The weather has certainly treated us very favourably, and now I will call on His Worship the Mayor, Councillor Slutzkin, to welcome the Convention officially to Livingstone.

HIS WORSHIP THE MAYOR: Thank you very much indeed, Mr. President. Firstly I would like to say how very nice it is to be here with you this morning, and to see amongst you some very old friends, whom I have known for a number of years. I am most grateful to see you and hope that you will be with us for many more years to come.

Now, Mr. President, Honourable Federal Member, Ladies and gentlemen, your wives, and all good people present here this morning: it is indeed a great pleasure for me to welcome you here to Livingstone, and to enjoy with you the proceedings of your convention, which I hope to attend. Livingstone is possibly one of the best venues that you could have picked for your conference, and from your agenda, I notice that you have a paper dealing on hydro power.

Most of you, or some of you, have done a round trip by going via Kariba, on to Livingstone, where during your leisure hours you will possibly have the opportunity of visiting one of the first hydro schemes in this country, viz. the Victoria Falls Electricity Scheme down the third gorge.

As you know this was built by the Victoria Falls Power Company, a South African Company at one stage, somewhere round 1936.

It was ultimately sold to the Northern Rhodesian Government, because the power company could not take all the power down to the Union, as they wished in the first instance. We are rather sorry about that, because the potential of the power company here is quite a big one.

Although we generate at the present moment only 8 megawatts of electricity, which is more or less bringing us on a peak now, we can take from this area 180 megawatts of electricity, and that is no small feat.

Certainly alterations would have to be made to allow us to take this amount of water from the river, but that would not be detrimental to the Falls itself, so therefore we have the potential here of hydro generation in a very big way, and perhaps, who knows, we may yet have Kariba coming in with us and allowing us to substitute for their shortcomings sooner or later. (Applause.)

Our small station is based, as I said before, at the third gorge. It is a pretty little station, and it has had its trials and tribulations over the last few years of floods. I do commend that you all go and see this station. You will see the very fine work put in by engineers, both electrical and civil, to try to protect the station at a time when the flood waters were rising to the gutters of the building; you will see from the protection wall that is placed round it, the enormous amount of work that had to be done in the smallest possible space available, and I mean smallest possible space available. You will notice when you go down the trolley that it is hardly possible for two people abreast to walk down.

Now the first power station was built in Livingstone in 1905, and the first street lights were turned on in 1925. This is quite a number of years after the first station was inaugurated, but I take it from the number of European people in the territory at the time, it did not want any street lights.

The cost of power in 1923 was something like 2/-, today we sell electricity and we boast of selling you the cheapest electricity in the Federation.

The Victoria Falls Power Board here can generate electricity at the low figure of .22d. per unit, which I take it will be far more cheaper than Kariba will ever be able to do in the year 1970, which after juggling around with figures by Government accountants — and I suppose there are a lot of you here who should know how to do it—you will probably find that their lowest figure in 1970 will be about .33d. per unit.

So you will see that from our small station developing into a very big one ultimately, we can produce cheap electricity here for people who want it.

And now, ladies and gentlemen, I would just like to say a few words to our Afrikaans friends here this morning:

'n Spesiale woord aan ons Afrikaans sprekende vriende hier vandag en aan hulle sê ons „Baie hartelike welkom, en ons hoop dat hulle 'n baie aangename tyd hier sal hê."

And thank you very much ladies and gentlemen for this opportunity, afforded to Livingstone for which I am officiating, in welcoming you here today. We have lots to offer, we have one of the greatest sights in the world — the Victoria Falls. Our hospitality is good, and we hope you will receive it well.

Thank you very much indeed, Mr. President.

THE PRESIDENT: Thank you very much, Mr. Mayor. Your welcome has certainly been very warm and genuine, and we who arrived last Friday have already sampled a few days of it and all I am sure have thoroughly enjoyed what we have seen and experienced up to the present time — this augurs very well for a most successful Convention.

I will now call on the Councillor from Germiston, Clr. Painton, to reply.

CLR. C. R. PAINTON, GERMISTON: Mr. President, Your Worship, Your Honour, ladies and gentlemen—On behalf of the City Council of Germiston, it is indeed a privilege to be able to extend a hearty word of welcome to you all at this convention.

Hartelike welkom aan u almal, dames en here. We naturally regret that it has not been possible to hold this Convention in Germiston, as we have much which would have been of interest to electrical engineers. Amongst other things, our Germiston industries produce electrical switch gear, transformers, motors, cables, appliances, etc., but the one thing we do not have is sufficient accommodation for a convention of this size.

However, I am sure that delegates will enjoy themselves more in the pleasant and beautiful surroundings of Livingstone than in a busy industrial city, and we all know that municipal engineers and councillors are generally so overworked that they deserve an occasional break!

It was not for the same reason that we substituted Livingstone for Germiston, as the story I heard the other day about the lady who said, "George, I have received a letter from mother saying she is not accepting our invitation to visit us, as we do not appear to want her. What does she mean by that? I asked you to write and tell her to come at her own convenience. You wrote to her didn't you?"

"Yes," said George, "but I couldn't spell the word convenience so I made it 'risk'." (Laughter.)

Mr. President, I sincerely hope that your deliberations will be fruitful and trust that you will not treat the papers delivered at this convention in the same manner as the story about the convention of electrical contractors. Each delegate was required to tell how much it cost him to wire a room. Finally one big breezy fellow got up and said, "Why I can wire a room for half what these fellows are talking about."

The next day he was taken to a room and told to wire it his way. To the amazement of the delegates, he merely fastened the wire to the walls with staples.

"But you can't put up electric wiring that way," he was told. "It is against the wiring regulations."

"What's that?" he asked. He was given a copy of the wiring regulations and was told to study it overnight. The next morning he laid the book on the table at the convention and remarked, "Well, I'll be darned: the more a fellow knows in this country, the less liberty he has got."

In thinking of electricity, one's mind naturally goes back to the early days of this world. No doubt a little light was needed even in those dark days. There was only one female so Adam probably had fewer troubles than we have today, but even Eve must have felt more complacent than the average wife today — at least she didn't have to be concerned as to whether her husband had a roving eye.

And so from biblical times we turn to those who produce light today.

Amongst others, the Municipal Electricity Undertakings. They are saying "Let there be light." But they also say "At so much a unit."

Well, we have come a long way from the old days and even electrical engineers have progressed — a little! How they love to put light in dark places, and spoil young people's fun.

Those street lights up the front porch when Jimmy wants to say "Goodnight" to Jenny — or as a mayor once expressed himself, "Perhaps the electrical engineers think that by putting out so much light they are improving the world's morals."

Judging by the engineers' irradiascent and urradiant countenances when suggesting more light in dark places, I am beginning to believe that electrical engineers are against matchmaking. Not that electricity is really required on such occasions, for I am sure that young nineteen stroking sweet eighteen's hair must experience more than a mere 220 volts passing through his system.

While we doubt, the light in each other's eyes on such occasions, would provide far greater illumination than anyone present here can hope to produce.

Mr. Mayor, on behalf of the City Council of Germiston, and all the delegates, I would like to convey our sincere thanks to you and your Council, I am sure that delegates are going to enjoy this convention much more because it is being held in Livingstone.

Mr. President permit me to extend a special word of welcome to His Honour the Federal Minister of Works, Sir, we know that you are a very busy person, but notwithstanding this fact, you have still found time, not only to honour us with your presence here today, but also to officially open this Convention, for which we are much indebted to you.

Thank you.

THE PRESIDENT: Thank you Clr. Painton. Of course one of the electrical engineers' main jobs is to insulate things including people from electricity!

Ladies and gentlemen, it now gives me very great pleasure to call on the Federal Minister of Works, the Honourable Mr. l'Ange, to open the convention.

THE HONOURABLE MR. L'ANGE, THE FEDERAL MINISTER OF WORKS: Mr. President, Mr. Mayor, ladies and gentlemen: It is with considerable pleasure, tinged with awe, that I accepted the invitation of your Council to open this 35th Convention of the Association of Municipal Electricity Undertakings of South Africa; pleasure that such an important convention was being held in the Federation and awe inspired by the knowledge of the highly professional calibre of many of the delegates who would be present—not to mention, of course, the large number of prominent City and Town Councillors who are so well versed in negotiations with Central Government that they can, with consummate ease, administer shocks, electrical and otherwise, to any mere Government Minister.

Right at the outset, ladies and gentlemen, I intend making certain reservations. My first reservation derives from the fact that I find myself in the company of specialists in a field of knowledge remote from the layman. I therefore ask that I be not pressed to expound on the Russian Astronaut and his safe return to earth by capsule or parachute at a given time and at a given point, somewhere in the icy wastes of Northern Siberia.

I have my own opinion on the probable discomforts of partaking of refreshment in an atmosphere of weightlessness, where the stuff won't pour down with the comforting thoroughness that it does on earth.

But as for the more technical aspects of the achievement, I think we can safely leave that as a little preoccupation for the Americans, and I trust that while they are so engaged, we in this part of Africa will be left to work out our own salvation, peacefully and logically, without being treated to too many of those unbalanced "Africa Freedom Day" speeches so beloved of some of the leading personalities of the United States.

My second reservation is more local in flavour. It is that I be not invited by any enthusiast to elaborate on the Kariba/Kafue controversy. All I would say on this subject is that the stern struggle to decide between Kariba and Kafue for our first major hydro-electric project was a struggle between exponents of two similar schemes, both with the same aim. It was between men who, despite their strong feelings in the matter, had one over-riding common goal—that of progress in this country. The claims of Kariba won in the end and, in the manner of civilised people, we rallied to give our support to the implementation of that decision. There were, however, some far more unsettling influences at work before Kariba finally took shape, and these I will refer to later.

I have glanced through your agenda—and a vastly interesting one it is. My admiration for you knew no bounds when I found that you proposed to cover a canvas ranging from the most highly technical facets of remote control installations, to the grave problem of defending meter inspectors from the vicious onslaughts of fierce dogs.

I felt tempted to apply for associate membership on discovering this, if only to obtain access to the members' forum at which this profound subject is to be discussed.

With an eye to the boosting of our national products, it has been suggested to me that discussion should present an opportunity to promote the claims of the Rhodesian Ridgeback. He is, I am assured, so highly intelligent an animal that his appreciation of the importance of the meter reader is instinctive. It is claimed that lesser breeds might be banned, and electricity supplied only to those consumers owning Ridgebacks.

Since you gentlemen held your last convention Kariba, not many miles from here and dependent for its existence on the water flowing a few hundred yards away, has become a reality, and possibly the most vital asset to Central Africa.

Power is being generated at Kariba and carried nearly as far as the Congo in the north and to the borders of Mashonaland in the east; it is also supplied to Bulawayo in the south and, through the Electricity Supply Commission system, it is distributed even further afield. There is no need for me to tell you of the economies and the security of supply that flows from a grid system of this sort.

You can hear "the smoke that thunders" as I speak, and it is no wonder that these great falls have excited the imagination of engineers past and present, right from the time when the Victoria Falls and Transvaal Power Company was set up in 1906 with the object of developing power to supply the Transvaal gold fields from the waters of the Zambesi.

It is true that, as things have turned out, the only project brought into being from this vast power potential by the Victoria Falls Power Company is the present hydro-electric power scheme which serves Livingstone and the Victoria Falls Township area. By comparison with Kariba the Livingstone scheme is a tiny unit, but it holds an important place in our history.

It was not the first hydro-electric installation in the territories which now comprise the Federation—that honour belongs to Zomba. But, prior to Federation, the Livingstone scheme pioneered in this country the export of electricity. It supplied power for the first time, I believe, across a political boundary. This being so, it seems to me highly appropriate that this important convention should take place right here.

The vision of those early pioneers has now been translated by others into the tremendous Kariba project—the golden dreams previously associated with the Rand have now been realised, largely in terms of copper.

Today, transmission lines cross our boundaries with the Congo and Portuguese East Africa. Similarly, our good neighbour south of the Limpopo provides a supply to Beit Bridge. This leads me to wonder whether perhaps we politicians have not something to learn from engineers in the sphere of international relationship.

We in the Federation are indeed fortunate in having a large potential of water power supplies. Kariba exists. Negotiations are taking place for finance to construct the first stage of the Shire River Scheme. Recently the Northern Rhodesia Government installed hydro-electric power at Kasama in the Northern Province of Northern Rhodesia. A further power unit is under construction near Fort Rosebery.

The great Zambesi itself has further potential, both above and below Kariba. And the Kafue is waiting to bestow on us both power and other gifts. Investigations have shown that a scheme involving power stations in the Kafue Gorge and storage at Meshi Teshi can produce some 1,200 megawatts—almost twice the generating capacity of the first stage of Kariba.

But it may well be that a part of this great source of water supply may be needed for extensive irrigation purposes. To this end, further investigations are being made to determine whether the irrigation potential of the Kafue Basin, with its deposits of rich alluvial soil, would justify the diversion of waters for irrigation purposes—either in conjunction with or separately from, power production.

With these natural resources, coupled with the use of the hydraulic turbine, we should indeed be very well endowed with low-cost power for years to come. Endowed moreover not only with electric power, but with commercial fishing and recreational centres of great value and interest.

Whether in the face of these facilities there is room also for the development of atomic power stations in the Federation I am not qualified to say. There are doubtless those among you who represent such interests and I imagine that during the course of this convention—whether in this hall or in the relaxing surroundings in which you will meet socially—this subject will be discussed.

Development along these lines may be something for the future. We still have some rather more pedestrian problems to sort out in relation to the present. Having secured the power we need for the moment, it is the Government's duty to decide on the most efficient means of distribution and sale. To this end two eminent consultants, one from the United Kingdom and one from the Union of South Africa (who, I believe, is with us today) were engaged to review the legislative framework and organisation of the electrical industry. Their report has been published and serves as background and "meat" for your discussions on electricity supply in the Federation.

The report deals largely with distributive and administrative problems, but hand in hand with these problems goes the constant search for new sales outlets. Obviously the

market created by the gradual but persistent improvement in the economic lot of the African must be developed to the full. There is in this so huge a consumer potential that steps must be taken to ensure its growth on sound basic lines.

Active encouragement in the use of electricity, in a social as well as an industrial sense, is essential among these emergent peoples, and I am glad to say that the Ministry of Power has instituted a Federal-wide investigation into the techniques, administrative and otherwise, of reducing to a minimum the cost of supplies to African townships. This is being done with the object of encouraging still further the expansion which is already taking place. The aim of the Ministry is to ensure that this expansion should take place on an economic basis.

My personal interest in these matters is, I must admit, mainly that of a consumer. But I know full well the heavy load of responsibility carried by members of this Association in catering for the public in a service so essential as that of the supply of electric power. My interest is not merely that of a layman. The Federal Government is a very large consumer of electricity. Its yearly bill is roughly £350,000. As Minister of Works, my concern is not merely to ensure the economic use of power in Government establishments, but also to keep the cost of that consumption to the lowest possible figure.

The main theme of your Convention, and therefore of this address, is Kariba. Kariba, known to the engineering fraternity throughout the world. The name has become synonymous with achievement, and I can well imagine how great a source of pride it must be to my friend and colleague Sir Malcolm Barrow who, in his quiet and self-effacing way, stood four-square to all the stresses and strains associated with its construction.

Your subject, as I have said, is Kariba. Nothing could be more appropriate to the times and to these surroundings, but I would ask you to remember that Kariba does not merely generate power. It has been built to give a stimulus to enterprise and to employment. It generates hope and future well being, as well as electricity—and it is a symbol of confidence in the future.

Let us not be over-modest about this. In any project of this magnitude, problems of extraordinary complexity are bound to arise, economic and technical. With Kariba there were, in addition, times during its construction when nature and superstitious fears and the activities of trouble-makers all seemed to combine to conspire against it. It took greatness to overcome these incessant body-blows. It took courage and determination in the political and in the administrative fields. It took skill of the very highest order in the fields of civil engineering, mechanical engineering and electrical engineering.

The world has recognised this. It has paid tribute to an undertaking bold and imaginative in its scope, accomplished with honour in the face of serious and at times grave difficulties.

All this but a short time ago and, mark you, in a country which is now thought by some people, both within and without the Federation, to be foundering at the hurdle of incompatibility between the races—an artificial hurdle, a false hurdle, created by extremist mischief makers and nurtured in an environment of power politics and sheer ignorance overseas.

With the example of Kariba before you, can you see this country lamely submitting to these pressures and accepting defeat? There were those who trembled over the odds that had to be faced on the Zambesi. There are those who tremble at the odds on the political front. Ignore them—they are not worth a glance or a hearing. They lack the spirit that built Kariba and they lack the spirit that will see us through our present difficulties. I do not under-rate these difficulties and I have no wish to try to gloss them over. In my job as Federal Minister of Works I see unemployment all around me in the industries with which I have most dealings. I know how urgent and imperative it is to remove the uncertainties which have so dire an effect on investment and progress in general.

I cannot express sufficiently strongly my contempt for those who thought that, by releasing a little of the wind of which they are so full, they could with impunity waft away their obligations towards their fellow-men in Africa who are carrying the burden of the great multi-racial experiment to which they themselves earlier gave their blessing. I cannot condemn strongly enough the calculated stab in the back from those same people who, having entrusted to us this great task, have chosen to refrain from expressing confidence in us and in our future at a time when their support could make all the difference to the overseas and to the local investor.

The development of this country is so great, and the opportunities for the exercise of the electrical and allied professions should be so limitless, that it is tragic that the exciting and challenging surge towards a great future, characterised by the magnificent achievement of Kariba, should have been even temporarily halted by the hysteria of the self-seeking agitator and the gullibility of his overseas supporter.

We are, however, not alone in our troubles. Countries the wide-world over are faced with complex problems—not a few of which stem from external interference with their internal affairs.

I make no apology for raising these grave matters in a gathering such as this. You have among you Councillors and electrical engineers and representatives of firms and organisations of wide repute. Many of you live and work here; others of you have strong ties with us. You are all of that standing and of that stamp which provides, professionally and otherwise, the very virtues which any country needs in ample measure in these troublesome times—enthusiasm, a sense of responsibility, judgement and steadfastness. You therefore have a greater part to play than you may realise, in showing the way, by the example you set, to the timorous and the faint-hearted.

The constitutional issues of this country must be decided soon. We can brook no further vacillation and delay. The issue will be fought in the coming months and not some time in the dim and distant future. We have the support of powerful forces overseas who have become almost as critical as we of the United Kingdom Government's strange manoeuvres.

We will see this thing through and I am confident that when next I have the privilege of attending a convention of this august body in the Federation, the future development of the Federation will vie for interest with the latest nuclear developments.

Mr. President, gentlemen, I wish you success in this convention and I have pleasure in now declaring it open.

THE PRESIDENT: Thank you Mr. Minister for your most inspiring and more than thought-provoking address you have given us this morning. I am sure it has cheered the hearts of many of us to hear a person in your position deliver such a forthright and encouraging talk.

Gentlemen, before proceeding further with the business of the Convention, there are several comments I would like to make relating to members of the Association.

I know that you will be very sorry to know that Mr. Arthur Rodwell, who was President in 1936/37 and again in 1944/45 is very seriously ill, and I am sure you would like our best wishes for a speedy recovery be conveyed to him.

I would also like to give a particular welcome to Mr. A. J. Eastman, a past president and honourary member of this Association, who has travelled up from Cape Town to be with us today. (Applause.)

We also have with us a number of Rhodesian visitors who are attending for the first time. We have the Director of Public Works, Mr. Beaton and Mrs. Beaton; Mr. P. G. Cuthbert, Mr. C. R. Dickinson, Mr. G. Herman, Col. H. Innes and of course Mr. C. W. R. L'Ange and Mrs. L'Ange, the Honourable Minister, Mr. W. E. le Page, W. H. Olds, Mr. B. M. E. O'Mahonay, Mr. C. N. Raisbeck and Mr. J. H. West. In addition of course we have people we know very well, Mr. D. C. Molyneaux of the Rhodesian Railways and Mr. J. Petterson of the Federal Power Board who have attended previously.

We have also a very well known Affiliate of our Association, Mr. H. M. Rochester, who is with us today, but probably will not attend any future conventions, unless he has time to spare for a trip to this part of the world from the country that he is going to live in.

As you know he is retiring shortly, proceeding overseas, and I think he is retiring to

Chile. I know the Convention would like me to wish him the very best of good fortune both for his journey to the U.K. and during his retirement. We do hope that he will spare us a visit one of these fine days and give us some information about Chile.

There are also a couple of new members that I would like to welcome to the Convention: Mr. T. J. Miller representing Tzaneen which is represented now for the first time since joining in 1957. Mr. Miller has of coures attended before, but not representing Tzaneen.

We would also like to welcome back to the fold Mr. H. J. Gripper, who has been touring in other parts and is now back in South Africa representing Knysna. We welcome him here as well. (Applause.)

I would like also to welcome a new affiliate by name of " Everglow Electric Company of Rhodesia ' which is represented for the first time by Mr. D. L. Colin, and also Mine Electric (Pty.) Limited by Messrs. T. A. Laxton and Bob Jackson.

With those matters of general information and welcome to new members and affiliates we can now proceed with the business of the Convention.

I would now formally call for nominations for the position of President for the ensuing year.

MR. J. E. MITCHELL, SALISBURY: Mr. President, Honourable Minister, Your Worship, ladies and gentlemen: Before I carry on with what is my job up here, and that is to propose a name for President, I would like, as the City Electrical Engineer of the city which supplies the Honourable Minister with Electricity, and charges him for it (which is rather different from the City Engineer, who, when the reservoir above his residence recently burst gave him 10,000,000 gallons for nothing; claims are still coming in), I felt very proud of our Minister's address, and I felt, as the representative from the Capital City of the Federation, I would like to express to him my thanks also from our country for showing that we have a minister who can show the spirit of Rhodesia.

Last year, Mr. President, I had the privilege of proposing as your Vice-President, one Chris Lombard, City Electrical Engineer of Germiston, and this year I am happy to have the similar honour of putting his name forward to you as president for the ensuing year.

I also told you last year that there are two types of engineers — AC types and DC types. AC types are those that come and go, but Chris is the DC type — steady and constant.

Chris was educated in South Africa and obtained his engineering degree at the University of the Witwatersrand in 1935. He then joined a firm with American connections. He hasn't become Americanised in the way that the Minister has mentioned to you this morning. However, he did go across to the United States, and spent some time there improving his electrical engineering knowledge, but he did not let the grass grow under his feet too much, because if the accent of his wife is anything to go by, he, during his time there, selected himself a beautiful and charming bride from the country of film starlets.

Chris returned to the Union in 1942, to represent the same American firm, but very shortly went into Municipal affairs — first with a small municipality, and then in 1946, Assistant Electrical Engineer of Bloemfontein. That's where I first met him.

In 1952 when Germiston, by virtue of the completion of the contract by the VFP, then taken over by the ESC, first became a municipal electricity undertaking, decided to put into the capable hands of Chris Lombard the job of organising and building up that electricity undertaking to what it is today — I think the eighth in size of those represented by the A.M.E.U.

There is an old adage which reads, " When all is said and done — usually more is said than done " . . . Now the reverse is the case with Chris. He has a logical brain and thinks deeply, and when he gives an opinion it has not been hastily conceived.

" Unlike the man who starts his speech
in the usual way
By not knowing what he is going to say,
And ends it in relief and dread,
By not knowing what it was he said."

Chris will not even start to speak until his draft is fully considered and carefully constructed.

Mr. President in proposing Mr. Lombard as your President for the ensuing year, I am sure you will be electing to that office, a man who will carry forward this organisation's high principles, and add lustre to another Presidential year.

Thank you. (Applause.)

THE PRESIDENT: Thank you Mr. Mitchell.

I will now call for a seconder for that nomination.

CLR. C. R. PAINTON, GERMISTON: Mr. President, Mr. Mayor, Your Honour, ladies and gentlemen, as the Councillor representative of the Germiston City Council I must say how honoured we are to have had our electrical engineer nominated for this important duty.

I believe this is the first time that we in Germiston have had that honour. I have known Mr. Lombard since his arrival in Germiston in 1952, and I can say in all sincerity that he is a credit to Germiston, and I am sure he will be the same to this Association.

When he took over our electrical system in 1952, he faced a colossal task, but by careful planning and perfect organisation, he has built up a fine department for which we, in Germiston, are very grateful.

Whenever Chris submits any items to our Council for consideration, we know that they are genuinely required, and it is useless to argue about it. If you approach him trying to scrounge an extra street light or something for your Ward, he will tell in his very nice, quiet manner that he doesn't think it is required, and that's the end.

I have always admired his quiet and unassuming manner and his impartial attitude at all times, and I am sure that you could not have made a better choice. I have great pleasure in seconding the nomination of Mr. Lombard as the President of this Association. (Applause.)

THE PRESIDENT: Ladies and gentlemen, Mr. Chris Lombard has been formally proposed and seconded. Are there any further nominations? I therefore now have great pleasure in declaring Mr. Chris Lombard to be duly elected President of the Association for the ensuing year. (Applause.)

(Mr. Lombard was invested with the Presidential Chain and took the Chair).

THE PRESIDENT (MR. C. LOMBARD): Mr. Mayor, Honourable Minister, ladies and gentlemen, I thank you for the great honour which you have conferred on the City of Germiston and myself, by electing me to this high office. May I assure you that I shall do my best to live up to the traditions set by my worthy predecessors.

I sincerely thank my proposer, Mr. Jimmy Mitchell, and my seconder, Clr. Painton for their kind and flattering remarks, which I hope the Convention will not take too seriously.

I would like to take this opportunity of paying tribute to the retiring President, Mr. Ronald Simpson, who has served this Assosiation so ably and with such distinction during his year of office. He has set a very good example and on behalf of all of you I would like to thank him most sincerely for the good work that he has done on behalf of this Association.

The next item on the Agenda, ladies and gentlemen, concerns the venue for the 1962 Convention, and I believe that Clr. Northcote of East London has something to say on this matter.

CLR. J. D. NORTHCOTE, EAST LONDON: Mr. President, Honourable Minister, Mr. Mayor, ladies and gentlemen: May I start Mr. President by being among the first to congratulate you publicly on your election to this high office, and I am sure the choice has been a very wise one and that the Association will go from strength to strength under your able guidance during the coming year.

And now Mr. President, it is my very great pleasure on behalf of the Mayor and City Council of the City of East London, to invite you and the members of your Assiciation to hold your conference next year in the "Fighting Port." May I take the opportunity, while I am on the platform, of contradicting a rumour which seems to have gained currency during the last few days that East London is known as the "Fighting Port" because we are always fighting amongst ourselves. That, I assure you Mr. President, is not true.

East London is becoming known as the "City of Conferences." We are very capable of handling these things, I have no hesitation in saying, and I am sure you will enjoy yoursleves in our fair city. I have no intention (you have a very tight schedule this morning) of going into the virtues of East London, but invite you to come down there to see for yourselves, and to enjoy the sea breezes.

I assure you, Mr. President, that the brevity of my address in inviting you to come to East London, is in inverse proportion to the warmth and sincerity of the welcome you will receive on arriving there.

Thank you Mr. President. (Applause.)

THE PRESIDENT: Thank you. Are there any other nominations, ladies and gentlemen?

If not, is it agreed, that we will hold our 1962 Convention in East London?

Agreed. (Applause.)

Councillor Northcote, will you then convey our appreciation to your Council, and tell them that we shall hold our Convention next year in East London?

CLR. J. D. NORTHCOTE, EAST LONDON: I'll do that, with pleasure, Mr. President.

PRESIDENT: The next item is the election of a Vice-President. I now call for nominations for the office of Vice-President for the ensuing year.

MR. R. W. KANE, JOHANNESBURG: Mr. President, Mr. Mayor, Mr. Minister, ladies and gentlemen: I notice that Clr. Northcote referred to the "fighting port." He didn't tell you that it almost has an airport! (Laughter.) In addition they had a severe shortage of water some years ago, but I hope they will be okay this year.

I mention the "fighting port" because of a paradox. There was an electrical engineer, when he joined this Association and first represented East London, round about 1954, distinctly referring to multiple earth neutrals, and he seemed to be very proud of the fact that in East London every circuit neutral was connected to the adjacent neutral, and in other words the "fighting port" is completely neutral.

I don't know if it is true, but it is alleged too, that all the dogs in East London, including the Rhodesian Ridgebacks, visit all these poles! (Laughter.)

I have great pleasure, gentlemen, in suggesting for your approval that our friend Percy Giles is Vice-President for the ensuing year.

Percy was born in 1907 in a place called Kimberley. He started training under John Roberts in Durban in 1924, and I think, following that, he spent a little time with ESCOM, which we will not hold against him. (Laughter.) And then in 1937 he went to East London. In 1939 he became a member of this Association as assistant to the East London Town Council; he has both Government certificates, is a corporate member of the Overseas Mechanical and Electrical Engineers, and in 1954 he became City Electrical Engineer of East London.

In 1957 he was elected to your Executive, and has remained with us ever since. We have done our best to get rid of him from time to time, mainly because of the cigars he smokes!

I would like to recommend to you good people — Percy Giles (the man with the very high forehead), as your Vice-President for the incoming year. (Applause.)

THE PRESIDENT: Mr. Giles has been proposed, and I call on Clr. Northcote to second the proposal.

CLR. J. D. NORTHCOTE, EAST LONDON: Mr. President, I have very much pleasure in seconding the nomination of Mr. Percy Giles as Vice-President of this Association for the ensuing year. I endorse most of the remarks made by Mr. Kane.

I would like to tell him that I think I can assure him, without any question of doubt, that when he comes there next year we will have an airport —it might even be a "Fight-

ing Airport" I don't know. However, we have plenty of water there too, and we have electricity.

I have very much pleasure, Mr. President, in seconding the nomination of Mr. Percy Giles as Vice-President. (Applause.)

THE PRESIDENT: Are there any further nominations? I have much pleasure in declaring Mr. Percy Giles, City Electrical Engineer of East London, as being duly elected to the office of Vice-President for the ensuing year, and I would ask him to come up and join us here on the platform.

(Mr. Giles took his place on the platform.)

MR. P. A. GILES, EAST LONDON): Mr. President, Honourable Minister, and members of the convention: I wish to thank you very cordially for electing me Vice-President. I was afraid for the moment there might have been a second nomination!

Instinctively, as has been remarked, we are the natural fighters at East London, but I can see now that I have to serve under my good friend Chris Lombard. I will have to reduce some of my potential; and the first thing I have done this morning is to discard by cigar! I sincerely hope that I won't cause any more confusion in the Executive Meetings.

Mr. Chairman it is a unique position for me today, and it is an honour which I feel very greatly. I do hope that I will carry out all duties to your satisfaction.

Thank you very much Mr. President. (Applause.)

THE PRESIDENT: Thank you Mr. Giles.

Ladies and gentlemen, time is getting on, and I have a few announcements to make.

(CONVENTION ANNOUNCEMENTS FOLLOWED.)

TEA ADJOURNMENT

*On Resuming*:

THE PRESIDENT: We have received a number of Apologies and I will ask the Secretary to read them out.

MR. R. G. EWING, SECRETARY: Mr. Chairman, ladies and gentlemen: First of all we have an unusual apology here — a telegram of greeting. I don't know whether it's "Scottish" or perhaps "Scotch." It is a telegram form, but to the best of my recollection the document was handed to me last night by one of the delegates who flew up here!

Mr. President, it comes from our friend J. C. Fraser. He says he is sorry he is unable to be with us and he wishes the conference all success, and to you, Mr. President, a happy year of office.

We have a long list of apologies today:

Mr. D. J. Hugo, Pretoria; Alderman Morton Jaffray, Salisbury; Mr. K. W. J. Halliday, Port Shepstone; Mr. J. C. Fraser, Johannesburg; City of Grahamstown; Borough of Port Shepstone; Kokstad Municipal Electricity Undertaking; Municipality of Riversdale; Strand Municipality; Rouxville Municipality; Municipality of Matatiele; Mr. G. F. Bellingan, Windhoek, conveys best wishes for a successful and pleasant gathinging; Town Council of Worcester;; Town Council of Piet Retief; Lydenburg Municipality; Municipality of Mossel Bay; Walmer Municipality; Municipality of Middelburg, Transvaal; Winburg Municipality; Municipality of Bothaville; Stellenbosch Municipality, Electrical Engineer conveys good wishes; Municipality of Bethal; Municipality of Dewetsdorp; Town Council of Barberton; International Combustion Africa Limited; James Howden and Safanco Ltd.; Hawker Siddeley Brush (Southern Africa) Ltd.; Councillor L. P. Davies of Springs; Yarrow (Africa) (Pty.) Ltd.; The President of the Transvaal and Orange Free State Chamber of Mines; Electricity Control Board, Union of South Africa; The Secretary for Labour, Union of South Africa; The Chairman, Transvaal Coal Owners Association (1923) (Pty.) Ltd.; The Chairman, Industrial Development Corporation of South Africa; The Resident Engineer, Victoria Falls Electricity Board; The Institute of Town Clerks of Southern Africa; Mr. C. Kinsman, Durban North, sends his regrets to all his old friends and best wishes for a happy and successful gathering; The Secretary for Education, Arts and Science, Union of South Africa; Mr. H. T. Aspinall, Pretoria; The President, South African Institution of Mechanical

Engineers; the Director of Local Affairs, Transvaal Provincial Administration; The Director of Public Works, Swaziland; The Chief Engineer, Department of Post and Telegraphs; The Secretary for Bantu Administration and Development, Union of South Africa; Mr. H. P. Alexander, Durban; The Chief Electrical Engineer, Public Works Department, Pretoria; Mr. Ivor J. Nicholas of Queenstown, who conveys good luck to all; Administration of the Orange Free State Province; Mr. A. W. Lineker; Mr. Baxter.

Thank you, Mr. President.

THE PRESIDENT: Thank you Mr. Ewing. There will now be an apportunity for delegates and visitors who are attending the Convention, and who wish to convey greetings from other organisations and bodies to do so.

MR. W. H. MILTON, ESCOM, JOHANNESBURG: Mr. President, I take pleasure in conveying to you the greetings of the Electricity Supply Commission of the Union to wish you a very successful year of office, and also to congratulate the outgoing President on the good work done by him during his year of office.

It is also my privilege on behalf of my friend Mr. Marchant to convey greetings to you and he regrets that he could not attend this convention.

MR. L. G. AXE, JOHANNESBURG: Mr. President; My Council (that is the Council of the S.A. Institute of Electrical Engineers), has asked me to convey to you and your members, their very best wishes for the success of this convention, and for a very happy year of office to you, sir, personally — and I add my own congratulations to you and to the outgoing President.

M. G. C. MOLYNEAUX, RHODESIAN RAILWAYS: My General Manager wishes me to convey to you his good wishes for a most successful and enjoyable convention. He also expresses the hope that the journeys of delegates while on our railways will be all that they might wish, both in service and in comfort.

MR. J. P. ANDERSON, SOUTH AFRICAN RAILWAYS: Mr. President, my General Manager wishes to convey to you his best wishes on your election, and his hope that this convention will be a successful one.

MR. L. H. M. DREWETT, JOHANNESBURG: Mr. President, the President and Council of the Institute of Certificated Mechanical and Electrical Engineers convey to you congratulations on your election, and extend best wishes for a very successful convention, and to you a very special year of office.

MR. R. W. KANE, JOHANNESBURG: Mr. President, the Council of the Institution of Mechanical Engineers send greetings, and wish you a very successful convention, and in particular congratulate you and wish you all the very best.

MR. C. DOWNIE, CAPE TOWN: Mr. President this is a duty which is usually performed by Mr. Alan Dalton, the Senior Representative of the Institute of Electrical Engineers, who is a fairly regular attender of our conventions, but hasn't been able to come to us today. I convey to this Convention the greetings of the British Institute of Electrical Engineers of Great Britain, for a very successful convention, and its congratulations to you, on being elected President for the ensuing year.

MR. S. REVOW, JOHANNESBURG: On behalf of the members of the Electrical Contractors Association of South Africa I would like to take this opportunity of congratulating you on your election to President of the A.M.E.U. and to wish you a fruitful conference and a successful year of office.

THE PRESIDENT: Are there any further greetings? If not, I'll pass on to the next item.

My next duty is a sad one, and that is to announce the death during the past year, of some of your members, and others who have been associated with this Association.

Councillor M. Gild of Durban.

Councillor A. Markman of Port Elizabeth. Both these councillors served on our Executive Council.

Mr. G. Mercier, who was elected member of the Association in 1919, and was an Associate member at the time of his death.

Lastly, Major S. G. Redman. Major Redman, as you know, was a very great friend of this Association and he attended every convention from 1937 until 1959. In 1956 he was elected an Honorary Member. As a tribute to their memory and as an expression of sympathy I am going to ask this Convention to stand for a few moments in silence.

Thank you ladies and gentlemen.

I referred this morning, ladies and gentlemen, to the excellent work done by our immediate past president Mr. Ronald Simpson, on behalf of this Association. He has thereby earned himself a medal and a certificate, and I will now ask him to come up here so that I can hand these over to him.

Congratulations, Mr. Simpson. (Applause.)

We now come to the election of the Executive Council. As you know ballot papers were included in the folders forwarded to you, those who are entitled to vote, and those who haven't got ballot papers please stand up and we will let you have them.

As you know, only engineer members and one councillor from each town are entitled to vote.

I must remind you of the provision in the Constitution regarding provisional representation. For the purpose of the Convention, of course, the Rhodesians are considered as a Province.

The exofficio members of the new Executive Council will be Mr. R. W. Kane of Johannesburg, Mr. R. M. O. Simpson, Durban, Mr. P. A. Giles, East London, Mr. C. Lombard, Germiston.

In addition, the two branch Chairmen, Mr. Waddy of Pietermaritzburg and Mr. Clark of Somerset East, will continue to serve on the Executive until November, and therefore they are not eligible at this stage for nomination.

There are six vacancies on the Council, the retiring members being Mr. J. L. van der Walt of Krugersdorp, Mr. D. H. Hugo of Pretoria, Mr. J. C. Downey of Springs, Mr. J. Mitchell of Salisbury, Mr. D. J. Muller of Bloemfontein, Mr. Chris Downie of Cape Town.

These members are, of course, eligible for re-election.

I want to ask you not to write down the names of those nominated already at this stage.

Will those who haven't ballot papers please put up their hands? They will be handed to you now.

I now call for nominations.

The following members were proposed and seconded: Mr. J. L. van der Walt, Krugersdorp; Mr. J. I. Ingles, Pietersburg; Mr. J. E. Mitchell, Salisbury; Mr. P. L. Vergottini, Brapkan; Mr. J. M. Gericke, Klerksdorp; Mr. J. K. Von Ahlften, Sasolburg; Mr. G. J. Muller, Bloemfontein; Mr. C. G. Downie; Cape Town; Mr. J. C. Downey, Springs; Mr. F. Stevens, Ladysmith; Mr. R. W. Barton, Welkom; Mr. A. R. Sibson, Bulawayo; Mr. D. J. Hugo, Pretoria; Mr. D. Murray Nobbs, Port Elizabeth; Mr. J. A. Matthews, Kimberley; Mr. W. Beasley, Livingstone.

THE PRESIDENT: We now require two scrutineers, and I call on Mr. Milton and Mr. Wilson.

I'll now ask Mr. Percy Giles to take the Chair whilst I give my Presidential Address.

## PRESIDENTIAL ADDRESS

I greatly appreciate the honour which members of this Association have conferred on the City of Germiston and myself by electing me to the office of President for the ensuing year.

In expressing my thanks to you, I am mindful of the great responsibilities of this office and of the difficult task with which I am faced to follow in the footsteps of my

## PRESIDENSIËLE REDE

Ek waardeer die eer wat lede van hierdie Vereniging aan die Stad Germiston en aan my bewyse het deur my as President vir die komende jaar te kies.

Waar ek my dank teenoor u uitspreek, is ek bewus van die groot verantwoordelikhede van hierdie amp en die moeilike taak wat op my wag om in die spore te volg van my voorgangers wat hierdie Vereniging op so predecessors, who have served this Association so meritoriously and with such distinction.

May I, in all humility, assure you that with your assistance and that of the Executice Council, I shall do my best to be worthy of this office and to further the interests of our Association.

In pondering over a suitable subject for a Presidential Address, it occurred to me that it would be appropriate to express a few thoughts on efficiency in municipal electricity undertakings. Before doing so however, I must draw attention to the fact that many of my remarks will only be applicable to municipal electricity undertakings in South Africa.

The unprecedented development and expansion which took place in the post war years placed a heavy burden on municipal electricity services despite serious shortages of man-power, material, plant and equipment. As a result of the inflationary conditions which existed after the war, the cost of labour and prices of material and equipment rose steeply and although there are signs that it is being curbed, the inflationary trend has continued to this day.

This continuing inflation has brought many problems to local authorities who, with their limited sources of revenue, are finding it increasingly difficult to provide the usual municipal services and amenities without continually increasing their rates and tariffs. As a result of this situation, local as well as provincial authorities have become increasingly " efficiency conscious,' and strenuous efforts are being made in many municipalities to offset the effects of higher wages and increased material and equipment costs by greater efficiency in providing municipal services.

Some local authorities are tackling this problem without external aid. Examples of this are the establishment of special committees such as Economy and Efficiency Committees and the appointment of O & M personnel on the municipal staff.

Other local authorities again, have engaged the services of outside consultants such as

'n verdienstelike wyse en met soveel onderskeiding gedoen het.

Mag ek in alle beskeidenheid u verseker dat, met u hulp en dié van die Uitvoerende Raad, ek my beste sal lewer om hierdie amp waardig te wees en om die belange van ons Vereniging te bevorder.

Terwyl ek om 'n geskikte onderwerp vir 'n Presidensiële Rede gepeins het, het dit my opgeval dat dit van pas sou wees om 'n paar gedagtes oor doeltreffendheid in munisipale eltktrisiteitsondernemings uit te spreek. Voordat ek dit doen, moet ek egter daarop wys dat baie van my opmerkings net van toepassing op elektrisiteitsondernemings in Suid-Afrika sal wees.

Die ongekende ontwikkeling en uitbreiding wat in die na-oorlogse jare plaasvind het, het 'n swaar las op munisipale elektrisiteitsondernemings geplaas wat moes tred hou met die toenemende aanvraag na elektrisiteitsdienste ten spyte van ernstige tekorte aan mannekrag, materiaal en toerusting. As gevolg van die inflasionêre toestande wat na die oorlog geheers het, het die koste van arbeid en pryse van materiaal en toerusting skerp gestyg en hoewel daar tekens is dat dit nou in bedwang gehou word, het die inflasionêre neiging tot vandag bly voortbestaan.

Hierdie aanhoudende inflasie het baie probleme aan plaaslike owerhede besorg wat, met hulle beperkte bronne van inkomste, dit steeds moeiliker vind om die gewone munisipale dienste en geriewe te verskaf sonder om belastings en tariewe voortduurend te verhoog. As gevolg van hierdie toestand het plaaslike sowel as provinsiale owerhede meer en meer „doeltreffendheidsbewus" geword en daar word in baie munisipaliteite ywerige pogings aangewend om die uitwerking van hoër lone en verhoogde koste van materiaal en toerusting teen te werk deur groter doeltreffendheid in die lewering van munisipale dienste.

Sommige plaaslike owerhede het hierdie probleme aangepak sonder hulp van buite. Voorbeelde hiervan is die daarstelling van spesiale komitees soos Besparings- en Doeltreffendheidskomitees en die aanstelling van O en M personeel in die munisipale diens.

Ander plaaslike owerhede het weer die dienste van buite-konsultante bekom soos O

O & M and management consultants who undertake surveys in one or more municipal departments and make recommendations on ways and means of improving efficiency and reducing administration costs. Some of the surveys which have been undertaken have included work-study investigations.

With the continual demand for a more efficient and well managed municipal service, it is inevitable that the activities of municipal electricity undertakings would also be subjected to close scrutiny. Now, Municipal Engineers as I know them, are always receptive to ideas and suggestions which would assist them to make their undertakings more efficient. For this reason, a Municipal Electrical Engineer would normally be only too pleased to co-operate with management consultants (or as they are often referred to, efficiency experts) appointed by his Council to make a survey of his department and to undertake the implementation of any recommendations submitted which would result in greater efficiency. It is, however, somewhat disturbing to note that there is a tendency on the part of some consultants who have had no engineering training to comment and make recommendations to Councils on purely technical matters. Such encroachment on the domain of the engineer can only cause resentment and harm.

Another matter of concern to Municipal Electrical Engineers is the fact that one finds all too frequently that investigations and surveys carried out by management consultants give rise to widespread unrest and uneasiness amongst staff. The resultant dislocation and disruption are often so serious that the benefits which may be derived from such investigations are to a large extent nullified.

I hope that these remarks will not create the impression that I am against the idea of efficiency investigations in municipal electricity departments, either by Council's own staff of specialists or by independent outside consultants. On the contrary, I am of the opinion that it is today more important than ever that every effort should be made to increase the efficiency of electricity undertakings if progress is to be maintained at the same rate as in the past.

en M- en bestuurskonsultante wat opnamens in een of meer munisipale departemente onderneem en aanbevelings maak aangaande maniere om doeltreffendheid te verhoog en administrasiekoste te verminder. Sommige van die opnames wat gemaak is, het werkstudieondersoekte ingesluit.

Met die voortdurende vereistes wat gestel word vir 'n meer doeltreffende en goedbestuurde munisipale diens is dit onverwydelik dat die werksaamhede van munisipale elektrisiteitsondernemings ook aan noukeurige ondersoek onderwerp sou word. Nou, munisipale elektrotegniese ingenieurs soos ek hulle ken, is altyd ontvanglik vir idees en wenke wat hulle behulpsaam sal wees om hulle ondernemings meer doeltreffend te maak. Om hierdie rede sal 'n munisipale elektrotegniese ingenieur normaalweg altyd maar te bly wees om saam te werk met bestuurskonsultante (of, soos hulle dikwels na verwys word, doeltreffendheidsdeskundiges) wat deur sy Raad aangestel is om 'n opname van sy afdeling te maak, en om te onderneem om enige aanbevelings uit te voer wat groter doeltreffendheid ten gevolge sal hê. Dit is egter ietwat ontstellend om op te merk dat daar 'n neiging is by sommige konsultante wat geen opleiding in ingenieurswese gehad het nie om kommentaar te lewer oor, en aanbevelings aan stadsrade te doen aangaande suiwer tegniese aangeleenthede.

Sodanige inbreuk op die terrein van die ingenieur kan slegs misnoeë veroorsaak en skade doen.

'n Ander verskynsel wat vir munisipale elektrotegniese ingenieurs sorg baar is dat daar maar al te dikwels gevind word dat ondersoeke en opnamens deur bestuurskonsultante aanleiding gee tot uitgebreide onrus en ongemak onder die personeel. Die ontwrigting en verbrokkeling wat hieruit voortvloei, is dikwels so ernstig dat die voordele wat uit sulke ondersoeke mag spruit, grotendeels vernietig word.

Ek hoop dat hierdie opmerkings nie die indruk sal skep dat ek teen die idee van doeltreffendheidsondersoeke in munisipale elektrisiteitsondernemings gekant is nie, hetsy deur 'n Stadsraad se eie personeel van deskundiges of deur onafhanklike konsultante van buite. Inteendeel is ek van mening dat dit tans meer belangrik as ooit tevore is dat alle

I am also conscious of the fact that there are numerous examples where management and other consultants have rendered excellent services to local authorities as a result of which the latter were able to achieve increased efficiency and effect considerable savings. The object of these remarks is to draw the attention of Councillors to some of the dangers and difficulties which may arise out of efficiency investigations so that these pitfalls may be avoided.

I mentioned earlier in this Address that provincial authorities have also become more conscious of the need for greater efficiency in local government. In this connection there has been an interesting development in the Transvaal where a Commission of Inquiry into Local Government was appointed some years ago. As a result of recommendations made by this Commission, an Ordinance has recently been promulgated which, inter alia, compels all Town and City Councils to appoint a Management Committee (unless the Administrator directs otherwise) and a Town Clerk, who is to be the chief executive and administration officer of the Council.

The introduction of this system of local government is an attempt to eliminate some of the disadvantages of the committee system and is expected to lead to greater efficiency by cutting out cumbersome procedures and making it possible to apply modern management methods to municipal activities.

Under this new system of local government, the position of the Town Clerk will be more or less equivalent to that of a general manager in a business or industrial undertaking.

It seems reasonable to expect that this system will lead to greater efficiency in the municipal service provided the Town Clerk has the necessary managerial ability and skills, and that there will be sufficient delegation of powers, not only by the Council to the Management Committee, but also by the latter to the Town Clerk and through him, to the heads of the various municipal departments. As far as municipal electricity undertakings are concerned, it would appear

pogings aangewend moet word om die doeltreffendheid van munisipale elektrisiteitsondernemings te verhoog indien die vooruitgang teen dieselfde tempo as in die verlede gehandhaaf wil word.

Ek is ook bewus van die feit dat daar talle voorbeelde is van waar bestuurs- en ander konsultante uitstekende dienste aan plaaslike owerhede gelewer het ten gevolge waarvan dit vir laasgenoemde moontlik was om groter doeltreffendheid te bereik en om aansienlike besparings te weeg te bring. Die doel van hierdie opmerkings is om sommige van die gevare en moeilikhede wat uit doeltreffendheidsondersoeke mag spruit onder die aandag van raadslede te bring, sodat hierdie valstrikke vermy kan word.

Ek het vroeër in hierdie rede daar melding van gemaak dat provinsiale owerhede ook meer bewus geword het van die behoefte aan groter doeltreffendheid in plaaslike bestuur. In hierdie verband in daar 'n interessante ontwikkeling in die Transvaal waar 'n Kommissie van Ondersoek insake Plaaslike Bestuur 'n paar jaar gelede aangestel is. As gevolg van aanbevelings wat deur hierdie Kommissie gedoen is, is 'n Ordonnansie onlangs afgekondig wat, inter alia, alle stadsrade verplig om 'n Bestuurskomitee aan te stel (tensy die Administrateur andersins sou gelas) en 'n stadsklerk wat die hoofuitvoerende en -administratiewe beampte van die raad sal wees.

Die instelling van hierdie stelsel van plaaslike bestuur is 'n poging om sommige van die nadele verbonde aan die komiteestelsel te vermy en word verwag om aanleiding tot groter doeltreffendheid te gee deur omslagtige prosedure uit te skakel en dit moontlik te maak om moderne bestuursmetodes op munisipale werksaamhede toe te pas.

Onder die nuwe stelsel van plaaslike bestuur sal die pos van die stadsklerk min of meer gelyk aan dié van 'n algemene bestuurder in 'n besigheids- of nywerheidsonderneming.

Dit wil voorkom of dit redelik verwag kan word dat hierdie stelsel aanleiding tot groter doeltreffendheid in die munisipale diens sal gee mits die stadsklerk die nodige bestuursbekwaamheid en vaardigheid besit en daar genoegsame delegering van bevoegdhede, nie alleenlik deur die raad aan die bestuursat this stage that the new system will make it possible to obtain better co-ordination between departments in connection with development planning and to avoid delays in filling staff vacancies in the lower ranks of the service.

Apart from the fact that it is, of course, a duty and a responsibility towards ratepayers and the public, there are certain reasons why it is today more important than ever that municipal electricity undertakings should function efficiently.

Firstly I wish to refer to the situation which exists in certain towns where the municipal electricity undertaking and another undertaking operate in the same area. Under these circumstances competition between the two undertakings is bound to arise. It can be foreseen that the same situation will eventually arise in many other towns as and when municipal areas and the licensed areas of other undertakings are extended. Municipal electricity undertakings can only meet this competition successfully by exercising constant vigilance and operating efficiently.

There is another reason why every Municipal Electrical Engineer should look critically at his undertaking and make every endeavour to eliminate its short-comings.

We have seen examples of the nationalisation of electricity undertakings in other countries. In the Union of South Africa and the Rhodesias the majority of municipal electricity undertakings no longer generate their own power and their function has been reduced to that of retailers of electricity.

There is no doubt whatsoever, that the creation of a national authority responsible for generating electricity and the establishment of national networks with the advantages of mass production and transmission of electrical power at costs lower than can be achieved by smaller systems, has been of great benefit to the country. It has thus been possible to justify the installation of larger, more efficient generating units at a lower construction cost per kW of capacity, and to produce electric energy at low cost in

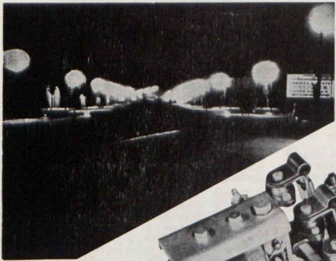
komitee is nie, maar ook deur laasgenoemde aan die Stadsklerk en deur hom aan die verskillende hoofde van departemente. Wat munisipale elektrisiteitsondernemings betref, wil dit op hierdie tydstip voorkom of die nuwe stelsel dit moontlik sal maak om beter ko-ordinasie ten opsigte van ontwikkelingsbeplanning tussen departemente te verkry en om oponthoude ten opsigte van personeelaanstellings in die laer geledere van die diens te vermy.

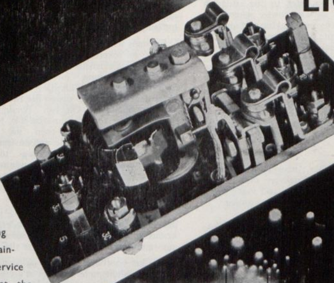
Behalwe die feit dat dit natuurlik 'n plig en verantwoordelikheid teenoor belastingbetalers en die publiek is, is daar sekere redes waarom dit tans meer belangrik as ooit is dat munisipale elektrisiteitsondernemings doeltreffend moet fungeer.

Eerstens wil ek verwys na die toestand wat vandag in sekere dorpe bestaan waar die munisipale elektrisiteitsondernemings en 'n ander onderneming in dieselfde gebied bedrywig is. Onder hierdie omstandighede moet daar kompetisie tussen die twee ondernemings ontstaan. Dit kan voorsien word dat dieselfde toestand uiteindelik in baie ander dorpe sal ontstaan na gelang munisipale gebiede en die gelisensieerde gebiede van ander ondernemings uitgebrei word. Munisipale elektrisiteitsondernemings kan hierdie kompetisie alleenlik met sukses die hoof bied deur gedurige waaksaamheid te beoefen en doeltreffend te fungeer.

Daar is nog 'n rede waarom elke munisipale elektrotegniese ingenieur sy onderneming krities moet beskou en alle pogings moet aanwend om tekortkomings uit te skakel.

Ons het voorbeelde van die nasionalisering van elektrisiteitsondernemings in ander lande waargeneem. Die meerderheid van elektrisiteitsondernemings in die Unie van Suid-Afrika en die Rhodesiës wek nie meer hulle eie krag op nie en hulle funksie het afgeneem tot dié van kleinhandelaars in elektrisiteit. Dit ly geen twyfel nie dat die instelling van 'n nasionale owerheid wat verantwoordelik is vir die opwekking van elektrisiteit en die daarstelling van nasionale netwerke met die voordele van massa-produksie en -transmissie van elektriese krag teen kostes wat laer is as dié waarteen klein ondernemings dit sou doen, tot groot voordeel van die land strek. Dit is dus sodoende moontlik om die installering van groter, meer doeltreffende





plants built close to sources of fuel and water. The reticulation of electricity in urban areas must, however, remain the function of municipal electricity undertakings. The latter can only make their position unassailable if they continue to be the recognised specialists in this field, and can demonstrate that they can carry out this function more efficiently than any other undertaking.

It is said that an American philosopher has christened our epoch "that of the Managerial Revolution" and a feature of our times is the widespread recognition of the importance of scientific management in any business or industrial undertaking. It is in fact, today regarded as essential that all persons in executive positions should have management training.

As an engineer-manager, the Muncipal Electrical Engineer requires the following qualifications for the effective discharge of his executive responsibilities:

1. Certain personal qualities which determine character, intelligence and general ability.
2. The necessary technological qualifications and ability to deal effectively with the technical aspects of his job.
3. Management knowledge. This includes knowledge of:
   - (i) the principles of management and how they are applied.
   - (ii) the various aspects in the general field of human relations as they apply to groups of people working together.
   - (iii) the methods and procedures by means of which the management functions of planning, control, co-ordination and motivation are carried out.

As his undertaking grows, the technical activities of the Municipal Electrical Engineer

opwekkingseenhede teen laer konstruksiekoste per kW vermoë te regverdig en om elektriese stroom teen lae koste to produseer deur kraginstallasies wat naby die bronne van brandstof en water geleë is. Die retikulasie van elektrisiteit in stedelike gebiede moet egter die funksie van munisipale elektrisiteitsondernemings bly. Laasgenoemde kan hulle posisie alleenlik onaantasbaar maak indien hulle steeds erken word as die spesialiteits op hierdie gebied en kan bewys dat hulle hierdie taak meer doeltreffend as enige ander onderneming kan uitvoer.

Dit word gesê dat 'n Amerikaanse filosoof ons tydperk „die van die Bestuursrewolusie" gedoop het en 'n kenmerk van ons tyd is die algemene erkenning wat die belangrikheid van wetenskaplike bestuur in besigheids- en nywerheidsondernemings geniet. Dit word inderdaad vandag as noodsaaklik beskou dat alle persone in uitvoerende poste oor bestuursopleiding moet beskik.

As 'n ingenieur-bestuurder moet die munisipale elektrotegniese ingenieur die volgende kwalifikasies besit om sy uitvoerende verantwoordelikhede doeltreffend te kan nakom:

1. Sekere persoonlike hoedanighede wat karakter, intelligensie en algemene bekwaamheid bepaal.
2. Die nodige tegnologiese bevoegdheid en bekwaamheid om die tegniese aspekte van die werk op 'n doeltreffende wyse te behartig.
3. Bestuurkennis. Dit sluit in kennis van
   - (i) Bestuursbeginsels en hoe dit aangewend word.
   - (ii) die verskillende gesigpunte op die algemene gebied van mense-verhoudings soos van toepassing op mensgroepe wat saam werk.
   - (iii) die metodes en handelswyse waardeur die bestuursfunksie van beplanning, kontrole, ko-ordinansie en motivering uitgevoer word.

Die tegniese bedrywigheid van die munisipale elektrotegniese ingenieur verminder na gelang sy onderneming uitbrei terwyl sy bestuursbedrywigheid toeneem.

Ingenieur-bestuurders is dikwels so uitsluitlik gemoeid met die praktisering van hulle beroep dat hulle nie genoeg aandag decreases as his management activities increases.

Engineer-managers are often so exclusively concerned with the practice of their profession, that they do not pay sufficient attention to their managerial responsibilities. This is particularly so in the case of electricity undertakings where progress was made mainly on technical foundations.

Until fairly recently, subjects dealing with business management were not included in engineering courses and many engineers therefore did not have the opportunity to pursue the systematic study of management in principle and practice. There are, however, ample opportunities today for technical men to broaden their knowledge in the field of management and to equip themselves with the essential management skills. Apart from the wide range of text books and literature on the subject of management which is available today and the correspondence courses offered by various colleges and universities, there are special organisations such as the National Development Foundation, which offer excellent management educational facilities.

Municipal Electrical Engineers would be well advised to make use of such opportunities, as the success of their undertakings will not only depend on technical skill and the perfection of its plant and equipment but also on sound management.

While Municipal Electrical Engineers play an important role as far as the promotion of efficiency in municipal electricity undertakings is concerned, the role played by Councillors is no less important.

For example, the effectiveness of the service provided depends to a large extent on the policy adopted by the Council in making the necessary funds available for extensions, improvements, reconstruction, etc.

The actions and policies of Councils on matters affecting staff such as salary scales, appointments, promotions, service conditions, health and welfare, etc. must have an important bearing on productivity. Without contentment and high morale, the effectiveness of operation in municipal electricity undertakings can never attain its maximum.

skenk aan hulle bestuursverantwoordelikhede nie. Dit is veral die geval met elektrisiteitsondernemings waar vordering grotendeels op tegniese fondamente gemaak is.

Tot onlangs was vakke wat oor besigheidsbestuur handel nie by kursusse in ingenieurswese ingesluit nie en ingenieurs het nie die geleentheid gehad om hulle sistematies toe te lê op die bestudering van bestuur in beginsel en praktyk nie. Daar bestaan egter vandag voldoende geleenthede vir tegniese persone om hulle kennis op die gebied van bestuur uit te brei en om hulle met die nodige bestuursvaardigheid toe te rus. Behalwe die wyse keuse van boeke en literatuur oor bestuurswese wat vandag beskikbaar is en die korrespondensiekursusse wat deur verskeie kolleges en universiteite aangebied word, bestaan daar sekere spesiale instellings soos die Nasionale Ontwikkelingsgenootskap wat uitstekende geriewe in bestuursopleiding aanbied.

Munisipale Elektrotegniese Ingenieurs kan aangeraai word om van sulke geleenthede gebruik te maag aangesien die sukses van hulle onderneming nie net van tegniese vaardigheid en die volmaaktheid van sy uitrusting en toerusting afhanklik is nie, maar ook van gesonde bestuur.

Ofskoon munisipale elektrotegniese ingenieurs 'n vername rol speel ten opsigte van die bevordering van doeltreffendheid in munisipale elektrisiteitsondernemings is die rol wat deur raadslede gespeel word, nie minder belangrik nie.

Byvoorbeeld, die doeltreffendheid van die diens wat gelewer word hang grotendeels af van die beleid wat deur die stadsraad gevolg word om die nodige fondse vir uitbreidings, verbeterings, herkonstruksie e.d.m., beskikbaar te stel.

Die optrede en beleid van starsrade oor sake wat personeel raak soos salarisskale, aanstellings, bevorderings, diensvoorwaardes, gesondheid en welsyn moet 'n uitwerking op werknemerverhoudings en moraal hê wat weer 'n belangrike uitwerking op produktiwiteit het. Sonder tevredenheid en hoë moraal kan die bedryfsdoeltreffendheid in 'n munisipale elektrisiteitsonderneming nooit die maksimum bereik nie.

Hoewel die doeltreffendheid van sekere funksies en bedrywighede in elektrisiteits-

Although the efficiency of certain functions and operations in electricity undertakings can be determined and comparisons made between different undertakings, there is as yet no standard means of assessing the overall efficiency or effectiveness of an electricity undertaking on a common and therefore, comparable basis.

The average cost per unit sold is often used as a measure of efficiency and for comparing the efficiency of one undertaking with that of another, but this is obviously not acceptable as any overall assessment must take the standard and quality of the service provided into account. Furthermore, the average cost per unit sold depends on many factors which vary from place to place, and which are either wholly or partially outside the control of the undertaking such as for example, coal and water costs in the case of undertakings generating their own power, bulk supply tariffs in the case of undertakings obtaining their supply in bulk, load factor, geographical conditions, wages rates, interest rates, etc.

It may be possible to assess the overall efficiency of an electricity undertaking by laying down certain indicies for the economy of operations which are under the control of the undertaking and the standard and quality of the service provided, all on a common basis, but this would be no easy matter and would require much study and investigation. To mention just one of the difficulties, in order to make an assessment of the standard and quality of the service provided, it would, amongst other things, be necessary to take consumer satisfaction into account. We are then immediately faced with the problem that there is no known means of accurately determining consumer satisfaction.

A paper on the assessment of the efficiency or effectiveness of electricity undertakings would be most interesting and valuable, and consideration could perhaps be given to the presentation of such a paper at some future date.

I trust that these few thoughts on a subject which is receiving much attention today, will prove to be of interest.

ondernemings vasgestel kan word en vergelykings tussen verskillende ondernemings gemaak kan word, is daar tot dusver nog geen standaard wyse waarop die omvattende doeltreffendheid of doelmatigheid van 'n elektrisiteitsonderneming op 'n gewone en dus vergelykbare grondslag bepaal kan word nie.

Die gemiddelde koste per eenheid verskaf, word dikwels gebruik as 'n maatstaff vir doeltreffendheid en om die doeltreffendheid van een onderneming met dié van 'n ander te vergelyk, maar dit is klaarblyklik nie aanneemlik nie aangesien enige omvattende bepalings die standaard en gehalte van die diens gelewer in aanmerking moet neem. Die gemiddelde koste per eenheid verskaf is bowendien afhanklik van sekere faktore wat van plek tot plek wissel en wat of geheel en al of gedeeltelik buite die beheer van die onderneming is soos bv. steenkool- en waterkoste in die geval van ondernemings wat hulle eie krag opwek, grootmaattoevoertariewe in die geval van ondernemings wat hulle toevoer in grootmaat verkry, belastingsfaktor, geografiese toestande, loonskale, rentekoerse, e.d.m.

Dit mag moontlik wees om die omvattende doeltreffendheid van 'n elektrisiteitsonderneming te bepaal deur sekere indekse voor te skryf vir die ekonomiese bestuur van bedrywighede wat binne die beheer van die onderneming ressorteer en van die standaard en gehalte van die diens, almal op 'n gemene basis, maar dit sal nie 'n maklike taak wees nie en sal heelwat studie en ondersoek verg. Om maar een van die moeilikhede te noem, teneinde 'n bepaling van die standaard en gehalte van diens verskaf, te maak sal dit o.a. nodig wees om verbruikerstevredenheid in ag te neem. Ons kom dan dadelik voor die probleem te staan dat daar sover soos ons weet, nie 'n wyse bestaan waarvolgens verbruikerstevredenheid noukeurig vasgestel kan word nie.

'n Referaat insake die bepaling van die doeltreffendheid of doelmatigheid van elektrisiteitsondernemings sal baie interessant en waardevol wees en die lewering van so 'n referaat op een of ander tyd in die toekoms mag miskien oorweging geniet.

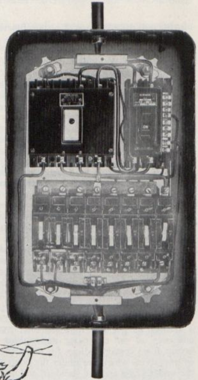
Ek vertrou dat hierdie paar gedagtes oor 'n onderwerp wat tans heelwat aandag geniet, interessant gevind sal word.

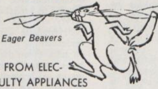
## HENLEY-SIMPLEX AFRICA

now offer a

## FOOLPROOF

# Earth Leakage Device





*. . . another triumph by Eager Beavers*

### COMPLETE PROTECTION FROM ELECTROCUTION DUE TO FAULTY APPLIANCES

Now everybody — in homes . . . in industry — can be protected from injury, and the danger of fire arising from faulty wiring on electrical appliances and apparatus. One of the greatest safety devices ever invented, the Earth Leakage Unit is so sensitive (5 milliamps) that it is more than adequate to protect even the smallest child. And it's Foolproof.

### A GROUP LIFE PREMIUM for only **R34.00**

The cost is only R34.00 and can be regarded as a permanent life premium against electrocution for an entire family or group of employees. Easily incorporated into distribution boards for new houses and flats. Can be fitted to existing boards and is even completely effective in old homesteads where plugs are without earthing.

AFRICA HENLEY Simplex (PTY) LTD.

ENQUIRIES WELCOME FROM MUNICIPALITIES, MINING & INDUSTRIAL COMPANIES, ELECTRICAL CONTRACTORS, ETC.

Write for full Technical details to: Henley-Simplex House, Corner Fawcus and Maritzburg Streets, City and Suburban, JOHANNESBURG. P.O. Box 100, Jeppestown, Transvaal. Telegraphic Address: "MEGOHM", Telephone: 24-9951.

MR. GILES, EAST LONDON: Thank you Mr. President for your very thought-provoking address.

I call on Mr. van der Walt to propose a vote of thanks to the President.

MNR. J. L. VAN DER WALT, KRUGERSDORP: Mnr. die Voorsitter, Mnr. die President, Dames en Here. Dit is my voorreg om ons President al van ons skooldae af te ken, asook as student op Universiteit. Oor hierdie lang tydperk het ek hom leer ken as 'n tegniese perfeksionis, deeglik in alles wat hy doen. In die afgelope aantal jare het ek hom as 'n administrateur van 'n hoogs tegniese departement leer ken en weereens het hy sy goeie deugde getoon en bewys dat hy daardie hoedanighede wat hy in sy rede aanhaal wel besit, n.l. bestuurstegniek sowel as deeglike tegniese kennis van sy vak. Dit is om hierdie redes dat dit vir my so'n aangename taak is om hierdie mosie van dank vir sy rede in te stel.

Sy waarskuwing dat ons nou ons posisies in oënskou moet neem, veral in die lig van ons bekwaamhede met doeltreffendheid as doel, is seer sekerlik op die regte tydstip gedoen. Ek vertrou dat raadslede sowel as ingenieurslede hierdie raad in ernstige lik sal beskou en daarvolgens sal handel.

Mnr. Lombard neem aan dat alle ingenieurslede die nodige tegniese kwalifikasies besit om hulle dienste in daardie faset deeglik te kan uitvoer. Hy maan ons egter aan dat vandag is tegniese kwalifikasies op sig self nie genoeg om as bestuurders van sulke handelsondernemings op te tree nie. Ons durf nie op ons tegniese louere alleen rus nie en so verewig as tegniese barbare bestempel word nie en daarom wil ek sy aanmaning dat ons bykomende bestuurskennis en mense verhoudingskennis moet opdoen, onderstreep.

Ons moet in besonder ons organisasies in oëskou neem met dié doel voor oë om hulle meer doeltreffend te administreer en wel ooreenkomstig die definisie van *administrasie* wat soos volg geestel kan word:

„Administrasie is georganiseerde, kooperatiewe, rationele en verantwoordelike optrede deur mense wat saamwerk om 'n voorafbepaalde en vooruitbeplande gemeenskaplike doelwit so doeltreffend moontlik na te streef."

Die woorde „so doeltreffend moontlik" beteken baie dinge en sluit in so goedkoop moontlik (nie in prys nie, maar in doel) sonder vermorsing van materiaal en arbeid. Ek laat dit aan lede om in die lig van die President se rede hieroor na te dink.

I repeat in English. Administration may be defined as follows:

"Administration is organised, co-operative, rational and responsible action by persons who co-operate to reach a predetermined and preplanned common goal as efficiently as possible."

The words "as efficiently as possible" have a wide interpretation and include as cheaply as possible (not in price but in purpose) without wastage in materials and labour.

I leave it to members to ponder over this definition in the light of the President's address.

Our President has also sounded a note of warning to Councillors not to lower the morale of employees by hasty and irresponsible policies. I take it for granted that he also had *nepotism* — probably the biggest enemy of an efficient municipal organisation — in mind. I trust that Councillors will take heed of this serious warning, because they are included in " the persons who co-operate to reach a common goal."

The remarks on O & M. officers, O & M. departments or Management Consultants are well meant and true. If properly applied it can be a scientific instrument in making for greater efficiency. It will certainly be applied detrimentally to all concerned if resisted by unco-operative attitudes.

Ours are municipal trading undertakings and as such should be run on business lines. They are municipal or public utilities because they are natural monopolies and public interest is therefore protected. The ideal of service plays an important role.

I repeat, these undertakings should be run on business lines with great efficiency so as to counteract the general public opinion that municipal trading thrives on unfair competition: curtails civil liberties through bureaucratic control; is inefficient, extravagant and levies extortionate charges.

Sound business approach to the administration of our departments should take into consideration: —

An organisation with well defined functions and clear allocation of duties.

Sound personnel management with provision for health and welfare of employees.

Cost accounting for maintenance of strict control over operations.

Efficient storekeeping and regular checking upon wastage of materials.

Scientifically determined rates of remuneration.

Keeping down of overheads to prevent the tendency to indulge in various extravagances — such as attending conferences.

The President's remarks re the search for more efficiency in local government is only too true. The Transvaal Provincial Administration is considering the investigation of the possible advantages of combined services for neighbouring municipalities. I again leave it to members to ponder over this step in the light of the Presidential address.

Although we must not relax, I think it is also fitting to mention here that Electricity undertakings may be held as an example to other business concerns in that the post-war cost of electricity has only risen 20% compared to the 300 % in other commodities. Taking the inflationary trends into consideration we may say that the cost of electricity has actually decreased. This speaks well of the efficiency of electrical engineers and in particular, municipal electrical engineers who contribute a large percentum of electricity generated and distributed. We may therefore be forgiven this once a year extravagance in overheads to hold a conference of this nature where we both play and work.

Mr. Chairman, ladies and gentlemen, it affords me great pleasure to propose a vote of thanks to our President for his well-timed address on a subject which must of necessity provoke deep thinking and action in councillors and engineer members.

Thank you. (Applause.)

MR. P. A. GILES, EAST LONDON: Thank you, Mr. van der Walt: I will now call on Clr. Main of Johannesburg to second the vote of thanks.

CLR. R. H. MAIN, JOHANNESBURG: Mr. Chairman, ladies and gentlemen: It affords me great pleasure in having to second the vote of thanks for a very fine Presidential Address indeed. As a matter of fact, when this Presidential Address was first handed to me, I congratulated myself on having a very short document to read for a change, and my reading went very well in fact, until I reached page 4. Page 4 about half way down. I would say at this juncture that the President rectified it, and it can be attributed to a typographical error, but I must say when I first read it, I rather felt, as I think our immediate past president, Mr. Simpson, felt when he reached the Immigration Counter at Jan Smuts Airport with a passport that had expired.

That I think, too, is an example of what can be done by way of O & M. The organisation in rectifying the error was indeed fine. Perhaps the methods employed were not quite Kosher!

Mr. Chairman, there is a tremendous amount to think about in perusing this particular document, and I notice too that your President, Mr. Lombard, has in fact made mention of the new Management Committee System which has recently been implemented in the province of the Transvaal.

I stand here today in fact as an example of that. I am the Deputy Chairman of the current Management Committee in the City of Johannesburg, and I want, on this occasion, without delving into any details, just to correct a few of the misapprehensions that exist in the minds of very many people and other councillors . . . that they no longer have very much to do.

Mr. Chairman I want to rectify that right away. Those other councillors have an all important task to perform and I would say, in fact, that if anything, they now have more time in which to do it.

The other misapprehension which is perhaps being created in the minds of people is that you now have a cabinet which is almost autocratic in its application of Council policy. That too, is entirely wrong. Every matter, every item for consideration, has still to run the gauntlet of full council. Perhaps that misapprehension has been created as a result of our recent experience in the City Council of Johannesburg, where, in fact (after normal council meetings, which have always taken anything from four to five, sometimes six hours, for a normal agenda) we finished in a quarter of an hour. We started at 2.30 and with the usual formalities, we finished at 2.45.

But I would say on that occasion, we were just very lucky indeed, and I am sure that this new system should be given a fair trial. I am the first to say it should be given a fair trial. And here again I think it has been indicated by the authorities who are responsible for making it an ordinance, that the first year of operation would in fact be considered a trial period, but not a trial period in the sense that the new system would be retracted after a period.

That trial period is only to smooth out the very many difficulties, and the anomalies, that must of necessity confront one when embarking on a new system. So much for that.

Mr. Chairman, I was reminded when I read this famous paragraph, which I am pleased to see has been since rectified, in regard to the lesser importance of Councillors, I am reminded in fact of how a typographical error, in fact, saved a man's life. This happened, I believe, in the period of the Czarist régime in Russia when a man had been condemned for the rest of his life to Siberia, and the final statement that was made was "Pardon Impossible, To Be Sent to Siberia." Fortunately there was a very fine typist hanging around, and she put the comma, not after "Pardon Impossible" but after "Pardon" so it read, "Pardon, impossible to be sent to Siberia." So these mistakes do help at times!

I do not wish to protract what I have to say, but I do want to congratulate the author of this fine paper on the very many ideas that he has left with us for consideration.

I am sure that members present will take the opportunity of perusing what he has said, and trying in some way or other to implement these ideas.

I notice of course, that in the last paragraph of his very fine address, he is leaving something over. That is rather typical, I think, of an electrical engineer. You know they are fine at putting a generator or alternator down on the foundation, and then looking to the mechanical engineer for something to drive it with.

What is intended here, of course, is very fine indeed, and I am wondering if, in fact, it is the function of an electrical engineer, to present the particular paper he is recommending. I think perhaps it is the job of a mechanical engineer.

Mr. Chairman, in conclusion let me say that it is indeed an honour for me to second this vote of thanks so ably proposed by Mr. van der Walt, and may I take this opportunity, too, of congratulating the recipient of this high office, viz. the President of the A.M.E.U., but I must also congratulate those who have been responsible in electing such a fine man to this high office.

Thank you, Mr. Chairman.

MR. P. A. GILES, EAST LONDON: Thank you, Clr. Main. It is now my job to vacate the Chair and hand over to your President.

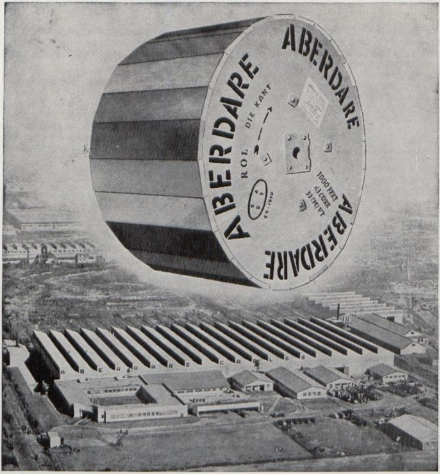
THE PRESIDENT: Thank you Mr. Giles, for taking over the Chair during my absence; and thank you Mr. van der Walt, and Clr. Main for your kind remarks.

## LUNCHEON ADJOURNMENT

*On Resuming at* 2.30 *p.m.*

(The President opened the afternoon session with Convention Announcements.)

Mr. G. A. Peterson presented his paper, and the President called on Mr. Sibson to propose a vote of thanks.


ABERDARE
ABERDARE
ABERDARE
ROL DIE KANT
A B E R D A R E C A B L E S

# The Kariba Project

*by*

G. A. PETERSON, B.A., M.I.E.E.,
M.I.Mech.E., M.Rhod.I.E.

## A. THE POWER SUPPLY SITUATION IN THE RHODESIAS BEFORE THE KARIBA PROJECT WAS UNDERTAKEN.

The power supply situation in the Rhodesias in the mid-1950's was comparable in many ways with that existing in Europe at about the time of the first World War. Power production was still concentrated mainly in comparatively small thermal power stations supplying individual communities although some degree of interconnection between power stations had already evolved and several areas were served by local transmission systems or "grids." The largest of these was that of the Southern Rhodesia Electricity Supply Commission which by the 1950's had established an extensive 88kV and lower voltage transmission system serving a limited degree of interconnection with the major cities of Salisbury and Bulawayo. A smaller but more heavily loaded grid had also been provided in the Northern Rhodesia Copperbelt by the Rhodesia Congo Border Power Corporation whose 66kV system linked the principal mine generating plants. These grids were, however, local in character and no general interconnection between the power stations and consuming centres of the Rhodesias existed.

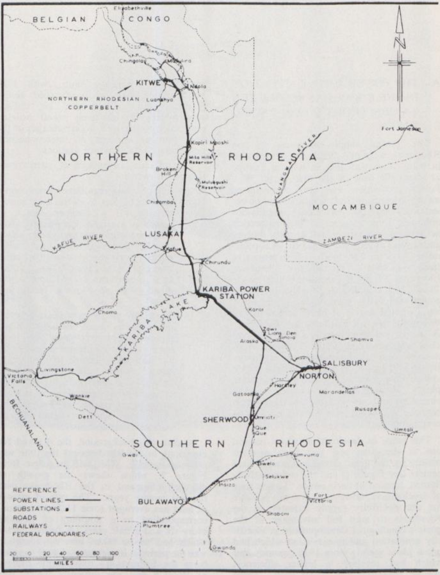
This stage in development was a natural one at the time and had been dictated mainly by the great distances between load centres (see Figure 1) and the comparatively limited demand at each centre. In this state of development, however, it was not possible for the electricity supply industry of the Rhodesias to take full advantage of the great technological developments in electricity generation and transmission which had taken place mainly from 1930 onwards and which had resulted in higher efficiency, greater reliability and lower costs. These advances were associated with the use of very large generating units, with high voltages and with other advanced design features which could not be utilised economically by relatively small isolated undertakings and with the advantages of the now familiar concept of interconnection between individual power stations.

The principal advantages of interconnection are of course:—

(i) Local power reguirements no longer need to be met from the local power stations. If a cheaper source of power is available elsewhere on the interconnected system then power can be generated there and transmitted over the grid to the point where it is required. Thus, at all times, power can be produced in the plants with the lowest production costs.

(ii) The costly provision of spare generating plant is much reduced. When power stations are isolated each must have at least one spare generator as an insurance against plant breakdown. When power stations are linked by a grid the total provision of spare plant can safely be reduced as it is reasonable to assume that breakdown will not occur in all stations simultaneously.

Against this background, the demand for electricity in the Rhodesias at the time was growing rapidly. This will be clear from Figure 2, which shews the growth of electricity demand in the Rhodesias over the last twenty years. The rate of growth of load has averaged some 11% per annum, corresponding to a doubling of demand every six and a half years. A further factor which had to be taken into consideration was the periodic inadequacy of coal supplies from the Federation's only major colliery at Wankie and the difficulty which was experienced at times by the Rhodesia Rail-


BELGIAN CONGO
Elisabethville
Chingola
Mufulira
KITWE
Ndola
Luanshya
NORTHERN RHODESIAN COPPERBELT
Kapiri Mposhi
Mita Hills Reservoir
Broken Hill
Mulungushi Reservoir
NORTHERN RHODESIA
Fort Jameson
LUANGWA RIVER
MOCAMBIQUE
Chisamba
LUSAKA
KAFUE RIVER
Kafue
ZAMBEZI RIVER
Chirundu
KARIBA POWER STATION
Karoi
KARIBA LAKE
Choma
Zawi
Lions Den
Sinoia
Alaska
Shamva
SALISBURY
NORTON
Livingstone
Victoria Falls
Wankie
Hartley
Gatooma
Marandellas
Rusape
Dett
SHERWOOD
Umtali
BECHUANALAND
SOUTHERN RHODESIA
Gwelo
Selukwe
Insiza
Fort Victoria
Shabani
BULAWAYO
Plumtree
Gwanda
REFERENCE
POWER LINES
SUBSTATIONS
ROADS
RAILWAYS
FEDERAL BOUNDARIES
20 0 20 40 60 80 100
MILES
N


LOCATION MAP

FIG. 1

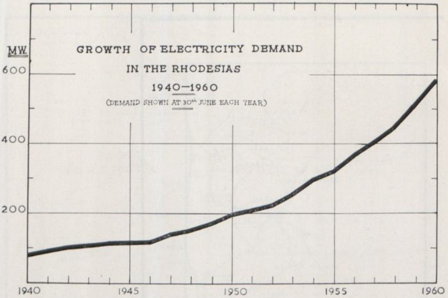



Fig. 2.

ways in transporting coal from Wankie to thermal power stations in other parts of the Federation. The location of Wankie Colliery and of the main railway lines is shewn on Figure 1 and it will be seen that Wankie is in the North Western corner of Southern Rhodesia, remote from the main centres of population at Salisbury, Bulawayo and in the Northern Rhodesia Copperbelt. The railway haul from Wankie to the Copperbelt, for example, is some 550 miles and to Salisbury some 470 miles.

In this situation the advantages to the Rhodesias which would follow from interconnection of the generation stations and the development of hydro-electric rather than coal-fired generating stations as the means of meeting increased power requirements were obvious. Before any decision was reached, however, a careful study was made of the alternative methods of development of the power supply system which were possible.

These included:—

1. Continued development of isolated coal-fired power stations serving local load centres.
2. The development of a large pit-head power station at Wankie colliery associated with high voltage transmission lines to transmit the power to the load centres.
3. The development of a large water-power station on the Zambesi or Kafue rivers with similar high voltage transmission.
4. Nuclear energy.

The last of these alternatives — the possibility of employing nuclear power — was soon concluded to be both impractical and uneconomic. At that date the best estimate that could be made of the cost of power from nuclear stations was that it would be something like twice the cost of power from conventional coal-burning stations. A further difficulty associated with

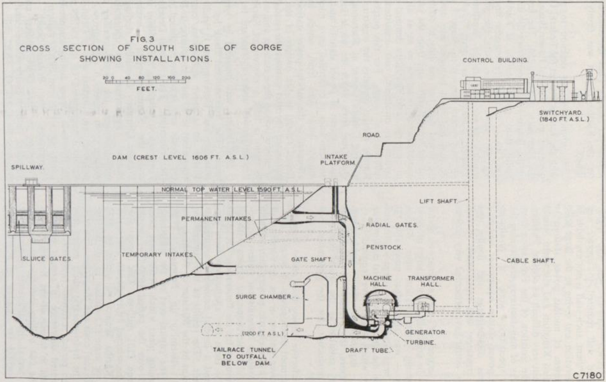


FIG. 3
CROSS SECTION OF SOUTH SIDE OF GORGE
SHOWING INSTALLATIONS.
FEET.
CONTROL BUILDING.
SWITCHYARD. (1840 FT. A.S.L.)
ROAD.
INTAKE PLATFORM.
DAM (CREST LEVEL 1606 FT. A.S.L.)
SPILLWAY.
NORMAL TOP WATER LEVEL 1590 FT. A.S.L.
LIFT SHAFT.
PERMANENT INTAKES.
RADIAL GATES.
PENSTOCK.
SLUICE GATES.
TEMPORARY INTAKES.
GATE SHAFT.
CABLE SHAFT.
MACHINE HALL.
TRANSFORMER HALL.
SURGE CHAMBER.
(1200 FT. A.S.L.)
GENERATOR.
TURBINE.
TAILRACE TUNNEL TO OUTFALL BELOW DAM.
DRAFT TUBE.
C7180

nuclear power stations was the highly specialised staff required to operate and maintain them; such staff is not available in the Federation and owing to the large-scale development of nuclear power stations in the United Kingdom and elsewhere, would have been very difficult to obtain. Furthermore, the isolation of the Federation from the works of manufacturers undertaking the highly specialised work of producing nuclear power station equipment was also a serious disadvantage and finally, the supply, treatment and replacement of fuel elements would have presented very serious problems.

The second of the alternatives listed above—the construction of a large pit-head coal-burning power station near Wankie Colliery — was also judged unsuitable. It would have imposed a large additional strain on the already overloaded coal mining industry which would have required heavy capital expenditure for development. Furthermore, the location of Wankie was not very suitable as the main centre of power production for the Federation (see Figure 1).

The effective choice thus rested between the continued development of isolated coal-fired power stations or the development of a large hydro-electric project coupled with a high voltage transmission system to provide a fully interconnected system with all its advantages for the Federation. Technical plans for these two alternatives were prepared and a careful economic comparison was made. The results of this comparison were given by the Minister of Power to the Federal Assembly in February, 1956. Briefly, the capital cost of the additional coal-burning plant which would have been required over the period 1960-1971 would have been £101 million. The comparable cost of the selected hydro-electric alternative — the Kariba Project — would be £113 million, or some £12 million more. But the saving in coal costs and the longer economic life of the hydro-electric plant meant that over the period reviewed (1960-1971) the accumulated difference in annual production costs in favour of the Kariba Project would be £44 million and that at the end of that period the difference in favour of Kariba would be running at nearly £10 million per annum. Thus, the economic case for the Kariba Project was firmly established.

To implement the decision to proceed with the Kariba Project the Federal Government set up the Federal Power Board under the Electricity Act of 1956. The first duty of the Board was to construct the dam and South Bank power station at Kariba and the 330kV "grid" of transmission lines linking this power station with the principal existing power stations in Northern and Southern Rhodesia (see Figure 1). As soon as this system, known as Stage I of the Project, had been brought into operation, the Board then had the duty to control the output from Kariba and from the interconnected thermal stations so as at all times to meet the total electricity demand on the system at minimum cost consistent with reliability of supply. For this purpose, the Kariba Project includes the construction of a large Control Centre at Sherwood, near Que Que, from which the whole interconnected system of power stations and transmissions lines is controlled on a minute-to-minute basis and from which load is allocated to the various power stations. The Board refund to the owners of the interconnected thermal stations the actual costs of production at these stations and sell back to them in bulk a mixture of Kariba and thermal power under a standard tariff.

The Project was financed by long-term loans. The International Bank for Reconstruction and Development is lending the Board an amount in various currencies equivalent to 80 million dollars, to be used for goods and services purchased outside the Federation. The Colonial Development Corporation is lending £15 million sterling and the Commonwealth Development Finance Company £3 million sterling. The Federal Government has undertaken to make loans to the Board totalling £Rh28 million from monies it will borrow for the purpose, and a further sum of £Rh6 million should it be required. Of this £Rh28 million the Rhodesia copper mining companies have jointly agreed to lend £Rh20 million to the Government; the British South Africa Company to lend £Rh4 million and the Standard Bank of South Africa Limited and Barclays Bank D.C.O., £Rh2 million each.

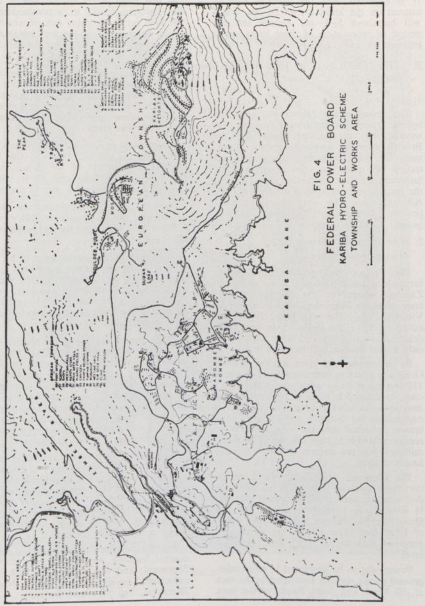



FIG. 4
FEDERAL POWER BOARD
KARIBA HYDRO-ELECTRIC SCHEME
TOWNSHIP AND WORKS AREA

It is expected that the average rate of interest on the loans drawn by the Board will be about 5¼% per annum and the period of redemption of these loans varies between 19 and 33 years.

## B. THE DESIGN OF THE KARIBA PROJECT.

### 1. General.

The design of the Project was entrusted by the Board to Consulting Engineers who worked out detailed proposals for the Board's approval and subsequently supervised for the Board the construction and testing of plant in the manufacturers' factories and the construction of works and the installation and testing of plant on site. All major contracts were placed by competitive international tendering and in general included transport and erection.

### 2. The Dam and Other Civil Engineering Works.

The Project involved the development for hydro-electric purposes, of a site on the Zambesi River at the Kariba Gorge, approximately 240 miles downstream of the Victoria Falls. The very large civil engineering works in this Project have been fully described in a number of other papers and only a brief resume will be given here.

By damming the river at the Kariba Gorge, an effective nett water head of about 310 feet could be obtained and a large lake could be formed to provide the seasonal and inter-seasonal storage of water required to compensate for droughts and floods. Calculations indicated that the total quantity of energy available at this site would be 8,000 million kWh per annum for the proposed height of dam.

The proposed dam was to be a double curvature concrete arch dam to raise the dry weather river level by about 320 feet. It would have a height of about 400 feet above the foundations, and a crest length of 1,800 feet. The normal top water level proposed was to be 1,570 feet above sea level.

Power was to be generated in two underground power stations excavated in the rock at the North and South flanks of the dam.

The first stage power station was to be in the Southern flank, to accommodate six 100 MW turbo-generator sets, of which five would be installed in the first instance. A cross-section of the works for the first stage at Kariba is shewn in Figure 3.

Individual permanent intakes were to be provided immediately upstream of the dam to lead water to each set, with temporary intakes for the first and second sets at a low level to allow generation to commence before the lake filled.

After passing through the turbines, the water was to be led back to the river channel downstream of the dam through three surge chambers and three tailrace tunnels, i.e., one for each pair of machines.

Accommodation underground was also to be provided for the step-up 18/330kV transformers in a separate chamber adjacent to the machine hall.

The underground works were to be connected to the surface by an access tunnel for vehicles, by a lift shaft, and by a cable shaft. The cable shaft was to accommodate the 330kV cables carrying the electrical output of the station to a switchyard on high ground above the gorge.

Other permanent works at Kariba were to include a control and office building; switchyard; workshops and stores facilities; and housing and amenities for the permanent staff, together with necessary services. In addition, since the site was remote, access roads, bridges, an aerodrome, a hospital, and construction camps were to be built. A general plan of the township and works area is shewn in Figure 4.

The cost of the civil works at Kariba, as described above, was estimated at £39.2 million, and it was considered that the first machine could be commissioned at the beginning of 1960. It was thought that the dam would be completed by mid-1960, but that a start could be made on impounding water in the lake at the end of 1958.

In other parts of the Federation, a system control building was to be constructed at Sherwood, and five substations with their associated buildings, at Kitwe, Norton, Sherwood, Salisbury and Bulawayo.

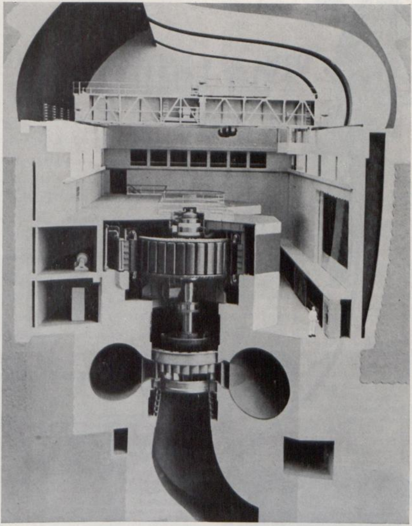
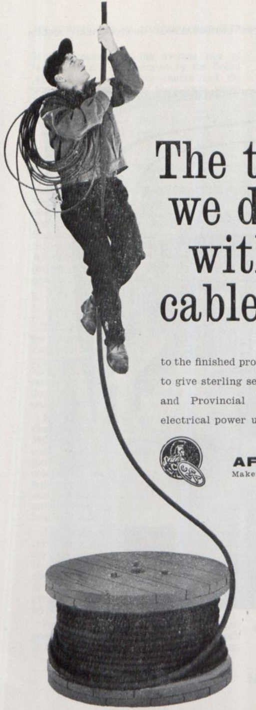


Fig. 5.



As the work progressed, some modifications were made to the original programme, the principal ones being that the height of the dam was to be increased by twenty feet, that the sixth generating set was to be provided in the first stage and that a further substation was to be constructed at Lusaka.

The increase in the height of the dam made it about 420 feet high above the foundations, with a crest length of 2,025 feet. The lake then became 175 miles long, with a total storage capacity of 130 million acre feet. In addition, the assessment of the total energy available was increased to 8,500 million kWh per annum.

3. The Electrical and Mechanical Plant.

(i) *Turbine-Generator Sets.*

The 100 MW turbines are of the Francis type (see Figure 5) which give their rated output of 140,000 B.H.P. at a nett head of 282 feet. The mean nett head will be 310 feet when the lake reaches its normal operating level. The maximum gross head is 352 feet. The generators are of the salient pole umbrella type, that is, with the trust and guide bearing beneath the rotor. The machines run at a speed of 166.7 r.p.m. and have a maximum continuous rating at 0.9 power factor, of 100 MW, the generated voltage being 18kV. The diameter of the stator is 32 feet and of the rotor 25 feet 6 inches. The total load on the thrust bearing including hydraulic thrust is 660 tons. Because of its great weight and large dimensions the generators, after assembly and testing in the makers' works in England, had to be broken down for shipment to site, the stator into quarters and the rotor into many parts, the shaft, the hub, the spider arms, laminated sections for the outer ring and the 36 poles which dovetail into slots in the periphery of this ring. The complete rotor with its shaft assembled for installation weighs nearly 400 tons and requires the two ton power station cranes to be coupled together to lower it into position.

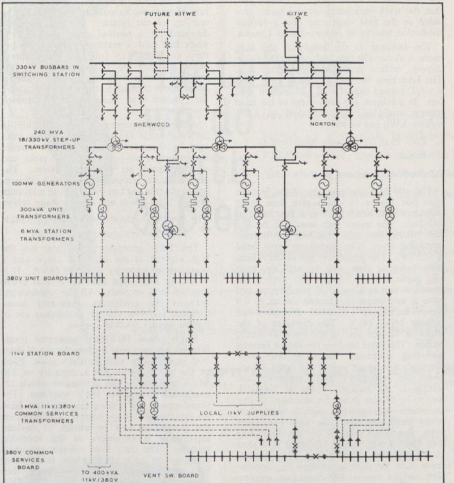
The machine is cooled by water coolers situated outside the stator in the closed air circuit. The turbine and generator bearings are also water cooled with water bled from the penstock. Excitation is by a 364kW 360 volt D.C. machine, on the generator shaft, and controlled by a combination of static and rotating magnetic amplifiers, ending with a flywheel booster. This has a high rate of response to assist in maintaining the stability of the system. The machines are designed for a normal speed rise of 21% when full load is suddenly thrown off, but they are tested to full run away speed, nearly double the normal speed, in the maker's works. A permanent magnet generator is coupled to the main shaft above the excitor for use with the turbine governor.

Auxiliary equipment includes built-in carbon-dioxide fire-fighting equipment initiated by thermostats in the hot air circuit, high pressure oil-operated rotor jacks and a compressed air breaking system. The generators are protected by overall differential protection backed up by denite minimum inverse time relays and over voltage relays.

(ii) *Generator 18kV Switchgear, 18/330kV Transformers and 330kV Cables.*

The 18kV generator switchgear has the high current rating of 4,000 amps and a short circuit capacity of 1,500 MVA. It is of the air blast type and has a total break time of 0.05 seconds. All the connections between the generators, generator transformers, and low voltage switchgear are of hollow square section copper.

Single phase 18/330kV generator transformers are arranged in three banks of three with one standby unit for the station. Each of the three banks has a capacity of 240 MVA and serves two generators which are connected to separate 18kV windings. The transformers are Ydd connected and have no tappings. Voltage control is effected on the generators and by means of on-load tap-change transformers at the receiving stations. The two low voltage generator windings on each single phase transformer unit are placed on separate limbs thus giving a high reactance (25% on 120 MVA base) between them to limit the short circuit duty on the generator switchgear. The reactance between each LV winding and HV winding is 12.5%. Transformer protection consists of balanced earthfault equipment with overcurrent relays for phase faults. Buchholz and winding temperature




KARIBA POWER STATION
SIMPLIFIED DIAGRAM OF CONNECTIONS

FIG. 6

relays are also fitted. Neutral displacement relays are fitted on the 18kV busbars. Cooling of the transformers is by forced oil and water/oil intercoolers, the cooling water being taken from the spiral casing of the turbines. The common 330kV winding, which has a solidly earthed neutral, delivers power via 330kV cables to the switching station at the surface 600 feet above. The cables are 0.85 square inch copper cross-section and were delivered to site in the finished lengths ranging from 560 to 650 yards. The cable is of an unusually advanced design having an impulse level of 1,500kV High mechanical stress is involved due to the hydrostatic pressure equivalent to about 600 feet of oil. One spare cable per circuit is provided for the vertically mounted section of the cable run and one spare cable for the three circuits in the horizontal sections. A surge diverter is connected to each transformer at the cable termination.

(iii) *Power Station Auxiliaries.*

Each generator has connected to it a 300kVA unit transformer which normally supplies all essential auxiliaries for the set. There are also two 6,000kVA station transformers, 1811kV, which can be connected to either one of two pairs of generators but never to more than one pair at a time. Figure 6, shewing the main Power Station connections will make this clear. These two station transformers feed the main 11kV Station board to which are connected three general service transformers, 1,000kVA, 11/380kV. The common services 380 V board can supply the unit auxiliaries if required in addition to the main other general auxiliaries, station lighting, air treatment plant, de-watering pumps, etc.

(iv) *Transmission System Substation Plant.*

Each generator transformer bank is connected to the switching station busbars by a bulk oil 330kV circuit breaker. These breakers are rated at 7,500 MVA rupturing capacity at 330kV.

Each phase is switched in a separate tank, and there are six breaks per phase, each one being shunted by a linear resistance having its own breaking arrangements. The

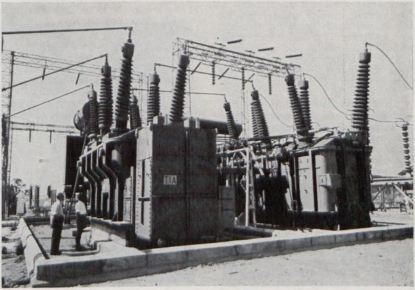


Fig. 7.

switchgear is similar throughout the transmission system except that in the case of breakers used on single circuit lines each phase is capable of operating independently permitting single phase auto-reclosing.

The breakers are capable of interrupting charging currents of up to 300 amps and magnetizing currents of up to 200 amps, without generating excessive over-voltages. Line switches are fitted at each end of every line except at Salisbury but on the single circuit feeders where only two transformers are at present installed a second circuit breaker (bus coupler) is provided to allow maintenance on the line breaker and for connecting and disconnecting transformers.

The transformers in the substation are all three phase units and with the exception of one substation are each of 60 MVA capacity having low voltage windings of 88kV or 33kV; the one exception is Kitwe where auto-transformers are used having a rating of 120 MVA, 330/220kV; a view of one of these transformers is shewn in Figure 7. The substation transformers have on-load tap-change facilities (—4.6% to + 17.6%) but in the case of Kitwe it was necessary to specify separate booster transformers for voltage control mainly because of transport weight limitation. The reactance of the substation transformers was specified as having a maximum value of 11% to improve the system stability. All these transformers have 11kV tertiary windings and advantage is taken to connect 11kV shunt compensating reactors to them at several points on the system. These reactors, each of 20 MVA rating, are used to compensate for part of the reactive power generated by the long transmission lines which might otherwise cause generator instability and other difficulties. They are controlled by 11kV air-blast switchgear.

(v) *Transmission Lines.*

The transmission voltage of 330kV was chosen after detailed technical and economic studies of various alternative voltages. Twin conductors, spaced at eighteen inch centres, of steel-cored aluminium and each having an equivalent copper cross-section of .35 square inch are used for each phase. This conductor arrangement limits corona loss to reasonable limits and reduces the line reactance giving improved system stability.

The possibility of using copper conductors was considered but the cost would have been excessive as compared to steel-cored alumium. The twin conductors are held apart by flexible ring type spacers. The conductor is strung to give a tension of about 20% of ultimate strength at 60 degrees Fahrenheit and Stockbridge vibration dampers are fitted. Suspension insulator strings contain nineteen discs 5¾ inches long, 10 inches in diameter, having a wet withstand value of approximately 600kV at the mean altitude of the line. The impulse level is approximately 1,400kV. Tension insulator strings consist of eighteen discs, 7 inches long and of 11 inches diameter. Double strings are used at tension points and a turn buckle adjusting device is provided to equalise the tension in the two conductors of the phase. Arcing horns are only fitted to the live end of each insulator string except for the first mile from each line termination and at railway crossings where arcing horns are fitted at each end of the string to reduce the impulse level below that of the

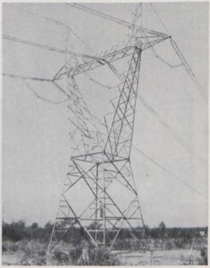


Fig. 8.

substation apparatus. Double overhead earthwires are employed of 19/.104" galvanised steel and give a shielding angle of 25 degrees at the towers and progressively more towards mid span.

Single circuit towers are used throughout the system, even in cases where circuits run parallel for a considerable distance, in order to reduce the risk of outages due to lightning. The towers are constructed of galvanised steel and are of the lattice-type waisted design (see Figure 8). This was shewn to be more economical than the portal type of structure. Other fundamental data are as follows:—

| | |
|---|---|
| Overall height of intermediate towers | 115 feet. |
| Conductor spacing | 37 feet 6 inches |
| Earthwire spacing | 48 feet 2 inches |
| Normal span length | 1,500 feet. |

The strain and angle towers are designed to withstand the breakage of a complete phase of line conductors and one earth conductor, at maximum tension. Suspension towers are designed for longitudinal unbalance corresponding to the breakage at normal tension of one of the pair of phase conductors or one earth conductor. All the main tower types were tested to destruction by full scale prototype tests.

Galvanised steel wire counterpoise is laid along the line route where the tower footing resistances exceeded 20 ohms. and for the last mile into each substation double counterpoise is laid irrespective of the footing resistances. The transmission lines are protected by three zone high speed distance protection with carrier acceleration for faults within the second zone. Power swing relays are provided to prevent operation during times of system instability. An exception to this protection arrangement is made on the Norton-Salisbury lines where 330kV breakers are only installed at the Norton end. These lines are protected by single zone high speed distance protection with carrier intertripping. Back-up protection is provided by definite minimum inverse time overcurrent and directional earth fault relays.

A system of high-speed self-locking voltmeters and ammeters is used at both ends of each line to record zero phase sequence components enabling the location of faults to be estimated.

Oscilloperturbographs are provided at certain of the main centres to record the performance of protective gear and circuit breaker operations.

The transmission lines are also used to transmit power line carrier for communication telemetering and supervisory purposes and more detailed reference will be made to this in the next section.

(vi) *Control System.*

The Kariba network is controlled from a Central Control at Sherwood, near Que Que. A view of the Control Room at this Centre is shewn in Figure 9. The control engineers are able to speak over a private telephone communication system (power line carrier) to any of the interconnected power stations or substations to control switching operations and issue loading instructions. Trunk dialling facilities are provided to all stations.

Telephone facilities are reinforced by teleprinters and between Sherwood Control and the Board's Head Office by photo-facsimile equipment. There is a general indication panel giving automatic indications of all important switch and isolator positions on the system. These include twenty-five 330kV oil circuit breakers and associated isolators, all the main transformer LV switchgear and 11kV reactor switchgear.

The general indications arrangements on the control panel are such that they immediately shew up any discrepancy between the mimic diagram and the remote switch position. Provision is made to enable the control engineer to initiate a check on all switch and isolator positions should he wish, the complete check taking only a few seconds for some 168 indications. The general indications can be bunched into groups of up to 96 on a chosen voice frequency telegraph (VFT) channel for transmission from the remote station and are scanned and sorted by means of uni-selectors at the terminals. The control engineers are immediately made aware of any important changes in system conditions, whether intentional or due to faults, by visible and audible alarms.

The usual local indications of system frequency, rate of change of frequency, system time and standard time are provided, and in addition the control engineers are kept informed of the load flow (MW and MVAR) at all important points on the system by telemetering.

Indications of busbar voltage, both 330kV and lower voltage (88kV, 33kV, 220kV) are also telemetered to Sherwood Control.

All these facilities are made possible by the use of VFT and power line carrier channels which are transmitted over two phases of each of the transmission lines. Signalling and dialling for telephone operation is by means of VFT transmitted with the speech on a power line carrier channel, separation being by means of filters. There are at present up to six channels of carrier on each transmission line (this may be extended later to eight channels) and associated with each channel there are one speech and six VFT channels. Carrier frequencies used on the system for communications and protection range from 64 to 476 kilocycles and the total number of communications and signalling channels employed on the system at this stage of the development is 71.

Telemetering employs the teleprinter code, a particular letter being associated with each reading to be conveyed from the outstation to the Sherwood Control Centre. VFT channels are used and an electronic pulse generating and scanning device enables six to twelve independent instrument readings to be transmitted over a single channel on a time division principle, the scanning sequence being repeated every 120 milliseconds. The magnitude of an indication is governed by the rate of pulse initiated by the measuring instruments which are of the rotating-disc, induction type. The higher the voltage or the higher the load flow, the higher the pulse rate.

The normal pulse rate for maximum meter indication is either $66\frac{2}{3}$ or $33\frac{1}{3}$ per minute,

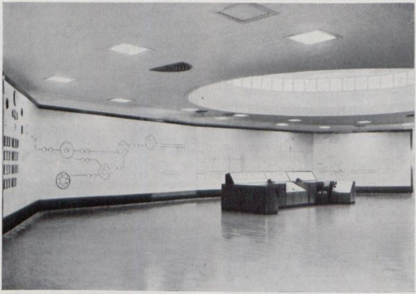


Fig. 9.

depending on the type of instrument. The identifying letter enables the signals to be routed to the corresponding indicating instrument in the control room.

In view of the important services which the power line carrier provides a number of safeguards are built into the system. Standby oscillators are provided for the power carrier racks which switch in automatically in the event of failure of the main oscillator. Auxiliary supplies are generally provided from three possible sources including two of the main substation transformers via an auxiliary transformer and automatic changeover contactor, or from a motor generator set run off the 220V D.C. battery supply. This starts up immediately, should the normal substation auxiliary supplies fail. At Sherwood, there is a further line of defence in the form of a diesel generator set which can be started from the control room.

While the equipment provided for communications and the supervision of the network is of a high standard, and reliable operation is to be expected, Post Office telephones are also installed at all centres, and, as a further insurance, HF radios are provided for communication between the Control Centre and other important operating points on the system. The same radio network is used to maintain contact with the transmission system maintenance organisation whose base depots and line maintenance vehicles are similarly equipped with HF radios.

All this complex electronic and other light electrical equipment requires careful maintenance to ensure proper performance and when it is realised that there are included in this some 6,000 relays and 9,000 radio valves the need for a skilled team of specialists to cover routine maintenance and repair of faults is apparent. With the widespread transmission system extending from Kitwe in the North to Bulawayo in the South — a distance of some 800 miles by road—there are considerable problems in rapid movement of these specialists from one centre to another as it is obviously not possible to have an individual with the required skill at each centre.

## C. SOME SPECIAL PROBLEMS OF CONSTRUCTION.

Having thus described the design of the Project, it may be interesting to review some of the special problems which arose during construction and which had to be systematically solved. They included the following:—

(i) *Hydrology.*

It was necessary to determine, as accurately as possible the behaviour of the river, particularly as regards the magnitude of peak floods and their time of arrival at Kariba. Hydrological records, on the whole, were good. Records of water levels at Livingstone had been kept since 1905 and the daily discharges were known, accurately, from 1924 onwards. Water levels had also been taken in the upper level and gauging stations were established at Chirundu downstream of Kariba, at Kariba itself, and on some of the major tributaries.

The vast catchment area covers 256,000 square miles, of which 196,000 square miles lies upstream of Livingstone (see Figure 10). Most of this area is undeveloped and sparsely populated, so that basic meteorological information was scanty and difficult to obtain.

The particular problem of the effect of floods on the construction work could not be entirely solved, but it was greatly eased by making reasonable allowance in the design of the river diversion structures and by establishing a flood warming system which successfully predicted the times of arrival of flood peaks at Kariba.

(ii) *River Diversion.*

The programme and method of diverting the river to allow the construction of the dam foundations in the deep channel posed a specially important problem, since the necessary construction work could only be carried out during the dry seasons, when the flow in the river falls to between 8,000 and 12,000 cusecs.

By the rapid action of awarding a preliminary contract in mid-1955, it was possible to save a year on this work, and this was reflected in the construction programme for the whole scheme.

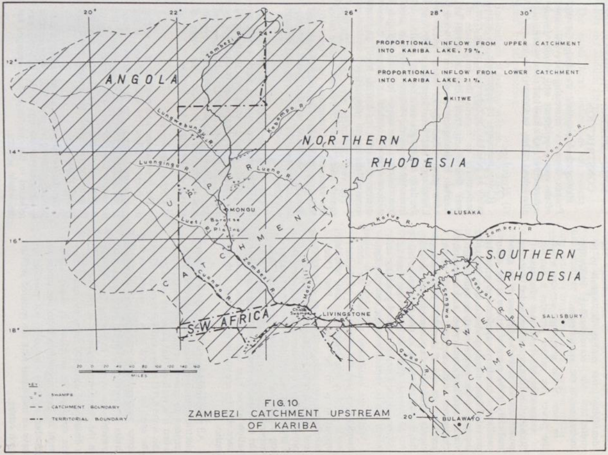



FIG. 10
ZAMBEZI CATCHMENT UPSTREAM OF KARIBA

The method of diverting the river was also solved by designing and providing an ingenious system of coffer-dams, including a semi-circular concrete coffer-dam of 300 feet radius on the North bank; a circular concrete coffer-dam of 370 feet diameter in the deep channel of the river; and a rockfill cofferdam immediately downstream of the site. Many of the operations involved had never previously been carried out on a comparable scale anywhere in the World.

(iii) *Access.*

The problem of access to and about the site, in the time available, appeared at first to be almost insuperable. Nevertheless, it resolved itself mainly into one of economics and hard work.

At first, only a rough track existed from the main Salisbury-Chirundu road to the South Bank at Kariba and, by mid-1955, access to the North Bank was achieved by a floating pontoon bridge across the river which was quickly supplemented by another rough track from the Chirundu-Lusaka road.

The main gravel-surfaced South Access road, 48 miles long, was completed by March, 1957. This North Access road was intended, primarily, for the transport of cement from the main source of supply — the Chilanga Cement Works, near Lusaka in Northern Rhodesia.

A suspension footbridge of 690 feet clear span across the Zambesi at the dam site was completed in May, 1956, and a road bridge, suitable for heavy traffic, was in operation by September, 1956.

The construction of all the main internal access roads at Kariba was well advanced by mid-1956.

The first airstrip was in operation in November, 1955, and it was extended and improved during the ensuing six months. This airstrip was ultimately inundated by the rising water of the lake and a new aerodrome was constructed and brought into operation in November, 1958.

(iv) *Labour.*

The peak labour force employed at Kariba amounted to about 1,500 Europeans and 7,000 Africans. The peak population, including other workers and dependants, was about 2,000 Europeans and 10,000 Africans.

Most of the Europeans were recruited outside the Federation and the largest number came from Europe.

At the start, some difficulty was experienced in recruiting African labour in competition with the large mining concerns. A similar system of contract labour to that used by the mines was therefore adopted, and valuable assistance in recruitment was obtained from the Rhodesia Native Labour Supply Commission. Good welfare services and amenities were also provided in the African Township. As these arrangements became known, volunteer labour presented itself in large numbers and even to-day, when construction is virtually completed, numbers of Africans travel long distances to Kariba seeking work.

It is of interest that, even when there was unrest in other parts of the Federation, no trouble arose at Kariba. Throughout the five years of construction there was only one strike which arose from a straightforward industrial dispute and was settled quickly and amicably.

(v) *Housing.*

The provision of construction townships for the labour force proved to be a similar problem to that of access, and was resolved in a similar manner. The construction of townships started in February, 1956, and was substantially complete in eighteen months, some six months' ahead of schedule. A truly remarkable achievement.

After several experiments, concrete block construction was used throughout with asbestos cement roofing, giving virtually permanent buildings.

Not only the necessary housing, but also offices, shops, schools, churches, posts offices, banks, meeting halls, beer halls, stores, canteens, clinics, a hospital and a swimming pool were built.

The townships were sited on a series of hills and ridges at the south sides of the gorge, the highest part being 2,700 feet above sea level, or 1,450 feet above average river level.

Water was pumped from the river to a modern purification plant and then distributed to the residential and works areas, partly by gravity but mainly by further pumping. The rated capacity of this plant was about 600,000 gallons per day of potable water, plus about 400,444 gallons per day of untreated water.

Electricity was provided by a temporary diesel generation station which, in the end, had an installed capacity of about 8½ MW. The output was mainly used for construction work, but it also served the townships. Distribution throughout the area was at 11kV.

Sewerage disposal was by septic tanks serving groups of buildings, the effluent from which was piped to soakaways.

(vi) *Transport* (See Figure 1).

The magnitude of the problem of transporting the vast quantities of plant, equipment, materials and supplies required at Kariba was realised at the outset, and the whole operation was meticulously planned. Sand and stone were obtained locally, but the 400,000 tons of cement required had to be brought by road 110 miles from the cement works at Chilanga. By far the largest portion of the plant and equipment required had to be brought from the factories in Europe and involved transport by road or rail to the docks, by ship to African ports, and by rail and/or road in Africa. Some items urgently required were transported by air. For normal items, a fairly loose degree of co-ordination was maintained between manufacturers, shipping agents, and the Board and their consulting engineers' transport organisation; but the transport of urgent items and abnormally heavy or bulky items was very carefully co-ordinated indeed.

Railway sidings to serve Kariba were built at Lion's Den in Southern Rhodesia and at Kafue in Northern Rhodesia, some 140 and 90 miles respectively, by road from Kariba.

The siding at Lion's Den was equipped with a 100-ton Goliath travelling crane, and the Board also purchased two special transformer well wagons of 110 tons capacity which were operated by Rhodesia Railways.

Two road transport contracts were awarded—one for transporting cement from the factory at Chilanga in Northern Rhodesia together with all other items under 12 tons from the railway sidings at Lion's Den and Kafue to Kariba; and the other for transporting all items over 12 tons to Kariba and to the substations. The contractor who was awarded the latter contract purchased a special 32-wheel road trailer, with a capacity of 125 tons, and had a similar trailer available in the Union of South Africa, in case of damage to the first.

The abnormally heavy items included twenty-six transformers, weighing between 88 and 109 long tons. Due to restriction on road loadings, the transformers normally had to be delivered during the dry seasons. The basic principles adopted were as follows:—

(a) That, as far as possible, at least two alternative methods should be available for transporting all items. This was achieved, except for turbine runners and certain heavy cables, which had to be transported by road from Beira.

(b) That the organisation should be sufficiently flexible to allow for the arrival of difficult items out of turn, due to causes such as delays or acceleration in manufacture, strikes, bad weather, etc. Among other things, this necessitated arranging for special holding areas throughout Southern Africa, but, by dint of complicated juggling of time tables, they were never needed.

(c) That shipment of items from overseas should never be held up because of doubt as to the possibility of transporting them in Africa, except as a last resort. This became a matter of pride, and no items were ever refused, although this incurred many risks, since port authorities would not allow heavy items to be unloaded unless a railway wagon was ready to receive them.

The railway authorities in South Africa, Mocambique and Rhodesia co-operated magnificently and allowed priority to be given to specially urgent consignments. Without this co-operation, it is highly probable that the whole scheme would have been delayed.

Altogether, over 600,000 tons of goods were transported to Kariba, of which about 400,000 tons were cement. The whole transport operation worked smoothly and no delays occurred. Only one important item was damaged and it was, fortunately, relatively easily re-placed.

(vii) *Health.*

The health of the construction force posed another problem, due to the hot climate and the remoteness of Kariba. The nearest doctor was 100 miles away and the nearest hospitals, at Lusaka and Sinoia, were respectively 130 and 150 miles away.

A medical organisation was, therefore, established by the Board, which started in mid-1955, with a small clinic and one medical officer, and was extended until in May, 1957, a modern ninety bedded hospital was opened, complete with surgical and X-ray units and laboratory facilities. The staff consisted of a chief medical officer, surgeon, a medical officer, a matron, and eight nurses, together with the necessary supporting personnel. A dental service was also provided by a visiting dentist.

The effect of the tropical conditions on the labour force, although appreciable, was much less than had been thought likely, and the general level of health was good. As was inevitable, due to the nature of the construction work, and despite every precaution, accidents occurred and deaths were caused.

Special precautions were taken against Malaria and Sleeping Sickness. For Malaria the taking of prophylactic drugs was enforced as far as possible; houses and buildings were sprayed internally with residual insecticides; and larvicidal sprays were used on any pools of water in the vicinity of the townships and working sites. Due to these measures, the incidence of the disease was remarkably low and the few cases encountered had invariably neglected to take the proper prophylactic precaution.

A programme of aerial spraying was carried out in 1956 to eradicate tsetse fly from breeding places near Kariba, and the fly was later controlled by the provision of sheds and barriers on all access roads entering the area.

No cases of sleeping sickness occurred at Kariba itself, and the few cases brought to the hospital all came from some distance away.

(viii) *Design Modifications.*

In addition to the above special problems, there were of course the usual problems of design modifications—civil, mechanical and electrical — which became necessary as the work proceeded and which had to be accommodated into the smooth flow of construction and installation. Some of these caused difficulties requiring urgent action at the time, but all were successfully overcome.

## D. CARRYING OUT THE CONSTRUCTION PROGRAMME.

(i) *Civil Engineering Works at Kariba.*

The early period of civil engineering construction was spent in preparatory work; establishing construction plant; developing local access, and diverting the river. The all-out effort commenced on the underground works proper early in 1957, and on the dam in the second half of 1957. Most of the 1¼ million cubic yards of concrete in the dam were placed between September, 1957, and June, 1959 — a period of only twenty-one months. Figure 11 shews the dam under construction with the central coffer-dam and the river flowing through the diversion openings.

The construction of the dam, however, was relatively simple compared with the underground works which were extremely complicated, and involved excavating and concreting a maze of halls, tunnels and shafts. The two main halls were the machine hall, 468 feet long by 75 feet wide by 132 feet high, and the transformer hall, 537 feet long by 55 feet wide by 60 feet high. The total quantity of rock excavated was nearly 800,000 cubic yards, and 184,000 cubic yards of concrete were placed. The six steel penstocks, 18 feet 6 inches in diameter, which lead the water to the turbines, were rolled and welded on site out of 1.125 inches thick steel plate.

The whole construction programme went well and all the target dates were achieved, and in many cases bettered. As could be expected, several minor setbacks occurred, but there was only one major setback — caused by the river itself.

The vagaries of the river during the construction period have become almost legendary. In 1956, when it seemed that the flood season had passed, a cyclone occurred and the accompanying heavy rainfall caused an abnormally late rise in the river, with consequent reduction in the dry season working time.

In 1957, the main flood peak rose to 290,000 cusecs, which was higher than had been known before and equalled the highest flash flood previously recorded. This inundated the North Bank coffer-dam and caused some delay although, fortunately, the damage was insignificant.

In 1958, freak weather conditions gave rise to a flood of almost catastrophic proportions, with a peak of 570,000 cusecs—almost double that of the 1957 flood. This caused delay and damage. The central coffer-dam, within which a start had been made on the main dam foundations, was overtopped and, even worse, a hole developed in the rock foundations beneath the upstream wall of the coffer-dam.

The road bridge was destroyed, and the foot bridge severely damaged. Access roads, offices and stores on both banks of the river were swept from the sides of the gorge. For a period of ten days the underground works had to be sealed off to prevent them from being flooded. During this time, all work at the site was almost totally disrupted.

The peak of the flood occurred on 4th March, 1958, and as soon as it started to recede, restoration of the damage commenced. The roads were repaired within a few days and the suspension foot bridge was re-opened on 10th April, 1958. Repairs to the coffer-dam were not completed until June of that year, and it was September before the new road bridge was in operation.

The falling flood revealed further problems. The main river diversion structures had been damaged, requiring the

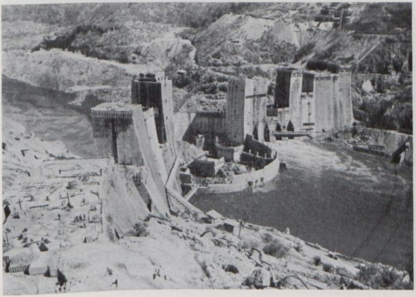


Fig. 11.

adoption of a different and more expensive method of sealing off the dam, and enormous quantities of debris had been deposited in the river channel immediately downstream of the dam site. This debris had the effect of raising the tailwater level and, if it had been left, would have brought about a marked reduction in the efficiency of the scheme. A channel, therefore, had to be excavated through the debris to restore the original conditions.

The whole of the construction programme for the dam had to be reviewed, both from the point of view of the delay which had occurred, and of the possibility of a similar flood occurring in 1959. A highly accelerated programme was, therefore evolved which, in the end, led to completion of the dam almost a year ahead of the original schedule. It was also thought prudent to increase the spillway capacity, and the number of sluice gates in the dam was increased fom four to six, giving a maximum discharge capacity of 336,000 cusecs — which, supported by the flood storage in the lake, could accommodate a very much greater flood than had occurred in 1958.

After the revisions had been made, the construction work continued smoothly and impounding of water in the lake commenced in December, 1958, as planned.

In spite, therefore, of the major disruption which was unprecedented in a scheme of this magnitude, all targets were achieved, with a substantial margin in the case of the dam. Figure 12, shows a view of the completed dam with water passing through three of the six spillway gates.

(ii) *Electrical and Mechanical Engineering Work.*

The electrical and mechanical engineering work covered the provision of the power station and substantion plant at Kariba, the 900 miles of 330kV transmission line required, the plant at the receiving substations and the protection, metering, communications and indication plant. Here, the

Fig. 12.

work was of a more normal nature but required detailed and careful execution to ensure co-ordination of manufacture, transport and installation of the very large quantities of plant and to achieve commissioning of each section by the required date. Once again, all targets were achieved and the first three turbine-generators at Kariba, together with the associated sections of the transmission system, were commissioned on

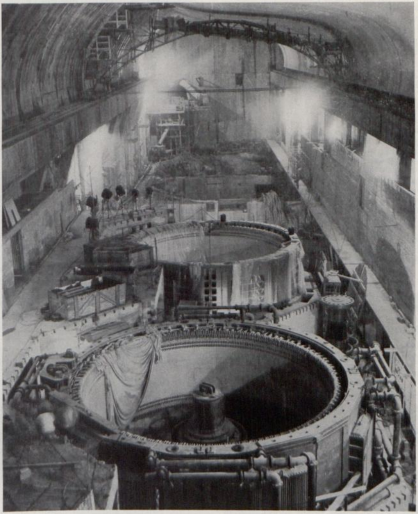


Fig. 13.

the programmed dates. Figure 13, shews a general view of the machine hall with the first three sets under construction.

(iii) *Construction Costs.*

The work of construction is not yet finished and it is still possible that unforeseen contingencies may arise. With this proviso, the present estimates of the cost of the Project are substantially below the original estimates as will be seen from the following figures:—

| | Original Estimate £Rh Millions | Latest Estimate £Rh Millions | Increase (+) or Decrease (—) £Rh Millions |
|---|---|---|---|
| *Civil Engineering Works.* (including engineering fees, expenses and contingencies). | 39.2 | 40.6 | +1.4 |
| *Electrical and Mechanical Works.* (including engineering fees, expenses and contingencies). | 27.5 | 21.9 | —5.6 |
| *Other Expenditure.* (re-settlement of displaced people, administration, medical services, preliminary investigations, etc.). | 4.3 | 5.0 | +0.7 |
| *Finance Charges.* (interest and other charges on loans). | 8.5 | 7.4 | —1.1 |
| TOTAL: | 79.5 | 74.9 | —4.6 |

In comparing these estimates it should be remembered that in addition to covering all that was provided for in the original estimates the latest estimate also covers:—

(a) Dam 20 feet higher.

(b) Substation to give supply to Lusaka.

(c) An additional 100 MW turbine-generator.

Despite the increased provision of plant and despite the phenomenal floods and other difficulties during construction the present estimate of cost is well below the original estimate.

## E. THE KARIBA PROJECT IN OPERATION.

(i) *The Federal Power Board's Bulk Supply Tariff.*

The Federal Power Board supply only in bulk and have but first consumers — three Municipalities, an Electricity Supply Commission and a private power supply company. Considerable thought was given to the establishment of the initial tariffs. It was obviously desirable that these initial tariffs should not require early alteration. On the other hand, they must be in a form providing from the start the maximum incentive to development of load so that the heavy capital investment at Kariba might soon be brought into beneficial use. Furthermore, account had to be taken of the fact that the public naturally expected to see some immediate benefit from the bringing into operation of the Kariba Project in the tangible form of reduced costs for electricity supply.

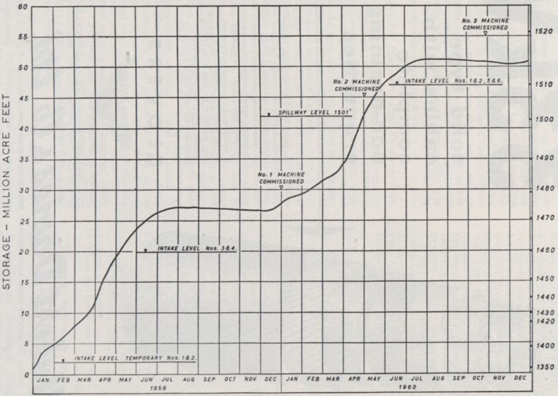
Although the Kariba Project is inherently a very low cost power scheme, it was nevertheless not easy to satisfy these requirements, for three reasons:—

1. During the first two or three years while the Kariba Project was under construction and plant being brought progressively into operation the output from Kariba would necessarily be relatively limited and hence the cost per unit supplier relatively high.
2. In accordance with the terms of the Loan Agreement with the World Bank, The Federal Power Board is bound to provide for half the capital cost of Stage II of the Project out of revenue from Stage I. The sum involved is very considerable and may be about £25 million.
3. The Board is bound to re-pay the loans raised for Stage I within the periods of these loans, which are in general shorter than the economic life of the plant to which they relate.

All these factors tend to make the initial cost of power from Kariba much higher than the ultimate cost will be. It was therefore decided to frame a tariff on the following principles:

(a) All Undertakings should pay for the supplies they now consume at their present production cost.

(b) All Undertakings should be able to purchase additional supplies at a uniform price fixed at a level equal to




KARIBA LAKE – INITIAL FILLING CURVE Fig. No.

little more than half the present average price.

The effect of this tariff was to secure to the Board the revenue necessary to meet the present production costs while at the same time making available to all Undertakings immediately the benefits of additional Kariba power at very much lower cost. The actual form of the increment tariff finally chosen was the normal two-part type with a relatively high fixed component (£7 per kW of annual maximum demand) since over 90% of the Board's costs of production is in the fixed component, and a very low running component (0.1d. per kWh).

(ii) *The Operation of the Project to Date.*

The Kariba dam was finally closed in December, 1958. By the middle of 1959, at the end of the 1958/59 flood season, some 27 million acre feet of water had been stored in the lake, and the water level had reached 1475 feet a.s.l.) when it was brought into service at the end of December, 1959. It will be seen from Figure 14, that the lake level then fell slightly until December, 1959, when the run-off from the following season's rains began to be felt. The fall in lake level was, of course, due to evaporation during the dry season, and to the compensation water which was allowed to pass through the dam to maintain a minimum flow of 10,000 cusecs downstream. This was in accordance with the agreement with the Portuguese Authorities in Mocambique. During 1959-60 rains a further 24 million acre feet of water was impounded, making a total of about 51 million acre feet. The total capacity of the reservoir is 130 million acre feet at the normal storage level of 1590 feet a.s.l. so it may be expected that the filling of the lake will take another two or three years. However, at the present level (December, 1960) of 1,513 feet a.s.l. it is possible to operate the number 3 and 4 turbines from the permanent intakes (invert level 1,460 feet a.s.l.) and to obtain about 90 MW from each 100 MW generator.

After No. 4 generator is in service, Nos. 1 and 2 will be transferred to their permanent high level intakes, provided the rise in the lake level has been sufficient to permit their satisfactory operation.

It will be seen, therefore, that at the present lake level water for the operation of the first four generators on restricted output is already assured. No. 3 generator was brought into service at the beginning of November and generator No. 4 is planned for commissioning in March, 1961. By that time, the maximum capacity of the Kariba station will be about 350 MW. It is probable that when the station is operating at its designed head of about 310 feet, the generators will be capable of a continuous output of about 112 MW each, though their designed rating is only 100 MW.

It may be of interest to give some details of the result of the operation of Kariba since it started generating at the beginning of 1960. The following Table 1 summarises the results for the first year of operation:—

TABLE 1.

*Summary of Operation Results for the Year Ended 31st December, 1960.*

| | |
|---|---|
| | *kW.* |
| 1. Maximum generation capacity at Kariba Power Station | 270,000 |
| 2. Maximum generation sent out from Kariba Power Station | 237,000 |
| | *kWh.* |
| 3. Units generated at Kariba Power Station | 1,047,506,000 |
| 4. Units purchased from interconnected Power Stations: | |
| Salisbury | 405,190,000 |
| Umniati | 397,323,000 |
| Lusaka | 46,785,000 |
| 5. Total Units generated and purchased | 1,896,804,000 |
| 6. Units sold: | |
| R.C.B.P.C. | 761,992,000 |
| Lusaka E.S. Corporation | 47,852,000 |
| Impresit | 9,581,000 |
| Salisbury Municipality | 509,826,000 |
| Southern Rhodesia E.S.C. | 519,824,000 |
| Cementation | 56,000 |
| 7. Total Units sold | 1,849,131,000 |
| 8. Losses and works power (5–7) | 47,673,000 (2.5%) |

The energy sent out by the Kariba Power Station during the year has resulted in a saving of coal consumption of about 630,000 tons; this represents about one-third of the total coal burnt in thermal power stations in the Federation. Bearing in mind that the cost of operating the Kariba Power Station is almost independent of output, it is obviously in the interests of the electricity supply industry as a whole to operate the plant at the highest possible load factor. For the first twelve months of operation the Kariba generating plant load factor was 78%. When the Kariba plant is fully installed the station load factor may be of the order of 70%.

(iii) *System Commissioning Tests.*

Owing to the necessity for commencing supplies to the Copperbelt area at the earliest possible date, the Kariba-Lusaka-Kitwe lines and associated substations were brought into service when only one generator was available at the Kariba Power Station. This introduced some special problems, since the charging current of these transmission lines corresponds to some 160 MVA, and, even with the two shunt reactors in circuit at Kitwe, exceeds the generator rating. This is not serious from the viewpoint of the generator current loading but the possible effects of self excitation of the generator has to be borne in mind. Figure 15 shews the leading current excitation characteristic of generator No. 1 at Kariba. It will be seen that at a leading current loading of 160 MVA the machine is approaching the condition of self-excitation which could lead to excessive voltages on the generator and substation equipment. It can be shewn that the limit of voltage stability in the absence of a high-speed automatic voltage regulator occurs when the machine excitation is zero at normal generator voltage. With a high-speed voltage regulator system capable of providing negative excitation, however, the limit is extended. To ensure that in fact dangerous conditions were not likely to arise, a series of tests were carried out during the commissioning period. The results of these tests indicated that zero excitation conditions might be approached during line charging operation, and that after some adjustment the generator voltage regulators were capable of preventing excitation instability even under these adverse conditions.

Tests were also carried out to confirm the performance of the 330kV switchgear and

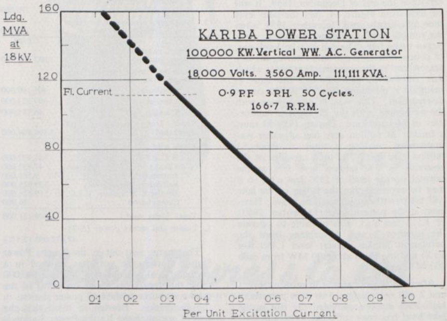



Fig. 15.

to calibrate the fault locating equipment. These tests involved fault-throwing on the 330kV lines. The opportunity was also taken by the Federal Post Office and the Rhodesia Railways to measure interference voltages on their communication circuits during fault conditions. The results of these tests have not yet been fully analysed.

## E. THE FUTURE.

From what has been said above, it is clear that the Kariba Project is off to a good start and that the objective of providing the Federation with an abundant supply of power at a reasonable cost is well on the way to being achieved. To conclude this paper it may be of interest to attempt to look into the future — although this is always a rather hazardous undertaking!

After the completion of Stage 1 at Kariba — the installation of the first six machines in the South Bank Power Station — it is obvious that the next major provision of generating plant will be the second stage of Kariba. As at present planned, this provides for a North Bank Power Station with a probable capacity of about 900 MW. Since the dam is already built and the reservoir will serve both power stations, the cost of the second stage of the Project will be much less per kW than the cost of the first stage; the relative figures being about £125 per kW for the first stage and about £55 per kW for the second stage. It is for this reason that the Board has been able confidently to quote a low incremental tariff in the knowledge that the Federation can look forward to a long period of progressively falling bulk supply costs. With the second stage there will of course come re-inforcements of the transmission system and it is planned that the single circuit lines to Bulawayo and to the Copperbelt should be duplicated, thus greatly increasing security of supply. Figure 16 shews the transmission system as provided for Stage I of the Project and for comparison the transmission system which it is planned to provide when Stage II is fully developed.

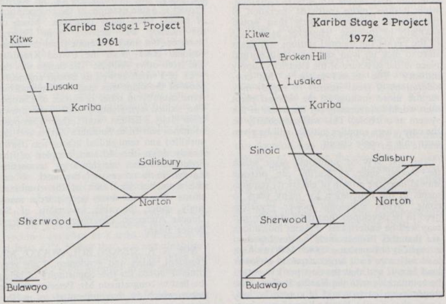



Fig. 16.

A word should be said here about the role of the coal-fired generating stations interconnected with Kariba and now operated as an integral part of the system. If it is remembered that the object of Kariba is primarily to provide additional capacity to meet normal growth of load rather than to displace the thermal stations, then it will be realised that these stations will have a life very similar to that which they might have expected under any other system of development of the power system. They are, in fact, likely to continue to be kept in service until the end of their normal economic life, but like most stations the amount of use which will be made of them will tend to be reduced over the years as they are displaced by more modern plant and relegated first to peak load and ultimately to standby operation. There are, however, two important factors which will especially effect the operation of the thermal stations connected to the Kariba grid. Firstly, there will be a period after the rapid installation of six machines at Kariba when a considerable surplus of generating capacity will exist in the Federation. This condition may persist for several years and, while it does, more restricted operation of the thermal stations is likely than would normally be the case. However, at the end of the period the thermal stations will again start to pick up load and take their normal place in the structure of the electricity supply industry. The second factor is that considerations of local security of supply may require more running of the thermal plant than would be necessary for the needs of the system as a whole. This will particularly be the case where supplies initially will be given over only a single circuit.

The 900 MW of additional plant which the second stage of Kariba can provide should meet the growth of electricity requirements in the Federation for many years to come. When additional power resources need to be developed then the Kafue Project may well be undertaken. Present indications are that this Project could be developed to a capacity of perhaps 1,000 MW at high load factor or to a larger capacity at lower load factor, and that the cost per kW would be comparable with the Kariba Project. The transmission costs would of course be less, since the Kariba-Kitwe lines have been routed so that they pass close to the probable site of the main Kafue power station.

Looking still further ahead, the time will come when the loans raised to finance the Kariba Project are fully re-paid. The plant which they have provided will, however, still have many years of useful life and the cost of electricity production will then fall still further. If the other side benefits which the Project has created are also taken into consideration, the Kariba Lake with its potential for tourism, transport and commercial fishing, the provision of nearly 100 miles of additional public roads, the regulation of the River Zambezi with the resultant implications for river transport and riverine agriculture, the creation of Kariba township with its hospital, airfield, schools and other amenities —the Federation may well feel satisfied with the bold decision taken five years ago to proceed with the largest water power project in Africa and one of the largest in the World.

In conclusion, it must be emphasised that the design and construction of the Kariba Project is a fine example of the co-operation of people from many countries. Much of the finance was derived from Federal resources but much too came from the International Bank, from the United Kingdom and from other sources. The design was the work of French as well as British engineers. Most of the plant was made in England but some came from other countries in Europe. The skilled construction staff were drawn from Italy, Britain and other European countries and from Southern Africa and the unskilled and semi-skilled labour was drawn mainly from the African peoples of the Federation and neighbouring countries. Kariba, in fact, was not the work of any one man but the result of the combined efforts of a great many people from many lands under the able leadership of Sir Duncan Anderson, Chairman of the Federal Power Board.

MR. A. R. SIBSON, BULAWAYO: Mr. President, ladies and gentlemen, I am very grateful indeed for this opportunity of being the first to congratulate Mr. Peterson for the paper which he has presented to us this afternoon.

Mr. Peterson has not been many years with us in this country, but he has shown his interest in local affairs, and his desire to co-operate with those already involved in the supply of electricity by amongst other things, becoming an Associate Member of this Association not long after his arrival in the country.

We are very glad indeed to hear him on this great project. His paper has, of necessity, been perhaps a little cold in its presentation of the facts of the case. There have been so many papers given, as our President said just now, about the various aspects of the Kariba project dealing not only with technical achievements, but with the dramatic side of it as well, and Mr. Peterson has very wisely kept straight to the facts, although in so doing he has avoided implicating himself in some of the drama that has been associated with the work, and that drama has been very considerable. There were exciting times in the two years preceding the closing of the dam: the Zambesi, for the first time in its history, came down in what I think the hydrologists called a "ten thousand year flood,' and not satisfied with that, it repeated the effort, with interest, the following year.

The fact that in spite of such circumstances, Mr. Peterson has been able to say, as he has that the project, in respect of each section has been completed on time represents a tremendous achievement, and apart from the pleasure of being able to listen to his paper this afternoon, I know you will join with me in congratulating him for the part he has played in bringing so major a scheme to fruition in so remarkably short a time.

It is not really my duty this afternoon, to discuss in any detail the technical portions of Mr. Peterson's paper, but there are just one or two things that I think there will be some advantage in mentioning.

It is of great interest, for example, to note that the maximum continuous rating of the machines installed at Kariba is found to be at least 12% higher than the manufacturer's guarantee. I don't think it is very often that that sort of thing happens in the engineering world.

But, by virtue of this, it really means that the cost per kilowat for the first section of Kariba, instead of that given in the paper, £125 per kilowat, is nearer a figure of £111 per kilowat. It is interesting also to find once again that old rule of thumb that a hydro scheme, broadly speaking, costs about twice what a thermal scheme costs, is brought once again to our attention.

Another point of interest that has arisen out of the Kariba project is the extreme facility and economy associated with the construction of underground power stations. Initially the first section of this scheme on the south bank was made an underground station largely because it was desired to proceed with the construction of the station at the same time as the work on the dam was being done, and thereby save a considerable amount of time.

When plans were commenced for the north bank station — and they have been commenced, and are at present in progress — I think a lot of us thought, "Well now they'll go above ground," but we found that this station too will most certainly be an underground station; and this time not because of time, but because of cost. This is a remarkable indication of the development of the technique of mining and underground working generally, showing that an underground power station, given certain geological prerequisites, is actually more economic than the building of a station on the surface.

Another of the points that did attract my attention is the extraordinary bravery of the Power Board in going in for 330 KV oil filled cables for carrying the power from the underground station to the surface.

This technique was very young at the time this decision was taken. One might almost say that at the time the decision was taken it was little more than a laboratory experiment, and it was a great, bold move to adopt this particular technique at that time. I think we have already seen that the move has been justified, and there is undoubtedly a considerable saving resulting from it.

Finally, Mr. President, Mr. Peterson has, in his verbal remarks, referred to the burden that has been placed on the Power Board by virtue of the requirement of the World Bank that half of the capital cost of the north bank station, and its associated work should be found from revenue.

Here we have, perhaps not for the first time, but certainly for the first time in this country, a clear example of the principles of applying to public finance what has already been exactly understood in private finance. Unless we do build up some sort of capital reserves, other than merely paying our way, we are not creating wealth or capital for the future. Private enterprise has its own way of generating its capital, and the increasing extent to which public enterprise is entering the field of major works of this sort and the growing proportion of industrial activity that is being carried on by public enterprise underlines the need for capital accumulations of this kind.

However, one might in the particular context of African history, wonder sometimes just how wise it is to build up enormous financial reserves and so offset the need of our successors to find capital, when we are so uncertain as to the nature of the public authorities or governments that will be in control in the future. I think perhaps the fact that we are doing it, is an indication of the confidence that we all have in the future of this country in the long run.

I would like now to offer my heartiest congratulations to Mr. Peterson on your behalf and to propose a very hearty vote of thanks for the excellent paper that he has given. (Applause.)

THE PRESIDENT: Thank you Mr. Sibson. I now call on Mr. Douglas to second the vote of thanks.

MR. T. K. A. DOUGLAS, SALISBURY: Mr. President, ladies and gentlemen. I think this vote of thanks to Mr. Peterson for his paper is extremely well deserved, but I must say I don't know whether he doesn't deserve two votes of thanks; because not only has he given us the paper which has been printed in the papers which you have, but out of the wealth of material that has been available to him, he has very generously given us what is, in fact, another paper on the more administrative aspects of the scheme.

I was particularly pleased that he mentioned one of the aspects of Kariba, which, like many others, is unusual, if not unique, which I think has been given far too little attention.

When, as Mr. Peterson has said, a scheme of this nature is undertaken, it is usually undertaken by a scheme which started 60 years ago with a couple of 20 KW Diesel sets, and has built up over the years a staff, a mass of "know-how," a tradition, which it can devote to the development of the new undertaking. But this was very far from the case with Kariba.

The Federal Hydro-electric Board, which was the body which started the construction of the scheme, had, I think, when the scheme was embarked on, started with half a dozen. It hadn't very much money either, and indeed its terms of reference were only to construct the scheme. It wasn't until the Electricity Act of 1956, which is now in force, that the Federal Power Board was charged with the additional duties of operating the scheme.

When you think of the wealth of information, of methods of doing things, which you gentlemen have at your disposal in your established undertakings, you realise the enormous task which faced the Federal Power Board in setting up a staff and an organisation to carry out the scheme, and I think that the feat of achieving that with the success that has been achieved, is hardly less of a feat than that of hacking the scheme itself out of the bush.

In the paper there is one technical point which Mr. Peterson has mentioned, which I would like to refer to again, and that is the problem of getting the first machine on to the bars, together with some 270 miles of transmission lines connected to it.

The problem arose of course from the very heavy charging current which the line took. You will remember the normal magnetisation curve of a generator with the straight line portion sloping upwards to the right, and then bending over at the top further to the right, as saturation is reached.

The effect of the charging current on this curve is to move it over to the left until the straight portion becomes vertical, or even leans over backwards, into the negative excitation zone. Obviously when the line is vertical you have a situation of complete instability, because with no excitation at all you can have a wide range of voltage generated.

It is all right if you can get round the knee of the curve and on to the upper portion, but the problem is to get there. In this particular case, the problem was solved by the very simple expedient of bringing the machine up at low frequency, which had the effect of reducing the charging current and increasing the reactence of the line, both of which had the effect of sloping the curve back over to the right and making it possible to get out of the danger zone, and then bring up the frequency to the normal at full voltage.

Mr. Peterson also referred in the oral part of his address to the frequency of lightning faults on the line which, as he says, have been rather more than calculated.

It is of course true that the number of faults is rather higher than one would obtain by exterpolation from lower voltage systems. But this is a common experience with all these extra high voltage lines, arising mainly from the use of very high towers.

In this particular system an endeavour was made, and a great deal of trouble was taken, to keep the towers as low as possible in order to avoid this phenomenon, and it is not certain that the number of faults is directly attributable to it. Although the statistics so far are very sparce, there does seem to be some evidence that the incidence of lighting faults is rather concentrated in areas where counterpoise has not been applied. Counterpoise was actually applied in cases where the tower footing resistance exceeded 20 Ohms, and it looks as though a solution to the problem very possibly would be to install more counterpoise and thereby reduce the number of faults.

Mr. President I have very great pleasure in seconding this vote of thanks.

THE PRESIDENT: Ladies and gentlemen, you have heard the vote of thanks so ably proposed by Mr. Sibson, and seconded by Mr. Douglas. Will you please show your appreciation to the author in the usual manner? (Applause.)

TEA ADJOURNMENT

ON RESUMING:

The President opened the session with Convention Announcements.

MR. J. H. WEST, MINISTER OF POWER, FEDERAL GOVERNMENT: Mr. President, ladies and gentlemen. Mr. Peterson's speech brought great pleasure to us all. It reminded me very much of a lady's dress — it was long enough to cover the vital points, and short enough to be interesting!

Mr. l'Ange, the Minister of Works, this morning was discussing the controversy which arose as to the decision between Kariba and Kafue, both of them such excellent projects, so economic and so suited to the needs of the Federation.

It takes me back to the early days of the Federal Government, which you will remember was formed only in 1953, and one of the priority targets of the Government was to construct one of these projects.

I had some connection with the development planning people in those days, and for a long time we were dithering between the two, " Should we have this Kariba or should we have that Kafue ? " Eventually when we produced the first development plan, we still hadn't made up our minds so we just called it a " K Plan," and there it was in the scheme as our famous K Project, and you could please yourself which one you decided to plump for.

Well, if I can make a pun, it certainly seems as if it's turned out O.K.

The construction of Kariba in four years — in fact less than four years — was a truly remarkable accomplishment. I think it would not be fair if someone did not mention the name of Lord Malvern in this connection.

It was " Huggy " above all others, who pushed this scheme through. He had a lot of opposition to fight, but it was his steadfast courage that eventually saw this scheme adopted as a Federal Project.

Also in this room we have many men — I have seen at least 20 this morning — whom I know have been intimately concerned with Kariba — two of them have been on this platform, Mr. Peterson and Mr. Douglas, but there are many of you sitting in the audience, who have had a very large part in the construction of this project, and you are the chaps who have been doing the real work, while people like myself in the Govern-

ment Departments have been pushing round pieces of paper and settling the priorities.

Talking about priorities, one of the things that had to be done was to arrange priorities for transport, and in this connection I would like to pay tribute to the South African Railways in two ways; firstly because they very often came to the rescue and expedited deliveries of goods from the Union; and secondly there were cases when the railways realised they hadn't the express facilities that were needed, and they were always very tolerant in waiving their objections to the movement of goods by road.

Now you know that there is a Road Permit Board in Pretoria, and we had a number of communications with this Board — and everything usually went by telegram. The name of this Board (I'm afraid I don't speak Afrikaans so I have probably got it wrong), but it is something like "Vervoer Pretoria."

An amusing thing happened on one occasion, when we had a request to expedite the delivery of something by road, and we had a procedure already worked out so that it was all pretty well cut and dried, and I told someone to send a telegram in the usual way to "Vervoer" and the next morning when I got to the office there was a spate of ,elegrams on the desk complaining, because, ,wing to a clerical error, we had addressed ,ur telegram to "Verwoerd"!

Mr. President it seems quite remarkable hat in those days one of the major problems ve were concerned with was what we called the "copper belt gap" in 1959. One of the dominating and over-riding considerations was that Kariba or Kafue, whichever it was to be, must be built in time for the copper belt gap — that was the time when the copper belt was going to be short of power, estimated to be in the latter half of 1959.

As you have seen, Kariba came in just in time to supply that gap, and it is quite amusing to think back to the hours that were spent in calculating whether Umniati Power Station, in the middle of South Rhodesia would be able to supply power to the copper belt and so tide over the gap between late 1959 and the date Kariba was expected (originally in 1961).

Thanks to the ingenuity of Monsieur André Coyne and thanks to the skill and devotion of the people who have built Kariba, it was commissioned in less time — far less time — than was originally thought, despite all the hazards it had to undergo, and was able to bring power to the copper belt in time to meet the gap.

It has in fact done more than that, because last July it actually supplied something like a million units to Katanga. There was a period during the political disturbances, of about four days, when Katanga couldn't produce enough for their requirements, let alone export the usual quantity to the copper belt, and the whole Rhodesian system was then able to turn itself in reverse and start supplying power to Katanga.

Mr. President, there is a chart in Mr. Peterson's paper which I think shows the growth of roads in the areas which are to be connected to Kariba.

It is not actually the growth in the Federation as a whole. It is a slightly smaller area, Kariba being eventually able to supply a considerable proportion of the load in an area which, at the moment, takes well over 90% of the total power which is consumed in the Federation.

That chart you will notice shows an increase of about 11% and it is really this which is the most fundamental thing, to my mind, in the whole paper. The reason is that when the project was being "pre-planned" the most important thing was that the people who were going to put up the money should feel confident that the forecast loads would materialise.

Now the decision to go for Kariba as being a scheme suited to the developing needs of the Federation was based initially, at the time when Lord Malvern and his Government took the decision, on a flat increase of 9% per annum in unit consumption.

If you have seen the published Krina forecase you may have noticed that it is slightly different. It has a rather steeper curve in the initial years, and then a slight flattening out, and then a flattening out again.

The reason is that the overall load growth has been assumed to be 9% but it has been taken as more than 9% in the first few years, 9% in the middle years, and then something lower than 9% in the last few years.

So far actual consumption has followed the load curve very closely, and it has followed it in the period when it is steepest, so that our chances of being able to achieve the forecast in the long run are pretty good.

Mr. Peterson has referred to the limitations on the Board's power to set its tariffs. I, as a Government representative, have always felt the boot was on the other foot — that they had complete freedom to do what they like.

The Board is one of the few undertakings in the Federation which has complete freedom within the limitations mentioned by Mr. Peterson which are not Government imposed, but within those limits, the Board has complete freedom, embodied in statute, to set its tariffs at any level it likes.

It is vital and essential that the Power Board, which is the focal point of the country's power economy, should be in a position to set tariffs at a level which will guarantee it the revenue it needs, not only to meet its costs but also to meet half the cost of constructing the second stage.

The Board is indeed fortunate to have this freedom.

Talking about freedom reminds me; last year I was on a holiday visit to Russia and they were talking about freedom there. Our Russian interpreter called Rudolph was quite adament that there was lots of freedom in Russia, but I felt that there wasn't perhaps as much evidence of that as one would like to see.

I said, "You know, Rudolph, anyone in Rhodesia can stand on the steps of the Federal Assembly and shout 'Down with Welensky' and there is complete freedom. No-one will say him nay; he is perfectly allowed to do that."

Rudolph said, "You know it is exactly the same thing in the Soviet Union, there is complete freedom; everybody is completely free. Why anybody could go and stand on the steps of the Kremlin and he could say 'Down with Welensky' and no-body would say a word."

And now, Mr. President, we feel that with Kariba we have gone a long way to solving the problem of bringing abundant and fairly cheap power to something like 90% of the area of supply, but we, and I think in South Africa too, you have the problem of the small isolated areas which are too far to be supplied from Kariba and the big producing stations.

I know that Mr. Slutzkin the Mayor this morning spoke about the cheapness of the power in Livingstone. Livingstone is a small place, but it has an excellent hydro site, and it does have very cheap power. I will cross swords with him on one minor point. He said that Livingstone has cheaper power than the Power Board can produce now, and that it won't be until 1970 before Kariba can get down to .35d. per unit. He didn't say (I am not suggesting or impugning anybody's motives in the slightest) but he didn't say what price the power would be in Livingstone in 1970.

However, we have many small areas which are dependent on diesel installations, or on very small steam plants, which are manifestly incapable of producing power in the mass quantities which is the only way in which, as with so many other products, you can produce cheap electricity.

There have been suggestions that we should take really drastic remedies; more or less nationalise the whole industry. That is one solution. Another is that we should aim at penalising the low cost producers and subsidising the high cost producers with the object of arranging costs so that everyone can pay the same tariffs.

You have a problem in the Kariba area, too, in that some undertakings benefit more from Kariba than others do. These problems remain to be solved, and I don't think that anyone has come forward with a panacea; if they have we would certainly like to know. For the moment, I think we will just have to rest content with what Kariba has done and is likely to do in the future.

Finally, Mr. President, I would like to touch on one or two points which I don't think were mentioned by Mr. Peterson as by-products of Kariba. One of them is a very fine road north from Salisbury to the

Kariba turn-off, and that of course was not part of the project. It was built quite separately, but about four years earlier than would otherwise have been the case according to the development plan.

I think I can hear someone muttering in the audience and they're probably saying that to offset the good work in Southern Rhodesia there is the break-up of the road going north to the Kafue Bridge — but I prefer to keep silent about that one!

I'm quite sure it wasn't the Kariba traffic!

I have mentioned the benefits of international goodwill expressed by the supply to Katanga, and I would here like to express a slight difference of opinion with Mr. Peterson over the value of what is called either "Operation Noah" or "Animal Dunkirk."

One of the main advantages was that it didn't cost the Power Board or the Federal Government a penny. That, perhaps, is not very important to some people, but it was a material consideration. Most of the things connected with Karina, such as the Lake, have involved the Federal Government in expenditure, but here you had the movement of animals on quite a large scale, which was paid for partly by territorial government funds, and partly by voluntary contributions. The beauty about Animal Dunkirk was that for as long as I can remember, it was the first occasion on which the world Press has focussed its attention on this part of the world in a favourable instead of the usual critical light!

Kariba also had an interesting by-product in that it provided a use for ladies nylon stockings. Ladies have often wondered what to do with their nylons, but on the occasion of Animal Dunkirk they had the most wonderful opportunity of sending their nylons in to the W.V.S. who organised the service, to supply the game rangers with material for tying up the animals' legs and noses. Unfortunately the Customs Department levied their usual tool when the used nylons came through the frontier.

Mr. Chairman, Kariba was built as a Federal Government project. I don't think it could have been built by Southern Rhodesia alone or by Northern Rhodesia alone. The financial requirements were so great that some form of union was necessary. Moreover, the demand which had to be satisfied embraced the two territories. Together, Southern and Northern Rhodesia, joined in the Federal partnership, have been able to build this economic link between the two countries and produced perhaps the most tangible evidence of the benefits of Federation.

Mr. President, I think I have read every paper that has been produced on Kariba — I have even written one or two — but in my opinion the paper we have had the pleasure of hearing today has been the best.

THE PRESIDENT: Thank you for your contribution, Mr. West. Are there any other contributions?

Mr. W. H. MILTON, Escom: Mr. President, there is one point in the paper which I think could be a little more clearly expressed.

As we all know, any large hydro-electrical project—and one might almost say any hydro-electrical project—can be successfully operated only if it is substantially loaded. In other words, it is difficult to justify a project if that project is built to take care of growth of load, as that load develops on the project.

Now, there is a statement in the paper—and I have seen it expressed in similar words elsewhere—which points out that the various municipalities and the electricity commission of the Rhodesias is charged their operating costs for the supply, but it is not stated as to whether that is in respect of additional requirements or whether it is a take-over of load formerly produced from the thermal stations then in use. One can gather from this paper, if one likes to so interpret it, that it is the original load which is taken over, because we are told that additional load is supplied at a special tariff rate which approximates half the production costs.

The words "production costs", of course, are very glibly used by all of us, and we use the phrase usually very carefully in context; so that the people listening to us know exactly what we mean. But when you talk of the tariff for the initial supply being equal to the production costs of the consumer at the outset, one does want to know exactly what is meant by that.

For example, supposing Bulawayo or Salisbury was required to cease generating its own requirements, and take the whole of its requirements from the Kariba scheme, was the charge then the fuel costs, fuel plus maintenance, fuel plus maintenance plus staff; or was some allowance made for capital as well? In other words capital which would become, to some extent, redundant.

I do think that the author could help those of us who may be faced with similar problems ourselves, if we had a little more explicit information on those particular points.

As regards the question of "freedom of tariffs", no doubt there will be speakers saying there are other bodies in other parts of the world who have similar freedom, and who probably abuse those freedoms; but I do think with Mr. West, that that freedom is a very necessary thing. I can say quite frankly that if you try to borrow money from the international or world bank, and you do not have that type of freedom to ensure that your revenue can be made to balance your costs, you will find it extremely difficult to get any money from them at all, and if you are forced to other sources, money is scarce and you would find your interest rates are so high you would probably have to abandon the project.

So that, provided you have some form of control, and shall we say reasonable trust in the goodwill of the people in charge of a project that has such freedom, it is not a bad thing.

In my own experience, provided you retain engineers in charge of your undertakings, you will find that those engineers, even when they become pure administrators, are people that one can trust because they are amongst those people who are almost the fools of the world, who deal fairly and logically with all problems that are put before them, whether the design is in their own interest or not. The success of their projects is usually a fetish with them to the exclusion of all personal consideration.

Thank you.

THE PRESIDENT: Thank you Mr. Milton for your contribution. Is there any further discussion?

Mr. J. YODAIKEN, Que-Que: I have a small question for Mr. Peterson, but before asking this question, I would like to remark that I have just travelled over this fine road that Mr. West was talking about as a by-product of Kariba, and I might add that I have also travelled on the broken up portion further north, and our South African friends may find this north road comparable to the untarred streets in Salisbury, but not to the national roads in South Africa, and I advise them not to use it.

However, Mr. Chairman, my question to Mr. Peterson concerns the Kariba weed.

Of course we are getting a lot of publicity in the paper nowadays about it, and the question I would like to ask Mr. Peterson about it is this: there is obviously going to be a considerable amount of decomposition of this weed taking place in the lake, and it will no doubt result in chemicals in the water which were not anticipated. Has Mr. Peterson any idea whether corrosion will result from that, and if so are any steps being taken at this stage in order to try and overcome it?

THE PRESIDENT: Thank you, Mr. Yodaiken.

Mr. H. J. GRIPPER, Knysna: Mr. President, may I ask two or three small questions of Mr. Peterson on this paper?

A point put by Mr. Milton I would like to enlarge on—the question of production costs. Depreciation will surely be hastened in the existing thermal stations, by the fact that they are now to work on peak loads. In other words, they will be stressing their machines; cooling them at one moment and running them up to speed at full load at another. This is a prospect which might create difficulties or at least some calm negotiation with the existing undertakings.

Another point of structural interest. I saw, in going through Kariba station, a rather fancy ceiling in the turbine room. I would like to ask whether that is just an architectural whim, or whether it has some functional purpose.

And my third point is this—the oil-filled cables running from the engine room up to the switch yard, are connected with the surge diverters at the bottom—that is at the transformer end. The surges are presumably coming from outside, and would it not have been more appropriate for the diverters to have been put at the top of the cables, to protect them as well as the plant in the turbine hall?

THE PRESIDENT: Thank you, Mr. Gripper.

Mr. J. E. MITCHELL, Salisbury: Mr. President, I want first of all to assure Mr. Peterson that I am not going to talk about production costs. It is his job to reply to that. But although you have had a plethora of Rhodesian speakers today, I felt I would not like the discussion on Mr. Peterson's paper to be concluded without myself also paying tribute to not only the production of his paper, not only even the additional paper that he gave us, but the wonderful way in which he presented it; which shows not only that he has full control of his subject but also that he knows all about it.

There have been one or two instances, of course, in regard to inter-connection—Salisbury was the first municipality to be connected (although they had inter-connected with the copper belt due to the Congo some time previously), so we were to some extent guinea pigs. What I was going to tell you about was an amusing incident which didn't appear very amusing at the time, and that was when Salisbury was inter-connected to Kariba, so was the copper belt, so was Umnaiti, and so was the Congo, and I think we had two machines on at that time at Kariba and both cut out at once, which left us short of a little power, as you can imagine.

Immediately instead of the Copper Belt taking something like 50 megawatts from the Congo, that load shot up to 90 and the Congo switched out at the Congo end. At the same time Umnaiti cut out and that left Salisbury hanging to the Kariba system.

I won't tell you what happened to the frequency, but during that short period, we did in fact supply the Federal Power Board, the Rhodesia Border, the Power Corporation and the Congo with 5 units!

To bring a little light relief into this, I dictated an official letter to the General Manager of the Rhodsian-Congo-Border Power Corporation, accusing him of violating the municipal regulations in extracting electricity from the municipal system, before he had signed up as a consumer, and I enclosed with the official letter, an application form to become a consumer, telling him I regretted that the Statutory Connection Fee was £20 per radius mile from the power station, and he being 560 miles away it was a bit awkward for him, but I was sure that he ought to sign up, because if he didn't and it happened again, I must take some action in the matter. I also told him that I understood at that time (and this was before the Congo got its freedom) that we had been supplying them too, and as they were another 300 miles away I enclosed a connection form for him to get it signed up by the Congo people as well!

And I thought it might be as well to get it signed up before the signatories were no longer of any use. I finally assured him that once he had become a consumer, a telephone call to our faults department at any time would have no effect whatsoever.

I got a wonderful reply from the General Manager to the effect that at the same time power went the other way, and they had enquired of Kariba, but at that time they were groping in the dark and didn't know what was happening, so he was quite convinced that the reverse swing of 60 megawatts must have come to Salisbury, and as their official tariff was £6 per annum per kilowatt of demand, he would be pleased to receive our cheque for £360,000 at the earliest possible date! (Laughter)

So you see it is quite possible for large undertakings, despite some disagreement, at times, and despite some feelings that other people have come in and taken over what you've built up, you can eventually get over all those things by a little goodwill on all sides and I think I can say, and I think Mr. Peterson will agree, that despite a few altercations the scheme is working very well indeed, and I congratulate Mr. Peterson and his staff, and anybody that has had anything to do with Kariba, on bringing forth such a magnificent project in such a short time.

THE PRESIDENT: Thank you, Mr. Mitchell. I wonder if Mr. Peterson would care to reply to some of the points raised by contributors.

Mr. G. R. PETERSON, Salisbury: In reply to Mr. Sibson's remarks we can't be sure what the capacity of the sets will be until we get the full head on the machines, and the figures of 112 megawatts is still a tentative one; it might even be slightly more.

North Bank station underground — it will undoubtedly be underground. Extensive exploration of the rock has been made, and it has been proved that the rock on the north bank is very sound. The civil work construction will be materially cheaper for a station underground.

The 330 KV cables—I agree with Mr. Sibson. I have always regarded these 330 KV cables as the outstanding bit of technical pioneering on the project, but being Scots myself, and somewhat cautious, I did insist that we had a spare circuit for every circuit up the shaft, so we have three complete spare cables in the vertical position, and in addition, there are spare cables for the horizontal position. So while we are being brave we are not being rash.

Mr. Douglas. I am glad Mr. Douglas mentioned the rather unusual problem of building up a team of men to operate the project at the same time as you build the project itself. It is an unusual thing. The Board have been very lucky. They have got together a first class staff, and I would like to take this opportunity of paying a tribute to the work that staff puts in. They have worked extremely long hours, both trying to cope with their side of construction work and trying to learn the job of operating the plant at the same time.

Mr. Douglas mentioned this question of charging current on these very long lines. It is a real problem of course. The charging current on the long line from Kariba to the Copper Belt is in excess of the capacity of a single machine—about 160 MVA in fact. The only thing is that, as Mr. Mitchell told us, we can always fall back on Salisbury!

Mr. West spoke of growth of load. It is true that this is of course the corner stone of the economics of the project. So far all has gone well. I wouldn't say the growth of load at the moment is quite as much as we would like, but it is jogging along about 5 or 6% at the moment, which is a little below the project estimate for this date, still, up to date, it has kept extremely close to the project estimates and I personally have every confidence that it will recover.

Tariffs—Freedom. Well, I am all in favour of freedom, and I entirely agree with Mr. West that we are lucky to have it, and I think it is absolutely essential that we should.

Mr. West disagreed with me about "Operation Noah". Well, I'm sorry, but I still think that human being are more important than animals! He also said that Operation Noah didn't cost the Board a penny, and that rather surprised me because I have a strong recollection of paying for all sorts of boats for people who were going to rescue animals from the lake. I might be wrong about that, but I don't think so.

And what made the thing even more irritating was that at the time we were paying for these boats and one lot of men were rescuing the animals, we were also paying for rifles for another lot of men who were shooting the animals. This was something to do with stopping the undesirable animals of Northern Rhodesia getting into Southern Rhodesia!

Mr. Milton, and also Mr. Gripper, raised the same point, and I am sorry I haven't made it very clear what the financial arrangements are between the Board and the existing undertakings. The position is this: as soon as the Board inter-connect with an undertaking, the Board then take over full financial responsibility for the station; they pay all the costs of production whatever that production may be, and whatever (in reason) costs may be. We pay capital charges, we pay fuel, we pay the lot. In return we sell to the undertaking the whole of their requirements, whether produced in their own generating station, or whether imported from Kariba, at our tariff.

So that the undertaking is, from the moment of inter-connection, no longer responsible for meeting the costs of production. The Board have power of course to direct the operation of the station, and if they operate it in an uneconomical way they have to foot the bill themselves; but they will take very good care that they don't operate it mechanically of course.

I hope that explains it, but I might be able to have a talk with Mr. Milton afterwards, and explain in rather more detail than I can now.

He did ask a question about the basic tariff also. Perhaps I can best explain this with an example.

The Board in fact agreed with each undertaking that before Kariba power was available, your power was costing you on average .8d. per unit, or whatever it might be, and your maximum demand and annual units at that time were 50 megawatts, 500,000,000 units, or whatever it might be.

All those figures are then written into the basic tariff for that undertaking, which means that in this case that undertaking would pay for the first 500,000,000 at a rate of 0.8d. per unit. The undertaking would then pay at the increment tariff £7 and .1 for any megawatts in excess of 50, in this case; and for any units in excess of 500 million in this case.

The question of whether the plant is full loaded—well, at the moment, we have got four machines running, and the daily load factor is about 65%, so that is not too bad.

Mr. Yodaiken firstly complained about the roads. Now that surprised me, because I have travelled that road fairly frequently, and I had thought that the road from Salisbury as far as Makuti (the turn off to Kariba) was the pride of Southern Rhodesia. It is a first class road by any standards, and better than most English roads. But I think that what he didn't like, was perhaps our old south access road, which the Government is now responsible for. That is, of course, a gravel standard road, and while admittedly not a very high grade road, it has had loads of over 100 tons on it on many occasions quite successfully, so it should be safe for private motoring.

The question of decomposition of weed in the lake and what effect it will have in metal corrosion: This is quite a problem. I won't say it is a serious problem, but there is no doubt that the chemical composition of the lake water is affected by decaying vegetation and a pretty close chemical watch is being kept on the water being taken into the power station, and on the effect which it is having on the turbine parts.

The principal thing to worry about is of course, the turbine runners, and these are being kept under observation. On No. 1 machine turbine runner, there is some evidence of some form of corrosion. It hope it is a temporary thing—something to do with the early stages of filling of the lake—but as there is some evidence of it, subsequent runners are being painted in various different ways to try to find out the best form of protective paint or coating. There is no evidence yet that this is a serious problem. It is one of quite a lot of problems we have had and I am sure we'll get the answer to it. But it is a good question, and it is a very practical problem, whether the chemican constitution of the water will affect the plant.

Mr. Gripper also asked why we had such a fancy ceiling in the turbine room, and if it had any real purpose. Well, it has a real purpose—it is a false ceiling. There is, of course, a ceiling above that, but it is practically impossible in these large underground caverns to prevent a certain amount of seepage of water through the rock. In fact it isn't even desirable that you should prevent it, because you are liable to build up too much pressure if you do; so the best way if you want your turbine hall to look something respectable and not get covered with stalactites and stalagmites (whichever the ones are that come from the top!) is to put a false ceiling in and do the drainage from the top, and that is what has been done. And if you are putting a false ceiling in you might as well put one in that is a little bit fancy, and that is what has been done.

Why not put the surge diverters at the top of the cables? Well I think the answer to that is that what we are most anxious to protect are the transformers, and the nearer you get the surge diverters to the transformers the better. The cables are expected to stand up to a surge; the transformers might not.

The main object is to get the surge diverters as near as you can to the main thing they have to protect. In fact the cables are reckoned to give some measure of additional protection.



Mr. Mitchell.—Well, I would like to thank Mr. Mitchell for his kind remarks, and I would like to take this opportunity also of thanking the other undertaking engineers (Mr. Mitchell, Mr. Sibson and Mr. Ford are here of course) for the very excellent co-operation that I personally have had from them, without which it is quite certain we should not have been able to complete and bring Kariba into operation so smoothly.

Thank you. (Applause).

THE PRESIDENT: Thank you Mr. Peterson. I think it is now time we adjourned, ladies and gentlemen.

(Convention announcements followed)

CONVENTION ADJOURNED UNTIL 9.30 TUESDAY

# SECOND DAY

*On Resuming:*

THE PRESIDENT: Ladies and gentlemen, I much regret having to report the death of Mr. G. A. H. Schaftenaar. Mr. Schaftenaar has been a member for quite a number of years, and as a sign of respect I am going to ask you to stand for a few moments.

Thank you, gentlemen.

We have received a telegram from Mr. Baxter of Kimberley, and I am going to ask Mr. Ewing to read that out to you.

Mr. R. G. EWING, Secretary: Mr. President the telegram is in fact from Burton and Baxter and it conveys best wishes for a very pleasant and successful convention.

THE PRESIDENT: Thank you. I have been given to understand that Mr. Leonard Axe has a communication from the S.A. Institute of Electrical Engineers to this Convention and I am going to ask Mr. Axe to speak on that.

Mr. L. G. AXE, Johannesburg: Mr. President, gentlemen; the Institute of Electrical Engineers of South Africa has considered recently a communication from Mr. Raynol of the Electricity Department, Johannesburg, in which he offered to read a paper on Cable Fault Location. The Council, in considering this, felt that perhaps a symposium would be a better proposition.

The point I wish to put to you now, sir, is that the A.M.E.U. must, of necessity, be interested, and it appears to us that some of your members might like to take part in this Symposium. If so we would like to have some indication some time in the near future, preferably by, say, one month from now. I hope that is clear, Mr. President.

THE PRESIDENT: Yes, Mr. Axe, I think that is perfectly clear. I think Municipal Electricity Undertakings have had considerable experience in cable fault location and several of the members should come forward with something worthwhile.

Mr. L. G. AXE, Johannesburg: Yes, I am quite sure of that, Mr. President, and that is why I am making this appeal now, and both for our benefit and your own I am sure you can contribute very effectively.

THE PRESIDENT: Thank you, Mr. Axe. I wonder if members who would like to submit contributions towards this symposium would send them to our Secretaries, care of Mr. Ewing.

Ladies and gentlemen, I want to inform you that the sub-committees and representatives which you find listed in the Agenda, will remain unaltered; the same members will continue; with the exception that Mr. Mitchell will join Mr. Kane on the sub-committee on Native Areas Reticulation.

The next item on the Agenda is the paper on Supervisory Remote Control of a Distribution System, and I will ask Mr. Brod of Salisbury to come forward and read his paper.

# Supervisory Remote Control of a Distribution System

*By*
E. BROD, Dipl. Ing., A.M.I.E.E.

*Summary.*

This paper describes equipment which has been installed in Salisbury for the effective control of the Distribution System from a Central Control Room. Two different control systems are described. One system, usually called the Direct Wire System, requires one or more pilot wires between the control point and each controlled substation for each function: whilst the other system requires only a very limited number of pilot wires in order to carry out a large variety of different functions. For this system the term Supervisory Control System is usually applied. In this paper, a system used for indicating and alarm functions is called a Supervisory System, while a system used for switching and telemetering functions is termed a Control System. A system combining all these functions is then denoted by the usual term, Supervisory Control System.

*Contents.*



## 1. INTRODUCTION.

### 1.1 *Reasons for Installation.*

For many years the Salisbury Municipal Electricity Department has maintained a 24 hour service for attending to consumers' fault calls, and for dealing with distribution outages. This service operated efficiently and

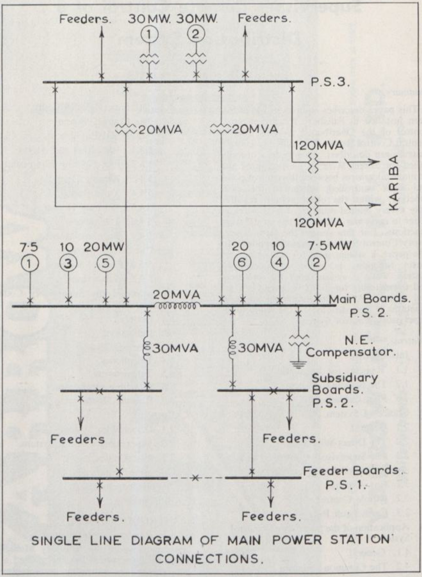

Feeders.
30MW. 30MW.
Feeders.
P.S.3.
20MVA
20MVA
120MVA
KARIBA
120MVA
7·5
10
20MW
20
10
7·5MW
20MVA
Main Boards.
P.S. 2.
30MVA
30MVA
N.E.
Compensator.
Subsidiary
Boards.
P.S. 2.
Feeders
Feeders.
Feeder Boards.
P.S. 1.
Feeders.
Feeders.
SINGLE LINE DIAGRAM OF MAIN POWER STATION CONNECTIONS.

Fig. 1.

was appreciated by the general public. But it had one drawback and this was, that the faults service had to rely entirely on reports from consumers whose supply had failed for information about outages on the distribution system. This drawback could be tolerated as long as the number of consumers was comparatively small and the distribution system simple.

As the Undertaking grew larger, it became apparent that some better system of notification of faults was required. In addition, some major substations were now on a closed ring system, such that feeders could be lost through faults without causing an interruption of supply to any consumer.

It was therefore decided to convert the faults service into a fully fledged system operation control and to install automatic supervisory equipment. Initially only remote indication and alarm equipment was installed, but lately telemetering and remote control facilities have been added.

### 1.2 *The Salisbury System.*

In order to understand the reasons for the choice of the type of supervisory system installed, it may be helpful if a short description of the transmission and distribution systems were given. A detailed description was given by Mr. Lynch in the paper presented to a previous convention. There is only one point of supply: the Salisbury Power Station. This station consists of essentially two parts: Power Stations Nos. 2 and 3. The supply from Kariba is fed into the busbars of Power Station No. 3, and therefore does not constitute a separate supply point with regard to the transmission system.

The generators at Power Station No. 2 feed into 11kV busbars, which are sectionalised through a busbar reactor. The feeders emanating from these busbars are therefore grouped in two halves, which must not be interconnected.

The generators at Power Station No. 3 and the transmission lines from Kariba feed into 33kV busbars which are interconnected with the 11kV busbars at Power Station No. 2. Figure 1 shows a single line diagram of the Power Station connections.

The transmission system shown in Figure 2 consists of a 33kV ring around the periphery of Salisbury which is fed in several places from the 33kV busbars at Power Station No. 3. 33kV lines also go out beyond the ring towards the boundaries of the area of supply and some of these are interconnected to form ring feeds. There are substations on this 33kV ring which step the supply down to 11kV. From these substation 11kV feeders go both outwards and inwards towards the centre of the town where they are interconnected with the 11kV feeds emanating from Power Station No. 2.

Wherever main feeders are interconnected a Control Substation has been erected. There are at present 17 substations controlling both 33kV and 11kV feeders and 17 substations controlling 11kV feeders only.

From all these Control Substations local 11kV networks are fed, mostly on the ring system with normally open points on the far ends of the rings. The local step-down substations, approximately 1,200 in number are equipped either with ring main switchgear or are solid tee-offs with fused transformers.

### 1.3 *Pilot Cables.*

All feeders connecting the Control Substations to the Power Station as well as all interconnecting ties between Control Substations are equipped with balanced protection using pilot wires. Pilot cables therefore had to be installed with all main cables since the inception of the system layout described in the previous section, over twenty years ago.

Thanks to the foresight of the engineers who designed the original system layout so many years ago, all pilot cables have at least two pairs of telephone conductors incorporated in addition to the pilot cores.

## 2. CHOICE OF SYSTEM.

### 2.1 *General.*

There are generally five functions which are required for the effective control of a distribution system. They are:

(a) Indication

(b) Operation

(c) Telemetering

(d) Alarms

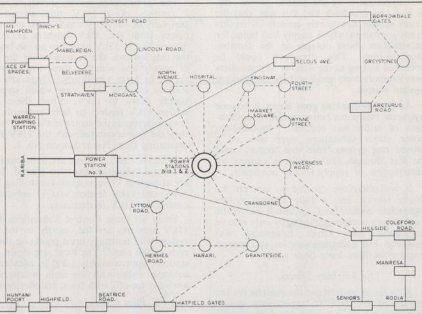


DIAGRAM OF MAIN TRANSMISSION SYSTEM.

Fig. 2.

(e) Telephones.

Each of these functions can be carried out by various kinds of control systems, such as the Direct Wire System and the Supervisory Control System which are employed in Salisbury. Both systems are equally reliable and the choice of system and of transmission medium for any particular function depends entirely on questions of economy and feasibility related to local conditions. Some of the factors which have to be taken into account are discussed in the articles listed at the end of this paper.

The choice of systems made in Salisbury need not therefore be generally applicable, and local conditions may require a different approach in each case.

Both systems use telephone-type apparatus in conjunction with interposing relays and instrument transformers. Pilot cables with very small conductor sizes can therefore be satisfactorily employed over considerable distances. The conductor chosen was 1/.040 copper conductor, paper or P.V.C. insulated and laid up in pairs, except for distances in excess of 15 miles, where 1/.064 copper conductors are used.

2.2 *The Direct Wire System.*

This system is used for three functions only:

(a) Gas Alarms

(b) Indication of Ripple Control

(c) Indication of Sensitive Earth Fault Relays.

The reasons for choosing the Direct Wire Systems were: firstly that these functions could not easily be accommodated within the Supervisory System chosen: and, secondly the availability of a sufficient number of spare cores in the pilot cables. It may be mentioned here that the number of cores in some pilot cables laid during the last few years has increased from the original two pairs to as many as 30 pairs.

### 2.3 *The Supervisory Control System.*

For all requirements other than those mentioned in the previous paragraph a Supervisory Control System was chosen.

The method adopted for this System is the display of a substation on a common diagram and its operation by means of keys and push buttons. All functions are carried out with a coded signalling system in which a train of pulses performs the selection and operation of all devices.

Equipment for indications and alarms was installed first and was later extended to cater for remote switching and telemetering facilities. One pair of pilot wires is required for indication and alarms, and a second pair for remote operation and telemetering.

## 3. APPLICATION OF THE DIRECT WIRE SYSTEM.

A free standing panel in the Control Room contains rows of indicating lamps, one for each alarm or indication enumerated below.

### 3.1 *Gas Alarms.*

All Gas Pressure Cables are equipped with devices which indicate the presence of gas leaks. The operation of such a device causes an alarm and the lighting up of the appropriate indicating lamp.

### 3.2 *Ripple Control.*

At present, three channels of the Ripple System are used for the switching of water heaters which are divided into 3 groups. A further 2 channels are used for street lighting which is divided into 2 groups: lights that burn all night, and those which are switched off at 1 a.m. Indicating lamps show which of these 5 channels are left in the "on" position.

### 3.3 *Earth Fault Relays.*

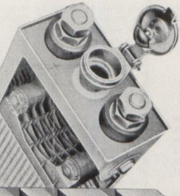
A novel type of very sensitive earth fault relay was recently developed by the Salisbury Electricity Department. In addition to its normal function as an earth fault relay, it also gives warning of small leakages to earth such as those caused by faulty insulators or tree branches in close proximity to conductors which may eventually develop into earth faults. These relays are installed on circuit breakers controlling 11kV overhead lines. Message registers, counting the number of warning operations of these relays are installed in the Control Room, one counter for each relay. If sufficient pilot cores are not available, only one counter for each substation is installed. On the occurrence of repeated warnings, the overhead lines in question are patrolled and the faults rectified before they cause an outage. It is hoped that a paper describing the design and operation of this relay may be presented to this Association at some future Convention.

## 4. APPLICATION OF THE SUPERVISORY CONTROL SYSTEM.

### 4.1. *General.*

The method of display and operation of the supervisory system is similar to several widely used standard systems, and was designed departmentally in consultation with the suppliers of the equipment. It was adopted because it appeared to be the one best suited to local conditions. The system used was designed by the suppliers, but various modifications and refinements were carried out by the Department after installation. The system is comprehensive, flexible and very simple to operate. In view of the large size of the system diagram, containing over 1200 substations and numerous isolating points on overhead lines, which occupies a complete wall in the Control Room, it was decided to keep this diagram hand-dressed. A common diagram in the centre of the control desk displays all conditions prevailing in a Control Substation and illuminated windows on the wings of the desk indicate which substation is presently displayed. Figure 3 shows a photograph of the Control Room.

As all substations controlling the 11kV transmission network are interconected, irrespective of their source of supply, i.e. the 11kV busbars of the Power Station or a step-down point from the 33kV system, it was decided to separate the Supervisory System controlling the 11kV substations from that controlling the 33kV substations. Two



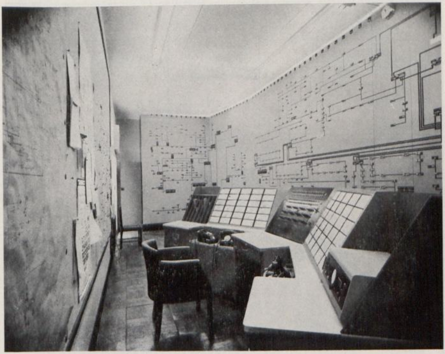


Fig. 3.

entirely independent systems each with a separate common diagram and separate operation keys were therefore installed, and each step-down substation was split into 2 parts, 3 33kV and an 11kV substation.

A total of 20 channels are available for each substation allowing for the indication of a maximum number of 20 facilities and for the control of a maximum of 18 facilities.

The whole installation caters for 20 — 33kV substations and 40 — 11kV substations, but is capable of being extended.

The following facilities are available for each substation:

(a) The indication of the position of all switchgear;

(b) Alarms indicating the tripping of a switch;

(c) Alarm on the operation of fire-fighting equipment;

(d) Indication of the position of switches which make the fire-fighting equipment inoperative;

(e) The operation of circuit breakers, interlocked with a warning signal;

(f) Buchholz relay alarms;

(g) Telemetering of ammeter and voltmeter readings;

(h) Telemetering of battery voltages;

(i) Telephones.

4.2 *The Common Diagram.*

The common diagram consists of 20 pairs of lamps, each pair corresponding to one of the 20 channels available, one lamp showing

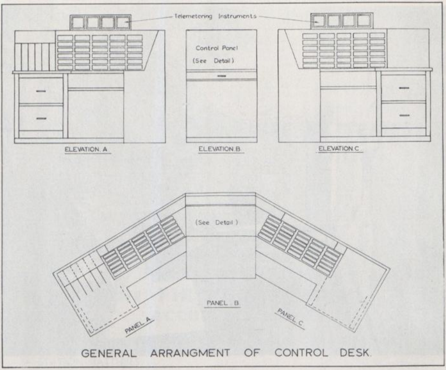



Fig. 4.

the device in the "on" position and the other in the "off" position. When a display is being given either one or the other of the 20 lamps must be lit up. Where, however, the total number of switches in a substation is less than the maximum allowed for, the redundant lamps are automatically blanked out to avoid confusion.

The 20 channels have been allocated as follows:

(a) On the 33kV system: 2 channels for fire-fighting equipment, 4 channels for Buchholz alarms, 1 channel for the warning of a switching operation, and 13 channels for circuit breakers.

(b) On the 11kV system: 2 channels for fire-fighting equipment, 1 channel for a telephone, 1 channel for the warning of a switching operation, and 16 channels for circuit breakers.

The illuminated windows on the wings of the control desk have transparent covers on which are engraved the name and number of the substation, a single line diagram showing all the switches in their correct sequence with their circuit labels and their normal position, whether "on" or "off". This is indicated by coloured pegs matching the indicators on the system diagram which can easily be changed.

A set of keys, one for each substation, is provided which selects the substation to be connected to the common diagram.

A further set of keys, one for each switch, selects the particular switch which is to be operated or telemetered. Push buttons and keys common to the whole equipment initiate closing, tripping, telemetering and telephone operations.

On top of the control desk are mounted the instruments for telemetering. There are

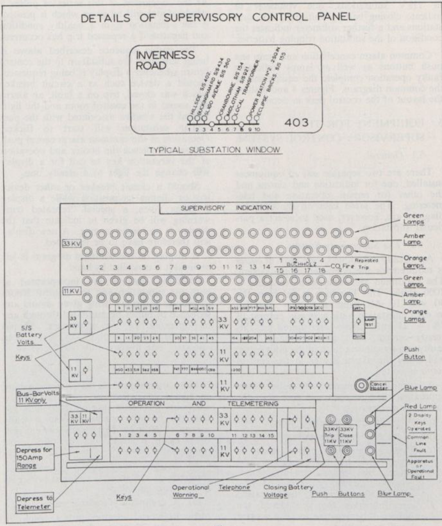



Fig. 5.

2 ammeters for each system, one scaled 0-600 amps and the other 0-150 amps. The 600 amp ammeter is normally in circuit, but should the reading be too low, the other one is connected by means of a key. One voltmeter is provided to indicate busbar volts in 11kV substations, one voltmeter to indicate closing battery volts in 33kV substations and a further voltmeter indicates the condition of the substation tripping batteries.

Common alarm cancellation and lamp test push buttons as well as lamps indicating faulty operation complete the equipment on the common diagram. Figures 4 and 5 show the layout of the control desk in detail.

## 5. EQUIPMENT FOR THE SUPERVISORY CONTROL SYSTEM.

### 5.1 *General.*

There are two separate sets of equipment installed, one for indication and alarms and the other for remote operation and telemetering. The same keys on the common diagram are, however, used to select a particular substation.

### 5.2 *The Supervisory System.*

As already mentioned, one pair of wires is required for the operation of the system. The maximum allowable loop resistance is 1000 ohms. This line loop is fed from the 30 volt 10 Ah tripping battery installed in each substation with a steady current of 18 — 21 mA. Any interruption of this steady current, such as one caused by a faulty equipment or a fault in the pilot cable, will cause the alarm hooter in the control room to sound.

A complete sequence of pulses lasts approximately 5 seconds and comprises the following elements:

(a) A preliminary negative pulse;

(b) A starting negative pulse;

(c) Twenty signalling pulses, each of about 100 m. sec. duration and spaced by similar intervals, whose polarities depend upon the position of the 20 devices. If for instance, circuit breaker No. 1 is closed, the pulse will be negative and if it is open it will be positive.

(d) A long negative pulse of about 200 m. sec. duration, used for the checking feature.

(e) A negative check pulse of normal duration.

At the conclusion of this series of pulses a steady signal will be given which is positive if the substation is in a healthy condition and negative if a repeated trip has occurred.

The entire sequence described above is being sent from the substation to the control centre whenever a display is being requested. Should a device such as a circuit breaker which was closed, trip on a fault, an alarm will sound in the control room and the light behind the window associated with the particular substation will start to flicker. Operation of the common alarm cancel push button will silence the hooter and operation of the substation key to call for a display will change the light to a steady one.

Should a circuit breaker or other device trip or change its position while a display is being given, a special "repeated trip" warning will be given to indicate that the display is no longer correct. A new display will therefore have to be requested.

A display on the common diagram is left on until it is cancelled by hand.

Checking features are incorporated at both the substation and the Control Room to prevent a display being given should any sequence of pulses be mutilated through any mal-operation of the equipment. Should more than one display key have been operated, one display only will be given.

### 5.3 *The Control System.*

As in the case of the supervisory system, one pair of wires is required with a maximum loop resistance of 1000 ohms, fed from the control room battery with a steady current of 10 mA. This steady current provides again a check on the pilot cable equipment.

A complete sequence of signals lasts approximately 4 seconds and consists again of 24 pulses as follows:

(a) A preliminary positive pulse.

(b) Eighteen selector pulses, each of about 75 m.sec. duration, of which

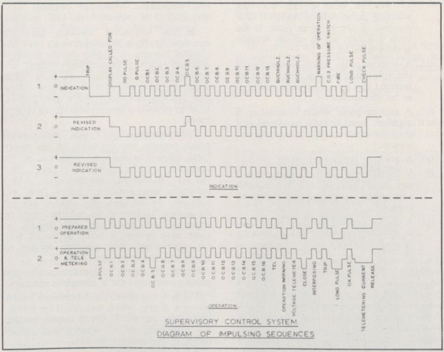

1
INDICATION
TRIP
DISPLAY CALLED FOR
OO PULSE
O PULSE
OCB1
OCB2
OCB3
OCB4
OCB5
OCB6
OCB7
OCB8
OCB9
OCB10
OCB11
OCB12
OCB13
BUCHHOLZ
BUCHHOLZ
BUCHHOLZ
WARNING OF OPERATION
CO2 PRESSURE SWITCH
FIRE
LONG PULSE
CHECK PULSE
2
REVISED INDICATION
3
REVISED INDICATION
INDICATION
1
PREPARED OPERATION
2
OPERATION & TELE METERING
S PULSE
OCB1
OCB2
OCB3
OCB4
OCB5
OCB6
OCB7
OCB8
OCB9
OCB10
OCB11
OCB12
OCB13
OCB14
OCB15
OCB16
TEL
OPERATION WARNING
VOLTAGE TELEMETER
CLOSE
INTERPOSING
TRIP
LONG PULSE
OK PULSE
TELEMETERING CURRENT
RELEASE
OPERATION
SUPERVISORY CONTROL SYSTEM
DIAGRAM OF IMPULSING SEQUENCES

Fig. 6.

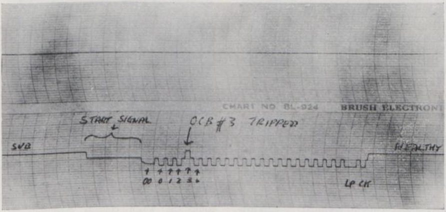


CHART NO. BL-924
BRUSH ELECTRONI
START SIGNAL
OCB #3 TRIPPED
SUB
HEALTHY
LP CK

Fig. 7.

17 will be positive and one, the selecting pulse, will be negative. The position of the negative pulse in the train indicates which circuit breaker is to be selected.

(c) A voltage pulse which is negative if the substation voltage is to be telemetered and positive if any current is to be telemetered.

(d) A closing pulse which is negative if a circuit breaker is to be closed and positive under all other circumstances.

(e) A positive interposing pulse.

(f) A tripping pulse which is negative if any circuit breaker is to be tripped, and positive under all other circumstances.

(g) A long negative pulse of about 200 m.sec. duration used as a checking feature.

This sequence of signals is sent from the Control to the appropriate substation. If the substation has received these signals correctly a positive check pulse is sent back from the substation to the Control. Receipt of this check pulse clears the line loop for telemetering. The operation of a circuit breaker cannot however be initiated until a warning signal has been sent over the supervisory system. Release of the key operating the warning signal clears the control system for the operation of a circuit breaker.

This warning feature, which sounds a hooter in the substation has been incorporated in order to guard against the possibility of maintenance fitters, working in the substation. If a switching operation should not have been carried out within half a minute of a warning having been given, the line loop is released and the whole procedure has to be restarted.

Whenever a switching operation is carried out on a particular circuit breaker, the current of that circuit is automatically telemetered. It is, however, possible to telemeter any circuit without a switching operation being carried out.

All telemetering is carried out with a weak direct current potential of negative polarity which operates directly a moving coil instrument. Ammeter readings have therefore to be converted into D.C. voltages.

As the substation selection keys are common to both the Supervisory and the Control Systems, a display on the common diagram is given automatically before any telemetering or switching operation. The successful completion of a switching operation automatically calls for a new display, so as to provide a visual check at the control room.

Check features are again incorporated which prevent any operation of the equipment through either mal-operation of the equipment or the operation of more than one key. Should mal-operation occur, a blue indicating lamp on the Control Desk will light up. In addition, the selector key for the circuit breaker to be operated must be depressed with one hand while the trip or close push button is being depressed with the other hand, thus guarding against an accidental switching operation.

Figure 6 shows diagrammatically the pulsing sequences for a complete operation.

The first line shows the supervisory system giving a display which was called for following a trip alarm. It shows circuit breaker No. 5 tripped, and all others closed and all relays in the normal position.

The fourth line shows the control system. Warning has been given that circuit breaker No. 5 will be closed.

In the second line the supervisory system indicates that the warning hooter has sounded in the substation.

The fifth line shows the control system sending the closing signal for circuit breaker No. 5 and at the same time telemetering the circuit of breaker No. 5.

The third line shows again the supervisory system giving the control display and showing circuit breaker No. 5 closed.

The actual shape of the pulses can be seen in Figure 7 which is the photograph of an oscillogram taken during commissioning tests.

5.4 *Additional Equipment.*

In addition to the supervisory control equipment which consists essentially of relays, selector switches and other Post Office type equipment, further apparatus is required in all substations to connect the supervisory equipment to the switchgear.

5.4.1 *Indication and Alarm.*

Auxiliary contacts are fitted to each circuit breaker to indicate whether it is closed or open. A relay is fitted in the common circuit from the tripping battery to the switchgear to initiate the switch tripping alarm.

5.4.2 *Fire-Fighting Equipment.*

This equipment, which releases carbon dioxide on the operation of fusible links, incorporates a pressure switch which actuates the fire alarm in the Control Room. It also incorporates a manually-operated lock-out switch which has to be operated whenever the substation is being entered for maintenance purposes to guard against the accidental release of carbon dioxide. The position of this lock-out switch is indicated on the common diagram in the same manner as any circuit breaker. The control engineer is therefore warned if this switch is being operated and can ascertain during his periodical checks, if the lock-out switch has been restored to normal.

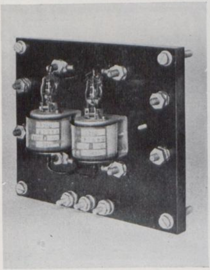


Fig. 8.

5.4.3 *Remote Operation.*

Interposing mercury type relays are fitted to each circuit breaker. These relays are connected to the closing and tripping circuits on the switch control handle. Figure 8 shows such a relay without its perspex cover.

5.4.4 *Telemetering.*

Interposing current and voltage transformers with rectifiers are connected to corresponding instrument transformers on the switchgear and to the closing batteries. Figure 9 shows an interposing current transformer with its rectifier and diodes for surge protection, with the cover removed.

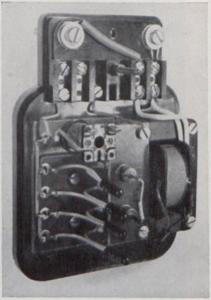


Fig. 9.

The voltage of the tripping batteries is metered directly as they supply the supervisory equipment.

5.4.5 *Warning Hooter.*

This hooter is installed in each substation and operates from the tripping batteries.

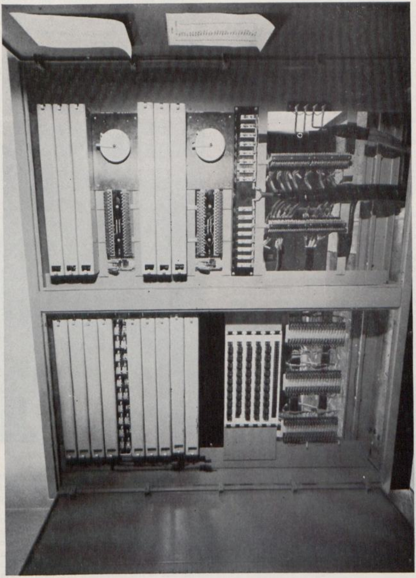


Fig. 10.

5.4.6 *Telephones.*

A telephone is installed in all 11kV substations. As all substations with 33kV switchgear also contain 11kV switchgear, one telephone is sufficient for both.

5.4.7 *Buchholz Alarms.*

Ordinary alarm relays energised from both the Buchholz alarm floats and from winding temperature indicators with maximum pointers operate the supervisory alarms.

5.5 *Cubicles.*

5.5.1 *Control Room.*

The equipment at the control room is installed in two places. The common diagram equipment such as lamps, keys, push buttons, meters and hooter are mounted on the control desk. All other equipment such as stepper switches, relays, condensers, resistances and terminal equipment is housed in 4 steel cabinets, 2 measuring 6′—0″ x 4′—8″ x 1′—4″ and 2 measuring 4′—0″ x 4′—8″ x 1′—3″ which are are installed in a special room adjacent to the control room. The battery required for the control equipment is housed, with

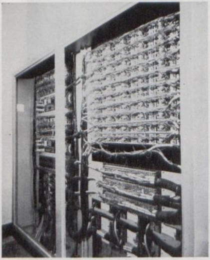


Fig. 11.

its trickle charger, in a special battery room which contains also the battery for the mobile radio equipment. Figure 10 shows a front view and Figure 11 a rear view of one of the steel cabinets.

5.5.2 *Substations.*

In each substation there are 2 wall mounted sheet steel cubicles, one measuring 1′—4″ x 2′—0″ x 11″ for the supervisory equipment and one measuring 1′—4″ x 2′—8″ x 10″ for the control equipment. These cubicles contain all equipment with the exception of the interposing relays and

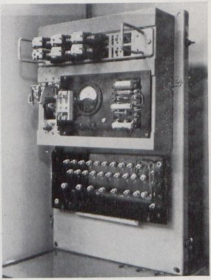


Fig. 12.

interposing instrument transformers which are mounted on the switchgear control panels. Figure 12 shows the supervisory cubicle and Figure 13 the control cubicle.

As this equipment is very compact, no difficulties were experienced in finding sufficient wall space in all substations. Figure 14 shows the control room in a step-down substation with two sets of cubicles on either side of the substation L.T. distribution board.

## 6. OPERATION OF THE SUPERVISORY CONTROL SYSTEM.

### 6.1 *General.*

A brief description of the actual operation of the system will help to clarify the design features described in preceding paragraphs.

It has to be emphasised again that there are two entirely independent systems installed, one for the 33kV network and one for the 11kV network. All equipment on the Control desk is therefore duplicated and can be operated independently and simultaneously. In order to distinguish the two equipments, every item is carefully labelled and in addition, all keys for the 33kV network are coloured yellow while the keys for the 11kV network are black. The engraving of the transparent substation windows is in red for the 33kV substations and in black for the 11kV substations.

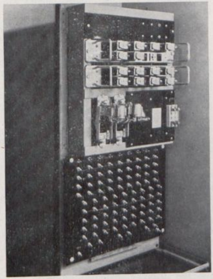


Fig. 13.

The indicating lamps of the common diagram are coloured green to show open devices and amber to show closed devices. The only exceptions are the lamps which indicate the operation of the fire-fighting equipment which are coloured red and the lamp indicating an incoming telephone call from a substation which is blue. This lamp is duplicated on top of the desk.

### 6.2 *Indication.*

If a display of a substation is required, the respective substation key which is labelled with the substation number is turned downwards. It stays in this position until released by hand. Immediately the white lamp behind the substation window lights up, and after completion of the pulsing sequence the lamps on the common diagram give a display of conditions in the substation. Returning the key to the neutral position disconnects the substation from the common diagram, but leaves the light on behind the substation window. Turning the

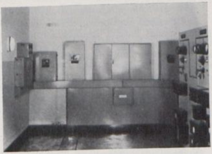


Fig. 14.

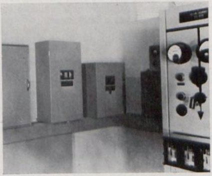


Fig. 15.

key upwards extinguishes this light. This is an important feature which will be explained in the next paragraph.

As mentioned before, should any device in the substation which is being displayed change its position a general repeated trip alarm sounds which lights up a special white lamp. This is an indication that the display on the common diagram is no longer correct. The substation key must now be released and depressed again, thus calling for a new display.

6.3 *Alarms.*

Should a circuit breaker in a substation trip, or should any other device such as fire-fighting equipment or a Buchholz relay operate, the alarm hooter sounds and the light behind the window of the substation in which the tripping has occurred will start flashing. Depression of an alarm cancellation push button will silence the hooter. Depression of the appropriate substation key will give a display and convert the flashing light into a steady light. A comparison of this display with the single line diagram on the substation window will indicate which device has changed its position from normal.

It sometimes happens that circuit breakers in two substations trip simultaneously. In this case the flashing lights will appear behind the windows of both substations. One display will be requested by depressing the substation key and the light behind a second substation window, whose corresponding key is not depressed, will serve as a reminder to call for a display at a later stage.

A fault in the pilot cable or terminal equipment connected to the pilots of the supervisory equipment will sound the ordinary alarm hooter. The flashing light will indicate which substation is affected, but no display will appear on the common diagram on depression of the substation key. The flashing light also cannot be changed into a steady light until the fault has been attended to.

A fault in the pilot cable of the control equipment will light up a red lamp behind the substation window as well as a common red "line fault" indicating lamp.

6.4 *Telephones.*

The operation of a call push button on the telephone in a substation will cause an alarm in the control room in the same way as a switch trip. The display will show the lamp marked "Telephone" lit up. When a display has been called and the telephone key been depressed, the telephone connection will be established. If the control room wishes to call a substation, it is only necessary to depress the substation key and the telephone key. An audible signal will be given in the substation.

6.5 *Telemetering.*

If the ammeter reading of a particular circuit is required, the substation is selected by depressing the appropriate substation key, the circuit breaker is then selected by pushing the appropriate switching key downwards where it remains until released by hand. This brings the higher range ammeter on the control desk in the circuit. Should the reading be too low, the common ammeter telemeter key is depressed and the lower range ammeter is put in circuit.

For voltmeter readings the procedure is simpler. The substation is selected in the usual way and depression of a common key will give an indication of busbar volts. This facility is available only in 11kV substations at present. Depression of a second common key will give an indication of the closing battery voltage. Closing batteries are installed only in 33kV substations. The operation of two other common keys will put the tripping battery voltmeter into circuit of either an 11kV or a 33kV substation.

6.6 *Switching Operations.*

As described previously, closing or tripping a circuit breaker requires selection of the substation, operation of the switching key upwards in which position it has to be held against a spring return, and depression of the common close or trip push button.

It should be emphasized that any mal-operation of the equipment, or the accidental depression of more than one substation or switching key simultaneously, will result in non-operation of the equipment.

At present, the only circuit breakers connected to the remote control system are those in the 33kV substations. The circuit breakers in the 11kV substations are not equipped with electrical closing devices with the exceptions of some having auto-reclosing relays. The cost of the conversion of all circuit breakers to electrical closing does not seem warranted, with the exception of a few which control ties between the 11kV and 33kV systems. These will be equipped with closing solenoids in the near future and then connected for remote control.

6.7 *Routine Operation.*

A very important consideration in the use of a Supervisory Control System is complete reliability. It has been found in practice that due to the fact that contacts on all telephone type equipment are self-cleaning, frequent operation of the equipment will ensure that contacts are always clean and that dust or other matter does not settle on any moving parts.

For this reason the practice has been established to operate the entire system at regular intervals.

At the beginning of every 8 hour shift the operations controller calls for a display of every substation, thus checking the position of every circuit breaker and other device. If time permits, telemeter readings of all currents and voltages are also taken at every shift, but if this is not possible, they are taken once every 24 hours.

Switching operations cannot, of course, be carried out regularly. But as the 33kV system is at present operated with open rings, the open points can be changed. This allows the opening and closing of some circuit breakers at least in every substation, thus ensuring the functioning of each substation equipment. The interposing relays on circuit breakers controlling spur lines are not operated except when actually required for general switching operations. These relays are however of the mercury type which is extremely reliable and it is therefore felt that the absence of check operations will not impair the reliability of the equipment as a whole.

7. COSTS.

7.1 *The Direct Wire System.*

All equipment for use with this system was designed and constructed departmentally. Most of the components were purchased locally, but some were drawn from existing stocks. It is therefore not possible to give a reliable figure of the total costs incurred by the Department, particularly because no check was kept on the time required for the design work.

7.2 *The Supervisory Control System.*

The equipment for this system was purchased by public tender. The lowest tender was accepted which was substantially lower than any other. The equipment for the control room including the operating desk cost £5,400. This sum includes installation charges.

The common equipment installed in each substation was £423 per substation. To this sum must be added the cost of interposing relays and instrument transformers which was £57 per circuit breaker.

Installation costs varied between £250 and £350 per substation.

7.3 *Pilot Cables.*

The total installed system comprises some 170 miles of pilot cable, of which half the mileage consists of cable having 2 pairs of 1/.040″ telephone conductors in addition to the pilot cores. As mentioned before, a large quantity of this cable had been installed for a number of years. The cost of the two telephone pairs was never ascertained separately but it can be assumed that it was no more than the cost of the copper and insulation of these conductors, as they occupy the space of the wormings normally used in pilot cables. The price of such cable is approximately £130 per 1,000 feet.

Approximately 20 miles of pilot cable consists of 5—10 telephone pairs in addition to the pilot cores and some 60 miles contains 20 or 30 telephone pairs. The conductor size in these cables is often increased to 1/064″ in order to reduce the loop resistance on long runs.

The additional cost of further telephone pairs in a pilot cable is £4 to £5 per pair of 1/040 conductors per 1,000 feet and £7 per pair of 1/064 conductors, in addition to the cost of the 2 pair pilot cable quoted.

## 8. OPERATING EXPERIENCE.

The Direct Wire System has been operating almost faultlessly for several years.

The Supervisory equipment has now been in operation for five years, but the Control System has only recently been installed and is not yet fully operational. The following remarks refer therefore to experience with the Supervisory System only.

Mal-operation of the equipment in the Control Room is very rare but faults on any one of the substation units occur on the average once a month. They are detected during the 8 hourly checks and rectified within a few hours. These faults usually require either the adjustment of a relay or the replacement of a condenser or resistance. Certain modifications which were carried out also reduced the proneness of some relays to maladjustment.

Faults on the pilot cables were at first more frequent, but as all weak spots, such as bad joints, are gradually eliminated, they diminish in frequency very rapidly.

Damage to substation equipment occurred on two occasions and was traced to overvoltages induced in the pilot cables during the passage of heavy fault currents through the high tension cables which are laid in the same trenches adjacent to the pilot cables. Post Office type surge arrestors were fitted to both ends of every pilot core used for supervisory equipment and appear to have cured this trouble.

No routine maintenance has so far been carried out on any part of the supervisory installation, as the very low incidence of faults did not warrant it. With the commissioning of the Control Equipment which contains many more parts than the Supervisory Equipment this position may change. Testing equipment has therefore been constructed which will enable the routine checking of substation equipments to be carried out. It is proposed to carry out routine checks monthly at first. Experience will indicate whether the interval between checks can be lengthened.

In general it can be said that the supervisory equipment has given excellent service and judging by its performance, an equally good service is expected of the control equipment.

The time required for the restoration of supplies following outages of distribution equipment has been appreciably shortened, and control of the transmission network has been immeasurably eased. It is felt therefore that the installation of the Supervisory Control Equipment has been justified in every respect.

## 9. ACKNOWLEDGEMENTS.

The author wishes express his thanks to the City Council of Salisbury for permission to publish this paper, to the City Electrical Engineer for his encouragement and advice and to several of his colleagues for their assistance. Finally the author expresses his thanks to the A.M.E.U., for having given him the opportunity to present this paper.

## 10. BIBLIOGRAPHY.

1. Lynch: Some Electrical Developments in the Salisbury Area. A.M.E.U. Convention 1956.
2. Kidd and McWhirter: Operational Control of electricity supply systems. I.E.E. Journal 1945, p. 311.
3. Day: Remote Control of Distribution Networks. Electrical Review 1959, p. 141.
4. Waureck: Neglected Hydro Electric Opportunities in S.A. S.A. Electrical Review 1961, p. 25.

THE PRESIDENT: Thank you, Mr. Brod. I will call on Mr. John Wilson to propose a vote of thank to the author.

Mr. J. WILSON, Pretoria: It affords me great pleasure to be able to propose the vote of thanks to Mr. Brod for presenting to us today, his paper on the Supervisory Remote Control System as applied to the Salisbury Distribution network. He is to be congratulated on the very lucid explanation he has given and on the orderly presentation of the subject which, after all, is not the easiest one with which to deal since it has so many facets.

I don't suppose there is any engineer in the supply industry who is not jealous of the reputation of his undertaking in regard to continuity of supply to consumers. Anything, therefore, which assists to this end and is both technically and economically feasible must engage his close attention.

As Mr. Brod has indicated, only in the smallest of undertakings can reliance be placed on consumers to indicate outages and other disturbances on the system and as distribution networks grow and become more complex recourse must be had to more reliable and definite means of pin-pointing trouble. This can be a relatively simple supervisory system which, as has been done in Salisbury, can be expanded later into a full supervisory remote control system. Just what facilities should be provided, however, will depend largely on the particular distribution layout, the number of manned substations and the organisational setup provided in the way of consumer and breakdown services. Thus the form of the system and the facilities to be provided must necessarily vary from undertaking to undertaking.

The main value of a paper of this nature, which is necessarily largely descriptive obviously lies in providing a useful reference to others who may have under consideration something of a similar nature. I don't therefore, propose to comment on it directly for I obviously lack the thorough knowledge of the system and the organisational setup for which it has been designed. Instead I feel my most useful contribution would be to outline briefly the system which we have had in operation in Pretoria during the past ten years.

This Supervisory Remote Control System is used for the supervision and control of our primary step-down stations and the previously used supervisory system has been superimposed in much the same way as has been done in Salisbury.

In Pretoria the primary transmission system consists of radial feeders operating at 33kV, each feeder supplying a primary step-down station of 20MVA nominal rating. Full transformer and feeder standby facilities are provided at each primary station by means of teed standby feeders.

Each primary step-down station supplies two or three satellite substations on a secondary transmission system at 11.5kV. This is a ring main feeder system so that the failure of any one feeder cable between substations will not cause an interruption of supply.

11.5kV distributor cables radiating from each primary and satellite substation supply the 11500/433/250 volt distribution substations of 200 to 1000kVA rating. In the suburbs the 433/250 volt mains are fed by up to four 200 kVA transformers in parallel, feeding the mains at strategic positions. This system while having the advantage of flexibility and improved transformer loading, has the disadvantage that one or two transformers may trip on transient faults causing the remaining transformers in that area to be overloaded and possibly damaged.

For this reason, apart from that of improving the consumer service, a direct wire alarm system was developed between the individual distribution stations and the satellite substations, and between the satellite substations and their associated primary step-down stations. This provides indication of the tripping of any feeder circuit breaker or any breaker controlling a 200 kVA substation.

These alarms, together with the alarm, indicating and control facilities associated with the primary step-down station are then transmitted to the central control room over the supervisory control system.

There are at present seven such substations of 20 MVA rating each equipped with supervisory remote control equipment. Initially quite lavish facilities were provided but experience has shown that some provided little or no useful purpose and the present system is therefore much more modest.

The supervisory control system for each primary step-down station provides the following facilities:—

(a) Indication of the circuit conditions of the 11.5kV switchgear in the primary stations.

(b) Closing and tripping of the incoming feeder and satellite feeder circuit breakers.

(c) Indication of the current in the red phase of the incoming and satellite feeders.

(d) Indication of the tapping position of the 20 MVA step-down transformers.

(e) Continuous indication of the voltage on the 11.5 kV side of the 20 MVA transformers.

(f) Raising and lowering the taps on these transformers.

(g) Thirty alarms, including the distribution substation alarms, fire and 20 MVA transformer temperature and protection alarms and some fleeting alarms indicating transient phenomena such as the flow of earth fault current.

Maintenance costs have been very low and the more usual failures have been due to dirt on the contacts of the telephone type equipment or oxidisation of the auxiliary contacts on the switchgear. No routine maintenance has been found necessary.

The supervisory control system has proved to be a valuable tool in routine switching operations for the maintenance and repair of equipment on the network, and its value in this respect has been greatly enhanced by the use of mobile radio facilities which make it possible to control switching operations from any part of the system.

In conclusion, Mr. President, may I again express to Mr. Brod our deep appreciation of all the trouble he has taken in presenting a paper which should prove a very useful reference to many of our members and formally propose a hearty vote of thanks to him.

THE PRESIDENT: Thank you, Mr. Wilson.

I now call on Mr. Kane to second the vote of thanks.

Mr. R. W. KANE, Johannesburg: Mr. President, ladies and gentlemen, Mr. Brod is to be congratulated on the well-presented and thoroughly descriptive paper, and which will be appreciated by our members when published. It is a pity that, by the nature of things, everyone is not able to be present at every convention and thus fully obtain the advantages of listening to and enjoying the presentation.

The events of the last few days, starting on Friday at Kariba (despite the excellent organisation for which our secretaries, our friends of Livingstone, and finally Germiston, have been responsible), make me feel that future conventions could be vastly improved if someone could adapt and adopt a system of supervisory control for our delegates at large—particularly our wives and daughters!

Mr. Brod referred to costs, and said that the costs are explained fairly fully in the paper. I am a little vague about this, I may have misunderstood him, but I have not made up my mind whether he has 34 sub-stations or 1,234 sub-stations equipped with this supervisory equipment, and at something like £200 odd per sub-station I am just really curious what it did actually cost Salisbury.

I am particularly interested in the reference to the ability to adopt preventive maintenance by virtue of this sensitive earth fault relay, and no doubt we will hear more about that later on.

One other item that is interesting is this warning feature for "maintenance fitters" I think is the name used. I query the necessity for that, when I presume anybody working on equipment in the substation must have some form of permit to work.

On the other hand when you use the term "fitters" perhaps the origin is purely mechanical, and I refer to a councillor who will be nameless, who seemed to imply that electrical engineers could do nothing without their mechanical counterparts. May I remind him I have never known of a purely electrical fault; it has always been a mechanical breakdown of some part of the electrical equipment!

Seriously though, for this type of installation—I think there is a tendency in every one of us (that small-boy tendency) to enjoy doing many things that may be troublesome, by remote control in preference to having to travel to the job and do it; and I think in planning an installation of this nature, one should move with caution, put down all the functions that you would like to consider, cut them in half, and then cut down a bit more. I have had very little experience of this sort of thing, but I think the general tendency is to rather over-do the requirements.

I would like, on your behalf, to join with John Wilson in thanking Mr. Brod for his very excellent paper and I have great pleasure in seconding the vote of thanks.

THE PRESIDENT: Thank you, Mr. Kane.

Gentlemen, you have heard the vote of thanks so ably proposed by Mr. Wilson, and seconded by Mr. Kane, will you please indicate your appreciation to the author in the usual manner. (Applause).

To set the ball rolling gentlemen: with regard to telemetering, I assume that the ratios of the various feeder current transformers are not all the same. I would therefore like to ask the author how a direct reading on the remote indicating ammeters is obtained, in other words, a reading which does not have to be multiplied by a constant is this achieved by selecting suitable ratios for the interposing current transformers, so that the overall ratio of the primary and interposing current transformers remains the same? Are there any more contributions?

Mr. C. G. DOWNIE, Cape Town: I was rather intrigued by the statement made in the paper that there are 1,200 substations in Salisbury. We in Cape Town are managing with about 500 substations at present. I am just wondering: what does Salisbury regard as being a substation? It may be that anything from a small transfer mounted on a pole, or a transformer kiosk with a few HRC fuses in it, to something involving one or more transformers with EHT and L.T. switchgear are all regarded as being substations. I am wondering what substations in Salisbury fall within the scope of supervisory and remote control, and how many of such substations Salisbury has. Also, where is the line drawn in the application of supervisory and remote control?

THE PRESIDENT: Thank you, Mr. Downie. Any further discussion?

Mr. D. MURRAY NOBBS, Port Elizabeth: I must congratulate Mr. Brod on his very excellent paper, but I am particularly interested in the economics of the installation.

I have seen supervisory remote control equipment installed in many large undertakings in Britain and on the Continent, and I have no doubt, no doubt at all, of its efficiency.

In Port Elizabeth we are at the stage when we are giving consideration to the possibility of installing such a system, but before doing so we must be satisfied that it will pay its way, especially in these days of difficulty in obtaining capital for such development. There are certain systems that we do install and look upon them as an insurance. For example, if we consider buss zone protection in power stations, such protection may be installed initially and during the life of the station may never operate, but if it operates once effectively, it probably pays for itself over and over again.

In the case of supervisory remote control, however, I was wondering if the economics of the system had been carefully studied by Salisbury, before deciding to go ahead with it. Again, when was the time considered opportune for the installation of such equipment; why wasn't it installed in Salisbury ten years ago? Why wasn't it postponed in Salisbury, say until ten years hence? Why was the present time chosen? In other words, at what stage in the development of the undertaking did Salisbury consider it essential to install such a system?

I don't think that Salisbury has the operating experience to date to give any indication of the effectiveness of the system but I can remember, 2 years ago, when I was with the Johannesburg undertaking, supervisory remote control was introduced at that time, consequently, I was rather disappointed that Mr. Kane, in his remarks, did not give us some indication of how the system had worked in Johannesburg during that period. I feel also that Mr. Kane might be able to give us some useful information on the question of the economics of supervisory remote control as installed in his undertaking.

THE PRESIDENT: Thank you, Mr. Murray Nobbs.

Mr. A. R. SIBSON, Bulawayo: I would like to join in congratulating Mr. Brod for this extremely valuable paper. I have just one point I would like to raise. I think it is true that some years before Salisbury decided to go in for supervisory remote control they did install ripple control for the automatic switching of water heaters and street lighting, etc.

I wonder whether, had they not done so previously, they would have revised their approach to ripple control in such a manner that the two functions would have been incorporated in the same system.

We ourselves at the moment are on the point of considering supervisory control, and are rather inclined to a system which would enable more functions, than supervisory control alone to be included.

I would just ask this question: would they have considered the matter differently in respect of all these functions, if the ripple control had not previously been installed.

THE PRESIDENT: Thank you, Mr. Sibson. Are there any further contributions.

Mr. R. M. O. SIMPSON, Durban: I would also like to thank the author for his paper; it is of very great interest to me as we have not as yet installed supervisory remote control in Durban having kept the system very simple in its control, having so far relied on an alarm system from groups of substations and from single important substations.

I would like to hear more of the operational experience of the common diagram system. I presume from the paper, that the author has retained both systems in operation? I would like to know of his experience of, say, a very serious shutdown affecting a number of major substations on the common diagram system, and in these circumstances are there undue delays in handling switch in the several substations controlled by the one common diagram?

From his experience would he use the common diagram system for all future extensions, leaving the existing direct line system as it is, without any further extensions?

Thank you.

Mr. R. W. KANE, Johannesburg: In reply to Mr. Murray Nobbs' query, to the best of my recollection this supervisory control of Johannesburg was ordered either during the war, or just prior to the war, and installed only after the war, and was designed to suit the then 20 KV network supplied by two power stations, and a number of radial substations. Two conductors per substation were used for all the functions, including direct line telephones.

Frankly, I didn't think there was much wrong with the equipment, but the development of the town, and the cost of the equipment at that time, which was in all about £26,000 was probably relatively cheap by today's standards. As I say, I don't think there was very much wrong with the equipment, but I think there was an awful lot wrong with the people in the control room who seemed to dislike this equipment entirely and did not trust it. There had been one or two wrong indications: I think Mr. Simpson referred to a complete shut-down. I remember being in the control room one morning about ten minutes to seven when practically the whole of the town had shut down, and there was no doubt about it, the supervisory equipment gave a true indication of the position that did exist for a portion of the town.

We have placed an order recently for another type of equipment altogether, because the whole pattern of the existing network with the third power station coming in and tending to shrink the perimeter of the town, has changed. This type of control system will be more of a unit pattern, which we can use for any individual substation.

We have cut down the functions considerably; the earlier equipment gave remote control of switchgear, which we don't think is necessary or wise. All we want is indication of the state of the system.

Thank you.

THE PRESIDENT: Thank you, Mr. Kane.

Mr. J. E. MITCHELL, Salisbury: It is obvious, Mr. President, that I am not going to reply to quite a lot of these questions—that is for the author—but I did want to emphasise one or two features of this supervisory control.

The first one is in answer to Mr. Murray Nobbs (an answer possibly that Mr. Brod can't give), and that is that I decided this would be required as far back as 1939, and it was in 1939 that we first started to put telephone cores into our pilot cables, so that over the years, really, the actual direct wires have cost us very little—the cost of the copper was when copper was at that wonderful figure of £50 a ton—some of it was put in then.

The other point which I did want to emphasise is the tremendous improvement in public relations. I am not going to boast about this, but the fact of the matter is that I don't think there is—I was going to say "one day"—but certainly not one week goes by that we don't get something like half a dozen letters—letters, not just telephone calls—from members of the public who have written in and thanked us for the expeditious way in which the supply has been restored, and to get public relations like that is worth a considerable amount of money.

The third point is that when we called for tenders originally for the first supervisory panel and equipment, there were various tenders. I won't tell you where they were from, but two or three were round about £25,000 and the one we accepted was one manufactured in Johannesburg for about £6,000.

Mr. G. J. MULLER, Bloemfontein: Mr. President, I would like to add my quota of thanks to Mr. Brod for his very instructive paper.

We have been toying with the idea of supervisory control. We have radio communication on our system, and we have got alarms on 33 KV system, but that is still not sufficient to keep us in touch with the 11 KV system as such, and even the 33 KV switching.

The point that exercised our minds was an economic one. Other speakers have touched on it, but it is still not very clear at what stage one should go over to installing supervisory control.

I think it would be just about impossible to make out an economic case for any council to prove to them that it would pay them, in hard cash: Goodwill and public relations are extremely valuable, but it is extraordinarily difficult to put it across to Council in £.s.d. when the capital programme is to be considered.

Mr. President, the other aspect has been the reliability of such a system. To be of any value at all, one must be able to rely on it implicitly. In Salisbury apparently they have had good experience so far, but it is rather young. Pretoria has had ten years; Johannesburg has had some—but apparently not much used, or I don't know to what extent they have used it—but Pretoria has had ten years of use and one would like to know from Mr. Wilson whether they consider it as implicitly reliable.

Thank you, Mr. President.

THE PRESIDENT: Gentlemen, I think we will adjourn for tea now.

(Convention announcements followed)

CONVENTION ADJOURNED.

On resuming at 11.00 a.m.

THE PRESIDENT: Ladies and gentlemen, some two years ago when municipal electrical engineers were racking their brains to see how they could carry on in the face of ever increasing costs without increasing their tariffs, it was announced in the press that the Sasolburg Town Council had decided to take the necessary steps to reduce their tariffs by ten per cent.

I think today Mr. von Ahlften of Sasolburg is going to tell us how this was accomplished. I have much pleasure in calling on Mr. von Ahlften to present his paper entitled Audio Frequency Remote Control to an Electricity Supply Undertaking's Distribution Network.

# The Application of "Audio-frequency" Remote Control on an Electricity Supply Undertaking's Distribution Network

By

J. K. VON AHLFTEN, B.Sc., B.Sc. (Eng).
TOWN ELECTRICAL ENGINEER—
SASOLBURG

## 1. INTRODUCTION :

Ever since the development of the township of Sasolburg in 1952 the large increase in the cost of distribution equipment over recent years has set the problem of keeping the capital investment within reasonable proportions to the energy handled, so that electricity could be supplied at an economic tariff to consumers in this new town that was to be associated with the Union's first Oil from Coal project. Furthermore, as it had been decided to establish an all-electric township, the question of reducing the peak demands on the electrical distribution system on account of the present day high maximum demand charges had to be considered.

It was, therefore, realised that some means of controlling the load on the distribution system which would enable the reduction of system peaks without decreasing the revenue earning energy sales, would be of immense value. Subsequent investigations established that such a method of control had in fact been in existence for some considerable time, which is commonly known as load or ripple control. This control is achieved by injecting signals into a distribution network which can then be absorbed by signal sensitive relays installed upon the consumers' premises, which will carry out any required switching operation by briefly disconnecting those circuits which could be controlled during the peak periods.

A consuming device which most readily lends itself to being controlled in this manner is undoubtedly the domestic water heater which is to be found in practically every modern home to-day and which accounts for quite a considerable amount of the total electric energy consumed upon domestic premises. In the case of Sasolburg it was established that approximately 33% of the total load taken during peak periods was accounted for by domestic water heaters so that the control of these could therefore lead to a substantial reduction in the peak demands on the distribution system.

In addition it was realised that various other applications exist apart from the business of keeping the load down which could be performed with this equipment, a typical example of which is the remote control of streetlighting installations with the advantage of considerable savings in cable costs.

A thorough study was therefore made of the various methods available to control the load on a distribution system and audio-frequency remote control equipment was eventually introduced towards the middle of June, 1959. It will now be the object of this paper to give an account of the various factors which led to the choice of the particular system employed and the general effect load shedding has had upon the distribution system as well as the consumer. In addition, operating experience and some other applications of the remote control system may be of interest.

## 2. REMOTE CONTROL SYSTEMS IN GENERAL :

Before it was decided to install a remote control installation, investigations established that various methods of load control are in existence to-day, and that certain essential requirements had to be fulfilled before such a system could be justified under present day conditions.

(2.1) *Requirements of a Remote Control System.*

Briefly these requirements are the following:—

1. The system must possess a multiplicity of control channels to allow the control of a number of various consuming devices and other equipment.
2. The system must have sufficient range to extend to the geographical limits of the distribution network.
3. The system must be insensitive to extraneous interference and network disturbances.
4. The system should not interfere with other services such as telephone, radio and television, nor impose any limitations on the manipulation of the power system.
5. The system should be flexible; in other words, should not be tied down to a fixed programme.
6. And, finally, the most important aspect of all, the total annual cost of the remote control installation must be small in relation to the monetary value of the peak loads and capital investments saved thereby.

It was therefore, important to compare these basic requirements with the various control systems which are in use at present in order to establish which system would prove to be the best for the duty required in Sasolburg.

(2.2) *Various Methods of Load Control.*

There are a number of system which have been, or are in use to reduce peak loads and these include the following:—

1. Multiple tariff metering.
2. Time switch control.
3. D.C. Signal tranmission through the low voltage network.
4. Audio-frequency signal transmission through the distribution mains.

Although multiple tariff metering is not in general use in South Africa, they have enjoyed great popularity in Europe. As a means of reducing peak loads however, the system suffers from inflexibility and its reliance upon each individual consumer seeking his own economic advantage at all times. On the other hand it does appear that the possibility exists of using multiple tariff metering in conjunction with a remote control system whereby the energy consumed by the domestic storage heater during any peak period can be metered separately. Whether this would have the same effect as would be the case with direct control seems unlikely as the extra cost of a double tariff meter has to be taken into account. By this means, however, flexibility of the switching programme could be achieved in a multiple tariff metering system. It would have been of interest to investigate this possibility further but unfortunately this means of controlling the load has not yet been tried out in practice.

Time switches have given very long and valued service in the task of reducing peak loads but time switches without clockwork mechanism are vulnerable to all breakdowns in power supply, whereas time switches with clockwork mechanism, though reliable, are expensive. In addition they can only operate to a fixed programme and through one channel so that maintenance and adjustment costs on time switches will tend to be rather high.

A pilot wire network for the control of peak loads can hardly be given thought to-day as the cost of installing and maintaining such a system must be geographically just as extensive as the distribution network and would impose an insuperable obstacle for most Electricity Supply Authorities.

The transmission of D.C. signals through the neutral of the low voltage network which has been used extensively has the serious disadvantages of being limited to one signal channel and that a great number of injection points must be provided. Unless an additional superimposed control network is provided this system can also only work to a fixed programme.

Turning finally to the principle of audio-frequency injection it was observed that it can meet all the requirements mentioned above. With proper design the provision of a multiplicity of control channels is easy, the audio-frequency impulses can be transmitted to all points in the network to be controlled, the energy of the control signal can be kept well below the level liable to cause interference to telephone, radio and television equipment. The system can further be rendered practically immune to external sources of interference whereas the flexibility of the system is undisputed.

(2.3) *Audio-Frequency Remote Control.*

Briefly the principle of operation of audio-frequency injection is as follows.

The centralised remote control installation comprises injection equipment located at some central point, the function of which is to inject audio-frequency impulses through a coupling circuit into the distribution network. These signals are then transmitted through the power distribution network to the audio-frequency sensitive relays, one of which is connected between the 220 volt phase and neutral of each circuit to be controlled on the consumers' premises. As an examination of the different systems of audio-frequency remote control will indicate, many different principles exist, the earliest of which was the multiple frequency system in which every different command whether ON or OFF, was allocated to a different frequency and detected by a series of frequency sensitive elements in the receiving relays. As the number of separate channels available was limited by the few frequencies which could be transmitted without mutual interference, this method of injection eventually fell out of favour.

Another system consists of a single audio-frequency carrier, modulated with a number of various low frequencies. After the detector stage these act upon a number of frequency sensitive elements in each relay but for mechanical reasons, the number of different channels which could be controlled in this way is very limited.

A radical departure from the foregoing principles, however, was the adoption of the selector principle, the most significant of which is the "impulse interval" system in which a start impulse causes the mechanical selector in the relay to start rotating. To switch on the loads in the various channels further impulses are transmitted at *definite* intervals after the start impulse, the *length* of the interval determining which channel is to be switched ON in each case, which meant that a multiplicity of control channels could be allowed for.

It was therefore decided to install "audio-frequency" remote control equipment in which the "Selector principle" was adopted, as it proved to be the best for the duty required in Sasolburg and the least likely to cause inconvenience to the consumers.

(2.4) *Basic Features of "Audio-Frequency" Remote Control Design.*

It was interesting to note that considerable differences exists among manufacturers of remote control systems, regarding the preferred frequencies of signal injection. Whereas in certain continental and U.K. systems the trend was towards the lower frequencies, general opinion seemed to favour the following:—

1. High injection frequencies preferably between 750 and 1600 c.p.s.
2. Parallel injection at the main busbars.
3. Injection at the intermediate voltage level.
4. Decentralisation of transmitters when necessary.
5. The view that remote control installations, being a subsidiary installation, must be designed to operate satisfactorily irrespective of any switching or inter-connecting operations that might take place in the network.

The choice of frequency may vary between very wide limits as the transmission characteristics of a network can vary and experience has shown that an optimum frequency usually exists for any given network. Cables and power factor correction condensors represent shunt connected capacitive impedances at audio-frequency so that if their capacity is large enough these shunt connected components can drain away a large proportion of the audio-frequency energy and thereby seriously reduce the signal voltage. On the other hand again the impedance of overhead lines and transformers rises in proportion to the control frequency which means that signal attenuation over long lines and through transformers would be greater at the higher frequencies than at the lower ones.

The fact that the propagation characteristics of a network are better at the lower frequencies than at the higher ones, is however alone not sufficient to justify the choice of a lower frequency because the problem of power factor correction condensors which will drain off an excessive amount of energy at *any* frequency, can be overcome by the use of series connected audio-frequency chokes, the size and cost of which is very much lower at the higher frequencies. Therefore, only after a thorough survey of the network characteristics has been made can a sound decision be taken regarding the frequency to be adopted for the remote control installation. However, the most important consideration in determining the injection frequency level is the interference problem which will be discussed in detail later.

The location of transmitters will depend upon whether the signals are injected in the low voltage (380 volt), the intermediate voltage, (6.6 or 11 K.V.) or even the extra high voltage level. The injection at the low voltage level will only be an economic proposition in small towns whereas injection into the 11 K.V. network at each stepdown transformer sub-station is the preferred solution, and is the method which has been adopted in the Sasolburg installation. Although injection at the extra high voltage level may at first seem attractive because of economy on transmitting stations, the serious disadvantage is that signal attenuation will be greater because two stepdown transformations, i.e. from the EHT to HT and from the HT to LT level are encountered and may lead to insufficient voltage at the receiver, unless a high signal voltage at low frequency is chosen. This again will mean loss in energy towards the extra high voltage level as there is usually only one transformation from the EHT to the HT level and the transformer impedance is lower at the lower frequencies. This all means then that a larger and more powerful and expensive transmitter has to be installed.

The degree of centralisation will depend upon the natural growth of the network and whereas the provision of additional high voltage stepdown transformer stations is easily predictable, the extra high voltage substation is usually only increased in size, which makes the problem of extra high voltage injection more complicated and expensive on account of the possible losses in signal strength. Therefore, if 6.6 or 11 K.V. injection is adopted additional transmitting plant can easily be installed in each stepdown transformer station thus safeguarding against loss in signal voltage and possible interferences at the remote ends in the network, with the added advantage that the capital outlay is kept within sensible proportions to the expansion of the network.

## 3. THE SASOLBURG REMOTE CONTROL INSTALLATION.

The following is a short description of the Sasolburg remote control installation.

### (3.1) *Injection Equipment*:

The method of injection normally adopted is either series injection or parallel injection. In the case of the Sasolburg remote control installation parallel injection was adopted. In the case of parallel injection the coupling circuit is connected on a 3-phase basis between the main 11 K.V. busbars and neutral as shown on the principle line diagram Fig. 1.

The main components of the parallel injection equipment are the insulating transformer T, the condensors C, and the tuning coils L, and all are mounted together in a coupling cell or cubicle in the manner shown in Fig. 2.

Fig. 1.
PRINCIPLE LINE DIAGRAM.

Fig. 2.
COUPLING CELL FOR PARALLEL INJECTION, SHOWING INSULATING TRANSFORMER (front), COUPLING CONDENSORS (rear) and TUNING COILS (centre).

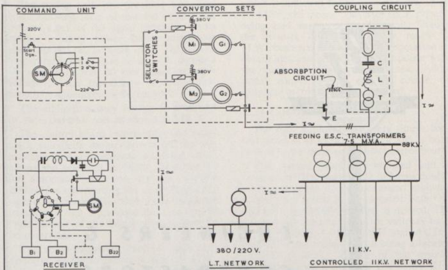
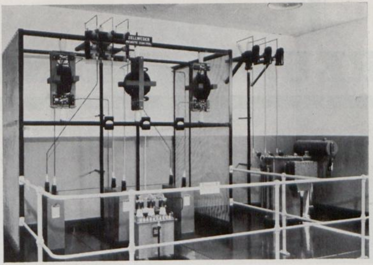



FIG. 1. PRINCIPLE LINE DIAGRAM.



The tuning coils are provided with tappings allowing their adjustment so that the induced e.m.f. of the signal generator works against a unity power factor impedance under normal full network load. The insulating transformer is also fitted with tappings allowing variation of the signal strength voltage to suit the degree of attenuation actually encountered in the network.

The audio-frequency energy is produced by two convertor sets as shown in Fig. 3.

The control board incorporates two automatic star/delta motor starters for the two convertor sets, a compensation cabinet which allows the selection of either convertor set for automatic operation and an impulse cabinet for transmitting the audio-frequency signals to the secondary side of the insulating transformer for super-imposition on the 50 cycle voltage of the distributing network to be controlled.

The audio-frequency power of each convertor set on the Sasolburg system is 5 K.W., which is sufficient for a network full load of 7.5 M.W., the second convertor set at present being used only as a standby unit. Should the network full load however, reach 15 M.W., both sets can be put into operation to obtain increased audio-frequency power with the increased network impedances. Additional convertor sets can of course be installed in future when required.

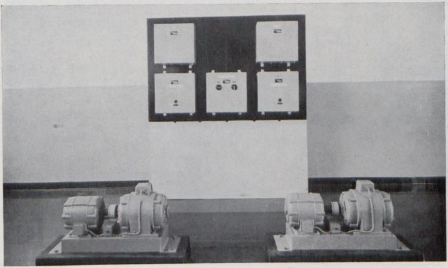
(3.2) *Control Equipment*:

The fully automatic but very simple control panel is as shown in Fig. 4 and is built in next to the main-substation control board.

The control panel or command unit is designed for transmitting 22 different double commands, each double command allowing a consumer group to be switched both ON and OFF repeatedly, as often as desired. The 22 manually operated control switches have three positions — ON, OFF and AUTOMATIC—one control switch being allocated to each channel. If one of the manual switches is turned from the ON to the OFF for example, the convertor sets are started and impulses injected in accordance with the setting of ALL control switches. Thus, every time the transmitting plant goes into

Fig. 3.

TWO CONVERTOR SETS OF 5 K.W. AUDIO-FREQUENCY POWER EACH AND CONTROL BOARD.



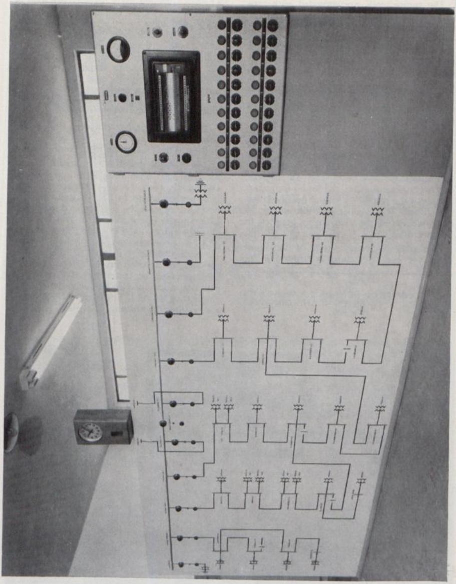


Fig. 4. THE CONTROL PANEL.

operation not only is the required command changed but also the commands already given in all other channels during previous transsmissions are confirmed. This is particularly valuable during breakdowns in power supply in sections of the network in case the injected pulses were not received by receivers in the affected section.

The time required for transmitting all or any combination of the 22 double commands amounts to three minutes. Whenever the control switches are set to AUTOMATIC a built-in programme clock will take over the functions of the manually operated control switches. The drum has 23 parallel grooves in which pins corresponding to the ON and OFF signals can be set which then automatically actuate micro switches in parallel with the manual switches, whereas receivers in the control panel supervise the correct transmission of the commands over the entire network.

(3.3) *The Receiving Relay*:

The electrical diagram of the Receiving Relay, which can be considered as one of the most important components in a remote control installation, is as shown in Fig. 5.

Fig. 5 shows the electrical diagram for the romote control relay. $L_1$ $C_1$ $L_2$ and $C_2$

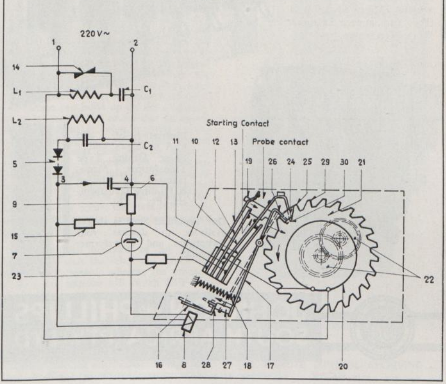
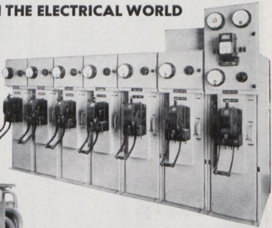
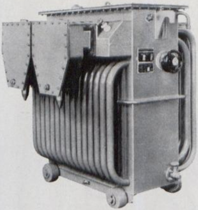



Fig. 5. Electrical Diagram of Receiving Relay.







represent the components of a double stage band filter with inductive coupling between the two filter sections. During an audio-frequency impulse, the output of the second stage is rectified and charges the condenser (6), the voltage of which rises exponentially with time. Once the ignition voltage of the glow tube (7) has been reached, the condenser (6) discharges through the auxiliary relay (8). When the relay armature (28) is attracted the support for the plate (17) is removed, and under the tension of the spring (18) the starting contracts close, thus connecting the 220 volt a.c. supply to the small synchronous motor (20). In this manner the selector mechanism starts to rotate, the motor remaining under voltage until a complete revolution has been performed, at which point the starting contacts open again automatically. At the instant at which the starting contacts close and the motor (20) starts, the probe contacts also close. Every time the follower (24) passes a tooth of the cam (25) the probe contacts again open for a short period. Normally these shunt the glow tube (7) and resistor (9), thus short-circuiting the condenser (6) through the auxiliary relay (8). Every time the probe contacts open however, this shunt is removed and voltage can build up on the condenser (6) again, provided of course that an audio-frequency signal is being received at the terminals during that period. As soon as the probe contacts close and the shunt is reapplied, the condenser (6) discharges violently through the relay (8) attracting it once again and causing the plate (17) to be rotated by the tension of the spring (18). Every time this occurs the plate (17) closes mechanically any relay switch connected to the relevant channel.

Therefore the presence of an active impulse will start the relay and switch on the relevant channels whereas the absence of an active impulse will switch OFF the required channels.

Fig. 7 represents a typical signal transmission series in the impulse interval system. Each pulse represents the superimposition of an audio-frequency voltage of constant frequency onto the intermediate voltage network. In Fig. 7 the control impulses would switch ON the loads allotted to channels 2, 8, 9, 12, 16, 17 and 22, whereas channel 0 represents the start impulse for ALL receiving relays. The very important innovation which has been made on this system is that it is not necessary to have a separate

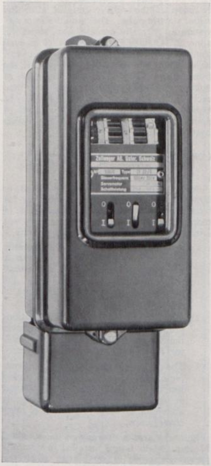


Fig. 6.
THE REMOTE CONTROL RECEIVING RELAY.

channel for the ON and the OFF signals, for any given load group. If any desired load is to be switched ON or to be left switched ON an audio-frequency impulse is injected into the network at the *correct interval* after the start impulse. If, on the other hand, it is desired to switch a load OFF or to leave it switched OFF a pause is made at the *correct interval* after the initial start impulse. The "impulse interval" system as normally executed can, therefore, allow 22 DOUBLE COMMANDS in each transmission, i.e. 22 different load groups can be switched ON or OFF as desired. If the transmission of a very large number of double commands should be required, then each transmitting unit can be extended to be capable of transmitting up to hundreds of double commands by simply fitting further control panels.

### (3.4) *Installation of Receiving Relays on Consumers Premises*:

As it had already been considered to introduce load shedding equipment as far back as 1952, the actual installation of receiving relays on consumers premises was fairly simple due to the following reasons.

1. As practically 99% of all the domestic consumers in Sasolburg have domestic water heaters installed all consumers' main boards are wired with the necessary loops for the installation of receiving relays.
2. The Electricity Supply Regulations promulgated in 1959 gives the right to the Supply Authority to install receiving relays on all water heater circuits.
3. The receiving relay is supplied complete with a very simple mounting bracket which allows the installation or removal of a receiver by simply attaching or removing the top relay cover screw.

Figure 8 shows a drawing of the standard 50 amp. Main Board installed in domestic premises capable of serving an all-electric home, and the position of the receiving relay. As a total of 1523 receiving relays had to be installed on all existing domestic water heater circuits, the actual time necessary to carry out the work was approximately 10—15 minutes per receiving relay, which meant that the installation of relays was done very expediently.

As the L.T. distribution system has ordinary 3 phase 4-wire underground mains and single phase service connections have been arranged to all residences with the same number of houses on each phase, a good overall balance on the distribution system is obtained. The receiving relays have now been divided into eight channels and it is therefore possible to shed the water heater load at one-eighth of the total connected load on the operation of each individual channel with equal affect on each phase of the distribution system.

### (3.5) *Testing of Receiving Relays*:

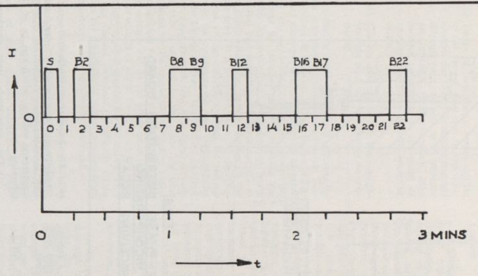
A very simple but effective portable relay testing unit has been supplied together with the equipment which makes the testing of receiving relays before being installed or during service a very simple matter.

This testing unit consists of a valve-generator which is capable of producing the required injection frequency current together with a control unit which can simulate any operating sequence normally executed by the master control board. Receiving relays are therefore tested and set to the required channel before being put into service which eliminates the possibility of a faulty receiving relay being installed. Furthermore, should a receiving relay fail in service it is a very simple matter to test the relay on site without the necessity of having to remove the relay.

These are important features of an audio-frequency remote control installation as the testing and maintenance of receiving relays should be straight-forward, and experience has shown that existing staff employed in a standard testroom can very easily cope with this kind of work. I therefore feel that the argument raised in the past that special trained staff and equipment is necessary to

Fig. 7

GRAPHICAL REPRESENTATION OF A SIGNAL TRANSMISSION. ORDINATE : INJECTED AUDIO-FREQUENCY CURRENT : ABCISSA : TIME.




ORDINATE: INJECTED AUDIO FREQUENCY CURRENT
ABCISSA: TIME

FIG 7

GRAPHICAL REPRESENTATION OF SIGNAL TRANSMISSION

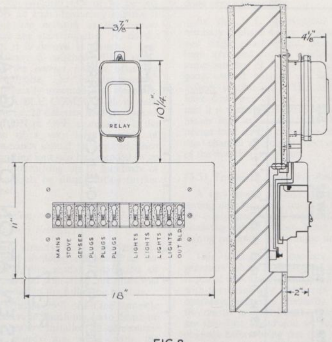



FIG.8.
50 AMP SINGLE-PHASE DISTRIBUTION BOARD INCORPORATING RECEIVING RELAY

successfully operate and maintain a remote control installation can be discarded with present day remote control equipment.

## 4. OPERATIONAL FEATURES AND EFFECT:—

The most important aspect of remote control operation is undoubtedly the interference problem and its effect upon the injection frequency of a remote control installation.

(4.1) *The Interference Problem*:

Interferences that may be encountered with audio-frequency control are basically interference voltages which can be of the following types.

(i) The semi-steady state interference voltage in the low tension network which rarely exceeds the level of 0.4. volts.

(ii) Surge-like interference voltages of many volts amplitude with exponentially decaying audio-frequency components. These are mainly due to the connection and disconnection of load and transformers, or to paralleling operations and lightning surges.

(iii) Trains of interference surges similar to the second class due to repetitive sources ond other devices connected through poor contacts or to mercury arc traction rectifiers which may become cumulative to the point of causing operation of the receiving relays.

(iv) Possible spill-over signals from neighbouring networks which may be controlled.

To eliminate the influence of semi-steady-state interference voltages the receiver acts as follows. It has already been shown in Fig. 5 and description of the electrical diagram how an audio-frequency signal starts the receiver by inducing resonance within the double frequency band filter then by being rectified and charging the condenser (6) to the point where the ignition voltage of the glow tube (7) is exceeded. Now, if the filter output voltage remains constant the voltage across the condenser (6) rises exponentially to the changing time. The receiver has now been designed such that if a signal of only 1.0 volt is applied to the input the time required for the condenser voltage to attain the ignition voltage of the glow tube is only five seconds but on the other hand, with an input voltage of below 1 volt of say 0.9 volts, the ignition time approaches 60 seconds. This design feature therefore, completely eliminates the possibility of relay operation from semi-steady-state interference voltages.

Surge-like interference voltages on the other hand, may reach 100 volts in amplitude but these are usually only of about 10 milliseconds duration. Even if the energy level of these signals exceeds 100 mWs (which is the energy necessary for an authentic audio-frequency signal to cause operation of the relay) the non-linear resistor (9) with its sharp cut-off at 4 or 5 volts severely limits the voltage finally appearing across the secondary terminals of the filter circuit and therefore offers full protection. This voltage usually occurring as it does for only 10 milliseconds or so is insufficient to charge the condenser sufficiently to start the receiver.

In the case of repetitive surges the non-linear resistor also greatly reduces the amplitudes of the initial peaks of each surge having the effect of draining off the condensor charge during the intervals between the individual surges in the train which normally are of only a few milliseconds duration. This then prevents the trains from becoming cumulative to the point of causing relay operation. In addition every transmitting plant is provided with standard protection against interference voltages and possible spill-over signals from neighbouring networks, consisting of a two-way contractor for control purposes incorporating an absorption circuit. In its rest position this contactor connects the 11 K.V. sub-station busbars to earth through the coupling circuit and an additional tuned coil which are all tuned to resonate at the required audio-frequency injection frequency level. This means that any interference voltages or spill-over signals appearing close to the injection frequency level are effectively short-circuited whenever on active audio-frequency signals are being injected or during pauses between actual impulses. And finally as will be seen from the graphical repersentation of a typical signal transmission, the long impulse duration of 7.5 seconds leads to the receivers a control energy which lies far above normal interference levels.

In the case of the Sasolburg installation a thorough initial survey was made to determine the correct frequency for injection which showed the optimum frequency to be in the region of 1050 c.p.s. No interference voltages of any magnitude were detected when the initial survey was made but it is of interest to note that subsequently a significant interference voltage at 1150 c.p.s. was detected to the point of becoming cumulative and causing relay operation. A subsequent survey brought to light that this steady interference voltage originated from mercury-arc-traction rectifiers installed on the S.A.R.

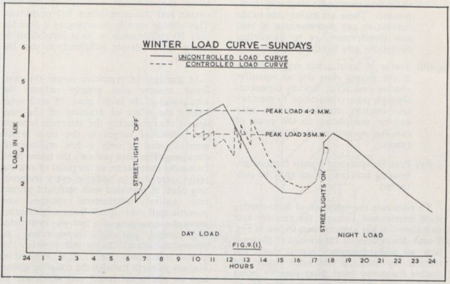
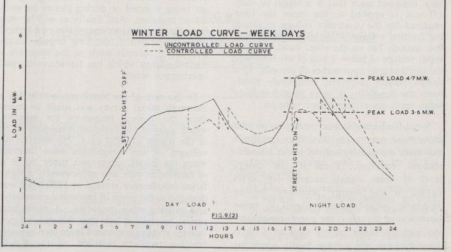



Fig. 9 (1) to 9 (4).

DAILY LOAD CURVES ON THE SASOLBURG DISTRIBUTION NETWORK.



Electrification system when these were commissioned some months later. These mercury-arc-traction rectifiers are being fed from the same 88 K.V. circuit feeding the Sasolburg network and are situated only some 4 to 5 miles from the Sasolburg Main Stepdown Transformer Station. As a single frequency absorption circuit had been supplied which was mostly effective in absorbing interference voltages at 1050 c.p.s. interferences from the 1150 c.p.s. frequency level was appearing close to 1050 c.p.s. to the point of causing relay operation. A slight modification to the absorption circuit had therefore to be made and by fitting additional small condensers into the tuned circuit double frequency absorbtion was achieved so that any interference voltages within these limits could be absorbed as well.

No further trouble from interferences has since been experienced in the network but from the foregoing it will be realised that possible interferences that may be encountered in a distribution network are the most important factors when determining the injection-frequency of a remote control installation. Furthermore a flexible absorption circuit that can be adjusted at no large expense is essential for an audio-frequency remote control installation so that any possible future interference voltages can be rendered harmless and trouble free operation can be achieved.

(4.2) *Effect on the System Load*:

It is of interest to detail some of the aspects of the automatic control carried out on domestic water heaters and street lighting in the Sasolburg network with special reference to the actual times these heaters are being controlled and the effect this has had upon the system load factor.

Fig. 9 (1) to 9 (4) represent typical daily load curves for winter and summer months on the Sasolburg system with and without load shedding.

These load curves are compiled from past winter and sumer loads actually recorded so that the reduction in peak loads can be regarded as fairly accurate. The following main data characterised the network under control.

(i) Installed transformer capacity at the main stepdown transformer station ...... 7500 K.V.A.

(ii) Rated load of domestic water heaters being controlled ...... 3650 K.W.

(iii) Number of receiving relays installed on domestic water heater circuits 1523

(iv) Rated load of domestic water heaters per receiver installed ...... 2.4 K.W.

(v) Rated load of street lighting system 300 K.W.

From the daily load curves one can clearly observe the effect of the switching "ON" and "OFF" of the domestic water heaters and street lighting with the aid of remote control equipment, during certain times of the day. The water heaters are switched off during the morning and evening peaks as and when required. Of the 22 double commands that can be performed with the remote control installation the allocation of channels is as follows: —

10 channels for domestic water heater control;

2 channels for street lighting control;

3 channels for Bantu Township Supply control;

7 channels are available for other applications.

The domestic water heaters are at present being controlled by eight channels which can be switched on or off in any desired group for load shedding purposes, depending upon the number of kilowatts that must be reduced from the peak. During the morning peaks the water heaters are only switched OFF when necessary and in this respect it is of interest to note that the Sunday morning peak is higher than for any other normal weekday. As the load on the Sasolburg system is purely domestic, this can be accounnted for by the fact that most consumers have their stoves in use on a Sunday morning preparing their Sunday dinners.

The maximum hourly demands recorded during these Sunday morning peaks was as

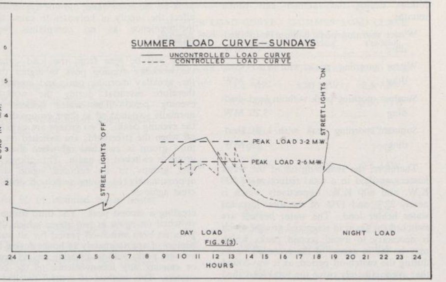

SUMMER LOAD CURVE—SUNDAYS
UNCONTROLLED LOAD CURVE
CONTROLLED LOAD CURVE
LOAD IN M.W.
STREETLIGHTS 'OFF'
STREETLIGHTS 'ON'
PEAK LOAD 3·2 M.W.
PEAK LOAD 2·6 M.W.
DAY LOAD
NIGHT LOAD
HOURS

FIG. 9(3).

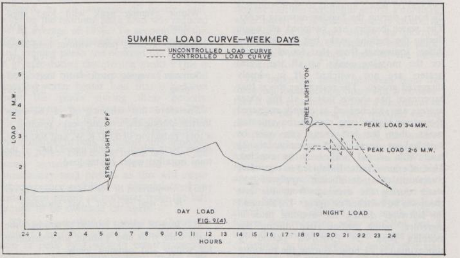

SUMMER LOAD CURVE—WEEK DAYS
UNCONTROLLED LOAD CURVE
CONTROLLED LOAD CURVE
LOAD IN M.W.
STREETLIGHTS 'OFF'
STREETLIGHTS 'ON'
PEAK LOAD 3·4 M.W.
PEAK LOAD 2·6 M.W.
DAY LOAD
NIGHT LOAD
HOURS

FIG. 9(4).

follows during the summer and winter months:

Winter morning peak without load shedding ........ 4.3 MW.

Winter morning peak with load shedding ........ 3.5 MW.

Summer morning peak without load shedding ........ 3.20 MW.

Summer morning peak with load shedding ........ 2.6 MW.

Therefore, the switching off of the water heaters resulted in a total reduction of 800 K.W. and 600 K.W. respectively which is nearly 22% and 17% of the total installed water heater load. The water heaters are switched on again in staggered groups which is necessary to avoid second peaks which may be far in excess of the recorded peaks during the switch-off period, as it was found that approximately twice the total load shed is restored when the water heaters are

The staggering of the switching ON and OFF of the water heaters further results in an even period all water heaters are kept swiched off which amounts to approximately 2½ hours during the Sunday morning peaks. The water heaters are switched off again during the evening peaks but the operation differs somewhat from that found suitable for the morning peaks as all the water heaters are not switched off in closely staggered groups. The reason for this is that experience has shown that if all the water heaters are switched off in closely staggered groups as is the case during the morning peaks, then the last group can only be switched on again after approximately 2½ hours if a second peak is to be avoided. This, of course, immediately led to consumer complaints of an insufficient supply of hotwater during the evenings from the last groups to be switched on again. The demand for hotwater during the evening peak is therefore, much higher than during the morning peak. A switch-off period of approximately 2½ hours during the morning peak on the other hand, did not appreciably affect the supply of hotwater to cause any inconvenience as no complaints were received.

As will be seen from the load curves, the weekday evening peak is higher than the weekday morning peak and control is therefore essential during the weekday evening peak. The water heaters are normally switched off in three groups during the evening peaks. Two groups are switched off when the streetlights are switched on. A third group is switched off when the first group is switched on again. This allows the first groups to be restored again after approximately 1½ hours switch-off without creat agniosec

creating a second peak. The third group is switched on again in two stages which then gives an even switch-off period for all water heaters of approximately 1½ hours during the evening peaks without creating second peaks or causing any inconvenience to the consumers. This method of control resulted in the following maximum hourly demands being recorded during the evening peaks.

Winter evening peak without load shedding ........ 4.7 MW.

Winter evening peak with load shedding ........ 3.6 MW.

Summer evening peak without load shedding ........ 3.4 MW.

Summer evening peak with load shedding ........ 2.6 MW.

Therefore, the switching off of the water heaters during the evening peaks resulted in a total reduction of 1100 K.W. and 800 K.W. respectively which is 30% and 22.0% of the total installed water heater load.

(4.3) *Comparison of the Daily Load Curves With and Without Load Shedding*:

It is now of special interest to compare the main data with and without load shedding for winter and summer loads.

| | WINTER LOAD CURVE | | SUMMER LOAD CURVE | |
|---|---|---|---|---|
| | Without load shedding | With load shedding | Without load shedding | With load shedding |
| Total energy sold over 24 hours | 58,000 Kwh | 58,700 Kwh | 43,480 Kwh | 43,720 Kwh |
| Morning peak loads | 4.3 MW | 3.5 MW | 3.20 MW | 2.6 MW |
| Reduction in morning peaks | | 0.80 MW | | 0.60 MW |
| As % of installed water heater load | | 22% | | 17% |
| As % morning peak | | 19% | | 19% |
| Evening peak loads | 4.7 MW | 3.6 MW | 3.4 MW | 2.6 MW |
| Reduction in evening peaks | | 1.1 MW | | 0.8 MW |
| As % of installed water heater load | | 30% | | 22% |
| As % of evening peak | | 23.5% | | 23.5% |
| Daily load factor | 51.5% | 68% | 53.5% | 70% |
| Morning load shed per receiver installed | | .525 KW | | .400 KW |
| Evening load shed per receiver installed | | .720 KW | | .525 KW |

The evening peak load was therefore reduced by an average of nearly 24% whereas the morning peak load was reduced by an average of 19%. To account for this difference in load shed during the morning and evening peaks the demand for hotwater is greater during the evening peaks. This is also shown by the percentage of the total installed water heater load that is reduced from the peaks during these periods. Although tests have shown that at least 33% of the total load taken during peak periods is accounted for by domestic water heaters, the reduction in peak load was only approximately 24%. This is due to the fact that the water heaters are not swiched off for unnecessary long periods as this will cause inconvenience and lead to complaints of an insufficient supply of hotwater from the last groups to be switched on again.

The above method of control was however found to give the maximum possible reduction in peak load without creating second peaks or causing inconvenience to the consumers. In this respect I would therefore suggest that the maximum period a domestic water heater of 30-gallon capacity should be controlled in 2½ hours during the morning peaks and 1½ hours during the evening peaks which will allow ample time for the water to reheat for later requirements.

The important results achieved from the foregoing loadshedding operation is however that it was possible to reduce a maximum of 0.72 KW per receiving relay installed during the winter months and 0.525 KW per receiving relay installed during the summer months. As an average over one year, therefore, a total reduction of 0.6 KW per receiving relay installed is achieved which is approximately 25% of the total installed water heater load. It is also known that some Supply Authorities who operate load shedding have claimed very much higher figures per receiving relay installed but I think this may be due to either longer periods of control or to diversity of habits as it was found that the higher the social standard of living the higher the consumer's reduction in load would be. The above figure of 0.6 KW reduction in peak load per receiving relay installed is therefore regarded as a fairly accurate average figure for the class of consumer in Sasolburg. The average monthly load factor was about 50% before load shedding was applied whereas the the effectseffect of load shedding was an improvement in the load factor to an average of about 63%.

(4.4) *Effect Upon the Consumer*:

As could be expected with any form of control over a consumer's free use of an electrical appliance, it was with some suspicion that consumers at first accepted the installation of receiving relays upon the premises.

The first complaint came from a group of consumers who had receiving relays installed during April and May 1959. The general complaint was that an immediate increase in their electricity consumption took place since the relay had been installed. Needless to say, that as control was only commenced towards the end of June, 1959, this complaint soon disappeared, as it was purely incidental that the installation of receiving relays happened to coincide with the seasonal increase in electricity consumption. Generally speaking however, the incidence of consum er complaints has been negligible. In this respect it was interesting to note that in the few odd cases where a complaint of an insufficient supply of hot water was received and it was found that the receiver had not functioned correctly, the consumer had as a matter of habit switched off the supply to the water heater circuit during the switch off period and had left it off until the following morning. This then naturally meant that the injected signals could not be received by the relay until late the following morning or evening when the next series of impulses was being transmitted, and the supply to the water heater circuit had been restored. This could of course have been avoided by connecting the receiver before the protective circuit breaker or fuse direct on to the busbar but this would have been contrary to the requirements of the Standard Wiring Regulations and protection for the receiver is desirable. However, as soon as the consumer realised that this was not leading to any savings on his monthly power bill, this practice seems to have ceased, as no further complaints of this nature were received. Only in cases where the consumer happens to drain the water heater completely just before being controlled would the interruption of the supply to the storage heater circuit cause any real inconvenience, as this means that the consumer has to wait 1½ hours longer for his water to heat up again as would have been the case without control, but I am of the opinion that it is mainly due to the following reasons that no inconvenience or change has been noticed by consumers.

1. There is ample hot water in the water heater for the early evening and morning requirements of most householders.
2. Control over morning hot water is restricted to Sundays and on certain week-days only.
3. As the switch-off period is restricted to 1½ hours during the evening peaks there is ample time for the water to heat up again for later requirements.
4. A switch-off period of 2½ hours during the morning peaks does not appreciably effect the supply of hot water as no complaints were received in this respect.

## 5. THE ECONOMIC ASPECT OF A REMOTE CONTROL SYSTEM.

The economics of a remote control system which is the most important aspect, depends mainly upon the following two points.

1. The fact that the capital outlay and running costs in providing a supply of electricity can be reduced mainly because the load factor of an electricity supply system can be improved if sufficient electrical apparatus exists that can be switched off during the peak periods.
2. The fact that with the aid of a remote control system new street lighting installations can be made much cheaper as compared with a separate pilot wire or cable network.

In most cases it will be found sufficient to have only one of these two main points to justify the capital outlay for the purchase of a remote control system, but can obviously be improved when it can be applied for both points together.

In order to calculate the economic advantages when used for the improvement of the load curves the following information must be available.

1. How many Kilowatts can be cut-off from the peak with the aid of the remote control installation?
2. What is the monetary value of the kilowatts that have reduced from the peaks?
3. What is the average cost of installing one receiving relay including part costs of the transmitting plant as well as service costs and extras?

The answer to question 1 will be found in actual operating results obtained with the Sasolburg remote control installation. As was shown earlier on in this paper it was possible to reduce an average of 0.6 Kilowatts per receiving relay installed from the peaks on the Sasolburg network. Although some Electricity Supply Undertakings may have achieved a reduction of more than 1 kilowatt per receiving relay installed, which is most probably due to diversity of habits of the various consumer groups and longer control periods, the following economic calculation will be based on 0.6 Kilowatts which is an actual obtained average figure.

The answer to question 2 is best illlustrated by giving the actual effect on —

1. Capital Investment, and
2. Running costs of the Sasolburg Electricity Supply Undertakings distribution system.

(5.1) *Effect on Capital Investment*:

As mentioned previously a substantial increase in the cost of distribution equipment has taken place since Sasolburg was developed in 1952, and an analysis of the investment per kilowatt on the Sasolburg network resulted in the following average figures:

| | | | |
|---|---|---|---|
| (1) Transformation from the E.H.T. level to the H.T. level and underground H.T. distribution | £15 | 0 | 0 |
| (2) Transformation from the H.T. level to the L.T. level and underground L.T. distribution | £35 | 0 | 0 |
| TOTAL CAPITAL INVESTMENT PER K.W. | £50 | 0 | 0 |

From internationally approved figures which exist concerning the capital investment per kilowatt, the accepted average figure for distribution costs at present appears to be about £85 per K.W. The above figure of £50 per K.W. can therefore be regarded as not too high under present day conditions and for the purpose of the following calculation, comparison will be made to this figure.

The cost of the Sasolburg remote control installation consisting of transmitting plant and 1700 receiving relays is as follows:

| | | | |
|---|---|---|---|
| (1) Price per receiving relay including installation costs | £9 | 10 | 0 |
| (2) Part cost of the transmitting plant and all equipment relating thereto | £2 | 6 | 0 |
| (3) Contingencies | £0 | 4 | 0 |
| TOTAL PER INSTALLED RECEIVER | £12 | 0 | 0 |

Each proposed new kilowatt installed on the Sasolburg network will therefore cost approximately £50. On the other hand as each receiving relay installed can reduce the peak by approximately .6 K.W., this means that for every 1.7 relays installed the peak can be reduced by 1 K.W. As the cost of 1.7 relays is approximately £20.0.0. the saving on capital investment with remote control equipment on each kilowatt of reduced peak load is:

£50 — £20 = £30. 0. 0.

In other words, on any proposed new extension of the distribution system about £18 less per installed receiver will be spent. As the above calculation is based on new raised capital for investment, the actual calculation, when based on annual capital costs, will be as follows:

| | per annum |
|---|---|
| Interest and redemption per annum on £50 per K.W. of new investment capital | £3 17 9 |
| As one relay can reduce 0.6 K.W. from the peak the saving per annum per receiver installed would be 0.6 x £3.17.9. which is | £2 6 8 |

As the cost of the receiving relay including its part cost of the transmitter and all extras is £12.0.0., it can therefore be amortised in approximately 5 years.

(5.2) *Effect on Running Costs*:

The effect on running costs of the Sasolburg Electricity Supply Undertaking distribution system is best illustrated by the graphic reproduction of the unit costs and load factor for the past four years shown in Fig. 10 together with the yearly load curves as illustrated in Fig. 11.

It must be observed that the steady rise in total unit costs over the past four years is due to tariff increases at the beginning of 1957, 1958 and 1959, imposed by the Electricity Supply Commission with the result that the cost of Electricity reached a maximum in the Sasolburg area at the beginning of 1959. A further increase in the unit costs was imposed by Escom. during April 1960 and during June 1960 a result of increased coal costs at the Commission's Generating stations. In the following calculation of the percentage saving attained in total unit costs, these facts will therefore have to be taken into account if a true comparison is to be made.

As will be seen from the load curves, load shedding was commenced during June 1959 when approximately 400 relays had been installed. As the installation of all 1523 receiving relays on water heater circuits was only completed by the end of November 1959, the calculations will be based on the total unit costs after all 1523 receiving relays had been installed. The average cost per unit bought for the five-month period from January 1959 to May 1959 immediately prior to load shedding was as follows:

| | |
|---|---|
| Kilowatt cost per unit bought | 0.4350d. |
| Unit cost per unit bought | 0.2180d. |
| Total cost per unit bought | 0.6530d. |

The subsequent reduction in total unit costs as a result of the savings in Kilowatt demand costs can be clearly seen from the curves in Fig. 10. By the time the installation of all relays was completed the average cost per unit bought with load shedding up to the end of September 1960 was as follows:

| | |
|---|---|
| Kilowatt cost per unit bought | .3384d. |
| Unit Cost per unit bought | .2413d. |
| Total cost per unit bought | .5797d. |

Therefore, the actual saving on Kilowatt demand charges per unit bought was as follows:

| | |
|---|---|
| Kilowatt cost per unit bought without load shedding | .4350d. |
| Kilowatt cost per unit bought with load shedding | .3384d. |
| Saving in Kilowatt cost per unit bought | .0966d. |
| % Saving in Kilowatt costs per unit bought | 22% |

For a true reflection of the percentage saving made possible on the total unit costs the recent increases in the unit costs must be taken into account, which will then give a total cost of .6763d. per unit bought without load shedding.

THE TOTAL SAVINGS MADE POSSIBLE per unit bought will then be as follows:

| | |
|---|---|
| Total cost per unit bought without shedding | .6763d. |
| Total cost per unit bought with load shedding | .5797d. |
| Total saving in unit cost | .0966d. |
| % Saving in total unit cost | 14% |

The possible savings on the Sasolburg Electricity Supply Undertaking's electricity account for the year 1960/61 based on an estimated total unit consumption of 16,000,000 units per annum will then be 16,000,000 units x 0.0966d. per unit, which is approximately £6,400. A otal of 1,600 relays will be installed on all water heater circuits before the end of the present financial year so that the annual savings on maximum demand charges per receiver installed will therefore be £4.0.0. The annual maintenance costs of the remote control installation must however be taken into

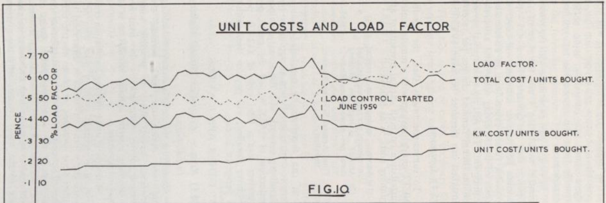

UNIT COSTS AND LOAD FACTOR
PENCE
% LOAD FACTOR
·7 70
·6 60
·5 50
·4 40
·3 30
·2 20
·1 10
LOAD FACTOR.
TOTAL COST / UNITS BOUGHT.
LOAD CONTROL STARTED
JUNE 1959
K.W. COST / UNITS BOUGHT.
UNIT COST / UNITS BOUGHT.

FIG.10

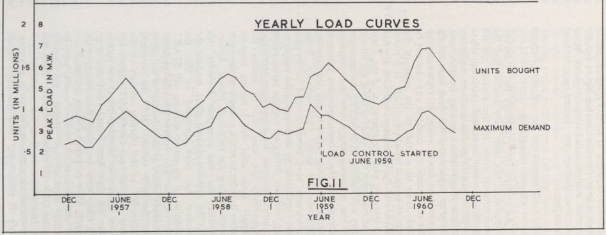

YEARLY LOAD CURVES
UNITS (IN MILLIONS)
PEAK LOAD IN M.W.
2 8
7
1·5 6
5
1 4
3
·5 2
1
UNITS BOUGHT
MAXIMUM DEMAND
LOAD CONTROL STARTED
JUNE 1959.
DEC
JUNE 1957
DEC
JUNE 1958
DEC
JUNE 1959
DEC
JUNE 1960
DEC
YEAR

FIG.11

account to arrive at a NETT figure, and in this respect the maintenance figure for the remote control installation has been based on five shillings per annum per receiver installed.

(5.3) *Maintenance Costs of the Remote Control Installation*:

As pointed out previously the consumer complaints has been very low so that the maintenance costs of the remote control installation and associated receiving relays over the past 18 months has been negligible. A few minor initial teething troubles were however experienced but these were mostly confined to faulty wiring in connecting up the relay itself and could in any case not be tied down to a fault of the relay or the remote control installation itself. It is sometimes said that consumers will soon attempt to interfere with the operation of the relays and that once the switching times are known they will succeed in by-passing the operation of the receiving relays. As the switching sequence of the various consumer groups is constantly being varied to suit the seasonal demands this seems very unlikely. Some consumers have however tried to by-pass relay operation by interrupting the supply to the receivers during an impulse series which naturally stopped the relays from operating. Apparently the idea was to restore the supply again after the 3 minute impulse series in order to retain a supply to the water heater during the switch-off period. Unfortunately for the consumer however this has the opposite desired effect, because the receiver has been designed so that the injection of an active impulse will START the receiver and switch ON the required channels where as the absence of an active impulse will switch OFF the required channels. As the starting contact of the relay is closed once the START impulse has been injected an interruption to the supply does not open these contacts but only stops the relay from operating. Restoration of the supply after an impulse series will therefore set the receiver in motion again, and as active impulses are absent, will merely switch OFF the various channels. What this in fact means is that the consumer will switch off his controlled circuit in any case. Only if the supply is interrupted *before* active impulses are being injected will it be possible to by-pass relay operation but as these times are constantly being varied, trouble from this source has not yet been experienced.

In view of past experience with the remote control installation I am therefore of the opinion that the estimated figure of 5/- per annum per receiver installed will cover all possible future expenditure in maintenance costs of the receiving relays and associated equipment. The nett possible annual savings on maximum demand charges per receiver installed can therefore be taken as £3.15.0.

(5.4) *Summary*:

To summarise briefly then, the possible NETT annual savings with a remote control installation on both capital investment and running costs, is as follows:—

| | | | |
|---|---|---|---|
| (1) Annual savings on capital investment per receiver installed | £2 | 6 | 8 |
| (2) Annual savings on running costs per receiver installed ...... | £3 | 15 | 0 |
| Total Annual Savings/Receiver Installed ...... | £6 | 1 | 8 |

It can therefore be concluded that a remote control installation as applied to the Sasolburg network with the actual obtained reduction of 0.6 K.W. off the peaks per receiver and a total cost of £12.0.0. per receiver installed, will pay for itself within a period of 2 years.

## 6. OTHER APPLICATIONS.

(6.1) *Remote Controlled Street Lighting Installations*:

Apart from its use as a means of shedding the load during the peak periods, the financial savings that are possible when remote control equipment is also used for controlling a street lighting installation is of major importance.

Normally a street lighting installation consists of a separate cable or pilot wire network the control of which is supervised by either time switches, or photo electric cells etc. The cost of such an installation on account of the vast geographical limits of the Electricity Supply Undertakings network, will tend to be rather high and therefore also one of the main reasons why most street lighting installations leave much to be desired for. In the case of a remotely controlled street lighting installation the cable or pilot wire network can be dispensed with in the following manner. The street light is connected through a short length of cable or pilot wire to the nearest existing low-tension main which is feeding either houses or other low-tension consumers. Each street light is then equipped with a protective fuse and remotely controlled receiving relay the function of which will be to automatically switch "ON" and "OFF" the street lights at the required times.

The cross section of cables necessary for a separate street lighting cable network will have to be large enough to maintain sufficient voltage at the end of the lines. On the other hand it was found, that sufficient voltage could be maintained with a smaller cable in the tee-off circuits from existing low tension mains as the street lighting load was small in relation to the system load and could be evenly distributed over the entire lowtension network without affecting the cross section of existing low-tension distributors.

In the case of a recent new Sasolburg extension to the street lighting installation the estimated cost of a remotely controlled system and a conventional cable network system was as follows:—

## COMPARISON OF EXPENDITURE ON A STREET LIGHTING INSTALLATION WITH AND WITHOUT REMOTE CONTROL

*Without Remote Control and With a Separate Cable Network.*

| | |
|---|---|
| Substation Control panel including time switches, control gear and street light feeder | £150 |
| 20,000 ft. of cable @ 2/6 per ft. | £2500 |
| 20,000 ft. of cable laid @ 1/- per ft. | £1000 |
| 125 Lighting standards @ £7.0.0. | £875 |
| 125 Street light lanterns @ £3.0.0. | £375 |
| Pole erection costs | £200 |
| Cable connection costs | £100 |
| | £5200 |
| Plus Contingencies | £520 |
| TOTAL COST | £5720 |
| COST/STREET LIGHT (SAY) | £46 |

*With Remote Control and Without a Separate Cable Network.*

| | |
|---|---|
| 1600 feet of cable @ 1/6 per ft. | £120 |
| 1600 feet of cable laid @ 1/- per ft. | £80 |
| 125 Receiving relays @ £12.0.0. | £1500 |
| 125 Lighting standards @ £7.0.0. | £875 |
| 125 Street light lanterns @ £3.0.0. | £375 |
| Pole erection costs | £200 |
| Cable connection costs | £400 |
| | £3550 |
| Plus contingencies | £350 |
| TOTAL COST | £3900 |
| COST/STREET LIGHT (SAY) | £31 |

The saving per street light erected on an underground remotely controlled street lighting system therefore amounts to ± 33%. The full cost of the receiving relay and part costs of the transmitting plant has also been proportioned to the street lighting installation so that the above comparison can be regarded as fair, when the system is used for *both* load shedding and street lighting control.

However, it is interesting to note that if a remote control system is used solely for controlling a street lighting installation then the full cost of the receiving relays and transmitting plant will have to be borne by the street lighting installation. The transmitting plant alone would cost approximately £4,000 including all erection costs, spares, testing apparatus etc., which means that for a minimum quantity of 275 receiving relays the cost of the transmitting plant alone would amount to approximately £15 per receiving relay installed. Therefore once the street lighting system is large enough and in excess of say, 300 street lights, the provision of a remotely controlled installation already becomes a payable proposition.

As mentioned previously therefore the provision of a remote control system can be fully justified when used either for load shedding or for the control of a street lighting installation, but when used for the control of both however, the justification for the capital outlay involved is immediately improved.

The overall unit consumption of a remotely controlled street lighting installation although not metered separately, can very easily be calculated as the actual burning hours of all lamps are accurately determined by the switching times of the 24 hour programme clock. An argument sometimes raised against a remotely controlled underground street lighting installation is that a multiplicity of tee-off cable connections from existing low tension underground mains will eventually lead to unnecessary interruptions in the power supply to the consumers in the event of trouble in the tee-off circuits. In Sasolburg where normally 6 house service connections are teed-off one single low tension underground distributor cable, experience has shown that during 8 years of service no tee-off cable joint trouble has been experienced apart from the occasional damage to underground cables by other instances when crossing these services.

As a result of improved cable jointing practice and with correct supervision, I think this is a risk worth while taking particularly in view of the large financial savings made possible thereby.

(6.2) *The Application of a Remote Control System in a Bantu Township*:—

Apart from load shedding and for street lighting control further interesting applications of the remote control system were to be found in controlling the supply of electricity in various sections of the Bantu-Township.

In the Sasolburg Bantu-Township provision is made for the housing of

(1) Unmarried Bantu's in Hostels

(2) Factory Employees in Compounds, and

(3) Married Bantu's in married Quarters.

In the Bantu-Hostel area it was found that the electric lights, in most of the Bungalows and Ablution Blocks were never switched off during the day time. As a result of the subsequent high consumption in electricity in this area a request was received from the Hostel Superintendent whether something could be done in this respect. As the installation of time switches with associated control gear or manual control would become uneconomic because of high maintenance and adjustment costs, it was decided to investigate the possibility of controlling the supply of electricity to these bungalows by the installation of receiving relays direct onto the supply mains. As the receiver is rated at 25 Amps at 220 Volts for pure ohmic loads and as the lighting load per bungalow was only about 3 Amps, 5 bungalows could be controlled by one receiver. This arrangement was found very satisfactory and at present power is only made available between sunset and sunrise and is controlled from the central transmitting station, thus eliminating maintenance and adjustment costs on individual time switches. Consumption of electricity in this area has since returned to normal.

In the Compound Area of the Bantu-Township the Bantu Employees of the S.A. Coal, Oil and Gas Corporation's factory are being housed. Although a similar problem confronted this section of the Bantu-Township regarding electric lights that were never switched off during the day time the solution here was not so simple. Firstly the majority of Employees housed in the Compounds do shiftwork and as such make use of the Quarters and Ablution Blocks at various hours of the night. Therefore, a switching programme had to be determined, and after a survey was made of the actual times during which a supply of electricity had to be made available to the Quarters and Ablution Blocks, receiving relays were installed. It was then a very simple matter to achieve any switching operation required by the Compound Manager by selecting the desired times on the 24 hour programme clock in the central transmitting station. Furthermore, as 22 double commands can be transmitted with this installation it was possible to allocate the necessary channels required for the control of electric lighting in the Bantu Township without interference to other preferential channels.

In the remainder of the Bantu Township, that is in the married quarters, each house has been provided with a supply of electricity together with street lighting which has been made available in every street. The street lighting installation is remotely controlled and as already shown in detail in this paper, this was only made possible by the financial savings obtained thereby as the funds made available for this kind of service in the Sasolburg Bantu Township was very limited.

Once a supply of electricity has therefore been made available to the individual homes in a Bantu Township then adequate street lighting which is also regarded as an essential service judging from previous papers and discussions delivered at these Conventions, can be provided very economically with the aid of a remote control system.

## 7. CONCLUSION.

I think I would be failing in my duty if I did not point out that success with load shedding can only be achieved if the network under control has sufficient electrical apparatus which can be switched off during the peak periods. Indications, however, are that the sale of domestic water heaters in this country and elsewhere over the past few years has reached such proportions that most Electricity Supply Undertakings must be supplying a fair amount of power to this kind of domestic apparatus. In this respect it may be of interest to refer to the following extract from a paper read at the twelfth British Power Convention held at Bournemouth, United Kingdom last year, by T. E. Daniels on "Electricity in the home."

> "Disposals of electric immersion heaters in the last year or two give a clear indication that we are rapidly moving towards nearly 100% saturation in those premises where the plumbing arrangements permit a heater of this kind to be used.
>
> It may be that the time is opportune for us to consider seriously that builders of new property should install hotwater vessels of not less than 50-gallons capacity with sufficient accommodation for them to be properly heat-insulated, if not now, at a later date so that the load can be taken at off-peak hours either by local time-switches or by means of supervisory control. We may be wise in making our plans now for water heaters with loads of perhaps 5 K.W. and to be considering the appropriate ways of connecting these."

I am of the opinion that this may become an important aspect of domestic power supply in this country as well, because most Electricity Supply Undertakings will be, or are already faced with a similar problem. In this respect load shedding experience in Sasolburg has also shown that at least 33% of the total load taken during peak periods is due to the water heater load and that approximately 25% of the total installed water heater load could be shed during peak periods. It was further established that the control of a 30-gallon capacity water heater is rather critical as the switch-off period had to be kept within reasonable limits if inconvenience to the consumers was to be avoided which is essential with any load shedding operation. The installation of a 50-gallon capacity domestic water heater on the other hand would naturally mean that far greater success with load shedding can be achieved as the switch-off period can be increased considerably. It should then be possible to fill up the valleys on the load curves that normally exist between 22.00 hours and 4.00 hours with a resultant greater improvement in the load factor. The installation of a 50-gallon capacity domestic water heater, apart from its initial greater installation cost, must therefore eventually pay handsome dividends as the sale of electricity during the off peak periods can be at a very low tariff.

Generally speaking, however, it can be said that a remote control installation will be justified where the Electricity Supply Undertaking makes special efforts or already has a sufficient number of domestic water heaters installed so that the load factor can be improved by the additional sale of electricity during the off peak hours. This will also apply to electric storage heaters which are becoming increasingly more popular for the space heating of offices and public buildings during the off peak hours.

Briefly then the following conclusions can be made when considering this question of remote or load control: —

1. Once an Electricity Supply Undertaking's distribution network has sufficient electrical apparatus installed which can be switched off during the peak periods load shedding becomes economically justified both on capital investment and running costs of the distribution system.
2. Technically the system must be of a very sound design if trouble from interference voltages is to be avoided and the maximum benefits can be derived from the load shedding operation. At the same time simplicity of construction of the various components must be observed so that normal test room facilities and staff can handle the maintenance of the system.
3. From operating experience it has been established that the maximum period a 30-gallon capacity water heater can be controlled is approximately 1½ hours during the evening peaks and 2½ hours during the morning peaks without inconveniencing the consumers.
4. The sale of domestic water heaters in this country and elsewhere seems to indicate that most Electricity Supply Undertakings must at present be supplying a considerable amount of power to this kind of apparatus during peak load periods. In the case of Sasolburg this amounts to approximately 33% of the total load taken during peak periods, whereas 25% of the total installed water heater load could be shed during peak periods.
5. It would appear that the installation of larger capacity domestic water heaters on domestic premises will eventually be justified especially as these can be heated up during the off-peak hours without causing inconvenience to the consumers particularly as the domestic demand for power must increase with the rise in the living standard of our consumers.
6. Apart from the business of keeping the peak load under control, the supervisory control of new street lighting installations becomes an economic proposition.
7. Once a remote control system of a suitable type has been installed it is soon realised that many additional functions can be performed which will suggest themselves almost immediately to the Supply Authority Engineer with a particular problem of this nature.

It must, however, be appreciated that the installation of a remote control system by any Electricity Supply Undertaking intended primarily to keep the system peaks under control, will need a thorough and careful analysis of the load characteristics of the system but at the same time it was pointed out that other applications exist, apart from the business of keeping the peak loads down, which can fully justify the installation of such a system.

In conclusion it is hoped that this paper will serve a useful purpose in making available some information relating to this question of load or remote control and I would like to thank the Sasolburg Village Board of Management for the opportunity of presenting this paper to the Association.

THE PRESIDENT: I now call on Mr. Theron, of Vanderbijlpark to propose the vote of thanks to Mr. von Ahlften.

Mr. G. C. THERON, VANDERBIJLPARK: Mr. President, I wish to open my reply by referring to the closing paragraph of Mr. von Ahlften's paper. The author states ". . . it is hoped that this paper will serve a useful purpose in making available SOME information relating to this question of load control. . . ."

We have always known the author as a modest person but a greater understatement could hardly be found.

The SOME information referred to by the author lines up with some of the most comprehensive papers read at these conventions and furthermore the thesis is developed in a clear and logical manner with summarised conclusions at each stage. It is therefore packed with information yet easy to follow and apply.

Sasolburg's neighbouring town, Vanderbijlpark, was probably the first in South Africa to install on a fair scale an audio frequency central injection system for load control purposes. The first installation which went into operation in 1952 consisted of 3,000 relays and at present there are over 6,000 relays on consumers' premises.

Our experience with this type of load control system therefore stretches over a slightly longer period than at Sasolburg and members may find a comparison of the results obtained of interest.

1. The Vanderbijlpark system operates at 815 cycles per second injected on the series principle. The steel works in the town are supplied from the same 88 K.V. busbars but had not reached production stage at the time when the reticulation network was tested for interfering frequencies. When commissioning of the load control equipment took place about two years later and some mercury arc rectifiers had by that time been placed in operation at the steel works, it was found that parasitic frequencies consisting mainly of the upper harmonics of the 50 cycle fundamental were causing a bias on the galvonometer type receiving relays and making them less sensitive than necessary for satisfactory operation. This trouble was overcome by means of a small 1,000 ohm resistance placed across the output terminals of the band filter.

The point of importance is that for the successful operation of an audio frequency load control system the network must be exhaustively tested for parasitic frequencies before a decision is taken regarding the carrier frequency.

2. The domestic habits of the average consumer at Vanderbijlpark must be very similar to those in our neighbouring town, because the operating results obtained and quoted in Section 4.3 are so similar that we may be suspected of comparing answers. The bulk of the water heaters is of the 30 gallon 2 K.W. type and we shed in winter up to 35% of the installed water heater load and about 25% during the summer months. Load shedding in the mornings during weekdays is found necessary only under very cold wintry conditions and even then is usually limited to Mondays and Tuesdays when the general washing and ironing habits of the population have a very decided effect on the electricity demand.

The best results are, however, obtained during the winter evenings. Throughout the year the water heater load is shed on Sunday mornings for periods of 1½ to 2 hours without the consumers being aware of the operation or suffering any inconvenience. This Sunday morning peak seems to be a feature peculiar to the load curves of industrial communities with all electric houses.

By applying the load control principle it was possible to raise the monthly load factor at Vanderbijlpark from 35% to 58% and that in respect of a 98% domestic load.

3. Many times we were called upon to explain to an upset consumer that the increased consumption of electricity especially at the onset of the colder weather was not due to the operation of the load control system and this is very forcibly brought out by the figures furnished by the author.

We are also often blamed for a shortage of hot water when in fact the load had not been shed at all. The cause of this type of complaint is usually a faulty element or a hot water cylinder which is inadequate for the family. I agree that the 30 gallon cylinder is just about the minimum for the average family in our town.

4. A type of load control not mentioned by the author is obtained by the use of thermal limiting switches which may switch the water heater automatically or merely disconnect the supply and leave the shedding of the load to the manual operation by the consumer. This system as well as a few of those listed in the paper suffer from the very serious objection that the control is at the discretion of the consumer. During times of system disturbances the shedding of a portion of the load at the command of the supply authority can be of immense assistance in restoring the supply but this feature cannot be utilized in the types of control systems mentioned above. Those of us who have experienced a power failure in the late afternoon on a Winter's day and the difficulty of holding the switches in when the waiting consumers keep all the light, heater and stove switches full on, will appreciate the value of being in a position to drop a third of the load without asking the consumers' permission or even putting him wise to the move.

This type of service cannot be measured in Rand and cents or £. s. and d. but is one of the hidden charms of a central injection load control system as described by the author.

5. The author makes an important point when he states that ". . . . the testing and maintenance of receiving relays should be straight forward." It is also our experience over the past 9 years that the testroom staff can very easily cope with the repairs and adjustments necessary on the type of relay used at Vanderbijlpark. Furthermore, the relay failures during the period mentioned have been less than 3%, a figure which we consider quite satisfactory.

When we receive a complaint from a consumer that he is without hot water we always give the customer the benefit of the doubt and check the relay but in approximately 50% of the cases reported, the trouble is *not* with the control apparatus.

In conclusion I am sure I speak on behalf of all present in offering to Mr. von Ahlften our congratulations and thanks on the excellent paper presented today and in expressing the hope that it will serve as a sign post to many Engineers and Councillors to indicate one of the directions which can be followed in order to reduce the cost of electricity to thousands of consumers.

THE PRESIDENT: Thank you Mr. Theron.

Mr. D. LEES (Benoni): Mr. President, Gentlemen, Mr. von Ahlften is indeed to be congratulated for providing this convention with a most interesting and comprehensive paper, embracing the technical and practical aspects of Audio-frequency Remote Control in its applications to demand, and street lighting control in a Municipal Undertaking.

The Sasolburg Undertaking, being a completely new all electric town, has the advantage of a planned reticulation system, into which all modern electrical developments could be incorporated, and since the Sasolburg load is of a purely domestic nature, and has a community of a uniform and high economic standard, the ideal conditions existed for the incorporation of demand and subsequent street lighting control.

The Author's observations in connection with the economies that can be effected in respect of a street lighting project, are amply justified in the following account of the Benoni Audio-frequency street lighting control system installed, and put into operation on 1st April, 1957, in the New Daveyton Bantu Township.

The Daveyton Bantu Township project of approximately 8,200 houses, all wired and connected to the supply main by an underground reticulation system, would, under normal conditions have had the street lighting system connected by means of underground cables, but since a ruling was received that street lights were to be erected at not less than 400 foot intervals, the cable cost alone became excessive, and would in fact have cost 3/10d. per foot laid, such being the ruling price of cable at that period.

The average cable cost per street light erected, would therefore have been approximately £77, which prompted an investigation into the possibilities of an alternate method of supply and control.

It was subsequently determined, that the substitution of a remote control system would cut this cost to approximately £16 per street light, thus a saving of £61 per street light was effected in this unique project.

The type of equipment installed at Daveyton, is similar in all respects to the Sasolburg installation. This equipment has, to date, performed 4991 trouble free injection cycles during its four years in operation, this also applies to the relays which speaks well for the reliability of this equipment.

The inherent flexibility of Audio-frequency control is such, that a further saving of £2,000 per annum in the cost of supply, has been effected. This is due to the observed trend, that Bantu retire to bed comparatively early, with the result that street lights, other than the main thoroughfares, and certain selected points, could be switched off at 10 p.m., which in turn effects a corresponding saving in fluorescent lamp replacement.

While on the subject of effecting savings on schemes of this type, I would be glad if the author would elucidate the considerable saving he intends to effect on all new extension to his distribution system. The Author's contention, that the substation and low tension reticulation costs can in future be reduced by 40%, infers that a uniform scaling down can be effected on his low tension distribution network. In other words, if the present design is for 5 kW. per stand, the new design will be for 3 kW. per stand, yet, it would appear that every section of the township will be loaded to the full 5 kW. per stand from time to time.

If this is so, how does the Author propose effecting this saving, without excessive voltage drop, and which could in turn give note to a spate of consumer complaints.

In conclusion, may I again congratulate the Author on his presentation of a very instructive, and interesting paper and have much pleasure in proposing this second vote of thanks.

THE PRESIDET: The paper is now open for discussion, gentlemen.

Mr. F. STEVENS, Ladysmith: Mr. President, I would like to congratulate Mr. von Ahlften on his paper, and to support the contention that most electricity supply undertakings stand to gain both financially and through the improvement of the pressure of supply to its consumers at times when it is most needed by the adoption of one or other of the available systems of load control.

In support of this contention I would like to present to the meeting a few comparative figures baseed on the ten years experience we have had with one of the other forms of load control — in this instance not audio-frequency, but that matters not. The thing is that the same results have been achieved.

To give a rough idea of the size of our undertaking, the maximum demand is 6¾ megawatts and the units sold annually 30,000,000.

I must, however, point out that our industrial load accounts for half. We are at presenet supplying 987 water heaters, mostly 2 kilowatt. Of these 530 are centrally controlled automatically when peaking takes place. The other heaters are looked after by load limiters or time switches. With the centralised control we shed between 500 and 760 KVA which is well illustrated on a chart I have with me removed from a recording ammeter installed at the point of supply.

The total capital investment to date is £6,155.0.0.

From this information it can be easily seen that a very appreciable saving is effected. I should have mentioned we are paying Escom 15/9 for KVA and the bill for the maintenance of the equipment is £450 per annum.

Thank you Mr. Chairman.

THE PRESIDENT: Thank you Mr. Stevens.

Mr. J. G. F. ERIKSON, Estcourt: Mr. President, I would like to take this opportunity of congratulating Mr. von Ahlften on a very interesting and comprehensive paper in which he has given a very clear picture of why the remote control which he has described was installed, its economic aspects, etc. which agree very closely with the experience I have had with the Estcourt installation.

The Estcourt installation is generally similar to that discussed by Mr. von Ahlften, that is the "impulse interval" system but of a different manufacture; the main differences being:

(1) Lower injection frequency, namely 725 cycles;

(2) More rapid transmission, i.e. 25 double orders in 30 seconds.

(3) Both on and off operations are done by separate impulses.

(4) The relays are of the all electric direct operating type, which obviate any necessity for any form of amplification. Choice of the lower frequency is following the general trend towards lower frequencies, the reasons for this trend being:

(a) With lower frequencies there is a better signal propagation throughout on the

whole network due to smaller voltage drop which can best be illustrated by an example. Take a line 10 miles long, at 11 KV terminating on a stepdown transformer and a 1 MVA load, the calculated total impedence for the line and transformer at 500 cycles is 124 ohms. and at 1000 cycles 249 ohms. with a resultant voltage drop of 30% and 56% respectively.

(b) The frequency gap between the various harmonics is much bigger and results in higher safety against interference from harmonics.

(c) The increasing number of power factor correction capacitors installed in all networks and the high number of fluorescent lamps with ballast capacitors is much less likely to influence the AF signal level with lower frequencies.

(d) At lower frequences the AF signal level is more constant between the low load and peak load periods.

Rapid operation is essential to deal with sharp peaks, especially where the supplier employs thermal KVA metering, which certainly records peaks in a considerably shorted period than the stated 30 minutes.

The advantage of separate on and off impulses is that, should a relay be started by say a spurious impulse, and with no control impulse being received, there is no chance of incorrect switching.

Mr. von Ahlften refers to the Sasolburg installation as fully automatic, but this I presume is only true as far as the transmission of commands are concerned. In the Estcourt installation the automation has been taken a stage further, as our equipment includes metered control by actual KVA demand.

The principle of operation of this is that the build up of KVA is compared with the build up of an ideal load, which can be preset as required. If the build-up exceeds the preset average, corrective action is taken by operation of the double order of the automatic transmitter. This is done through an ancillary unit comprising various relays etc. which forms the necessary liaison between the metering and the automatic transmitter. In our case we have the water heaters divided into five blocks or groups, each controlled by one of five channels of the transmitter, with some or all operating in rotation to shed the load as required. Thus this installation provides a fully automatic shedding and restoring of load above and below a predetermined value. This of course has obvious advantages, as load shedding only takes place when required, and then only sufficient to keep the maximum load below the predetermined value.

This is particularly useful in Estcourt where the industrial load is greater than the domestic, and an excessive peak may appear at any time between 8 a.m. and 8 p.m.

As the Sasolburg load is purely domestic, I presume the various peaks appear at the same time every day, but if there is a variation of time, is there not a chance of missing the peaks with switching taking place at preset times?

At Estcourt there are no Sunday peaks to consider, as the factories run light during weekends, but we have fairly frequent operations on Tuesday mornings, obviously due to the ironing load.

Mr. von Ahlften says that during the morning peaks the water heaters are only switched off when necessary. How is it ascertained when it becomes necessary? I assume that times of known peak loads are preset on the programme transmitter, and transmission takes place daily at these times.

As Estcourt peak load varies quite a bit during the month, and operations only take place on actual peak loads; the result is that we have occasional days with several operations, both morning and evening, or either, but there are times when there may be a week or more between operations.

However the peaks are rather sharp and therefore the fast operation of the Estcourt equipment is essential when suppressing these peaks.

Like Sasolburg Estcourt also installed relays on all water heaters, and as was expected there were a number of complaints of no hot water immediately after our control went into operation. These complaints were all investigated, and apart from switch off of water heaters during off periods, as was mentioned by Mr. von Ahlften, they were found to be due to one element in the heaters being burnt out, and therefore their recovery being slow. Consumers are now used to it, and as switch offs happen at irregular and infrequent intervals, the consumers don't know when their water heaters will be off, and thus not knowing when to look for trouble, they miss the opportunity to complain!

Although the Estcourt domestic demand is less than half of the total and we have only a third of the number of water heaters controlled, as compared with Sasolburg, our saving in the reduction of maximum demand is considerable as is borne out by the increase of the load factor since commissioning our installation.

In this respect, the average annual load factor for the last five years before the start of control was 59.4% the highest being 52.1%, whereas the load factor for the last year increased to 69.7% with a maximum monthly load factor of 77.2%.

With these few remarks I again congratulate Mr. von Ahlften on his paper, and conclude by saying that I think question No. 12 in tonight's Forum has been adequately answered.

THE PRESIDENT: Thank you Mr. Eriksen. Ladies and gentlemen, we haven't had any contributions from our affiliate members today. I just want to make it clear that contributions from affiliate members will be very welcome.

Mr. J. YODAIKEN, QUE QUE: Mr. Chairman, ladies and gentlemen:

I have been exceedingly pleased to hear the paper deliverd by Mr. von Ahlften and the subsequent comments by other contributors, and I must make a few remarks and ask a few questions. In initially considering the possibility of load control in some form, I discussed this matter with an engineer from the Ministry of Power — I can't imagine that Kariba is fully loaded, because even in a small place like Que Que he felt it was interfering with consumers' rights and that they should have power when they desire it. However, I don't think he was interested at all in the costs which may be accrueing to the township.

In Que Que our annual demand charges are £9 10s. per KVA and that against Mr. Stevens' earlier remarks about 15/9d. makes a considerable difference to the consideration of load control.

I think it's obvious that it becomes fairly important to consider load control on an annual demand tariff over and above a monthly demand tariff.

First of all, I would like to ask Mr. Theron a question, in regard to harmonics being generated by rectifiers adjacent to Vanderbijlpark. I gathered from his remarks that the common point of coupling between his normal domestic network and the supply to the rectifiers was on the 88 KV bars.

I am very interested to know whether he can give any figures in regard to the values on a percentage or actual basis of the harmonics at — I think he said 815 cycles — at his point of coupling, and at the same time to know what the rupturing capacity of the 88 KV network is calculated to be.

I would like to know from that point of view how much accuracy there is in the assumption that the higher the rupturing capacity of any network the less likely — or rather the smaller value harmonics will come on to the 11 KV network and exactly how that compares in practice.

The other point I would like to make is that it appears from Mr. von Ahlften's remarks that he does alter his time settings under his present set-up on his programme clock month by month in accordance with seasonal alterations, and, I presume, in accordance with the experience so far gained. I would like to know if that is correct in the first instance. Secondly, as I understand he is anticipating fully automatic control, I would like to know whether he feels that he will get additional advantages from the installation of the fully automatic control and what the difference will be in his operation.

I would like to make one last point, Mr. Chairman, and that is to say that a survey was carried out in Que Que area and in the Hartley area just recently in regard to domestic water heater installations, and it was found that 97% of maximum possible number of consumers had water heaters installed; and these are two areas, incidentally, which are not all electric construction of modern times.

One last point is that reading a paper on this subject in New Zealand, I think the size of the water heaters there was 15 gallons and it was suggested by the author of the paper that they were able to switch off for periods as long as 14 hours without getting consumer complaints. As just remarked, they either don't bath, or something of that nature!

With those few remarks I'd like to thank you, Mr. Chairman.

Mr. W. H. MILTON, ESCOM: Mr. President, ladies and gentlemen: a point has been covered by previous speakers, which I had noted, but I do think that the scope of the paper is very limited in that it takes into account a necessity, in the interests of economy for the control of water heating load. What is happening here is that we are either diagnosing and treating a disease without looking back to seek the origin of that disease, and if the late George Swingler and the late John Roberts were here they would probably be horrified at what we are talking about.

I well remembered in the early conventions how much was said, and how much pressure was brought to bear on devising ways and means of encouraging the water heating load, and the domestic cooking load, in order to fill in those valleys which were so objectionable. Cheap tariffs were designed for that purpose, etc., etc.

We have encouraged something which has now become a burden, and few of us stop to really impress the laymen and our consumers of the costs to which we are put in meeting peak demands. Much of the cost of operating electricity undertakings arises from that provision for peak demand.

As a result of our past efforts to encourage these loads, which we wanted, we have now landed ourselves in the difficulty of meeting those requirements without saying "Well, I'm afraid the price has got to go up."

We are often accused of interfering with the consumers' liberty in utilising the commodity we have for sale. But I think where we are failing is in not bringing home to our consumers the costs to which we are put in giving them that freedom of use. I am one of those people who likes to be fair and I do feel if men or women want to be free to use electricity they should also agree to pay for the service that they are receiving; and from that point of view, control of water heating alone is only a palliative. I think we are nibbling at the problem, that in time to come those of us who are still with this organisation will hear the younger generation dealing with the problem from a totally different aspect, and that is to try and overcome the "evil" shall we say, that their forebears have handed them.

From that point of view I do think we should go a stage further than just look to these various methods of controlling load by controlling water heaters, and endeavour to ensure, shall we say, the user pays for the cost of the service that he is getting. He can then have complete freedom of use, and you will probably have automatic control of load from the users' end which is where it should really start, not from the supply authority's end.

It is all very well saying that by switching off water heaters, we are shedding load and the consumer doesn't realise what is happening to him, and we are getting away with something.

I think the consumer should be free to exercise that control. If a man is willing to pay for a special service, I don't see why he shouldn't have it. But a man who wants to save should earn that saving for himself, in view of what he has been doing for the community.

The speakers so far have all been of the bulk supply type, and from that point of view they have been able to cost the saving to themselves in the purchase of that supply, against the cost of controlling their peaks, and to indicate substantial savings arising from that cost.

In so far as the bulk supply authority is concerned we have the statement that from the point of view of Kariba they are not particularly interested.

That is rather a dangerous statement to accept. It is a very short-time view. If you take the case of Sasolburg, the cutting of the peak there, in so far as the supply authority is concerned, is negligible in its effect on cost. The drop in load there is so small that one could not cater in generating plant capacity, main transmission capacity, for so small a change, so that although there is an apparent saving in the purchase price of electricity to the consumer who has cut that peak, there is no real saving. The same thing applies, to some extent, in respect of the remarks by our friend Mr. Stevens of Ladysmith.

There again, the relatively small reduction in load, in relation to the total load for which the system is designed, is so negligible as not to affect the costs of the supply authority. After all, the units are taken at some later stage, so the coal is burned, and the plant is used. Although he apparently saved 15/9 per KVA, in reality from the supply authority's point of view we lost 15/9d. per KVA not sold!

Now, that is well brought home if one considers it from the point of view of the generating authority going into this question of load control. And this is where I want to point the remark that I made earlier that we must not take the short-term view.

If you take the long-term view what will happen of course, is that you can extend the periods between increases in generating capacity, and by a multiplicity of these controls, that extension of time may be very real. We actually have a very specific case in point (I am looking at the gentleman concerned, but I mention no names!) where plant has been installed to meet a peak load, and naturally the tariffs were designed on the basis of an expectation of increase in the peak load to be met averaged over a period of 5 years. Shortly after that tariff design was put through, the particular consumer decided that he would introduce this peak load control, with the result that the peak remained fairly stagnant for a matter of three years — to the discomfort of the poor devil who designed the tariffs — and who in turn was subject to an awful lot of criticism for a very bad design of tariff, which didn't work out in practice, and instead of debts being cleared up they were allowed to accumulate a bit longer, and things like that.

Mind you, the consumer won the day because that's what he really wanted.

But in the long run, of course, that very load control does mean that the further increases in generating capacity have been postponed, and they may be postponed in this particular case by a matter of one or two years. And when you look at savings from that point of view, they become very real savings.

In conclusion, Mr. President, I would like to reiterate that we are nibbling at this problem by dealing with water heating load alone. I think we should examine it from the point of view of the cost of meeting peak loads and devise some ways and means of ensuring that the consumer who creates a peak, pays for it.

THE PRESIDENT: Thank you Mr. Milton.

Mr. G. J. MULDER, BLOEMFONTEIN: Mr. President, I was somewhat taken aback by Mr. Milton's opening remarks, but later on in what he said it became very clear that the saving that Sasolburg had made, unfortunately could not be passed on; as the saving was so small that he couldn't possibly suddenly reduce his system by that amount.

That is an unfortunate thing, Mr. President, about we who generate — that once we have spent capital there is nothing much we can do about it to reduce it again.

He has also mentioned the fact that all speakers so far, except Mr. Milton himself, were bulk supply people, who could see their saving on their monthly bill.

I represent an isolated generating authority, where we have no inter-connection and where we have to provide capital to meet demands however sporadic they may be. It is costing us in Blemfontein a matter of, shall we say, 12 megawatts, which is the best part of a million pounds, to warm that town up in winter; it is the difference between winter load and summer load. I presume the main difference between winter and summer from the load angle, is that people want to be warmed up in winter.

From that angle we have considered this super-imposed control ever since 1948, and until very recently it has been quite impossible for me to convince successive councils that (1) control could be exercised without the consumer being inconvenienced; and (2) that you could make any saving.

Some headway has been made, I may say, but with us the saving of 12 megawatts is very real. Water heaters alone would account for probably about 3½ MW at the most. So we take the water heaters in our stride. That is something, money from home, in the process of saving; but our major hope lies in controlling heating load in the winter.

We have done some experimental work in that direction, with the help of time switches. We have several large buildings on thermal storage heating, and these have operated for some years now. My offices are entirely storage heated. These have operated very satisfactorily for a number of years. To the great delight of users of storage heaters when we changed tariffs recently — the night storage tariff change is basically capital expenditure, and the capital expenditure is not affected by the night load.

Mr. President, I feel that more attention should be given to control of other loads than water heating. In spite of what Mr. Milton said, that we have now saddled ourselves with something that burdens or worries us, I differ. Water heating doesn't worry me; it is still a very welcome load, and more welcome than ever because it is amenable to control, and until the introduction of storage heating, nothing much can be done with the heating load.

I may say that storage heating is very effective, and from the maintenance angle and the consumer angle, it is economic, and

it is on storage heating that I mainly place my arguments with council for control.

THE PRESIDENT: Thank you Mr. Muller.

Mr. J. E. MITCHELL, SALISBURY: I felt that I could not let this discussion go by without making some contribution, as the author of the first paper given to this A.M.E.U. convention on audio-frequency control of water heaters, 9 years ago.

Consequently, I think I was a guinea pig, and this guinea pig, different from the animal species, has a "tale" despite it's being spelt differently.

I would like not to discuss so much the paper, which I think will be very useful for undertakings, possibly the size of Sasolburg, and the like.

I rather agree with Mr. Milton to a certain extent, because, although the undertakings taking bulk supply do, because of their tariff, save money, you must really look at this from the national scale; or if you are your own generating authority, from your own individual point of view.

The E.S.C. (Escom in the Union, as you know it) — anybody who is connected to that authority is going to be connected to stations which will now have machines of 100 or 120 MW. Obviously the E.S.C. are looking to some form of control which will delay the installation of the next 100 or 120 MW machines, because in the national interest that type of control is the only one that is going to save any money.

When we first went in for ripple control in Salisbury, it was definitely with the intention of reducing the load over peak by 20 MW and therefore delaying the capital cost of a machine of that size. That has not come about. We have had various difficulties. At that time, I think there was only one type of audio-frequency control on the market, though there are many today, and, as a matter of fact with the gracious consent of my council, my test engineer has only just returned from a visit to the whole of Europe looking into what is happening in audio-frequency control over these. And most of those who have put it in are installing up to 40 thousand relays, and nobody is very much interested in anything much under that figure. That gives you some idea of the continents point of view, possibly on the same national lines.

I would like, however, to throw a little spanner into the whole of this discussion, because — I don't know whether you have read papers recently — there are now purchasable 3 MW machines, instant start—remote instant start. Put them anywhere you like on the network, and at the present moment those are costing £30 per KW.

There has now been developed a machine which will give you 30 MW. It is a gas turbine job, instant start—which I believe is going to cost about £15 a KW for that size of machine. And when you start thinking in terms of those, you might think completely differently on a system which can shed something like that type of load, because not only can you save it in the power station, but by putting it possibly at the other end of the system altogether, you can save considerable distribution transmission losses.

I think from the point of view of the smaller municipalities that are paying bulk suppliers, and even the larger ones who are paying on the basis of demand, it must be watched very carefully.

Mr. Yoadiken of Que Que mentioned that Kariba wasn't very much concerned at the moment. That, possibly, is correct, because they have surplus power. We have surplus thermal plant which has been paid for and only costs the coal and water to run it, and it does seem paradoxical that we should go in for load control, for instance, in Salisbury, when we have possibly 120 MW of plant doing nothing.

There is the difficulty, of course, in regard to legislation where you are not allowed to generate yourselves, and it may be difficult for somebody who is taking bulk supply from Escom to get agreement that they should generate 3 MW over peak to save them the bulk supply!

But eventually there is no doubt about it that, even considering if the peak load can be reduced so that a second stage of Kariba, could be delayed even by one year, the capital charges believe me, on £40,000,000 for one year—are well worth saving! And that is the way you should look at this problem rather than from the purely individual saving on your bulk supply tariff.

As I see it, and I think that is what Mr. Milton had in mind, if you save that for five years, and Escom doesn't get its return, then quite obviously the tariff will go up, and all that you have gained is lost. It seems to me that that is possibly what they have in mind!

I would like to thank the author for preparing this paper, and giving us some additional figures, which I find interesting; I find it interesting from the point of view of the load shed per water heater, especially in regard to the standard of living. He is quite correct there. We find that in the more "snobby" areas, you might say—the load shed is considerably more than it is in the poorer class areas.

I will warn him on one factor though, and that is this; that he will find that the more water heater control he puts in, the amount of load shed per relay will gradully decrease. On the numbers he has got in at the moment, he will not realise the effects of diversity, but when he has got up to 10 — 20,000 relays (I don't know whether he will ever get that at Sasolburg), he will find that the load shed per relay drops quite a considerable percentage.

Thank you Mr. President.

THE PRESIDENT: Thank you for your contribution, Mr. Mitchell.

Mr. A. R. SIBSON, Bulawayo: I was not intending to join in the discussion on this paper, Mr. President, but some of the remarks that Mr. Milton made have spurred me on, as Mr. Milton's remarks so often do!

On this occasion I don't propose crossing swords with Mr. Milton—I find myself very much on his side, which is perhaps a little unusual!

The question that he has raised, of considering this issue on a much broader basis, is one that has given me a lot of thought over recent years, and I don't know whether it is fully appreciated, that even with a thermally supplied network, with coal costing £1 to £2 per ton, the proportion of costs of supply to a domestic consumer is still something of the order of 75% in respect of fixed charges and only 25% in respect of those charges that are related to KW hours.

And yet over the years, we have consistently measured the service given to these consumers, as though KW hours were all that mattered. It is true that we have such things as room tariffs, and various other devices to increase the total amount of revenue, and, at the same time, make the consumer think that the KW hour is really very much cheaper, but these devices in themselves do not take account of fixed charges as such. It is interesting to note that some towns are beginning to realise this. I think (I am not sure, but I think it is) in Port Elizabeth, they actually use, in addition to a KW hour meter, some form of current limiter, which brings in therefore the maximum demand factor in some way or other.

Other towns are using the maximum demand meter to bring in this factor, and this is a move in the right direction.

In the case of supplies in Rhodesia in the future, the ratio that I quoted just now is, of course, very much greater. In the future we shall have something like 90% of the cost of supply to a domestic consumer related to the fixed charges, and only about 10% related to KW hours.

Now under these conditions it is obviously logical to go on slavishly measuring these KW hours for the purpose of rendering the monthly account. In fact, if we are going to be illogical at all, we might as well be illogical the other way, and ignore the KW hours altogether, since they represent only 10% of the total cost, and take account only of the maximum demand, and it is on these lines that I, myself, am thinking.

If we do this sort of thing, it puts into effect what Mr. Milton is worrying about, and that is that it puts over to the consumer the job of deciding how much of a demand he wants, and how much he is prepared to pay for it.

I don't want to dilate any further at this stage on this matter, because I am hoping in a short time to be able to present much more detailed information on certain work we are doing in Bulawayo in this direction, so perhaps I shall just leave these thoughts with you and at the next convention I may have a good deal more to tell you about it.

Mr. G. J. MULLER, BLOEMFONTEIN: Mr. President, if I may speak again?

Mr. Mitchell, I think, has now changed sides. He is no longer really a generating authority, he is now speaking on a national scale from Kariba.

We — and a few others left in South Africa — still have generation and distribution to contend with. It may be of interest to people who are placed in a similar position that in one case, without mentioning the name of the building, there was 400 KVA of night storage heating.

Now that is definitely not required during the day; the power for night heating is cut off. So that we have available in that building a 400 KVA substation for the day load. And virtually the capital cost on the distribution system for that night load is nothing, because the load is required for other purposes. We have regulations which entitle us to supply from such a consumer substation to neighbouring consumers; I think it is fairly general.

One should not imagine that load control, and the benefits of load control, stop at the power station. It is basically there to put off the incidence of capital expenditure system, and the savings on capital on distribution system. As I say, in this case, we have a 400 KVA which virtually became available free for other consumers.

Mr. D. MURRAY NOBBS, PORT ELIZABETH: A number of previous speakers, Mr. President, have spoken in support of a system of control of domestic water heaters, and there is no doubt that, taking the short view, such equipment does effect savings, particularly to those undertaking taking a bulk supply, but before embarking on a system of this nature, a very close scrutiny of the load curve of the undertaking is called for.

If the base of the peak load is of short duration, then I would say that such peak would lend itself very very well to the system of control under discussion, but if the base of that peak is of long duration, then its application may not be so advantageous.

Again, if such a system is going to be installed, then consideration should be given to an adequate multiplicity of channels.

In Port Elizabeth, some year ago, equipment for the control of domestic water heaters was installed and the injection components cost in the region of £35,000. About 5000 relays were installed initially at a cost of around £3 8s. per relay; and when we decided to increase the number of relays, the cost had gone up to approximately £5 10s., and later to approximately £9. Under such circumstances it is impossible to estimate the ultimate cost of such equipment and to appraise its economic value.

This system did not work too well in Port Elizabeth, simply because our load curve is affected to a very great extent by our industrial load, and is comparatively flat.

To illustrate my point, there was one occasion when the undertaking was running to full capacity as far as installed generating plant was concerned, and we were compelled to operate the control system and cut out the geysers at about 10 o'clock in the morning. We dropped in the region of 2½ thousand KW.

On several occasions during the day we endeavoured to bring back the geysers, but each time we operated the control system the steam pressure dropped in the power station, the frequency went down, and it wasn't until 8 o'clock that night that we were able to restore full supply.

This procedure resulted in considerable consumer opposition, and were very unpopular indeed. Now we have discontinued the use of the ripple control system for controlling domestic water heaters.

Fortunately it is still paying its way in the control of street lighting, and in that direction, we find it very effective indeed.

Of course, the characteristics of load curves can change, and there is no doubt that there are indications that this is happening or tending to happen, in Port Elizabeth at the present time, but rather than restore the system of remote control of domestic water heaters, I would prefer if necessary to give consideration to the equipment referred to by Mr. Mitchell, which has come on to the market, and which is creating a great deal of interest as far as meeting peak loads is concerned. Apparently an aviation gas turbine is used to operate an alternator, and the beauty of this equipment is that it can be installed at any convenient point, and it can be controlled by remote means from any predetermined control centre.

As Mr. Mitchell pointed out in regard to this plant, the cost per KW installed is coming down to about £15. When you compare that with the £60 to £80 per KW installed for generating plant in the major power stations, then obviously peak load generating plant of this type may have something to commend it.

THE PRESIDENT: Thank you Mr. Murray Nobbs.

Mr. W. H. MILTON, ESCOM: I rise to defend myself, Mr. President!

As far as this question of peak cutting is concerned, our consumers can rest assured that, if they can do so and it is in the national interest that they be permitted to do so they will have no difficulty in installing the necessary peak cutting equipment.

In that connection of coure, one has to be very, very careful, because when you are dealing with a large number of consumers supplied from a large system, peak cutting by one consumer at certain times, is not necessarily peak cutting on the supply authority's system itself. In other words one must have regard to the diversity of load on a large network, and once again you are in the position that you may instal equipment of that sort to cut a peak, only to find your tariff has to be increased to compensate for loss of revenue to meet the cost of the bulk supply authority.

As regards the equipment to which Mr. Nobbs has referred, i.e. the small gas turbine, which has been developed principally, of course, for aviation purposes—just a note of warning. We have been studying the availability of that equipment ourselves very carefully, and I would warn anyone who is not at sea level to study the de-rating of that equipment for purposes of peak shedding. You will probably find the cost per effective KW output increases tremendously.

Down at sea level it seems to be the ideal thing.

Then, of course, there is another aspect to be considered. Most of us here are dealing with growing loads, so that if we decide to cut a particular peak with the installation of one or more of those machines, it may be quite effective for a time. Then your peak overtakes the capacity of peak plant, and you have to put in more of these sets. So that you may land up with quite a multiplicity of them in a small network.

Once that stage is reached their economy is such in operation that you would probably find yourself wishing you didn't have them, but that you had put in more efficient plant in the first place. After all with growing loads, with the passage of time one does get more and more efficient plant, and if you go in for peak shedding, you defer the day when you introduce that type of equipment.

It is not such an easy problem to solve as might appear at first sight.

THE PRESIDENT: Thank you Mr. Milton.

Mr. R. M. O. SIMPSON, DURBAN: Mr. Milton must be supported. This time it is quite unnecessary to defend himself! My remarks are therefore rather in support of his remarks.

Control of peak loads is a problem which, of course, interests every engineer in charge of an Electricity Supply Undertaking, and, as a matter of fact, I think on one occasion I heard Mr. Milton speak in favour of peak loads. I think he suggested that they had certain advantages, in that you aways had spare plant in hand for shutting down for overhauling, and it is an advantage for that purpose.

We have not as yet installed load control in Durban but we continually have this problem in mind, to some extent we have attempted to reduce the system peak by means of tariffs. I know that Tariffs and in particular time tariffs, can eventually get you into difficulties, and are therefore subject to considerable criticism. The particular tariff developed in Durban has been criticised, but we looked at it from this point of view: we have a rapidly growing industrial load, which today consumes over 60% of the total units sold and we felt that by encouraging the consumer to make their demand on the system at times other than the daily system peak period it would give a better overall system load factor and also tend to reduce the monthly system peak. This tariff has worked very well but undoubtedly has its limitations and no doubt in the future we will meet with some difficulties. I estimate that this tariff has reduced our peak by approximately 10%—which amounts to over 20,000 KW. This has obviously been an advantage to the overall system characteristics.

Referring to the use of load control equipment which has been so ably described by the Author, considerable research must be carried out into the economies of such a proposed installation, paying particular attention to the habits of the people, the tariff of the Bulk Supply and also to the avoidance of inconvenience to the "all important consumers". I must support Mr. Milton in his comments on the need for careful timing in the installation of load control equipment. This is essential if real benefit is to be obtained by all parties otherwise generating plant may not earn adequate Revenue with the consequant necessity for the generating Authorities to increase tariffs.

In Natal, for instance, if a number of Municipalities installed this equipment without consultation with the generating Authority, the other towns may find themselves confronted with a tariff increase to offset the loss of Revenue.

Load control equipment most certainly can play a most important part in the development of a system, particularly when its additional functions such as Street Lighting Control etc. are taken into account, but for full benefit, it is essential to instal such equipment only after full consultation with the Authority responsible for generating.

In conclusion I must compliment the author on a most interesting and useful paper. The information given regarding the other uses of such control equipment such as street lighting control etc. is most useful and on its own may well go a long way towards paying for such an installation.

THE PRESIDENT: Thank you Mr. Simpson.

CONVENTION ADJOURNED.

*On Resuming at* 2.30 *p.m.*

THE PRESIDENT: I think we'd better make a start gentlemen.

I have a telegram here from Mr. Lineker: "Best wishes and greetings for successful convention on behalf of Institution London and myself."

(CONVENTION ANNOUNCEMENTS FOLLOWED)

I have been asked to announce that a message has just been received, that the Town Clerk of Potchefstroom, Mr. Stanley Jackson, has passed away. I believe several of the councillors here knew him.

We have received many requests for copies of the Minister's speech. A list will be posted up in the foyer. Will those who like copies please put their names down and we will see what we can do about letting you have copies — at a small charge. As these will have to be posted to you, will you please give your names and addresses.

We now come to the next item on the Agenda, which is the paper on The Utilization of Hydro Electric Power in the Union of South Africa. I don't think that Mr. Langford needs any introduction. He is, of course, the Chief Engineer of Merz & McLellan, South Africa, and I will ask him to come forward and read his paper.

# The Utilisation of Hydro Electric Power in the Union of South Africa

by

C.E.R. LANGFORD, M.I.E.E., M.(S.A.) I.E.E.

## 1. INTRODUCTION.

In his address at Durban a year ago, your President drew attention to the power potential of Natal's water resources, and quoted a few figures which were sufficient to stimulate interest in this field. He also said "it is therefore in this direction that I feel very careful and comprehensive investigations should be made during the next few years." Although considerable care has been taken in its preparation, I make no pretence that this paper is a comprehensive investigation. It is, however, my hope that it will lend weight to your President's remarks, and give rise to the detail investigations that are a necessary preliminary step before any hydro electric scheme can come into being.

It is irrefutable that the basic use of the water that falls on the land is to support the population — to produce food (either where it falls or by irrigation), to meet the domestic requirements of the people, and to fulfil the needs of industry. But while this is accepted, a considerable quantity of water flows into the sea annually having commenced its journey at a fairly high altitude, and the purpose of this review is to examine the energy potential of some of South Africa's waters. Our objective is only to extract this energy (in the form of electricity) from the water in its journey from the hills to the sea, leaving the water unaffected and still capable of serving the basic needs of the people in many other ways.

South Africa has to-day reached the stage when it has several major transmission networks, fed by large thermal power stations, supplying several thousand million units annually. The transmission systems are expanding steadily, and the day is not far distant when the three major grids — Natal, Transvaal and Cape Western — could conceivably be interconnected. The interconnection would save on standby generating plant, but the considerable increase in demand each year would still require additional generating plant to be brought into service from time to time. It should be the continual aim to keep the cost of new power as low as possible. This paper examines the water resources of the country to see where, and whether, economical hydro power can be found to help meet the increasing demand.

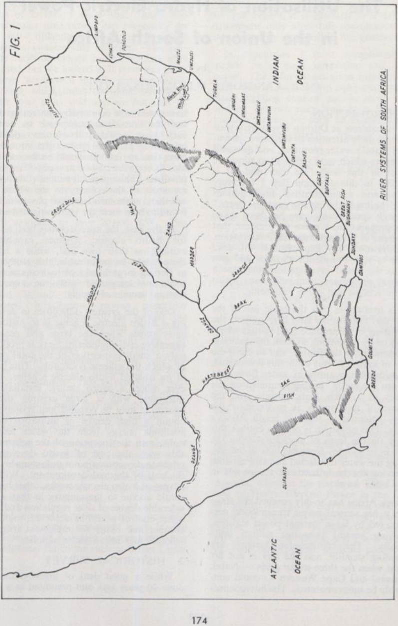
In the past, the approach has been to look for hydro electric schemes capable of existing on their own and, while a few of these might be practicable, this study aims at finding large blocks of hydro power that could be integrated with the expanding thermal sources of supply.

One of the greatest difficulties in developing a hydro electric scheme is to justify the early stages when the large and generally expensive civil engineering work is producing only a small proportion of the total output of which the scheme is capable. This is true of an isolated hydro electric scheme. However, where a hydro electric installation is integrated with a large existing thermal system, it may be possible and economic to obtain a high degree of utilisation of the available energy from the water resource right from the inception of the scheme. In this way, the cost of hydro development might to-day compare not unfavourably with the cost of thermal development. With the advent of hydro electric works, other benefits would accrue to the country in that a considerable degree of river regulation and flood water control would be achieved, making it cheaper and easier to implement irrigation schemes and urban water supplies.

## 2. HISTORICAL SURVEY.

While a good deal of investigation was done 40 years ago, and presented as a paper

FIG. 1




RIVER SYSTEMS OF SOUTH AFRICA.

by Dr. F. E. Kanthack, very little published work on South African hydro electric investigations has appeared since. It is interesting to recall that in 1920, Dr. Kanthack said, "studying a topographical map of South Africa, one would expect to find power possibilities on most of the rivers of the coastal fringe, and within certain very pronounced limitations, this is actually the case." In the past, there were undoubted difficulties in the way of hydro development, not the least being the fact that the possible power station sites were far removed from the then existing load centres. Moreover, it became evident very early on that river flows in South Africa were extremely erratic and very few records had been accumulated to enable the river potentials to be appraised. In addition, coal was very cheap. To-day, the picture is totally different. The existing transmission networks do not require very much extension to reach certain of the sources of water power. The systems are sufficiently large to absorb large blocks of energy (provided it is cheap) and this makes it easier to justify large scale river regulation. Finally, coal is a relatively expensive commodity to-day compared with forty years ago.

A great deal more investigation into the nature and potentialities of our South African rivers has taken place since the earlier investigations. The Department of Water Affairs are continually adding to their records and although, in the main, their efforts have been directed towards providing water for irrigation and urban water supplies, a wealth of information is available to from the basis of further investigations into the power potential. This information, as well as a great deal of technical assistance, has been made avaliable by the Director of Water Affairs.

In 1952, D. C. Midgley produced a thesis entitled "A preliminary survey of the surface water resources of the Union of South Africa." This work has been used extensively in the production of this paper.

## 3. GENERAL POTENTIAL.

The Union of South Africa is roughly 470,000 square miles in area, and consists of a large plateau sloping gradually from East to West. In the East and South, the plateau is bounded by a distinct escarpment. This range, in the East, runs roughly from North to South, starting off as the Zoutpansberg, then becoming the Drakensberg, Quathlamba and Stormbergen. In the south, the mountain ranges become folded and run from east to west, finally turning northwards in the west. The folded ranges comprise a series of steps inland from the coast over a distance of about 300 miles, the first step for the most part being only about 50 miles or less from the sea.

The country has a number of river systems which are shown in Figure 1. By far the largest portion of the great plateau is drained by the Orange River system, of which the Vaal River is the major tributary. These rivers between them drain approximately 236,000 square miles, a large portion of which unfortunately is blessed with extremely low average rainfall. The next largest river system is the Limpopo which drains about 70,000 square miles of the interior plateau, as well as the northern-most tip of the escarpment. The remaining river systems virtually drain from the escarpment into the sea, and range around the coast from the Olifants river on the west coast to the Komati on the east coast.

From analysis and extension of available rainfall and river gauging records, and a detailed study of the topography, vegetal cover and other factors, Midgley has estimated gross average annual runoffs for the various river systems, as shown on Table 1.

The gross surface runoff shown in Table 1 is subject to certain losses for which allowance must be made. There are unnatural losses due to upstream usage, and natural losses due to water seeping into river beds and to evaporation. A large proportion of the water which seeps into the ground does, at times of low flow, return to the stream, the ground acting like a sponge. The figures shown do not take account of water usage, losses and accretions. It has been estimated that the present total usage is approximately 2.8 million acre feet per annum, while the river bed losses (nearly all in the arid and semi-arid areas) would amount to about 6 million acre feet. Thus the average net

**TABLE 1.**

| Region Number | Drainage System | AREA IN SQUARE MILES Gross | Ineffective (No run-off) | Net | Gross average annual surface runoff from net effective area. (acre-feet) |
|---|---|---|---|---|---|
| 100 | Limpopo | 70,549 | 7,660 | 62,889 | 5,531,520 |
| 200 | Komati | 11,866 | 51 | 11,815 | 3,264,570 |
| 300 | Vaal | 75,730 | 23,115 | 52,615 | 4,058,140 |
| 400 | Orange (excluding Vaal) | 160,302 | 44,851 | 115,451 | 6,347,710 |
| 500 | Olifants | 17,993 | 776 | 17,217 | 865,850 |
| 600 | Cape Western | 11,187 | 2,499 | 8,688 | 57,860 |
| 700 | South Western | 9,834 | 2,637 | 7,197 | 1,695,060 |
| 800 | Breede | 5,987 | 455 | 5,532 | 1,539,850 |
| 900 | Gouritz | 17,546 | 71 | 17,475 | 544,760 |
| 1000 | Outiniquas | 2,807 | 15 | 2,792 | 549,490 |
| 1100 | Gamtoos | 13,270 | 103 | 13,167 | 458,130 |
| 1200 | Algoa Bay | 1,000 | — | 1,000 | 122,190 |
| 1300 | Sundays | 8,061 | — | 8,061 | 240,820 |
| 1400 | Great Bushmans | 2,202 | 367 | 1,835 | 66,990 |
| 1500 | Great Fish | 11,724 | 910 | 10,814 | 541,490 |
| 1600 | Amatola | 3,081 | — | 3,081 | 432,480 |
| 1700 | Great Kei | 7,989 | — | 7,989 | 988,160 |
| 1800 | Transkei | 18,201 | — | 18,201 | 7,994,240 |
| 1900 | Natal | 7,127 | — | 7,127 | 3,218,500 |
| 2000 | Tugela | 11,257 | — | 11,257 | 4,114,070 |
| 2100 | Zululand | 23,078 | — | 21,415 | 6,149,750 |
| Totals | Whole Union (including Swaziland and Basutoland) | 490,791 | 85,173 | 405,618 | 48,781,630 |

surface runoff of the Union, reaching the sea, is approximately 40 million acre feet per annum, this being roughly 8% of the average rainfall or just over 1½ inches averaged over the whole surface.

This net average runoff is referred to as the mean annual runoff (MAR) and is the volume of water, expressed in acre feet, flowing in the river system in an average year. It will be fully appreciated that in some years considerably less flow than the MAR is experienced and in some years considerably more.

If but half of the mean annual runoff reaching the sea could be utilised at a head of 400 ft., it would provide more than 6,000 million units, i.e., about one-third to the total electrical energy used in the Union in 1959. Bearing in mind that much of the water comes from altitudes in excess of 4,000 ft. above sea level, it should be possible to find some sites where large blocks of hydro electric power are economically feasible.

An analysis of Table 1 in relation to the Union's present power requirements very quickly restricts the scope of investigations.

The Limpopo and Komati rivers flow largely in adjoining territories and are also very far from any major load.

The Vaal and the Orange rivers are well situated with respect to load centres, and carry a lot of water — in fact about one-fifth of the total runoff of the Union.

The Vaal with its existing development and usage combined with the terrain through which it flows, provides no major hydro electric possibility, though it may be of interest to examine the cost of units that could be generated from the water flowing through Vaaldam. The Orange, however, has several possibilities, which are dealt with in detail later.

The remaining river systems draining the escarpment do not really offer much scope until one reaches the Transkei and Natal, where one finds that the four river systems listed, (Transkei, Natal, Tugela and Zululand), account for nearly half of the total Union potential. All these river systems are in areas where present water usage is relatively limited, losses due to evaporation least, and perennial rivers plentiful.

Although the potential of the Transkei is fairly high, there is at the moment insufficient load to justify development of any major scheme. If, however, there is large scale development of the Bantu Areas, there may well be a case for hydro power, particularly as the alternative thermal power would be relatively expensive. This potential is reviewed later in the Paper.

In Natal and Zululand, we have nearly one-third of the Union's water resources, and the power potential is considerable. In order to keep this paper to a reasonable length, only the more promising rivers in this region have been examined, these being the Tugela and the Pongola.

## 4. UTILISATION OF WATER.

### (i) *General characteristics of S.A. Rivers.*

The long-term MAR figures shown in Table 1 give only a broad picture of the river flow. These represent total flows in an average year, whereas actual discharges during the year may vary in some rivers from nil to a hundred or more times the mean annual discharge. During some years, actual total flow is well below the MAR, while during others it is considerably in excess. This characteristic, which is more accentuated in the Union than in many other countries, presents the problem underlying river regulation, particularly from the point of view of power generation, for which the water supply must be reasonably constant throughout the year and from year to year. Midgley and others have shown that in order to achieve reasonably accurate assessments, say, within ± 10%, MAR's should be based on observations over a period of at least 30 years.

Long term records are also necessary when it comes to assessing the capacity of storage required to withstand a given drought. For every river there is a typical relationship between storage and permissible sustained yield: a typical curve for a Natal river, in which these variables are expressed as percentages of the MAR is shown in Fig. 2(a). The lower curve is the yield after allowing for evaporation losses. It is clear

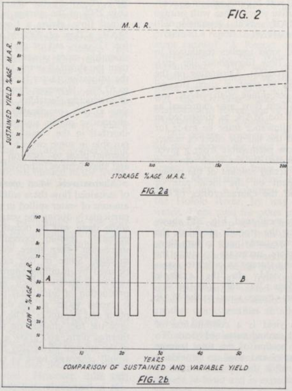



FIG. 2

FIG. 2a

FIG. 2b

that the curve represents a law of diminishing returns.

(ii) *Assessment of River Potential.*

As may be well appreciated, the usefulness of natural stream flow in South Africa, i.e., not regulated by storage, is extremely low. Unregulated flow is in any case restricted to perennial streams. The sustained yield from unregulated rivers is the minimum flow experienced during severe drought and this figure for South Africa averages probably less than 3% MAR. Seasonal yields, occurring during the summer months over the greater part of the Union for 70 years out of 100, have been estimated by Midgley at about 20% MAR, with failures lasting generally less than two consecutive seasons. This type of flow is of limited use for hydro electric development and so it is necessary to resort to storage.

With storage there are three types of yield that can be considered. These are:—

(a) intermittent yield (seasonal regulation),

(b) sustained yield,

(c) variable yield.

(a) With seasonal regulation it is permissible to draw off in the dry season the water than has accumulated in the wet season. On this basis it has been calculated that with storage equivalent to the MAR, it is possible to use up to 90% MAR for 70 years out of 100 with failures seldom exceeding two consecutive years. Thus with storage equal to the MAR, seasonal regulation will give a utilisation of 63%.

(b) Sustained yield implies regulation to give a uniform flow throughout the year, irrespective of droughts. Depending on the characteristic of the river, a given storage, expressed as a percentage of the MAR, will allow a certain firm flow, also expressed as a percentage of the MAR, as illustrated in Fig. 2(a). An allowance must be made for evaporation and this has the effect of reducing the firm flow permissible from a given storage, as indicated by the lower curve in Fig. 2(a). The actual amount of the reduction is dependent on the local rate of evaporation and the characteristics of the storage basin.

As previously mentioned, Fig. 2(a) shows that the greater the storage provided, the smaller is the incremental gain in firm flow, and it is, therefore, necessary to study the costs of providing storage in order to assess the optimum yield. In the example illustrated by Figs. 2(a) and 2(b) the sustained yield from storage equal to the MAR is 50% MAR.

(c) Variable yield is a combination of seasonal regulation and sustained yield. To achieve this, a portion of the total storage is kept in reserve and used to provide a sustained yield while the balance is used as seasonal storage.

Again consider a total storage equivalent to the MAR, but in this case reserve 25% for sustained flow and use 75% for seasonal flow. In the example of Fig. 2(a), the 25% MAR storage will allow a sustained flow of 26% of MAR, while the remaining 75% of the storage will give flow of 90% MAR which will be available for 65 years out of 100. The same storage thus gives:—

90% MAR for 65 years, and

26% MAR for 35 years, which represents an average utilisation efficiency of 67.6%.

Fig. 2(b) has been prepared to illustrate the overall gain by working on the basis of variable yield. This figure has been plotted to show the annual flow over a 50 year period on the basis of 100% MAR provided as storage. The sustained yield would be 50%, shown by the line AB. If, however, only 25% of the storage is reserved for sustained flow, giving a flow of 26% of the MAR, a flow of 90% MAR can be taken for 32 years out of the 50. There is considerably more power above the line AB than the shortfall in the 18 "lean" years, and the utilisation factor is improved from 50% to 67.8%. However, from the point of view of producing electricity, this form of operation is not practicable unless there are alternative power sources to make up the shortfall in the "lean" years. It might be possible in some cases to retain obsolescent thermal plant to "firm-up" the hydro power and thus achieve improved water utilisation.

Alternatively, when operating on the basis of sustained flow there will be a considerable amount of water spilled in the rainy seasons, particularly during the years of high rainfall, while there will be occasional periods, but probably seldom exceeding 3 years in succession, when there will be little or no spillage. Some of this excess water could be used by installing appropriate additional turbine capacity which would permit the production of additional power when there is excess water at the cost merely of the plant and penstocks. This generation would save the fuel charges on the corresponding thermal plant, and allow a partial reduction in the amount of standby thermal plant that would otherwise have to be provided.

(iii) *Silt.*

It is frequently said that silt is a major problem when it comes to storage in South African rivers. While this is to a certain extent true, it is a problem that to-day can be reasonably well handled. A great deal of investigation has taken place into the silt burden of various rivers and quite accurate information is available as to the volume of silt likely to be deposited under natural conditions in a reservoir.

When designing storage works, allowance must be made for the accumulation of silt, and it is possible to calculate the life that can be expected from a particular reservoir basin from the point of view of silting, and provision can be made either for separate silt basins or for "dead" storage in the main basin. When considering storage dams for hydro-electric works, as distinct from irrigation works, the "dead" storage may not be such a serious matter. To produce power one wants both head and volume of water: provision of "dead" storage increases the head available on the "live" storage. Silt can therefore be dealt with fairly readily — in fact, adequate "dead" storage would very often be inherent in a dam designed primarily for hydro electric purposes, since some "dead" storage is probably an automatic result of establishing the head and limiting the drawn-down to that for which the turbines are designed.

It is hoped that as soil conservation measures are extended there will eventually be a decrease in the silt burden in the rivers, though this will also result in a reduction in water available.

(iv) *Evaporation.*

In South Africa, particularly in the arid areas, evaporation has an appreciable effect on the quantity of water available from storage. Here too extensive investigations have been carried out over a number of years, and information is available to enable satisfactory allowances to be made when calculating the yield from storage.

In recent years, there has been a great deal of research into means of treating water surfaces so as to reduce evaporation. Considerable claims have been made for the use of cetyl alcohol powder, but tests in the Union have indicated that these claims cannot be substantiated. However, it is not unreasonable to hope that success in this field will eventually be achieved.

5. ORANGE RIVER SCHEMES.

On the Orange River, several schemes have been investigated. Three which are concerned primarily with the production of hydro electric power are listed below, although several other projects have been suggested.

(i) The Ox-Bow Lake Scheme in the upper reaches of the river in Basutoland;
(ii) The Vanderkloof Scheme near Hopetown, and
(iii) The Oranjedam near the mouth of the river.

The Reports published on these schemes to date are all in the nature of preliminary studies.

(i) *The Ox-Bow Lake Scheme.*

In February, 1956, Mr. Ninham Shand presented a report to the Basutoland Government entitled "A Report on the Regional Development of the Water Resources of Basutoland." This work dealt with three possible developments on the upper Orange River system, the most attractive of which was the Ox-Bow Lake Scheme on the Malibamatso River, one of the main source tributaries of the Orange.

This scheme consists of building a rockfill dam across the river at an altitude of about 8,200 feet above sea level. A tunnel approximately four miles long through the Maluti Mountains enables the water to be dropped into a tributary of the Caledon, the Hololo River, by way of which the water, if not used for other purposes, would eventually return to the Orange River. By this means, the water from the Ox-Bow Lake commands a head of nearly 2,000 feet and is able to produce a considerable amount of energy. The general layout of the scheme is shown in Fig. 3, from which it will be seen that further tunnel system taking the water off from the Hololo River through another tunnel enables an additional 800 ft. head to be used.

Since 1956, investigations have been proceeding with the collection of hydrological data in the catchment areas and the preparation of accurate maps. A further report is at present in hand and is expected to give more accurate assessments of the hydro electric potential and more detailed estimates of costs. This report should be completed towards the end of 1961.

In addition to using the waters of the Malibamatso River, it has been pointed out that it might be practicable to tunnel through the various divides and collect, into the Ox-Bow Lake, water from several other rivers, namely the Motete, Matsoku and Khubelu. All these rivers eventually join up to become the Orange. At present, however, no real assessment is possible as to how much extra water will be available from these other rivers, but they could conceivably double or even treble the Ox-Bow potential.

The preliminary assessment of the Ox-Bow Scheme indicated that the Malibamatso

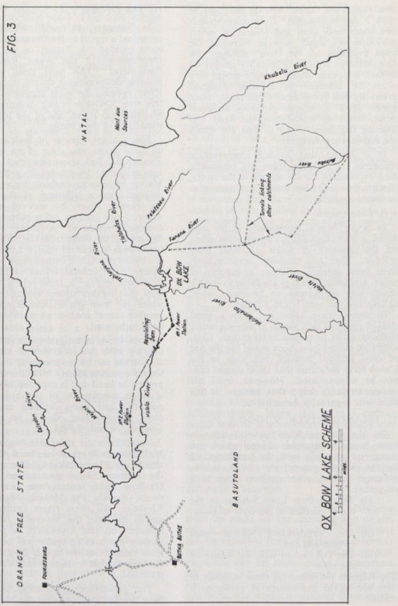



FIG. 3

OX BOW LAKE SCHEME

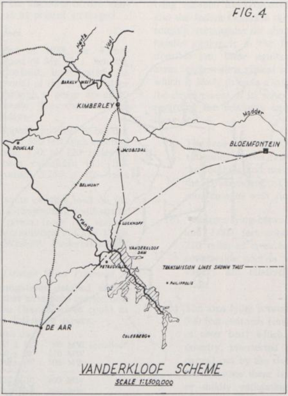



FIG. 4

VANDERKLOOF SCHEME

SCALE 1:1,500,000

River system alone could produce about 395 x $10^6$ units of electricity per annum, or slightly less electricity (about 10%) and some 40 million gallons of domestic water per day. With the addition of three rivers, it will be appreciated that a large block of electric power could be made available in the northern Free State.

(ii) *The Vanderkloof Scheme.*

Early in 1959, Merz and McLellan (South Africa), using an earlier report of Mr. Ninham Shand as a basis, made a preliminary investigation into the hydro electric potential of the Orange River at Vanderkloof. This was done at the request of the Northern Cape and Adjoining Areas Regional Development Association.

At Vanderkloof, which is roughly 50 miles up river from Hopetown, it appears feasible to build a dam 350 ft. high, impounding some 3.3 million morgen feet of water (or 7 million acre feet) of which effective use could be made of some 1.5 million morgen feet. This could produce about 940 x $10^6$ units per annum and sufficient water to gravity irrigate 95,000 morgen of land immediately below the dam itself, not to mention the vast possibilities of irrigation further down the Orange River through the regulated flow that will result from the production of electricity.

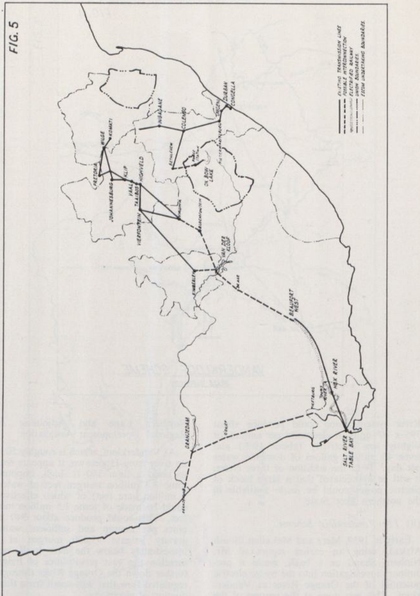


FIG. 5
PRETORIA
WILGE
KOMATI
JOHANNESBURG
VAAL
KLIP
HIGHVELD
TAAIBOS
VIERFONTEIN
INGAGANE
COLENSO
DURBAN
CONGELLA
OX BOW LAKE
KIMBERLEY
VAN DER KLOOF
BEAUFORT WEST
HEX RIVER
SALT RIVER
TABLE BAY
GRANZEDAM
EXISTING TRANSMISSION LINES
POSSIBLE INTERCONNECTION
ELECTRIFIED RAILWAY
UNION BOUNDARIES
ESCOM UNDERTAKING BOUNDARIES

Figure 4 shows the situation of the Vanderkloof Scheme as at present envisaged.

(iii) *The Oranjedam.*

Towards the end of 1959, Dr. Henry Olivier, at the request of Mr. D. J. Scholtz, M.P. for Namaqualand, investigated the hydro electric potential of the Orange River where it passes through a gorge about 80 miles from its mouth. This site has been named the Oranjedam.

At this site it appears possible to build a dam between 500 and 550 feet high creating a reservoir of some 110 to 120 miles in length. It has been calculated that this scheme could produce 2,250 x $10^6$ units per annum.

While there is some existing load on the west coast from Oranjemund southwards, the bulk of the power from this scheme would have to be transmitted to Cape Town and the Cape Western Undertaking of Escom.

*Summary of the Orange River Potential.*

From the investigations detailed above, which are not all that have been carried out, it appears that the Orange River could at least produce the following power:—

| | units p.a. | | |
|---|---|---|---|
| Ox-Bow Lake | 395 x $10^6$ | 90 MW | installed* |
| Vanderkloof ... | 940 x $10^6$ | 210 MW | ,, |
| Oranjedam ... | 2250 x $10^6$ | 500 MW | ,, |
| TOTAL | 3,585 x $10^6$ | 800 MW | |

Figure 5 shows the above three scheme in relation to existing transmission networks together with possible interconnection to facilitate using the hydro electric power. It should, of course, be borne in mind that, at the best, only a small proportion of the projects shown on this figure could be in existence by 1970.

## 6. TUGELA RIVER.

*General.*

Tugela River system drains a catchment area of approximately 11,200 square miles, lying between the Drakensberg in the west and the Indian Ocean in the east. Its basin, roughly rectangular in shape with a short handle joining it to the Indian Ocean, is divisible into three significant topographic areas, each with a typical surface formation which is likely to have a strong influence on the development of its water resources. Disregarding the relatively small coastal area, these are: —

(a) The area above the 4,500 foot contour (20 miles of river bed) which includes the foothills and main escarpment of the Drakensberg. This is hilly and mountainous with steep escarpments.

(b) The area lying between the 4,500 and and 3,000 feet contours (involving 210 miles of river bed) with rolling countryside and in which the river valleys are relatively shallow and wide.

(c) The area lying between the 3,000 and 500 feet contours (involving 140 miles of river bed) which is very broken country, intersected by deep gorges carved out by the rivers and streams. In this zone there is very little level or mildly undulating land and the rivers are at great depths below the surrounding country.

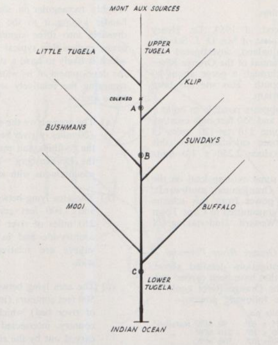
From these divisions, (b) should be investigated to provide the long-term regulation, while (c) should provide in the main the heads for power generation.

Figure 6 shows diagramatically the main river system, while Table 2 shows the extent of the catchment areas and the mean annual run-offs.

An interesting comparison between the Vaal and Tugela River systems is shown in Table 3.

* The installed capacity has been worked out on the basis of a load factor of approximately 50%.

FIG. 6




TUGELA RIVER SYSTEM

**TABLE 2**

| | Area in sq. miles | M.A.R. |
|---|---|---|
| Upper Tugela, including Klip River ...... | 3,266 | 1,300,000 acre feet |
| Lower Tugela ...... ...... ...... ...... ...... | 750 | 360,000 „ „ |
| Sundays ...... ...... ...... ...... ...... ...... | 970 | 240,000 „ „ |
| Mooi ...... ...... ...... ...... ...... ...... ...... | 1,150 | 500,000 „ „ |
| Buffalo ...... ...... ...... ...... ...... ...... | 3,990 | 1,200,000 „ „ |
| Bushmans ...... ...... ...... ...... ...... ...... | 1,074 | 500,000 „ „ |
| TOTAL ...... | 11,200 | 4,100,000 acre feet |

**TABLE 3**

| | Vaal Basin | Tugela Basin |
|---|---|---|
| Total area — square miles | 75,000 | 11,200 |
| Mean annual run-off — acre feet | 4,000,000 | 4,100,000 |
| Population — all races | 3,000,000 | 552,000 |
| Population supplied by urban water undertakings | 1,700,000 | 64,000 |
| Total capacity of storage reservoirs — acre feet | 1,400,000 | Negligible |
| Area under irrigation — morgen | 60,000 | 9,400 |
| Length of main river bed — miles | approx. 650 | 315 |
| Total fall — feet | approx. 2,500 | 10,000 |

From this comparison it will readily be seen that there is considerable scope for development of the Tugela and that, in particular, it should be possible to produce a significant amount of hydro electric power between Colenso and the sea.

As far as records go, the Tugela river was first looked into by Mr. Hangartner at the instigation of Dr. Kanthack, in whose 1920 paper Mr. Mr. Hangartner's estimates were published. Amongst a number of sites listed there were three at which heads of between 410 and 600 feet could be obtained without involving unreasonable lengths of canal. Although existing records do not reveal the exact sites examined by Mr. Hangartner, it is fairly clear from contour maps that the 600 feet head must have been just below Colenso, while there are several places lower down where heads of 400 feet can be obtained. With the assistance of the Water Affairs Department the development of three sites has been examined in the light of present-day knowledge of river regimes and modern dam-building techniques.

*Possible Development on the Tugela.*

SITE A.

A few miles downstream of Colenso the the river falls fairly rapidly and it appears possible to construct a wall approximately 300 feet high and, by means of a canal approximately eight miles long, to command a head of over 500 feet.

The Water Affairs Department have investigated a number of storage sites upstream from Colenso, and at one of these, known as Gorge, it is possible to design for a firm flow of 500 cusecs at a reasonable cost. With additional storage at Colenso itself, assuming only the top 50 feet of a reservoir there to be available for regulation, it has been estimated that a steady flow of about 670 cusecs can be sustained: with a head of 500 feet this will produce only 196 x $10^6$ kilowatt-hours per annum. Alternatively, the combined Colenso and Gorge storage could be operated on a variable flow basis to yield 400 cusecs minimum flow and 1150 cusecs for 65 years out of 100, with a maximum dry period not exceeding three years. On this basis, the energy available over a 100 year period would average 260 x $10^6$ kilowatt-hours per annum. For 65 years out of the hundred there would be 335 x $10^6$ kilowatt-hours per annum available for the system, while the minimum energy during the 35 "lean years" would be 120 x $10^6$ kilowatt-hours per annum. This means that there would have to be sufficient standby plant on the system to make up the shortfall in these years (one 60 MW machine would suffice). The calculations in Section 9 of the paper are made on the basis of the average energy available, i.e., 260 x $10^6$ kilowatt-hours per annum.

This supply could easily be fed into the existing transmission system at Colenso power station. Assuming that the hydro

plant would largely be contributing peak units, i.e., operating on a comparatively low load factor of about 25%, the station would have to have approximately 120 MW of plant installed. During times of good river-flow this plant could be run at a higher load factor.

SITE B.

Site B is situated a few miles above the confluence of the Bushmans river. The flow provided by the storage at Site A and Gorge would be augmented by contributions from the Klip River.

At Site B it would seem practicable to build a wall 120 feet high. Storage of 120,000 acre feet at this site will give a sustained flow of 870 cusecs or a variable flow of 520 cusecs minimum and 1,480 cusecs for 65 years out of 100. A canal approximately 17 miles long from this site would command a head of 430 feet. This site with 150 MW of plant would be capable of producing 300 x $10^6$ kilowatt-hours per annum.

SITE C.

At this site practically the full flow of the Tugela river system becomes available. In this section the gradient of river is relatively flat and head would have to be created by damming up the narrow river valley. Whilst there are a number of possible sites that merit detailed investigation, one particular site has been selected for the purpose of this exercise. At this point it would appear feasible to construct a wall approximately 300 feet high in a narrow gorge and a tunnel one mile long would give a further 200 ft. head. With the storage already provided on the river at sites A and B, together with regulation in the upper reaches of the Buffalo, and using the top 100 feet of this dam, it should be possible to obtain a sustained flow of at least 3300 cusecs. With the 100 feet draw-down, the mean head available at this site would be 450 feet. The site has thus a potential of 1,000 x $10^6$ kilowatt-hours per annum, from an installed plant capacity of approximately 300 MW.

*Summary.*

Preliminary investigations indicate that the three sites are capable of producing nearly as much energy as was supplied by Escom to the whole of Natal in 1958. At the present rate of growth of power consumption, the hydro installations envisaged above would meet Natal's increasing demand for a period of about eight or ten years.

The suggested broad programme of development of the Tugela river illustrates an important characteristic of river utilisation. This is that by commencing regulation works in the upper regions of a river system, the regulated flow can be used several times over in the lower reaches of the river. Moreover, the development of the river potential can take place in stages, keeping in step with the growth of the electrical system and the demand.

## 7. PONGOLA RIVER.

Next to the Tugela, the Pongola river is the largest in Natal. The river rises at an altitude of more than 7,000 ft. above sea level, falling fairly rapidly to an elevation of 3,000 ft., where it flows through the middleveld zone. Here the river is contained in a narrow valley. Shortly after being joined by the Bivani river, and some 140 miles from the source of the Pongola, the valley broadens out into two relatively wide basins, both below 1,000 ft. in elevation. The first of these has been used as the Pongola Government Irrigation Scheme, while the lower has now been reserved as the storage basin for the Pongolapoort Dam.

Any development of power on the Pongola River, other than that which can be produced at the Pongolapoort Dam, must take place in the upper reaches of the river or in the middleveld zone. Basic storage would have to be developed in the upper reaches of the river system and in the narrow valleys it will be necessary to build high dams which would provide some additional regulation and create head. It might even be possible, where the river falls rapidly, to obtain more head by means of canals or tunnels. The investigations of Hangartner and Tonnessen in 1920 estimated that the Pongola could produce nearly 1,000 million units per annum and this potential is certainly worth detailed investigation in the light of modern knowledge and dam building techniques.

## 8. TRANSKEI AREA.

The Transkei is the centre of a good deal of interest at the present stage of South Africa's development. We are told that it is the Government's intention to develop the area and, in particular, to foster the growth of industry. Power, at reasonably economic rates, is an essential for modern industry, and its production in these somewhat remote areas will be a major problem to be tackled before any real development can take place. If thermal stations are to be considered, they will have to be sited within reach of adequate water and rail access. The latter may necessitate the building of special railway lines which, to obtain a true comparison, should be added to the capital cost of any thermal power station. All these factors considered, it is extremely unlikely that power from thermal sources in the Transkei could be produced for less than 1½d. per unit.

It has been estimated that this 18,000 square mile region loses water to the Indian Ocean at a minimum rate of 150 million gallons per day. This area is the best watered in the Union, having a run-off of twice that of the Vaal from a catchment less than one-quarter the size. However, a great deal of work is still required to obtain sufficiently accurate information to form the basis of reliable studies. For example, silt in this area would be a major problem.

There are already a few hydro developments in the Transkei, e.g., the town of Umtata obtains its main requirements from the Umtata River. There are numerous possibilities for small power generation schemes all over the area, either as run-of-river schemes or requiring only moderate storage.

On the Bashee River, D. C. Midgley has estimated that a modest amount or regulation would give a minimum flow of 300 cusecs and this could be used to produce 15 MW of firm power.

The Umzimkulu river also has numerous spectacular waterfalls. This river however has a comparatively steep gradient along its entire length, and would require a fairly high dam to arrest its flow. Nevertheless, power installations of the order of 7 MW should be possible.

Thus, it is quite apparent that the Transkei has considerable power potential, a large portion of which could be developed with reasonable economy in comparatively small stages. This sort of development would fit in particularly well with the building up of the territory, and it is hoped that these sources of power will be fully investigated when the time comes.

## 9. COSTS.

### (i) *General.*

There is no doubt whatsoever that the fundamental fact which will finally determine whether or not hydro electric power comes into being in South Africa is the question of cost. There are certain other factors, such as the general benefit to the country of river regulation and the utilisation of a non-wasting asset, but these can only help to swing the balance if the cost of hydro power compares favourably with the cost of thermal.

For the comparison with hydro electric possibilities, it is proposed only to examine the present costs and trends of conventional coal-fired steam generating plant without complicating the issue by considering nuclear generation. This is a separate problem and one which will also eventually have to be decided on the basis of economics, although the day may well come when we will have in South Africa a nation-wide system embodying all three forms of generation.

### (ii) *Costs of Thermal Generation.*

The cost of producing electricity at the power station busbars is made up of three components. These are:—

(a) the annual charges on the capital invested,

(b) fuel costs, and oil water and stores, and

(c) operating and maintenance costs.

It has been the constant endeavour of planning and generation engineers to try to keep down the cost of producing electricity, but the only means at their disposal is resorting to larger power stations and machines, and higher steam conditions, which result in a lower cost per kilowatt installed and which give an improved heat rate. Against this there are several factors

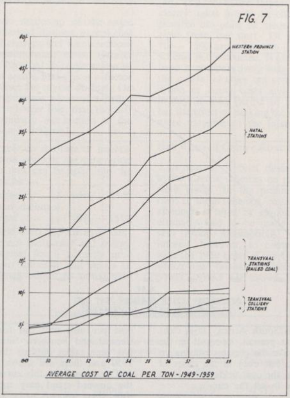



FIG. 7

AVERAGE COST OF COAL PER TON - 1949 - 1959

— higher interest charges on capital, increases in the cost of coal, and increases in the cost of labour. These seem to have outweighed the falling construction costs and the improvement in efficiency, and the nett result has been a steady rise in the cost per unit sent out from power stations in South Africa. It is extremely difficult tc see when, if ever, there will be a change in this trend insofar as thermal generation is concerned.

From the figures published in the 1959 Electricity Supply Commission Report (assuming that five-sixths of the loan and reserve charges are on account of generating plant, and one-sixth on account of transmission), it would appear that the average generation cost is made up of the following proportions:—

(a) loan charges ...... ...... ...... 47%
(approximately half being interest and half redemption and reserve funds)

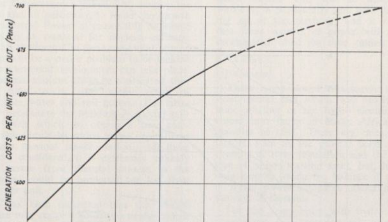
(b) coal costs ...... ...... ...... 38.5%

(c) operating and maintenance 14.5%

Of the above figures, more than half, i.e., coal costs and operating and maintenance, are subject to inflation, after any given station is built.

Figure 7(a) illustrates what is happening to the costs of coal delivered to various

FIG. 8




GENERATION COSTS PER UNIT SENT OUT.
FOR COMBINED NATAL UNDERTAKINGS

power stations in South Africa. It is clear from this that, at present, increases in the cost of railage have the greatest bearing on the rising prices, but even in the cases of power stations on the coal fields, there is an upward tendency in all the curves.

In recent years, information has been published in the Annual Escom reports, from which it is possible to derive total generation costs per unit sold or sent out from various power stations. The generation cost per unit sent out for the combined Central and Southern Natal Undertakings has been taken out for the years 1955 to 1959 and these are shown in Figure 8. It will be seen from this curve that, although the upward trend may continue for some time, there appears to be a decrease in the rate of rise.

From the published information, Table 4 shows the generation costs per unit sent out for various Escom Undertakings in 1959.

**TABLE 4**
**Generation Costs — 1959**

| Undertaking | Total units sent out x $10^6$ | Total generation cost £ x $10^6$ | Cost/Unit pence |
|---|---|---|---|
| Natal (Central & Southern) | 1,931 | 5.331 | 0.663 |
| Cape Western | 920 | 3.663 | 0.956 |
| Rand & O.F.S. | 11,157 | 17.966 | 0.386 |

(iii) *Cost of Hydro Generation.*

These costs are made up of the same components as thermal stations, except that there are no fuel charges and much reduced operating and maintenance costs. Greater capital costs are involved in construction of hydro stations as a rule, and this is a factor which tends to offset the saving on fuel. On the other hand, the main assets of a hydro power station have longer lives than thermal plant and consequently the burden of the annual redemption is lessened.

Dependent largely on the rate of interest and the redemption periods, the generation costs of a hydro unit can be split into the following proportions:—

| | |
|---|---|
| Capital charges ...... ...... | 90% — 85% |
| Operating and maintenance charges ...... ...... | 10% — 15% |

As both of these costs are virtually constant, whether or not the power and energy the plant is designed for is actually produced, the cost per unit sent out varies as the ratio of designed output to actual output. It is, therefore, important that if hydro electric units are to be cheap, the greatest possible use must be made of the potential right from the start. Of these costs only 10 — 15% are subject to inflation once the scheme is constructed. Hydro power stations have a comparatively long life over which the capital charges are constant. In a condition of rising costs and devalutation of money, a long period of constant charges has the effect of making the energy relatively more valuable in the later years.

(iv) *Costs of Orange River Schemes.*

In Section 5, brief descriptions of three hydro electric schemes on the Orange River were given. In the preliminary investigations of these schemes, costs were estimated, although it must be emphasised that these estimates had to be made of necessity on very broad assumptions. It may be of interest, however, to compare these costs with the 1959 costs of the Undertakings into which the various projects might supply power. These are shown in Table 5.

**TABLE 5**

**Comparison of hydro and thermal costs**

| Hydro Scheme | Cost per hydro unit supplied | System into which power would be fed | 1959 cost of thermal units generation only | Coal Cost component | 1959 average selling price/unit |
|---|---|---|---|---|---|
| Ox-Bow Lake | 0.345d. | Natal | 0.663 | 0.315 | 0.822 |
| Vanderkloof | 0.47/.39 | Cape Northern | 0.386* | 0.118* | 1.1509 |
| Orangedam | 0.46 | Cape Western | 0.956 | 0.334 | 1.2317 |

* This price is for the Rand and O.F.S. Undertaking which supplies the Cape Northern Undertaking. The Vanderkloof costs however include transmission, and therefore should be compared with the average selling price in the Cape Northern Undertaking.

Although the figures shown in Table 5 must be treated with some reserve, there certainly appears to be a case for detailed investigation into these possible sources of power.

(v) *Economics of Development of Tugela Power.*

In Section 6, an indication was given of the possible power that might be developed in stages on the Tugela river. We have also seen that, in 1959, the cost per unit generated in Natal was .663d. and the trend indicated still further increases. This trend may be arrested (or even reversed slightly) when Ingagane power station comes into operation in 1963/64. If it is assumed that hydro power could be sold at a maximum cost of 0.65d. per unit, the revenue obtainable from each scheme can be derived and, on the basis that the capital charges and running costs would be not more than 7½%* of the capital spent, we can estimate the maximum amount of capital which could be invested in hydro electric works on the river. These figures are set out in Table 6.

**TABLE 6**

| | Annual Units Available | Annual Units sent out (97.5%) | Annual Revenue (at 0.65d. /unit) | Capital which could be spent |
|---|---|---|---|---|
| Scheme A (Colenso) | 260 x $10^6$ | 254 x $10^6$ | £688,000 | £9.15 x $10^6$ |
| Scheme B (Bushmans River) | 300 x $10^6$ | 292 x $10^6$ | £790,000 | £10.5 x $10^6$ |
| Scheme C (Lower Tugela) | 1000 x $10^6$ | 975 x $10^6$ | £2,640,000 | £35 x $10^6$ |

Scheme A requires 120 MW of plant — say six sets of 20 MW each. It is reasonable to assume that the electrical and mechanical equipment in the station will cost approximately £1.92 x $10^6$, while the transmission required to connect this station to the existing system at Colenso is estimated to cost £200,000. This leaves approximately £7.0 x $10^6$ to be spent on the civil engineering works.

It has been estimated that the cost of the Gorge Dam will be £2.8 x $10^6$ and that of a 300 ft. high dam below Colenso £2.5 x $10^6$. It is necessary to add to these figures an amount to cover the canal, penstocks, surge chamber and power house, which have been estimated to cost £1.5 x $10^6$. Thus, the total civil costs might be approximately £6.8 x $10^6$, which means that the first stage of the Tugela development appears to be possible at a lower cost than the 1959 average thermal generating cost in Natal.

Having now obtained a regulated flow of 730 cusecs at an altitude of 2,500 feet above sea level, considerable further use can be made of this as it flows to the sea. Although the possible site at the Bushmans confluence has not been examined, it is believed that the total civil works here would not exceed the costs for the Colenso installation. These works still further increase the water available and it is not unreasonable that a scheme making use of the full flow of the river below the confluence of the Buffalo river can be built for not more than £18 million, which would result in halving the costs of generation. If this site is still sufficiently far upstream, it is not inconceivable that other falls could be made use of, either by means of tunnel or canal deviations, again making use of the water at very low cost. It is, therefore, quite possible that, having done most of the regulation upstream, the sites on the lower reaches of the Tugela could produce power at a cost considerably less than the present thermal stations, and possibly at a cost comparable with a station the size of Ingagane, built on a coalfield.

Even with collieries immediately adjacent to the power station, the output is very much dependent on a large labour force, and the coal itself is a wasting asset. Neither of these two disadvantages are present in the case of a hydro electric power station.

## 10. COMBINED OPERATION OF HYDRO AND THERMAL PLANT.

(i) *General.*

From one point of view the operation of a hydro power station is considerably less complicated than that of a thermal station. In the latter there are boilers with their requirements of make-up water and coal or oil, and high speed turbines with their accessories and cooling water. All these items of plant make the starting up and shutting down of steam turbines a com-

* 6½% interest and redemption over 50 years plus 1% for operation and maintenance.

paratively lengthly process. Hydro turbines on the other hand are dependent merely on the opening and closing of valves, and although not quite as simple as turning on a tap, it is a good deal easier to run-up or shut-down a water turbine than a steam turbine. On the other hand the proper operation of a larger reservoir or series of reservoirs needs careful study and constant review.

This feature of greater flexibility in a day to day operation is the basic reason why it can be advantageous to have both types of plant on a system. It means that the hydro plant can in general be used to meet the peak requirements of the daily load curve, while the thermal plant can supply the steady base load. This form of operation, saving the costs of bringing up and banking of boilers, plus the necessity of having thermal machines running for some time before they are actually required, could well result in an improvement of the operating efficiency.

In South Africa, the seasonal variation of the rivers is such that storage is essential for the production of electric power. This means that it will always be practical to run a comparatively large amount of plant for a short time, drawing the available water off at a high rate for this time, and using the rest of the daily (or weekly) cycle for replenishing the storage. Earlier in this paper I have stessed the utilisation of the total energy output of the water resource, but this output can be used at a high rate over a short time simply by installing more plant and larger penstocks. By running hydro plant at a low load factor (many of the Scottish Hydro Board stations run at a load factor of 20% or less), the capital cost per kilowatt available can be considerably reduced.

When the pre-existing system is predominantly thermal, it will usually be preferable, for the reasons stated above, to develop such water power as can economically be justified in comparison with thermal power with the greatest installed capacity, i.e., the lowest firm load factor which the system can accept in conjunction with the more or less fixed amount of energy. This large installed capacity will also permit of the use of flood water which would otherwise be spilled and thus additional energy can be produced at certain times, saving fuel costs on the thermal stations.

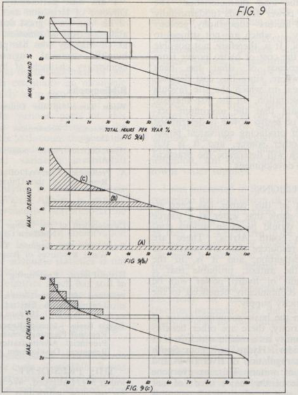
(ii) *Practical Operation.*

Figure 9 (a) shows a typical annual load/duration curve representing a system having an annual load factor of about 50%.

If this load has to be met by thermal plant alone, machines will, so far as possible, be brought into operation sequentially in ascending order of their fuel cost per kilowatt-hour sent out. This generally results in the oldest and least economical machines running on peak load only.

It is not possible however to achieve the theoretical optimum use of plant in practice; factors such as reduced availability of base-load plant, lack of flexibility of thermal peak load plant, transmission limitations and operating difficulties (such as the tendency to run up the peak-load plant sooner than is necessary, or even completely unnecessarily) result in the less efficient stations generating more than their theoretically desirable quota, and the more efficient stations generating less. Fig. 9 (a) has superimposed on it the blocks of energy generated by different plants grouped in order of fuel costs per kilowatt-hour sent out. It can be seen quite clearly how the less efficient machines being run to meet the upper 40% of the demand produce considerably more energy than the theoretical optimum.

Consider now the same load/duration curve with a portion of the energy available from hydro sources. Assume that the total hydro energy available is a relatively small proportion of the total system requirements, as would be the case with almost any hydro development in South Africa. This means that the installed capacity of the hydro plant could be determined independently of the load. The hydro station could be built as a base-load plant, operating at an annual load factor of 100%, or the total block of energy could occupy any position on the load curve, ultimately operating entirely as peak load plant. Three possible positions are shown in Fig. 9 (b), each of the hatched areas representing an equal quantity of




energy. Position 'A' represents base load plant operating at 100% load factor and having a total installed capacity of 'X' kilowatts. Position 'B' represents plant operating at a load factor of 50%, i.e., the installed capacity now being 2x, while Position 'C' represents plant operating at a load factor of about 10%, i.e., an installed capacity of 10X.

It might possibly be found from a detailed study of the system conditions and the costs of the hydro plant, that it appears advantageous to supply the upper energy requirements from hydro sources. This conceivably could result in plant utilisation as illustrated in Fig. 9 (c). Owing to its greater flexibility, the hydro plant can be brought into service (and taken out) more efficiently than steam plant which results in a closer approach to the theoretical optimum plant operation over the portion of the curve supplied by hydro plant. This means that a greater proportion of the total energy requirement is left to be supplied by the more efficient of the thermal plant, resulting in greater overal efficiency and a reduction of system cost.

It must be emphasised that there are many factors which determine the optimum integration of hydro and thermal plant on a common system. The basic consideration must, in most cases, be costs, influenced to a greater or lesser degree by the physical arrangements of the system, operating conditions and the load characteristics. The cost of hydro power depends fundamentally upon physical factors—topography, geology and hydrology — which are not subject to human control. It is, therefore, not possible to determine the cost of hydro power from general experience of what has been achieved elsewhere, since this cost depends upon the extent to which the site favours economic exploitation. In the last analysis, it may be said that the maximum permissible cost of hydro power is determined by the cost of producing equivalent power from some other source, and it is this criterion which will determine the practical level of hydro development.

## 11. CONCLUSIONS.

The object of this paper has been to endeavour to show that water as a source of electricity should be given serious consideration in South Africa. There are undoubtedly resources that are worthy of detailed investigation, and it is, in the opinion of the author, probable that a certain amount of hydro power will be found to be economically beneficial to the present electricity supply.

Apart from the basic economic factor of cheaper electricity, there are other benefits to the community as a whole which it is as well to consider. Hydro power in South Africa means regulation of river flows and conservation of water. This, as everyone knows, is one of the major needs of our country, and one in which development is always hamstrung on account of capital requirements. Production of electric power can possibly provide a lot of the capital necessary for regulation and thereby cheapen irrigation works and conservation of water for domestic and industrial purposes.

And lastly, water power, unlike coal, is not a wasting asset, it is being constantly replenished year after year in a never ending energy cycle.

## ACKNOWLEDGMENTS

I should like to express my thanks to several of my colleagues in Merz and McLellan for their valued assistance and to Mr. Ninham Shand for his helpful advice.

I am also particularly indebted to the Director of Irrigation and several members of his staff for a great deal of hydrological and statistical information, and to Professor D. C. Midgley who has patiently steered a humble electrical engineer through the elementary channels of hydrology.

### Bibliography

Water Power in the Union of South Africa — Dr. F. E. Kanthack

Fundamental Economics in Hydro-Electric Design — C. M. Roberts

Hydro-lectric Power possibilities in Southern Africa — Dr. D. F. Kokot

A Preliminary Survey of the Surface Water Resources of the Union of South Africa — D. C. Midgley

The Orange River — a Prelimenary Survey — Ninham Shand

Development of the Orange River — Northern Cape Water Resources.

Report on the Regional Development of the Water Resources of Basutoland — Ninham Shand

Hydro-Electric Engineering Practice, Edited by I. Guthrie Brown

Problems of Hydro-Electric Design in Mixed Thermal-Hydro Electric Systems — T. G. Haldane and P. L. Blackstone

Tugela Basin — Interim Report by the Town and Regional Planning Commission for the Natal Provincial Administration and the Natural Resources Development Council.

THE PRESIDENT: Thank you very much Mr. Langford. We are going to break for tea now, gentlemen.

(CONVENTION ADJOURNED FOR TEA.)

*On Resuming.*

THE PRESIDENT: I am now going to call on Mr. R. M. O. Simpson to propose a vote of thanks to Mr. Langford for his paper.

Mr. R. M. O. SIMPSON, DURBAN: Mr. President, Mr. Langford, Ladies and Gentlemen, when I raised the question of "The Water Resources of Natal" in relation to possible Hydrogeneration of Electricity in my Presidential Address last year, I did so in the hope that my sketchy references might encourage further investigation into this cinderella of our natural fuel resources in South Africa and my hope has not been in vain: I have therefore listened to Mr. Langford's paper with very great interest and pleasure.

I fully realise that the development of our water resources is essentially an economic problem, particularly so in respect of Hydro Generation due to the abundant coal supplies available in various parts of this Country. There is also a tendency on the part of many people to discount the potential of our water resources due to the very considerable seasonal variation in rainfall experienced throughout South Africa.

It is very gratifying to know that our Department of Water Affairs is rapidly building up comprehensive statistics on the Country's water resources which are essential before any scheme of conservation and generation can be fully investigated.

The problem of adequate statistics is not only a South African one, as even in the older developed Countries much has still to be done. In fact I think I am correct in saying that some of the British Hydro Stations have been engineered on limited statistics but backed by experience and good judgement.

From papers presented by authorities on the problem of the cycle of rainfalls, it was considered to be very problematical that any reliable information could be obtained from statistics in respect of forecasting either floods or droughts.

In a recent article in the "Engineer" it was recorded that Sir Alexander Binnie had started in 1892, that 30 to 35 years measurements were required to lay down a reliable water supply to a town.

In France an eminent Engineer studied all floods on the Seine from a serious one in 1658 and came to the conclusion that a recurrence of these floods could not be experienced for a 1,000 years: 37 years later this previous highest was exceeded (1910).

This difficulty in finding the cycle of annual rainfall has been experienced in many parts of the world and it is safe to say that even in the Kariba catchment we do not know the periodicity of either the minimum or maximum annual rainfall.

When we take into account the pace of advancement of modern science such as Nuclear sources of generation and possible desalting of sea water on a large scale, it will be necessary to place a limit on the time available for the compilation of water records, if we are to gain the benefit of Hydro Generation in the very vital drive for the conservation of South African water supplies and the regulation of river flow, with the consequent added advantages of irrigation, soil conservation and adequate towns water supplies.

I was interested in the Author's suggestion regarding the installation of small automatic plants in the Bantu areas of the Transkei; such schemes deserve careful investigation as they may well prove to be cheaper than extending hundreds of miles of high voltage overhead transmission lines into these areas from the nearest thermal Power Stations. Here also we must not loose sight of the benefits that could be obtained by the use of electricity in these areas for railway traction purposes and the saving of long hauls of coal for this purpose.

I was most interested in the Author's schemes on the Tugela River in Natal and I must agree with him that at present day costs of power generated in Natal's Thermal Stations, a case can be made for the establishment of Hydro Generation. This is borne out when we consider that in Durban the cost of electricity purchased from the generating authority is in excess of .75 pence per unit sold (based on the Corporation units sales) on a system with an annual load factor exceeding 55%. There is no doubt that further investigation into the problems of Hydro Generation is necessary, particularly in the light of economics of operation including operation in conjunction with Thermal Power Stations. In the case of the smaller stations where cost of civil works can be kept to a relatively low figure, peak load operation cannot be overlooked in certain cases.

In conclusion I would like to stress the need for an immediate thorough investigation into the establishment of Hydro Generation in South Africa and particularly as a start using the Tugela River in Natal due to the ease of interconnection with the existing 132 K.V. transmission system and the proposed 275 K.V. system from Ingagane. If Rhodesia can have the courage to build Kariba, South Africa surely cannot be afraid to venture into a relatively small scheme on the Tugela River, particularly when we consider the advantages that will most certainly accrue from the regulation of its river flow.

Mr. President, Ladies and Gentlemen it gives me very great pleasure to propose a hearty vote of thanks to Mr. Langford for his interesting and most valuable paper and I trust that his efforts may be rewarded by a determined effort on the part of the authorities concerned to objectively investigate the use of South Africa's water resources for generation of electricity in conjunction with irrigation and Railway electrification.

THE PRESIDENT: Thank you Mr. Simpson. I'll now call on Mr. Milton to second the vote of thanks.

Mr. W. H. MILTON, JOHANNESBURG: Mr. President, Ladies and Gentlemen, once again this Association has been presented with a very valuable paper not only from the point of view of its contents but viewed in the light of future requirements for power and energy.

Not long ago the Chairman of the Transvaal Coal Owners' Association expressed the view, if my memory serves me correctly, that we had sufficient reserve of coal in the Union of South Africa to last for the next two hundred years at our present rate of use of that commodity.

I have expressed the view on previous occasions that it may not be permissible for us to view the availability of coal in the light of our isolated requirements because there have been statements made that elsewhere in the World this commodity will become virtually non-existent before the lapse of such a period of time.

If one could take the selfish view one might be apt to disregard alternative sources of power except on grounds of present day economy. It seems to me, however, that we may be forced to take a different view and to regard our mineral resources for power production as being required by others as well as ourselves.

It would be disastrous if the possession and, worse, the wasteful use of an essential commodity while others were starving for that commodity developed into the stage of actual warfare. In spite of our progress, history might repeat itself in that direction unless we are careful to guard against the possibility by taking specific precautions to avoid the possibility.

Power from nuclear sources is now a practical possibility though we can recall it as being considered a fantastic dream — that is those of us who are old enough to remember those days and there are many of us of such an age.

Whilst the development of nuclear power does relieve the scarcity arising from the growing shortage of mineral fuels, there are serious attendant disadvantages arising from that development which have not yet been satisfactorily overcome so far as I am aware.

We may be able to dispose of radio-active waste in the quantities arising from present day and committed future operation but, in view of the life of that radio-activity, one wonders whether or not future generations may not curse us for what we have done to them. That may be too strong a statement but we must have regard to many future generations to come if we are to be honest with ourselves.

In so far as mineral fuel resources are concerned, I think that the statement made by Dr. Lategan was based on bringing coal to the surface for utilisation.

As we are aware, there have been practical suggestions put forward to enable us to extract at least part of the energy from underground coal which cannot be effectively brought to the surface. I have in mind proposals for the gasification of the coal so as to enable the gas to be used for energy production on the surface. Knowing the inventiveness of man it may be predicted that an even more efficient method of utilising the underground stored energy on the surface may be developed and applied in practice.

If that is done then our coal resources may be sufficient for our own power needs on the basis used by Dr. Lategan for a considerably longer period than he has been reported as having stated.

Having expressed the view that we must not view this position in Southern Africa with complacency, you will appreciate all the more the value of the excellent paper presented by the Author.

In introducing his subject the Author draws attention to the amount of water which reaches the sea unused in this country but perhaps the most important aspect of his remarks is that much of the information must be deduced. One cannot stress too much the value of actual measurements taken over long periods of time when dealing with the problem of the utilisation of rainfall and the availability of spring water.

He really does bring home to us the significance of available water power when he gives as an example that one third of the total electrical energy used in the Union in 1959 could have been produced by half the run-off reaching the sea if the head for that purpose was only 400 feet.

As is usual when one is compelled to consider power production in the light of the relative positions of source and utilisation, the impression is gained that this theoretical availability is a dream and not a reality. Such an impression is, to my mind, fallacious because industry will go to a power source when power represents an appreciable portion of the cost structure of that industry and therefore one could imagine that, with the development of hydro electric power there would be concommitent development of industry within reasonable reach of such a power source.

An aspect of hydro electric power production which is often not given sufficient consideration is that the water so used is still available below the point of use and the only region which may be regarded as being "starved" is that between the intake or storage site and the point of use. When hydro electric generation is an economic or satisfactory proposition, it may be said that, in general, the distance of starvation is very small in relation to the distance of remaining utilisation for other purposes.

An aspect of hydro generation which is often not given sufficient consideration is touched upon by the Author of the paper and that is those periods during which a shortage of make-up water occurs.

As the Author has pointed out, the greater the storage provided (to overcome these variations), the smaller is the incremental gain in firm flow and therefore quite a severe restriction is placed upon the utilisation of water flow for power production.

As the Author points out, quite rightly in my opinion, the disability which we suffer in Southern Africa as a result of the amount of silt carried by our rivers is not as real as some are inclined to think. Only in the case of shallow storage does this become a severe limitation, in my opinion, and anyone who has seen the weir on the Orange River near Aliwal North will apreciate what silt can do to shallow storage.

It will be interesting to learn in the course of time how effective the method adopted at the Umgeni Dam site for diversion of heavily silt-laden waters will be in reducing the rate of silting of the main storage dam.

I have mentioned this latter case to indicate that it seems that there are ways and means which may be adopted to give effect to increasing the life of storage dams which we may build in the future to provide not only storage but useful head.

Deep storage as compared with shallow storage also has the advantage of reducing comparative evaporation losses as dealt with by the Author although deep storage with resultant reduced surface area exposed carries the attendant disability, if such it may be called, of increasing the variation of head when storage is being utilised to maintain flow.

It was pleasing to hear the Author mention three of the major hydro electric projects which have been under consideration in the Union for the past few years.

Each of these offers many attractive possibilities. On the other hand, I feel that we should be a little careful of the scheme which he refers to as "the Oranjedam" as I have been given to understand that the views expressed in that connection are based on a very cursory examination of the project.

In this connection the figure (5) showing the location of the various schemes in relation to existing networks may be very misleading to people who have listened to this paper and those who will, I am sure, later read it.

As regards the Ox-Bow Lake proposition, it is shown that a relatively short length of line would be required to connect the power station to an existing transmission network terminating at Bethlehem. The impression then created is that the cost of utilising the available hydro electric power from this station involves only generating costs plus the cost of transmission to Bethlehem.

When one examines the facts, however, it is observed that the station would have 90 MW installed and would operate on a 50% load factor, this being the basis of determination of the installed capacity.

In point of fact the transmission from Bethlehem to Ladysmith under present loading conditions may have a capacity of some 20 MVA delivered at the Ladysmith end of this single transmission line. After Ladysmith the transmission capacity into the remaining system is much greater as multiple lines then become available. It will be seen, therefore that after deducting the load at Bethlehem itself, additional transmission capacity to the extent of say 40 or 50 MW would be necessary between Bethlehem and Ladysmith if the Ox-Bow scheme is to be utilised to the capacity envisaged.

Admittedly there are other terminals from the Rand and O.F.S. Network (also shown in conjunction with the Van der Kloof scheme) which could probably absorb part of the output from the Ox-Bow Lake scheme but separation of supplies would then probably be necessary to avoid interlinking the Rand and O.F.S. and Natal schemes for parallel operation. Thus more extensive transmission than that indicated in the figure would inevitably be required before the output of the Ox-Bow Lake scheme could be effectively utilised. These factors must not be overlooked when preparing comparative cost schedules.

There are other factors which I will deal with later in my remarks.

As regards the Vanderkloof scheme, once again the transmission system interlinking the hydro generating station with existing networks and loads would require increasing capacity in the existing transmission before the 210 MW would be absorbed in the existing systems.

As regards the Oranjedam scheme this same remark applies because it would appear from the sketch map that an output of 500 MW could be injected into the existing transmission line extending to Piketburg. The distribution of 500 MW less the requirements of Oranjemund would necessarily involve a very extensive increase in the existing distribution transmission capacity from Piketburg and into the Cape Western system in order that the output might be effectively utilised. As the total load in the area is only of the order of 400 MVA at present, all plant would have to be shut down and even then full output would not be met.

The foregoing remarks must not be taken as destructive criticism but to indicate the necessity for studying the complete problem so as not to be carried away by a false impression of the advantages of these schemes as described by the Author.

The Author's study of the power possibilities of the Tugela River has produced some very interesting results. Once again, however, one must view these possibilities in the light of alternatives and must not overlook the existing capital investment in thermal generating plant which must be maintained in an operating condition.

Shortages of water cannot usually be foreseen in sufficient time to enable a thermal station to be staffed and brought into operation when needed as a result of the infrequent occurrance of such water shortages — they are mentioned in terms of intervals of years between.

The most important and unfortunate aspect of these hydro schemes is that the majority of the expenditure required for final development of a particular hydro site must be incurred at the outset and the benefit of that expenditure is not fully realised until the generating plant installed is expanded to the maximum capacity for which the scheme is designed.

The study of the resources of the Pongola and Transkei areas provides a very useful reference for the future and it seems not unlikely that developments in the Pongola region may occur if there is an attempt to develop this area industrially.

In the Transkei no mention is made of the possibility of using the Tsitsa which should also add to the power availability as mentioned in the Author's paper. The utilisation of one fall on the Tsitsa was studied several years ago by the late A. E. Val Davies and stood every reasonable prospect of being developed in conjunction with the Umtata Municipal requirements. It may well be that such a scheme will come to fruitition if the Transkeian territories are developed.

Coming now to the Author's comments on costs, he has utilised figures given in Escom's annual report for the purpose of indicating the trend of the cost of coal per ton at all Undertakings and of generating costs per unit sent out on the Natal Undertakings.

Table 4 also shows the cost per unit sent out on the three principal Undertakings of Escom in 1959, the statement made being that these have been obtained from the published data of Escom.

As regards figure 7 which shows the cost of coal per ton, this is very informative as it does show what has happened since 1949 in this connection. It might be of further interest to add to the Author's comments on this aspect in order that the reason for these trends may be better appreciated.

The curve shown for the Western Province Station is that for Escom's Salt River Power Station. Since 1949 the cost of coal has been influenced both by an increase in railage rates and an increase in the controlled price of coal. A pea duff mixture is used at this power station and special arrangements were made to give an incentive to coal producers to improve the calorific value in order that the incidence of the high railage rate per ton might be reduced on cost per unit sent out.

A somewhat lower price is paid for the coal supplied to Escom's Hex River Power Station.

Where this trend of increase will end is anybody's guess but it would seem that further increases may be expected as time passes.

The curves given for the Natal Stations are those for Congella (the higher price) and Colenso (the lower price). Once again the effect of increase in the controlled price and railage rates are amply demonstrated.

It is not possible, at this stage, to show a comparative curve for the new pit-head power station but it may be stated that that costs will approximate and possibly better the costs shown for 1949. This should have an appreciable affect on the average cost per unit sent out with which I will deal later.

As regards the Transvaal stations for which curves have been drawn, the higher curve for railed coal has resulted from an admixture of coal obtained when operating the particular station as a "pithead" station and the resultant cost when it became necessary to supply this station with railed coal. The rising trend indicated is therefore very misleading.

As regards the lower of these two curves, the principal change in the price per ton has arisen from introduction of price control as it affected a low price coal contract which covered the coal required by the particular station from which the figures are taken.

Much of the coal required by this station is hauled by Escom over private sidings using Escom's own locomotives and trucks with the result that the average cost resulting can hardly be ascribed to a cost of "railed coal" which implies the payment of standard Railway rates to the Railway Administration.

A clearer indication of the effect of a pithead contract is that given in the curve demonstrating the coal cost for Transvaal Colliery Stations. The higher curve which commences in 1956 has been raised appreciably because coal for the particular station concerned required to be railed from the Witbank Coalfields for a portion of the year. This had the effect of raising the cost very appreciably and, as a matter of interest, for the year 1960 that price rose every considerably. The curve including points of this nature is not really a fair curve for indication of pithead coal supplies because it would not be fair to assume the disastrous conditions which occurred as being normal annual occurrances.

It is then necessary to examine the schedule of average generating cost for 1959 which the Author has used in order that full appreciation of the significance of these figures is made available in the records of this Association.

I have no quarrel with the figures used for the Natal and Rand and O.F.S. Undertakings but must point out that each of these figures includes capital charges and operating costs in respect of the interconnecting transmission network used between the power stations in operation on these Undertakings. If the figures are to be compared with hydro-electric generating costs, similar transmission costs must also be taken into account and by drawing attention to the fact that transmission costs have, in fact, been included a false impression is likely to be created when making comparisons.

As regards the Cape Western System, I do not know the source of the information used by the Author because published figures do not permit of the analysis being made in the manner which he has used.

To exemplify the fact that the figure which he has derived cannot be accepted it is only necessary to point out that the same source which he must have used indicates that the total cost including the capital charges on all transmission and distribution in that area result in an average price per unit sent out of 0.975d.

On the other hand the total generating costs, excluding generating capital charges, amount to 0.441d. per unit sent out (this figure being readily obtainable from the published annual accounts). The Author's figure of 0.956d. per unit means that capital charges on generation have been included to the extent of 0.515. per unit sent out and that transmission and distribution therefore only resulted in capital charges averaging 0.019d. per unit sent out.

From the published diagram of the area of supply and transmission such a comparison of generating capital charges with transmission and distribution capital charges cannot be accepted.

A further quite effective illustration of proportions can be obtained by considering the average cost of fuel per unit sent out in each of these cases with the total generating costs per unit sent out.

In the case of the Natal Undertakings the average fuel cost obtained from the Author's source is 0.315d. leaving 0.348d. to cover other charges including capital charges.

In the case of the Rand and O.F.S. Undertaking the average fuel costs is 0.133d. per unit sent out leaving 0.253d. per unit for other costs.

If we use the Author's figures for Cape Western we find that of the 0.956d. per unit sent out, fuel accounted for 0.334d. per unit sent out leaving a balance of 0.622d. per unit to cover other charges. The disproportion in this latter case, bearing in mind the high cost of fuel on the Cape Western Undertaking should immediately become clear.

I am not permitted to disclose the actual figure in this case as this figure is not published and I can only publically express figures which can be calculated from those tabled in the House as required by the Electricity Act.

Having in mind the effect on the cost of coal of a pithead power station, I do not think the Author was justified in extending the curve of generation costs per unit sent out for the combined Natal Undertakings as he has done.

I am not in a position to disclose Escom's views on this matter officially but personally do not expect much rise above the figure for 1960 until the new pithead power station comes into operation in 1963 and thereafter am hopeful that there would be a tendency to either decrease these prices or at least stabilise them for a period before a decrease occurs.

I would again reiterate that the curve "sent out" in figure 8 includes an allowance for interconnection between power stations which are operated in conjunction with each other.

When making a comparison between the items of cost involved in thermal generation and those involved in hydro electric generation, a particular point is made of the difference in the redemption period involved.

In most instances the life of the main assets of a hydro power station is longer than that of thermal plant and therefore the relationship between redemption and reserve charges, which together may represent the depreciation rate accepted for contingent major disasters, is usually in favour of the hydro-station.

In some cases, however, this difference is more theoretical than real, the reason being that when investors are called upon to "tie-up" money for longer periods the interest rate is usually increased. In making this statement one must bear in mind that it is applicable to investment periods of from say 20 years to the 50 years on which the Author bases his figure for interest and redemption of 6½%.

It would appear that the 6½% interest and redemption is based on 6% interest with provision for ½% to a sinking fund account on the assumption that sinking fund account can be re-invested at 5% per annum throughout the period of 50 years (which to my mind constitutes a risk).

Considering a thermal station and basing the loan period on 30 years, the interest rate equivalent to the 6% of a long period loan is not likely to exceed say 5½% and, assuming 5% for re-investment (which is safer than the assumption for the hydro plant period), the sinking fund required would amount to 1.5% per annum.

Thus it will be seen that it would be reasonable to assume annual cost on interest and redemption account for the thermal station of 7% per annum or somewhat less for comparison with the 6.5% per annum allowed for the hydro electric station.

It would seem that the difference in annual capital charges occasioned by extending loan periods is not fully appreciated and there is an exaggerated idea of those savings. It is as well always to bear in mind that, ignoring very short period loans for money "on call", the interest rate increases the longer the period of the loan involved and the sinking fund contributions do not decrease as markedly as many people seem to expect.

From a financial point of view it is also necessary to bear in mind the very factor mentioned by the Author namely a condition of rising costs and devaluation of money must never be overlooked.

When this condition is regarded as a reality by investors they strongly object to long periods of constant charges unless those charges are sufficiently high to justify the loss which will arise from devaluation because that devaluation is also applicable to the return on the investment and, at times of such devaluation it is usually found that the interest rate increases appreciably — an increase not available in respect of a long term investment which remains fixed.

If the long term investment is subject to the periodic changes in interest — as for example in some Building Society investments, then there is little difference between a succession of relatively long-term loans redeemed in succession and an exceedingly long-term loan redeemed at the end of that very long term when viewed in the light of the annual costs resulting.

This does bring to mind, however, one of the disadvantages attendant upon very long period loans which require annual contributions to a sinking fund account for the redemption of those loans. If there is devaluation of money and increase in interest rates, the value of the investments of sinking fund account contributions in the earlier years will depreciate and, if those assets require to be sold in order to achieve repayment of the loan account, that depreciation in the value of the investment must be catered for by increasing the amount of later investments to make good the shortfall on realisation of sinking fund investments for purpose of repayment of the loan. When conditions are not stable a very false impression indeed of the benefits of long period loans is created unless this aspect is seriously taken into account.

Bearing in mind the relative amounts of capital invested for the same safe output or installed capacity of thermal and hydro stations, it is not wise, in my opinion, to stress the advantage of long-term redemption periods available in connection with the hydro plant.

It should suffice to point out that it is usual to find the annual cost of operating and maintaining a hydro station and its attendant civil works for a given capacity is considerably less than the annual cost of operating and maintaining a thermal station and it is on this account that the hydro electric station is so advantageous.

When operating to Government Regulations regarding the availability of staff etc., small hydro electric stations can be relatively expensive to operate. Figures in this connection are obtainable from Escom's annual reports where the cost of operating the Sabie Hydro-Electric Station is reported (that cost is now absorbed in the Eastern Transvaal Undertaking and cannot be segregated).

For example, for the year ended 31st December, 1957 it will be seen that the cost of generation at the Sabie Station amounted to 0.404d. per unit sent out and that this was in respect of an output of approximately 6 million units during the year, the capital charges being the almost negligible amount of £74 during that year, redemption of the loan capital having been provided for and paying the interest on the loan involved with the small shortfall.

If this figure of 0.404 which virtually excludes capital charges is compared with the figures given by the Author for the three schemes which he deals with in sufficient detail, it will be seen how great is the advantage of the more effective utilisation of staff on the larger schemes than on small schemes as the increase in cost of staffing the larger stations is not proportionate by any means to the magnitude of the installation.

It is also noteworthy that the figures given in Table 5 for comparing the cost per unit supplied from the hydro plant and those of thermal units in 1959, which the Author stresses for being for generation only, are based on the assumption that the entire output possible from the hydro plant is sold and neglects entirely the fact that standby to that plant must be provided in the thermal stations. The cost of standby is therefore neglected in the comparison when quoting the cost of hydro units but is taken into account in mentioning the cost of thermal units.

Also, quite apart from the question of normal standby, there is the problem of providing for water shortage on occasions by the installation of some form of thermal plant to make good the deficit arising from water shortage. Such costs also have been neglected. Admittedly, if dealing with a progressive requirement or starting de novo, plant to make good such shortages may be purchased very cheaply because efficiency under those conditions is of hardly any account. That is, every effort should be made to save the capital investment on such standby required only after long intervals of operation and for short times and efficiency can therefore be sacrificed.

There is also the aspect which I have already mentioned, namely that the figures which have been used for cost of thermal generation include the interconnection of the power stations operating in the areas dealt with, the Cape Northern Undertaking being costed on the basis of the interconnected power stations of the Rand and O.F.S. Undertaking, and therefore allowance should be made for the effective interconnection of the hydro schemes with the systems served from the thermal stations at least to the extent of the standby capacity required.

Coming to the Authors' views on hydro electric plant for installation near Colenso, it is noteworthy that he forms the opinion that the first stage of Tugela development would appear to be possible at a lower cost than the 1959 average thermal generating cost in Natal. In expressing this view he has assumed the installation of six 20 MW hydro sets having an aggregate capacity of 120 MW and that all units available would be supplied into the system.

Bearing in mind that the figure of cost for thermal generation includes the capital charges arising from the investment in the thermal generating plant including that provided for standby, the Colenso scheme (or Scheme A) is only a comparison on the basis of an additional load of 120 MW served and then without standby.

If it is considered as partly a replacement load then the annual costs would be considerably inflated above the figures used by the Author and one doubts whether or not there is such an apparent good case for hydro electric generation.

In one thing I do agree and that is that a thorough investigation of all aspects of this problem is probably justifiable even if it does prove that the hydro electric proposals are not attractive.

I agree with the Author's point regarding the starting up and shutting down of hydro plant as being much more simple than this type of treatment of thermal plant but there are other aspects which are not so simple of solution. I have in mind the stability of frequency and governing unless there is the elasticity of long transmission lines between the hydro stations and the thermal stations with which they operate.

We are indebted to the Author for his comments on the potential best methods of operation of combined systems and the views which he has expressed on the various methods of operation of combined systems and the views which he has expressed on the various methods open.

If the cost of the water storage civil works can be shared with some other body benefitting from the presence of those civil works and their control of river flow, there is no doubt that an excellent case for hydro electric generation can be made in almost every instance.

In my own experience many such schemes which could have been profitably developed have been ruled out on account of the control of water outflow required by the other body utilising the water. The nature of that control has been such that a thermal equivalent of the hydro plant with its attendant standby was found to be necessary in order to take over from the proposed hydro electric plant as a result of that water control. In such circumstances, the only savings which could be achieved would have resulted from savings in coal costs while the hydro electric plant was in operation but staff for each station would have been required and those savings on coal account in no way approached the annual cost of the capital involved in providing the necessary waterwheels and electrical equipment alone.

Developments in the Union under consideration at the present moment, however, do seem to indicate that the civil works required in connection with water storage for water control and other purposes may open up the way to the utilisation of that water or at least a part of the water stored for hydro electric generation and I agree with the Author that we should be able to look forward to the day when hydro electric generation will become a practical reality in the interests of economic electricity supply.

Two aspects of the use of hydro electric power in the Union are not touched upon by the Author and I feel that some remarks from him on those aspects would be very valuable for future reference.

I have in mind the use of pumped storage as a means of peak load regulation, a matter raised in one of the questions for the Forum, and also the utilisation of the head behind Municipal water supplies where such utilisation could be effective.

In my early experience with Escom (Union) one such case was developed to the stage of actually selecting a suitable tender for the required plant before the scheme was abandoned. You will find reference to it in Escom's earlier reports which dealt with the expenditure on the Gordon's Bay Hydro Scheme.

At that time the intention was to utilise the head available from the Steenbras

Reservoir being built above Gordon's Bay to provide the supply of water for greater Cape Town. It was essential that break-pressure be introduced in order to save money in the mains conveying the water from Steenbras to Cape Town. No better means of utilising the drop in pressure could be devised than the introduction of a hydro-electric generating set. I believe that fear of polution of the water was the only thing that ultimately demanded the abandonment of the scheme.

Prior to that time the Barberton Municipality had been faced with a similar problem and installed a hydro-station to utilise the head which had to be dissipated and that hydro plant is still in service, effectively aiding the economy of the Barberton Municipal Electricity Scheme.

I believe a somewhat similar scheme from the point of view of end use of the water was introduced at Clan William.

If the proposed Midmar Dam is also utilised for Municipal water supply, a similar proposition to that at Barberton might be quite useful.

I have always held the view that the real value of a paper rests not only in the original presentation but in the contributions to discussions which it invokes in the direction of qualifying, extending, or confirming the Author's opinions.

I feel sure that the present paper will therefore form a most valuable contribution to the annals of this Association.

I must congratulate the Author on his achievement and thank him for the time which he must have spent in the preparation of this very valuable paper.

Mr. President, I very much appreciate the honour of being invited to speak at this stage and I have great pleasure in recording the Vote of Thanks to the Author.

Mr. H. M. S. MULLER, UPINGTON: Mr. President, ladies and gentlemen, we have already shown our appreciation of this very good paper. I have had many years of hard experience of the Orange River. It is a comparatively fast flowing river, I believe ranging up to 10 miles per hour at high flood. The soil-bearing or silt content of the water is very high. It is of course inevitable that in due course the waters may be considered for hydro electric development.

This however is inseparable from irrigation projects. We cannot expect anything else; as water for irrigation is the major requirement.

Both call for storage on a vast scale. We already have sufficient examples of successful failures attempted on a tentative scale. If we consider the lower reaches of the Orange River, say from the Vaal River downwards—higher up we have weirs—then it should be abundantly clear that the first requirement is prevention of soil erosion on a very extensive scale. That may probably cost many millions, but is a national necessity to ensure success of any such scheme. We must think in terms of at least a century, if not for power generation, then for irrigation.

We have other means of generation of electricity, but irrigation water is of vital necessity. We cannot take the serious risk of fast diminishing capacity due to silting up of a dam.

Now I remember that many years ago Mr. Milton read a paper, and I had the honour of replying in part to that paper. Mr. Milton mentioned the suggestion of a scheme on the Aughrabies Falls. I contended that it would never be put into practice, for the simple reason that there is no storage area in that vicinity. Therefore, if they construct, and they construct on a big scale, such as is contemplated, then you have the dam, and you have the necessary head elsewhere. Hence the usual cry at all these farmers' conventions throughout the southern Cape, "Develop the Orange River Falls and everybody will be happy" is a dream.

Thank you Mr. President.

THE PRESIDENT: Thank you Mr. Muller.

Mr. G. B. GILL, ZULULAND: Mr. Langford's paper is certainly of very vital interest in showing the potentialities of

hydro-electric development in the Union. And there is one section that is of interest to me personally. On behalf of the Natal Provincial Administration I investigated the possibility of industrial development in the Tugela Basin, and some of these dam sites mentioned by Mr. Langford I know very well.

I think the best dam site that I ever saw, and it is very close, approximately, to what he has given in his paper, is just below the Klip River. That site would give a five or six hundred foot high head, and it would not flood Colenso. It always struck me with the Escom system so handy it would be a very good development.

I am not a hydro-electric expert but it seemed to me rather obvious that the gorge there is capable of very fine development.

The other point which is not mentioned in his paper, but Mr. Peterson mentioned it himself, is the loop in the river below Kranskop. That is certainly a very fine site. That loop is 12 miles long. He gave it as six miles wide; I like to think of it as twelve miles long, because it seems to me there is a very useful fall and a tunnel across the neck of the loop, which would be a very useful contribution to hydro-electric development.

On the other hand, the terrain down there is terribly rugged and could not be absorbed locally at all. Although there are mineral developments there, that might be considered — particularly plutonium and some iron.

The other point I would like to bring up is that of the silt question. Tugela, I suppose, must be one of the most silted rivers in South Africa, and I am wondering if the original investigators found the silt question quite so bad as it is today.

Because of industrial development in the Tugela Basin, and industrial development I think will really produce more silt than if the land is fallow, and the roads, too, are made in the foothills of the Drakensberg are largely on gravel and I think that is another factor that is causing extra slit in the river. I don't know whether it will affect the design of the dams, but I should say that the silt is probably getting worse and not better from the reports that Mr. Langford mentioned by Dr. Kanthack. That could be proved, no doubt, by investigation.

The silt question I think might be well summed up . . . I was looking at the river with a farmer the other day and he said, "It's a pity it's too wet to plough!"

Mr. H. J. GRIPPER, KNYSNA: Mr. President, I would offer my congratulations in the first place on the very excellent manner in which the ground has been covered by this paper. What about tidal power?

Has anybody considered the amount of water which rises and falls, and flows backwards and forwards through the Heads at Knysna? I would like the author not to throw this aside too hastily. Before coming up here I took some very quick assessments. We have there an area of the ocean averaging four square miles, — it varies from 3½ to 5 according to the tide, — and every six and a quarter hours 3,400,000,000 gallons flow in or out and rise or fall an average of 5 feet. A very cursory summation of that produces a figure of only 4 MW which is rather disappointing, but it is a point of interest. There we have, in a space of less than 200 yards width, and about 15 to 20 ft. depth, this terrific quantity of water flowing in or out, four times a day. On the Heads themselves there is an ideal situation for a pump storage reservoir—which of course I realise would be necessary. I dare say the cost would go into millions of pounds, and certainly Knysna wouldn't be able to afford it. However I put it to the author as a possibility with a big question mark!

Thank you, Mr. President.

Mr. D. MURRAY NOBBS, PORT ELIZABETH: I would like, Mr. President, to add my congratulations to Mr. Langford for a most instructive and exhaustive paper on hydro-electric power in South Africa.

In the past we have not been encouraged in South Africa with developments of this nature — due primarily to the comparatively cheap coal that is available, and the penality of this attitude is the wide-spread erosion that occurs throughout the country, and the irretrievable loss of our valuable top soil.

If we fly around the South African coast after wet weather up country we realise the amount of good top soil that is washed out to sea. If this were trapped by dams, it is reasonable to assume that the silt in those dams would ultimately become a major problem. When one considers the countries where hydro-electric power is common, in these countries the catchment area is not generally of the sandy composition, as exists throughout many parts of South Africa, and the problem of silt does not appear to present the same difficulties as would be expected in the Union.

Civil engineering works associated with hydro schemes are looked upon more or less as permanent works, therefore it would be unwise in my opinion to start off on projects of this nature by limiting the life of such stations in accordance with the amount of soil that is expected to accumulate.

On the other hand, there may be areas with ground conditions that lend themselves more readily for hydro electric purposes, and in such cases I agree with the author, that investigations should proceed with the object of developing such schemes for the purpose of power generation.

I feel that the subject at this stage is one mainly of academic importance, and will remain so until potential load centres develop within economic distances of the sources of water power, and then a completely new and more encouraging picture may present itself.

On the other hand, if such projects could be developed in the vicinity of existing transmission systems, then the matter may become one of economic feasibility. One big advantage of inter-connecting systems is the saving in stand-by plant in generating centres, and in this connection I came across some published figures recently in regard to the electricity undertakings throughout Holland, where, on the basis of 2,000 MW of installed capacity the spare generating plant for Holland's inter-connected system, was estimated to be at least 620 MW. Now if the generating stations in Holland were not interconnected, then the amount of standby plant would be represented by a figure of 1170 MW.

From those figures, it will be observed that under the circumstances quoted the saving in stand-by plant through interconnection in Holland, would amount to a capital sum of close on forty million pounds. That is one benefit that could be derived from the inter-connected system which might arise from the establishment of hydro-electric power stations in South Africa.

Now there are many other advantages in hydro-electric plants — for example there is the almost instant availability for serve, the very high reliability with simple and robust plant, low maintenance costs, able to respond to rapidly changing loads without difficulty, no standby losses, efficiency of plants does not change with age, except for certain replacements, fewer highly skilled engineers required, cost of production varies little with the passage of time, and there are no fuel and fuel transport charges, and no refuse disposal problems.

So altogether there are indeed many advantages to be gained from the consideration of hydro electric power.

I would just like to pick up Mr. Simpson of Durban on the question of the Scottish hydro-electric schemes.

The Scottish Hydro-Electric Board was established in the first instance to assist the thermal stations, and to sell the surplus power to the Sassenachs over the border, and try to make some money out of the English men.

Well, things went all right for some years, and in addition to the fact that every care was exercised in the design and location of those stations, and there were records of rainfall covering many many years previous to their establishment — despite all that, in 1956, owing to a particularly dry summer, quite a number of the hydro electric stations in Scotland were put out of commission — and that is a very important point to take into account especially in a country where the rainfall is very sparse and intermittent.

When the stations in question were put out of service, it went against the Scottish grain very much when they found themselves in the position where they had to purchase one million pounds' worth of power from England in that particular year.

Nevertheless, Mr. President, I feel that Mr. Langford has brought up a very important point at this stage, that will justify the fullest investigation. I feel therefore that a body should be formed for that purpose.

Thank you, Mr. President.

THE PRESIDENT: Thank you, Mr. Murray Nobbs.

I am afraid we have run out of time.

(Convention announcements followed)

CONVENTION ADJOURNED.

## MEMBERS' FORUM

*On resuming at* 8.30 *p.m.*

*Quizmaster*: Mr. J. E. Mitchell (Salisbury).

QUESTION 5: "The annual electrical statistics published in the Municipal year book contain comparative figures, relating to the case of distribution systems of most Municipalities. It is obvious from the figures submitted by some local authorities that they do not all arrive at them in the same way, for in comparing them we find that in the case of undertakings the size of Ladysmith the variation is from £131,000 up to £851,000. Ladysmith being £178,000 (1958/59). In selecting the system of a like size for comparison the maximum demand was considered but I admit the number of consumers, miles of mains and installed transformer capacity should be taken into account.

Which is considered the better:—

(a) To keep adding current capital expenditure to a previous total?

(b) As for (a) but deduct for obsolete equipment and mains dismantled?

(c) As for (a) but to depreciate annually? or

(d) Any other system which should be simple?"

Mr. GRIPPER (Knysna) confirmed that the figures returned by many undertakings appeared to be ridiculous; yet he thought it should not be difficult to render what was asked for in the tables, viz; the original cost of distribution, plant in service, including all buildings and Civil Works, connected with the distribution system; in other words everything except generating plant.

Mr. Gripper emphasized that the average cost of distribution today should be in the region of £120 to £150 per consumer.

Mr. R. W. KANE (Johannesburg) said that just as the cost per kilowatt for generating plant had risen considerably, the same also applied to distribution plant. Mr. Kane did not agre that there was much variance in the load factor of towns or the percentage of bulk consumers.

He claimed method (a) would give only historical values; but no indication of present day value. Method (b) could only be operated accurately with considerable staff. Mr. Kane thought it best to write off all bulk assets at the end of the life allocated to such assets, as, he maintained that understated costs or assets were preferable to disclosing an inflated value.

QUIZMASTER: Cited Pretoria as an example where a very large percentage of its output was sold to one consumer; thus Mr. Mitchell intimated that bulk supply should be ignored for the purposes of evaluating averages.

Mr. VAN DER WALT (Krugersdorp) in considering (c) to be the correct answer referred the questions to a paper given in Pretoria in 1955, indicating various methods.

QUIZMASTER: referred to the standard of accounts of the Institute of Municipal Treasurers and Accountants, as being the true accounting system, combining historical cost, the amount written off by depreciation, and the book value for the year in question. In the Quizmaster's opinion an accurate comparison of distribution costs between undertakings would not be achieved by taking the actual cost per consumer of distribution, as had been suggested.

Mr. MILTON (Escom) thought that it was unrealistic to compare large towns, where they have primary and secondary distribution mains, apart from distribution networks, with small places, where there was almost entirely reticulation to the individual consumer.

He felt engineers were primarily concerned with the costs of their final reticulation and distribution to consumers. In an unrealistic comparison of towns, the value of these statistics tended to be lost.

Mr. GRIPPER (Knysna) emphasised that what should really be defined as the capital expenditure was the total capital loans in operation at the time figures were called for. He considered it illogical to have an historical record which would go adding from year to year, eventually reaching a totally inflated figure.

Mr. R. M. O. SIMPSON (Durban) recapitulated the method of recording capital costs in Municipal accounting. He appreciated the questioner's difficulties, in that it was impractical to divide capital expendiutre by the number of consumers and arrive at a 'cost per consumer.' The answer was influenced by the size of the consumer. He considered the statistics offered by Mr. Gripper indicated to-day's costs were approximately three times higher than pre war.

QUIZMASTER: summed up by stating that the IMTA system of accounting provided the most convenient means of recording assets.

QUESTION 10: "When testing 3 phase transformers to determine their no-load losses and three wattmeters are used to measure this loss, different watt-loss readings are obtained in the three phases. In the case of some transformers it has even been found that the reading in one phase has a negative value. This would seem to indicate that the phase angle exceeds 90° lagging in that particular phase. What is the explanation for this condition as one would expect that the readings for the two outer phases would be approximately the same?

Example: 100 kVA 330—220/380 41 DY 11.

| *Phase* | *Watts* | *N.L. Amps.* |
|---|---|---|
| A | —50 | 10.5 |
| B | +160 | 7.5 |
| C | +734 | 10.5 |

Voltage constant on all 3 phases at 380 volt between phases during test.

NOTE: The difference of the currents in the outer phases A and C from that in the inner phase B is due to the difference in the magnetic circuits."

Mr. MILTON (Escom) pointed out that with the 3 watt meter method individual readings could be most misleading, owing to the shift of the neutral, and the consequent alteration of the voltage positions on the meter. However these readings taken in aggregate were more accurate than those achieved with the usual 2 watt meter method.

Mr. MIDDLECOTE (Pretoria) thought that a careful tie up of the neutrals of the four wire supply to the transformer, would minimize errors.

QUIZMASTER suggested the question was ambiguous as to how the 3 watt meter was to be connected for test, but he thought the 2 watt meter preferable.

Mr. LOMBARD (Germiston) claimed text books recommended the 3 watt method.

QUESTION 15: What minimum insulation resistance in megohms would the Forum regard as satisfactory between H.T. and L.T. windings of a 6300/400/230 volt 400kVA oil-filled transformer, at normal operating temperatures? Standard specification and handbooks are silent on this point.

Mr. MIDDLECOTE (Pretoria) stated there was no accepted formula for establishing a satisfactory insulation resistance in megohms. Reference to the manufacture of the transformer, in each instance, was the answer.

Mr. GRIPPER (Knysna) agreed there was no standard formula; he also suggested that tests should be commenced before normal operational temperature on the transformer was reached.

Mr. R. W. KANE (Johannesburg) concurred that 'operating temperature' was the crux of the question. He stated that the normal installation between high and low voltage varied from about 2,500 to 1,000 megohms. Mr. Kane quoted a text book formula of one megohm per 1000 volts, with a minimum of 1 megohm.

Mr. LOMBARD (Germiston) claimed that a manual issued by manufacturers regarded the mega test useful only for comparative purposes. High voltage was the only satisfactory test.

Mr. MIDDLECOTE (Pretoria) argued that insulation was affected not only by the type of oil used, but by variance in the dryness of the paper.

Mr. VAN DER WALT (Krugersdorp) expressed the view that the degree of testing depended largely on how urgently the transformer was required. Given the time, a proper high voltage test was the answer.

Mr. BARTON (Welkom) said that a text book on the subject gave the figure of 1 megohm plus twice the line voltage in kilowatt, so for a 6.6 KV transformer the figure was about 14.2 megohms.

QUESTION 1: "Several Municipal electrical undertakings are now using PVC cable for service connections. What are the advantages and/or disadvantages of using this type of cable instead of paper insulated steel tape or wire armoured cable for service connections?"

Mr. WOOD (Vereeniging) informed the forum that newly developed jointing techniques of PVC cables were achieving significant reductions in costs in time, labour and reliability, as well as materials. He further suggested that PVC was more versatile in use, and its adaptability should ease training problems. Mr. Woods referred generally to BS No. 3346 which he thought would be of assistance to engineers.

Mr. R. M. O. SIMPSON (Durban) in jocular vein said the question referred to PVC cables and then to wire armoured steel tape paper insulated cable; and he hoped PVC cable was not buried without armouring.

Mr. J. DOWNEY (Springs) gave an example showing PVC cable joints were not quite as impervious to water as a previous speaker had suggested.

Mr. SIBSON (Bulawayo) queried that the principal advantage of PVC cable was that it would be used by electricians, thus obviating the costs of cable jointers.

QUIZMASTER agreed PVC cable was labour saving.

Mr. R. M. O. SIMPSON (Durban) said he was a little concerned about the difficulty in finding suitable jointing and termination methods for PVC cables. No ideal solution had been provided by the manufacturers. Cheap jointing could lead to ingress of water, as had been suggested.

Mr. EMERY (Johannesburg) said in comparing PVC cable, cost was the essence. PVC had its advantage up to a certain size, but above that paper was more advantageous, having regard to the extra installation costs.

There were, however, numerous types of PVC as well as paper cables. Mr. Emery outlined different techniques for installing these cables under varying circumstances.

Mr. MILTON (Escom) claimed that in his experience PVC service joints could be executed quickly and satisfactorily by an electrician, providing the manufacturers recommendations were closely followed. Faults could also be rectified much more quickly than with paper cable. PVC cable was also most suitable for above the ground distribution boxes, the advantages of which Mr. Milton outlined.

Mr. J. DOWNEY (Springs) pointed out that he had experienced ingress of water into the joints of PVC and paper service cables; he then proceeded to outline the methods by which this problem had been overcome.

QUIZMASTER then described in some detail the method of underground jointing of PVC cable in Native Townships in Salisbury.

Mr. C. LOMBARD (Germiston) disagreed with a previous speaker in the use of polyester resin type joints with PVC cables. Mr. Lombard claimed that the period required for this compound to set depended largely on temperature.

QUESTION 30 & 19: "One problem which members would like discussed is the

question of testing installations completed by Government Departments (i.e. P.W.D., S.A.R. & H. etc.)."

"(1) Are the Provincial Authorities exempt from the provisions of the Wiremen's and Contractor's Act and the local authorities by-laws when they do wiring work in provincial buildings within the local authority's area of jurisdiction?

(2) What is the position when the wiring work in (1) is sub-contracted out to an electrical contractor who may even be a local contractor?

(3) Has the local authority the right to:

(a) demand that the wiring work be carried out by a registered wiremen:

(b) demand that the wiring work be done according to the local authority's by-laws and wiring regulations:

(c) test the installation in accordance with the by-laws before connecting to the local authority's suply."

Mr. GRIPPER (Knysna) stated that in 99% of the cases of which he had knowledge, be it Government, Provincial or otherwise, installations were conducted in accordance with the requirements of the local supply authority. He went on to quote a legal opinion, wherein it was submitted that Council and its officials were bound by local by-laws, and would endeavour to abide by them, whosoever owned the premises to be serviced.

Mr. JACKSON (Provincial Administration, Cape Town) offered the opinion that the state was not bound by local by-laws, but contractors were.

Mr. MILTON (Escom) pointed out that in the Union, there was nothing to prevent the Provincial Authority doing whatever work it wished, but it could not compel a Local Authority to connect such work to its mains.

Mr. R. W. KANE (Johannesburg) argued that in practice various government departments were quite prepared to co-operate with local Municipalities, until a dispute arose, and then the Government would politely claim that the Law did not apply to them. Mr. Kane then referred to the ambiguous wording of the Wiremen's Act, and alluded to its possible amendment.

QUIZMASTER implied that non co-operation by the Government may tend to delay supply.

QUESTION 29: "In the United Kingdom, fused socket outlets have been introduced to protect power circuits in the home. Do the members think the same method of protecting power circuits should be encouraged in the Union?"

Mr. KANE (Johannesburg) advised that fuse socket-outlets were permissible in the Union, and were, he thought to be encouraged, in that they fused the appliance.

Mr. C. LOMBARD (Germiston) called for comments by Mr. Von Ahlften.

Mr. J. K. VON AHLFTEN (Sasolburg) referred to a consumer who substituted wire for the right fuse, thus the appliance was still alive, with the plug removed. Mr. Von Ahlften went on to describe how the problem was rectified.

QUIZMASTER said the answer appeared to be that the method of protecting power circuits, under discussion, was in fact, already being encouraged in the Union.

QUESTION 28: "Should Municipalities not now ease the restrictions of direct-on-line starting of Motors? The limit is frequently as low as 3 h.p. for 3 phase Motors and this should be related to the consumers' connected load in that area."

Mr. GRIPPER (Knysna) thought that some form of control related to the size of the service was desirable. Mr. Gripper referred briefly to Worcester in the Cape where the h.p. allowed for direct starting of a motor was 4 plus 100P/R. P. represented the size of the service in kVA and R the revs per minute, the synchronous speed of the motor. This meant one could start a 4 h.p. motor on just a 10kVA installation and up to 9 h.p. on a 50kVA installation.

Mr. MILTON (Escom) stated that it was now generally recognised that the maximum change in current, which could be permitted, on any system, which would not give rise to the disturbance to other users, was one where the maximum change related to the fault MVA of the system under consideration was limited to 1%. Mr. Milton felt that the diverse factors made the problem unsolvable by a set formula. Individual assessment was essential.

QUIZMASTER agreed each case of direct on starting should be considered on its merits.

QUESTION 36: *"Earth Leakage Protection for Low Voltage Installations*:

Whereas Earth Leakage protection equipment for low voltage installations is now available at reasonable prices; and for all practical purposes is considered to be infallible, especially those which operate on the principle of magnetic amplication is it not high time that the installation of earth leakage protection equipment for low voltage installations be made compulsory by law?"

Mr. DALTON (Johannesburg), offered a written contribution by Mr. K. Adams of Johannesburg who was unable to be present. Mr. Adams' first point was all types of earth leakage equipment were equally fallible, as all used rectifiers of same type. Secondly, Mr. Adams made the point that it was up to engineers to decide whether earth leakage equipment should be installed or not. Recourse to law was not a good thing.

Mr. JACKSON (Provincial Administration, Cape Town) said the answer to the question must surely depend on the word 'reasonable' in relation to the cost of an installation.

QUIZMASTER concurred with Mr. Jackson's views and asked if an affiliate could indicate a price.

Mr. G. R. HAIN (Alberton) speaking for the manufacturer gave as a present-day indication approximately £12 per installation.

QUIZMASTER suggested it was a question of economics. He did not agree all earth leakage devices were infallible.

Mr. A. R. SIBSON (Bulawayo) saw the solution in the strict adherence to the use of three pin plugs for all apparatus, and ensuring that every earth fault becomes in fact a phase to neutral fault; thus obviating the necessity of earth leakage devices.

QUESTIONS 3 and 3(a): "Is subsidised electricity necessary for the success of rural electrification and if so to what extent?

"Does the farming community require electricity and if so, does the farmer require a subsidised selling price? If so, who should make good the subsidy?"

Mr. H. J. GRIPPER (Knysna) felt the question was tantamount to a contradiction in terms in that subsidised electricity should not be linked with the term success. He felt the question might well lead both the consumer and the authority into the wrong channel of thought.

Mr. G. J. MULLER (Bloemfontein) intimated his opposition to subsidisation.

Mr. A. JACKSON (Provincial Administration, Cape Town) associated himself with Mr. Muller's remarks.

QUIZMASTER recapitulating said everybody believed that every supply should be economic regardless.

Mr. W. H. MILTON (Escom) made the point that in Escom a rural development scheme would not be entertained unless it was self-supporting.

QUESTION No. 6: In view of the large proportion (probably 70% to 75%) of expenditure that is demand (load) related and the current emphasis on higher and higher load ratings of appliances such as kettles, stoves, etc., why is there no attempt to persuade the South African manufacturers to explore the thermal storage type of appliance, with particular reference to the Bantu township load? What success has been achieved in this field?

Mr. MORRISON (Johannesburg) said enquiries had been made in England to see whether it was possible to develop some form of thermal storage heater that would be suitable for Native Township, but without much success. The project appeared too expensive for Native Townships.

Mr. H. J. GRIPPER (Knysna) did not regard thermal storage as a practical proposition, particularly in Native Townships.

QUESTION No. 8: Does ultra cheap electricity cause a distortion of consumer demand and capital investment to the detriment of the economy?

Mr. W. H. MILTON (Escom) reafirmed the view that it was impractical to sell electricity, at uneconomic rates. [See questions 3 and 3(a)]. Cheap electricity in itself was all right, provided it was supplied on an economic basis.

QUESTION No. 9: Theoretically, electricity tariffs are painstakingly worked out by the supply authority to ensure an adequate and business-like return from the various classes of consumers according, mainly, to their demands and load factors. This being so, should a consumer have the right to elect the tariff under which he desires supply, or should the right be vested in the supply authority?

Mr. H. J. GRIPPER (Knysna) argued that if the tariff adequately covered a particular service, the consumer need not be consulted. However, where two tariffs were available, the consumer should be given the choice.

Mr. P. A. GILES (East London) considered that the consumer should not have the right to elect the tariff, until such time as a uniform method of metering was introduced. He continued, that it was impractical to have a tariff for every consumer, so tariffs were therefore divided into three classes: domestic, commercial and industrial. Mr. Giles thought the authority should elect its tariff, and then enforce it.

QUESTION No. 11: Can rise of station earth potentials under fault conditions constitute a serious hazard as far as underground pilot cable circuits between substations for protection, alarm and communication purposes are concerned and if so, what precautions should be taken in order to protect personnel and equipment from this hazard?

Mr. MIDDLECOTE (Pretoria) thought trouble might arise if the earth resistance of the electrodes was not sufficiently low. He believed the Railways had experienced such difficulties, and suggested the remedy was gas filled type low voltage protection.

QUIZMASTER agreed in his experience Mr. Middlecote's solution was sound.

Mr. W. H. MILTON (Escom) referred to two methods, viz: the isolating transformer, and the gas discharged tubes. He suggested, however, that the most dangerous condition was due to induced voltage rather than earth resistance.

QUIZMASTER concurred in this view.

QUESTION No. 14: Should not the scope of the A.M.E.U. and the duties of the Secretaries be widened to make it possible for information on tenders, and on other matters of common interest to be exchanged and circularised among members of the A.M.E.U.

Mr. J. L. VAN DER WALT (Krugersdorp) mentioned that Justice Russell's judgement in Britain was against ring prices, and there the whole matter was being reconsidered.

Mr. C. DOWNIE (Cape Town) suggested that more could be done to keep the members of the Convention in touch with one another, if only by means of having a regular publication. On the subject of tenders, Mr. Downie suggested it would be quite interesting for members to know what prices were obtainable for transformers, cables, and other equipment, even to the extent of having personal notes about individual members and so on.

QUIZMASTER proposed the question be placed on the Agenda for the next executive meeting.

FORUM ADJOURNED

# FOURTH DAY

THE PRESIDENT: Ladies and gentlemen we can now start with the business of the day. The first item on the Agenda is the Annual Report of the Secretaries, and I'll ask Mr. Ewing to present his report.

Mr. R. G. EWING, SECRETARY: Mr. President, ladies and gentlemen: the Report has been circulated, and if there are any questions we will be very pleased to deal with them.

THE PRESIDENT: I call on Clr. Blignaut to propose a vote of thanks to the Secretaries and the adoption of the Report.

Clr. P. G. C. BLIGNAUT, PRETORIA: Mr. President, electrical engineers usually are very conservative but they are also people who never accept things as they are —they always want to alter them, to step them up, step them down, transform them or condense them.

As I glanced through the acounts for the year I noticed the figures for the previous year being fenced in, and that immediately aroused my suspicion, that that must be a transformer. There it was! It was transformed from pounds to rand. And as I went further down I saw that the excess expenditure over income was condensed to the accumulated funds account, now that just shows you how they do things.

Mnr. die President, soos u sien was daar redelike groot uitgaaf gewees; dit is veral soos ek verneem, toe te skrywe aan die feit dat daar heelwat uitgawes was aan die referate sowel as aan die illustrasies. Ek verstaan dat die skrif vir die ingenieurs bedoel is en die illustrasies vir raadslede. Gevolglik reken ek dat ek seker nie veel daarop kan sê nie, maar ons verstaan ook dat met veranderde omstandighede in die toekoms dinge sal verander.

Nou ons weet natuurlik in elektrieseteit verander die stroom ook gedurig, hy wissel, so ons sal maar uitsien en hoop dat dit volgende jaar baie beter sal gaan. Ek wil dan van hierdie geleentheid gebruik maak om mnr. Ewing en die Finanskommitee te bedank vir die manier waarop hulle die rekeninge van die vereniging gehanteer het, ek wil ook gebruik maak van die geleentheid om voor te stel dat ons die finansiële state soos in hierdie verslag uiteengesit goed te keur en aan te neem. Dankie.

THE PRESIDENT: Dankie Raadslid Blignaut. Thank you Clr. Blignaut. I now call on Clr. Hoffman to second the proposal.

Clr. J. J. HOFFMAN, KRUGERSDORP: Mnr. die President, dames en here, Krugersdorp is die hoofstad van die Witwatersrand!

Mnr. die President dit is vir my vanmôre 'n baie groot eer en 'n voorreg om die voorstel tot die aanname van die jaar verslag te kon sekondeer. Alhoewel daar tot my 'n vriendelike waarskuwing gerig is deur dat ons raadslede natuurlik altyd 'n bietjie langdradig is en selfs lief is om baie te praat — nouja ek vind my ongelukkig in hierdie posisie natuurlik tussen die elektro-tegniese-ingenieurs. In Krugersdorp maak ons ook gebruik van elektrisiteit. Dus sal u ook sien dat ek natuurlik op gevaarlike grond beweeg indien dat ek nie daardie waarskuwing sal aanneem nie want kerse is deesdae maar baie skaars. Ek verwys natuurlik daar na die afsluiting van ons ligte.

Mr. President, I wish to state, that with the close ties between the members of the Federation and the Union, and their cooperation in the field of electricity supply, the European population have brought light to a dark part of Africa, which has been of advantage to all races. You have your problems in the Federation, which are not very dissimilar to those in South Africa, and we are all determined to continue to build on the light that we have brought to our respective parts of Africa.

This is reflected in the Annual Report of the Secretaries, in the papers delivered, and the symposium on the reticulation to Bantu — or as you call it African — Areas. It was a great pleasure to study such a report, and I am sure that with secretaries such as Davidson & Ewing (and, Mr. President, that, to us means "Mr. Ewing"), this Association will go from strength to strength.

Dan wil ek graag net so 'n puntjie of wat aanraak, in verband met die Finansiëleverslag. Mnr. die President dit is natuurlik verblydend om te kon sien dat hierdie jaar daar geen slegte skulde op verkope van die verigtinge was nie. Dit spreek natuurlik groot dele daar, en as besigheidspersone is ons bly om dit te kon sien. Dan het ek ook gemerk, soos wat mnr. Blignaut alreeds genoem het, dat in die afgelope jaar het u die opgehoopte kapitalefonds net mooi verdubbeld van £4,460 na die bedrag van R8,920.00. Mnr. die President, en ek wil graag hierdie gedagte uitspreek vandag tot nadenke vir die nabye toekoms, of daardie opgehoopte fonds in tyd om te kom indien dat u reken dat dit 'n sekere bedrag bereik het of dit wel nie so aangewend kan word tot die hulp miskien van minder bevoorregte studente wat hulle wel wil bekwaam in die rigting van ingenieurswese nie.

Ek glo nie daar bly veel meer oor nie; ek wil net ook my waardering uitspreek vir die mooi wyse waarop die Sekretarisse hulle verslag vir ons voorgelê het en weereens mnr. die President, wens ek nou formeel die voorstel van mnr. Blignaut tot aanname van die verslag te sekondeer. Dankie.

THE PRESIDENT: Thank you Clr. Hoffman.

I hear Clr. Hoffman said that there was a shortage of candles in Krugersdorp. For his information I can tell you that there is a candle factory in Livingstone, and I can assure you that the Livingstone Publicity Association will be able to assist Krugersdorp to get in touch with the local candle factory!

Are there any comments, gentlemen?

(THE SECRETARIES' REPORT WAS ADOPTED).

# Annual Report of the Secretaries

To the President and Members of the Association.

Mr. President, Gentlemen,

It gives me great pleasure to submit to you the Annual Report of your Association together with the Revenue and Expinditure Account and Balance Sheet for the financial year ended 28th February, 1961.

*Obituary*:

I deeply regret having to record the passing of Members and others who have been connected with the Association. Firstly, I wish to refer to the tragic death of Councillor M. Gild of Durban, whose aircraft was reported missing on the eve of the 34th Convention. Councillor Gild served on the Executive of the Association.

Another Councillor representative to the A.M.E.U., Councillor A. Markman, one of Port Elizabeth's most popular and successful Mayors from 1958 to 1960, passed away at the beginning of December, 1960.

One of our very early Members, Mr. G. Mercier (an Associate Member at the time of his death) and who was elected a Member of the Association in 1919 when in the service of the Bethal Municipality, died in September, 1960.

The Association and its Members lost a great friend in the passing of Major S. G. Redman on the 4th June, 1960. Major Redman came to South Africa in 1937 to become the first resident partner of Merz & McLellan (South Africa). From that year onwards until 1959 Major Redman attended every Convention of the Association. In 1956 the Association extended honorary membership to him. In the death of the Major the A.M.E.U. and all others who were privileged to know him have lost a sincere friend, a gentleman in the fullest sense of the word.

*Thirty-fourth Convention*:

The 34th Convention of the Association was held in Durban from Tuesday, 3rd May, 1960, to Friday, 6th May, 1960. Delegates were welcomed by His Worship the Mayor of Durban, Councillor Cyril Milne, who also officially opened the Convention. The total attendance of members, delegates, representatives, officials, visitors and ladies amounted to 501.

On behalf of the President, Members of the Association and all others who attended the Convention held in the Durban City Hall I have pleasure in recording appreciation to His Worship the Mayor and City Councillors of that city for the hospitality extended to those who attended the Convention. I also wish to extend sincere thanks to the City Council and to the various officials thereof for their unstinted assistance in the organisation of the Convention.

To the President I have much pleasure in placing on record the appreciation of all concerned for his dignified and effective discharge of his duties. Our grateful thanks are also extended to Mrs. Simpson for her support.

Although I do not wish to introduce the precedent of referring to the Presidential Address in the Annual Report, I crave Mr. Simpson's indulgence in this instance to refer to one aspect of his address at the Durban Convention. He referred to the possibilities of hydro generation of electricity with particular reference to Natal. It is significant that following from this we are going to have the pleasure of having presented to us at the 35th Convention a most important paper entitled "The Utilisation of Hydro Electric Power in the Union of South Africa."

The first paper presented to the Convention was "Some Economic Aspects of Nuclear Power Station Operation" by Mr. W. Eric Phillips, D.Sc. Eng., LL.D. (Alberta), M.I.E.E., M.(S.A.)I.R.E., Sen. Mem. I.E.E., Professor of Electrical Engineering, University of Natal, which was a further valuable contribution on this aspect of electricity supply which although not yet of practical importance to Municipal Electricity Undertakings in Southern Africa is one which they cannot afford to lose sight of in the point of view of future developments.

The next paper to be presented was "A Survey of the Control of Stage Lighting", by Mr. J. T. Wood. In its presentation Mr. Wood referred to certain aspects of this subject which were not covered in the printed version of the paper, and in particular dealt with equipment now available for small halls at a moderate price.

The final paper "Electrical Protection of Distribution Systems" by Mr. J. Michel-Smith, B.Sc. (Eng.), formerly of the Electricity Department, City of Durban, evoked informative discussion.

The symposium on the Supply of Electricity to Native Townships was a most successful feature of the Convention and I wish to thank all those who prepared contributions. To Mr. G. Masson of the Electricity Department, Johannesburg, we are particularly grateful for his detailed work in preparing a report on electrical work planned or in progress in the Native areas. The exchange of information through the symposium was, we are confident, of value to all Members involved in the problems of electricity distribution in Native areas.

The high standard of Members' Forum was again well maintained and our thanks are again due to Mr. J. Mitchell for conducting the Forum. A number of questions proposed to the Forum concerned economic aspects of Municipal Electricity Undertakings and the hope was expressed that this most important aspect would be dealt with further at a subsequent Convention. The suggestion is receiving the most serious attention of the Executive Council.

The Convention unanimously accepted the recommendation of the Executive Council that Councillors C. F. Castelyn and L. P. Davies of Bloemfontein and Springs respectively be elected Honorary Members of the Association.

It was unanimously agreed to accept the invitation of Livingstone to hold the 35th Convention in that town.

*Membership*:

The following new members were elected during the year ended 28th February, 1961:

*Councillor Members*:

Walvis Bay Municipality.
White River Municipality.
Vanderbijlpark Municipality.
Carletonville Municipality.
Knysna Municipality.

*Engineer Members*:

U. B. Gresse (Nelspruit).
W. Bozycsko (Edenvale).
F. R. Waldron (Walvis Bay).
J. J. Boshoff (Ceres).
H. J. Gripper (Knysna).
J. W. Pretorius (Nigel).

*Associates*:

J. J. Greef (White River).
V. G. Flint (Middelburg, Transvaal).

*Associate Members*:

W. P. Ford (Central Electricity Corporation Ltd.).

G. B. Gill (Zululand Electrical Utility Co. (Pty.) Ltd.).

*Affiliate Members*:

N.V. Nederlandsche Kabelfabrieken, Ltd.

The following resignations took place:

*Councillor Members*:

George Municipality.
Upington Municipality.

*Affiliate members*:

Pretoria Metal Industries Ltd.
John Brown Land Boilers Africa Ltd.
Sir Alexander Gibb & Partners (Africa).
Morgan Crucible Company (S.A.) (Pty.) Ltd.
Lusaka Electricity Corporation Ltd. (transferred).

Comparative membership figures are as follows:

| | 1959/60 | 1960/61 |
|---|---|---|
| Councillor Members | 120 | 124 |
| Engineer Members | 119 | 118 |
| Honorary Members | 12 | 13 |
| Associate Members | 30 | 29 |
| Associates | 9 | 10 |
| Affiliates | 90 | 85 |

*Finance*:

The Income and Expenditure Account for the year under review and the Balance Sheet as at the 28th February, 1961, which are sub-

## ASSOCIATION OF MUNICIPAL ELECTRICITY

## BALANCE SHEET —

| 1960 R | | | £ | R |
|---|---|---|---|---|
| 9,490 | ACCUMULATED FUNDS | | 4,460 | 8,920 |
| 8,184 | Balance at 29th February, 1960 | 4,745 | 9,490 | |
| 306 | *Less*: Excess of Expenditure over Income for the year ended 28th February, 1961 | 285 | 570 | |
| | PROVISIONS | | 179 | 358 |
| 178 | Agents' Commission | 90 | 180 | |
| — | Sales Commission | 89 | 178 | |
| 1,796 | SUNDRY CREDITORS | | — | — |
| — | SUBSCRIPTIONS IN ADVANCE | | 496 | 992 |
| — | DEPOSITS ON LIVINGSTONE CONVENTION TRAVELLING EXPENSES | | 1,851 | 3,702 |
| — | GRANT RECEIVED IN ADVANCE FOR LIVINGSTONE CONVENTION EXPENSES | | 250 | 500 |
| R11,464 | | | £7,236 | R14,472 |

DAVIDSON AND EWING (PTY.) LTD.,
*Per* R. G. EWING,
*Secretaries.*

Report of the Auditors to the Members of the Association of Municipal Electricity Undertakings of

We report that we have examined the books, accounts and vouchers of the Association for the received all the information and explanations we required. In our opinion the above Balance Sheet is as at 28th February, 1961, according to the best of our information and the explanations given to us

Johannesburg, 7th March, 1961.

## UNDERTAKINGS OF SOUTHERN AFRICA

## 28th FEBRUARY, 1961

| 1960 R | | | £ | R |
|---|---|---|---|---|
| 2 | PRESIDENTIAL BADGE Nominal Value | | 1 | 2 |
| 110 | FURNITURE AND FITTINGS — at cost less depreciation | | 49 | 99 |
| 7,930 | INVESTMENTS | | 4,155 | 8,310 |
| | 200 6% Permanent Paid Up Class "B" Shares of R10 each, fully paid | 1,000 | 2,000 | |
| | Fixed Deposit | 1,997 | 3,994 | |
| | Savings Account | 1,158 | 2,316 | |
| 1,876 | DEBTORS | | 1,050 | 2,099 |
| 40 | PAYMENTS IN ADVANCE | | 91 | 182 |
| 20 | DEPOSIT: Davidson and Ewing (Proprietary) Limited | | 10 | 20 |
| 1,486 | CASH AT BANK | | 1,880 | 3,761 |
| R11,464 | | | £7,236 | R14,472 |

R. M. O. SIMPSON,
*President.*

Southern Africa:

year ended 28th February, 1961; we have satisfied ourselves of the existence of the securities and have properly drawn up so as to exhibit a true and fair view of the state of the affairs of the Association and as shown by the books of the Association.

SAVORY, BRINK, CREMER & CO.,
Chartered Accountants (S.A.)
*Auditors.*

## ASSOCIATION OF MUNICIPAL ELECTRICITY

## INCOME AND EXPENDITURE ACCOUNT

| 1960 R | | £ | R |
|---|---|---|---|
| 38 | Audit Fee1960 | 19 | 38 |
| 2 | Bad Debts—Sale of Proceedings | — | — |
| 24 | Bank Charges | 14 | 28 |
| 2,892 | Convention Expenses | 1,940 | 3,881 |
| 12 | Depreciation—Furniture and Fittings | 6 | 11 |
| 592 | Executive Council Expenses | 363 | 726 |
| 34 | Insurance | 9 | 18 |
| 174 | Postages and Telegrams (General) | 69 | 138 |
| 120 | Presidential Chain written off | — | — |
| 678 | Printing and Stationery | 175 | 350 |
| *Cr.* 206 | Proceedings | 39 | 78 |
| 1,800 | Secretarial Fees | 900 | 1,800 |
| 30 | Subscriptions Paid | 15 | 30 |
| 116 | Sundry Expenses | 13 | 25 |
| 70 | Telephone | 43 | 87 |
| R6,376 | | £3,605 | R7,210 |

## ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS OF SOUTHERN AFRICA

### Schedule I

| | | |
|---|---|---|
| PROCEEDINGS: | | |
| Cost of Printing | | 1,946 |
| Provision for Sales Commission | | 178 |
| Provision for Agents Commission 1961 | 180 | |
| *Less*: Overprovision for Agents Commission 1960 | 23 | 157 |
| | | 2,281 |
| *Less*: Advertising (gross) | 1,783 | |
| Sales | 420 | 2,203 |
| Net Loss on sale of Proceedings | | R 78 |

## UNDERTAKINGS OF SOUTHERN AFRICA

## FOR THE YEAR ENDED 28th FEBRUARY, 1961

| 1960 R | | £ | R |
|---|---|---|---|
| 384 | Interest on Fixed Deposits and Savings Account | 190 | 380 |
| 2,790 | Subscriptions—Affiliates | 1,384 | 2,769 |
| 3,506 | Subscriptions—Council and Other | 1,746 | 3,492 |
| 2 | Sundry Revenue | — | — |
| *Cr.* 306 | Excess of Expenditure over Income transferred to Accumulated Funds | 285 | 569 |
| R6,376 | | £3,605 | R7,210 |

mitted to you call for analysis in view of the fact that an excess of expenditure over income of R569.00 (£285) is reflected therein.

The major increase in cost structure over the previous year, amounting to R624.00 (£312) included in Convention Expenses represents the increased cost of printing the Papers and Contributions to the Symposium. The increased length of the printed matter circulated prior to the Convention compared with that of the previous year was 52 printed pages. In addition, the large number of blocks incorporated and certain tabulated data increased the printing costs by more than the proportionate increase attributable to the number of pages involved.

I next wish to refer to the loss of R78 (£39) compared with a profit of R206 (£103) in the previous year incurred on the publication of the Proceedings. Certain advertisers who last year contributed to revenue to the extent of R240 (£120), this year found it necessary to prune their advertising allocations and revenue to this extent was thereby lost. However, through the introduction of new advertisers, this reduction in gross advertising revenue was brought down to R134 (£67). Revenue from sales of Proceedings was slightly reduced. The increased size of the Proceedings (16 extra pages) together with the cost of Art Work and new Blocks for Papers as well as re-setting of portions of Papers all necessitated by authors' alterations to illustrations and text, resulted in an increase in printing costs of R156 (£78).

Other items of expenditure do not call for any particular comment.

Despite the above factors, the accumulated funds of the Association still stand at the satisfactory figure of R8,920 (£4,460) and it is considered that no radical adjustments in its financial affairs are called for at this stage. Altered conditions over the next year or two may result in a more satisfactory balance between income and expenditure being achieved.

Messrs. Kane and Downey continued to constitute the Finance Committee of the Association during the year under review and once again I thank them sincerely for their assistance. The support of the advertisers in the Proceedings is once again acknowledged with appreciation.

*General*:

The Regional Branches of the Eastern Cape and Natal continued to function satisfactorily during the year under review.

Johannesburg again acted as hosts for the Mid-year Executive Meeting in 1960, and on behalf of all concerned we convey thanks for the hospitality extended to the Executive Council on this occasion.

To the various members of Sub-Committees of the Association and representatives of other Technical Committees and Organisations we convey the appreciation of the Association for their invaluable work during the year under review.

To you, Mr. President and all Members of the Executive Council I express sincere thanks for the assistance and courtesy extended to us during the past year.

To the Association and all its Members we extend best wishes for 1961/62.

R. G. EWING,

for DAVIDSON & EWING (PTY.) LTD.,

*Secretaries.*

15th March, 1961.

---

reappoint Messrs. Savory, Brink, Cremer & Auditors, and I would propose that we reappoint Messrs. Savory, Brink, Cremer & Co. as auditors for the ensuing year.

(AGREED).

Now we come to the reports of subcommittees and representatives. These reports have all been published, the first one being the report of our Association's representative to the S.A. Bureau of Standards Sub-Committees.

Our Representative is Mr. Downey and he is standing by. If there are any questions, I am sure he will be prepared to answer them.

I wonder if Mr. Middelcote would like to say something?

## REPORT ON THE ACTIVITIES OF THE SOUTH AFRICAN BUREAU OF STANDARDS RELATING TO ELECTRICAL ENGINEERING

Mr. President and Gentlemen,

I have much pleasure in presenting the report on the activities of the South African Bureau of Standards during the past year:

### CABLES

*S.A.B.S.* 97—*Paper Insulated Cables for General Purposes*

The first revision of this specification was approved by the Standards Council on the 5th October, 1959, and this is now available in printed form.

*S.A.B.S.* 98—*Paper Insulated Cables for Heavy Duty*

The first meeting of the committee appointed to revise this specification and to bring it into line with the revised S.A.B.S. 97, was held on the 5th April, 1960. The document as amended is being prepared for submission to the Standards Council.

*S.A.B.S.* 182—*Copper Wire and Bar for Electrical Purposes*

The committee appointed to draw up this specification was reconstituted and copies of documents together with minutes from previous meetings have been sent out to members of reconstituted committee.

*S.A.B.S.* 168—*Medium Voltage Vulcanized Rubber Insulated Cable and Flexible Cords for Power and Lighting Purposes*

Following the decision by the Standards Council on the 9th December, 1957, that this specification and also S.A.B.S. 168 be revised, the committee was reconstructed and a meeting was held on the 23rd March, 1961.

## DOMESTIC APPLIANCES AND ELECTRIC INSTALLATIONS

*S.A.B.S. SV. 122—Safety Specification for Domestic Radio and Electronic Apparatus*

A draft for comment was circulated on the 6th April, 1960. Due to the lack of replies to this notice the closing date for comment was extended and it was then decided to await issue of the revised I.E.C. draft before proceeding with the project. Copies of the I.E.C. revised draft have now been issued to the committee and a meeting was held on the 7th February at which the project was finalized by the committee, bringing it into line with current I.E.C. practice. The final draft is now being prepared for submission to the Standards Council.

*S.A.B.S. 151-1958—Fixed Electric Storage Water Heaters*

A meeting was held on the 28th April, 1960, to discuss a proposed amendment to the specification.

*S.A.B.S. 155—Miniature Circuit-breakers for Lighting, Heating and Domestic Installations*

and

*S.A.B.S. 156—Miniature Circuit-breakers for the Protection of Electric Motors*

Two meetings were held on the 1st April and the 10th November to discuss a draft standard for Moulded Case Circuit-breakers, intended to supersede S.A.B.S. 155 and 156. The committee has finalized the draft specification which has now to be submitted to the Standards Council for approval.

*S.A.B.S. 184 — Electric Heating Pads and Blankets*

This specification was finalized at the 6th meeting of the committee held on the 17th September, 1959. It was approved by the Standards Council on the 4th April, 1960 and is now available in printed form.

*S.A.B.S. 185—Immersion Heaters for Portable Electric Appliances*

The specification for immersion-type heating units for use in portable appliances for heating water and non-corrosive aqueous solutions (viz. kettles, coffee percolators, etc.) was finalized at the second meeting held on the 18th February, 1960. It was approved by the Standards Council on the 4th April, 1960, and has now been published.

*S.A.B.S. 186—Impulsing Energy Regulators for Electric Heating Units*

This specification was finalized at the second meeting on the 5th July, 1960, and was approved by the Standards Council on the 28th November, 1960. The specification is at present with the printers but roneoed copies are available.

## DISTRIBUTION

*S.A.B.S. 171—Low Voltage Lightning Arrestors*

This specification was finalized at the third meeting held on the 12th November, 1957, but was brought back to the committee for a further meeting on the 7th August, 1958. The amended document was submitted to the Standards Council on the 9th June, 1960, and has now been published.

*S.A.B.S. 177—Porcelain and Toughened Glass Insulators for Overhead Power Lines* (Previously S.A.B.S. 178)

A meeting was held on the 8th November, 1960, at which the second committee draft was discussed. A draft for comment is under preparation and will be issued shortly.

*S.A.B.S. 188—High and Low Voltage Bushing Insulators*

*S.A.B.S. 187—Standard Bushings for Voltages up to and including 36 kilovolts*

(Previously S.A.B.S. 179 High and Low Voltage Bushings)

Three meetings were held on the 30th June, the 28th July and the 8th December. The committee decided that the specification be divided into the two sections as above, and drafts of the two proposed specifications were discussed. A further meeting will be held before the drafts for comment are issued.

## TRANSFORMERS

*S.A.B.S. 517—Distribution Transformers*

Meetings of this committee were held on the 29th April, 21st May, 3rd June and 10th June, 1959. A new committee draft has been prepared for submission to the committee, after which a draft document will be issued for comment.

## CODES OF PRACTICE

*The Handling, Installation and Operation of Electric Cables*

No meetings of this committee were held during the period under review.

*Code of Practice for the Testing of Power Transformers*

At a meeting held on the 12th April, 1960, it was decided that a project to compile a code of practice for testing power transformers be recommended to the Standards Council for approval.

## AMENDMENTS

During the year under review amendments were issued on:

*S.A.B.S.* 154—*Electric Cooking Plates;* and

*S.A.B.S.* 185—*Immersion Heaters for Portable Electric Appliances, Apparatus, Connector Type.*

J.C. DOWNEY,
*A.M.E.U. Representative to S.A.B.S. Commitees.*

Mr. A. A. MIDDLECOTE, BUREAU OF STANDARDS: Mr. President, I would just like to add a little to the report of the activities of the S.A. Bureau of Standards, because I think that they might be of interest to all the members.

This information has come to hand just in the last week so Mr. Downey couldn't add the additional information to his report.

I would like to refer to distribution transformers. We have had several sub-committees that have been very active recently and it is hoped that the resultant draft will be discussed by the full committee very soon. This standard had to go hand in hand with the standard bushing specification which is now ready for final comment and which, when completed, will do much to simplify production on the part of the manufacturer, and give the benefit of easier maintenance to the operating engineers.

It has been a great pleasure, actually, to observe the co-operative spirit displayed by members of the sub-committees in discussing the very contentious standardisation features of distribution transformers, and the agreement which has already been reached augurs very well for the future.

The specification will cover many points which are frequently debated by consumers, and a large amount of simplification is being aimed at.

To mention some points of interest—some of which have been mentioned in the Forum — (1) the standardisation of bushings and cable boxes is being aimed at, to simplify maintenance and also to reduce the costs as regards the manufacturers.

In the second place we are aiming at standardisation and simplification of fittings. Good examples here are the fittings for sealed transformers. We are aiming at a basic minimum of fittings, because we find that very many consumers are rather apt to overdo little unnecessary refinements, and this does tend to raise the primary cost of transformers.

In the second case, the probable deletion of features such as explosion vents on small free breathing transformers, since there seems to be a great lack of any proof that they fulfill any useful function whatsoever.

We also are aiming at the establishment of rating at which conservators should be provided. This point, I think, was raised in the Forum and is of interest. It will probably be between 300 and 500 KVA that conservators are advised. This is a little open at the moment.

Also provision is being insisted on for features like facilities for cleaning the conservators. We are also aiming at a minimum dimensional standardisation for pole mounted transformers.

Then we come to standardisation of tappings and voltages. We hope, actually, hereby to overcome a little confusion which does exist between the so-called declared standard voltage of a system, and the rated voltage of a transformer. You know the old idea that your declared system voltage might be 220 and you order a transformer with a 240 to allow for the average regulation. There seems to be a bit of confusion here, and we hope to clarify this point by making recommendations concerning the recommended standard voltages to fit in with the standard declared voltage in South Africa which is 220 volts.

The other point, a very contentious one, on which I hope we will have a lot of help, is the possible standardisation of losses in small distribution transformers to eliminate the need for capitalisation formulae in adjudicating tenders. This should result in a definite drop in the primary cost of such transformers since it will eliminate the need for the large variety of transformers which have to be manufactured in this country to satisfy the enormous variety of capitalisation formulae.

All of these formulae, in the case of small distribution transformers, depend to a large degree on a selected value of load factor which normally is only a very good guess. The alternative approaches of establishing recommended standard capitalisation formulae is also being examined. Whatever the final approach, something *must* be done to rationalise the transformer industry and to enable the manufacturers to return to the consumer the benefits resulting from better production runs, i.e. lower primary costs and ease of tendering.

The code of practice for the testing of power transformers will also do much to eliminate variations in testing techniques between different manufacturers. One example of such possible differences was given in the Forum where the question of 3 watt meter measuring losses was debated.

A further point that might interest the convention is the work which is going to be done on radio interference. Another point of interest to members will be the inclusion in future of radio interference requirements for electrical appliances and components such as insulators. This will be necessary in view of the V.H.F. radio programme which will shortly be commissioned in South Africa, and the possibility of TV in the future.

These two projects will require increasing control of radio interference. Step 1 in this regard will be the specification for VHF radio receivers which will include a re-radiation interference limitation and the establishment of the necessary test equipment.

This will have quite a bearing on components in engineering, and we will have to be prepared for this.

Finally, Mr. President, I would like to thank the AMEU representatives for the very large amount of help they have given us; and particularly our old friend Mr. Jack Downey who has never ceased working to the best of his capacity in this connection. Thank you.

THE PRESIDENT: Thank you Mr. Middlecote. Are there any queries or comments, gentlemen?

Is it agreed that the Report be adopted?

(AGREED).

We now come to the Wiring Regulations Committee, and our representative is Mr. J. C. Downey.

## WIRING REGULATIONS COMMITTEE

During the period under review the Committee has met on four occasions and the main business has been the consideration of proposed amendments to the Regulations concerning auto-transformers, control of signs, underwater lighting, lifts, hazardous situations, mixed loading on circuits, estimated load and the current ratings of p.v.c. cables.

In addition a number of queries concerning interpretations of the Regulations were handled.

Since my last report the Committee has been augmented by representatives from the S.A.R. & H. and by the Electric Cable Manufacturers of South Africa.

Members will be interested to know that at the end of February, 1961 approximately 3,550 copies of the English version and 1,400 copies of the Afrikaans version have been sold. The Afrikaans version has the errata slip inserted that was referred to last May in Durban. It is possible that a few purchasers have not received this and an approach to the South African Institute of Electrical Engineers will be welcomed.

Concerning Regulation 204 on estimated load, all large supply authorities were approached for information concerning their habits and opinions. The Committee is very grateful to those that helped and summarized copies of the replies received have been forwarded to those authorities. Somewhat associated with this investigation was an approach to the five Provincial Ad ministrations for details concerning their procedure on the promulgation or otherwise of the Regulations and which towns or supply authorities have adopted one or other of the editions. At the time of preparing this report only three Administrations had replied. It is, however, obvious that habits differ between provinces, for example, the Electricity Supply Commission apply the latest editions of the Regulations Union wide, certain Transvaal supply authorities also immediately apply the latest edition; a move is afoot in Natal for a similar approach through Provincial Administration channels. South West Africa has promulgated their own Regulations mainly based on the 1955 edition, the majority of supply authorities in the Cape and Orange Free State have adopted the 1955 edition. The balance of the country and certainly some of the Transvaal authorities are apparently still concerned with the First Edition published in 1940.

Arising from the above replies concerning Regulation 204 and the Provincial procedure, your Committee is inclined to the opinion that the requests for amendments of Regulation 204 may not be warranted in so far as it appears that what was considered extremely conservative in the editions up to that of 1955 — namely the estimated loading of socket outlets — has been materially altered in the 1960 edition and it is felt that some further experience must be gained in the application of this latest edition before Regulation 204 is altered if at all.

Another matter of interest concerns the current rating of p.v.c. cables. Because of a loophole in the 1951 and 1955 editions the country has apparently accepted ratings somewhat comparable to those of paper insulated cables. The introduction of the 1960 edition has created (for those who have adopted this edition) a problem since V.R.I. ratings are specified. Considerable discussion has ensued and since to date no authoritative guide can be obtained from either overseas or locally, the Committee has decided to await such an issue before recommending any alterations. The whole problem highlights the necessity for means of universal adoption of the Regulations throughout the country and possibly some approach to the Provincial Administrations may help in this direction.

Finally there is a matter of interest regarding the use of mineral insulated cables for space heating purposes. The Regulations and particularly Table 12 only treat these cables as normal conductors. It stands to reason that when used for space heating or heating elements a considerably higher current is necessary and acceptable. This value is usually about twice that of the tables.

J. C. DOWNEY, Representative.

Mr. A. JACKSON, PROVINCIAL ADMINISTRATION, CAPE TOWN: Mr. President, I note Mr. Downey's suggestion that an approach to the Provincial Administrations may help in the universal adoption of the regulations. I am not sure to which particular edition this refers, but I would very strongly recommend that the regulations be examined to see whether they can be separated into true safety regulations as distinct from a code of practice which at present is masquerading under the guise of regulations.

The fact that some undertakings are working to the latest edition, others to the 1955 edition and yet others to the original 1940 edition would seem to confirm that it would be possible to divide the regulations in this way; and I feel that it would facilitate the general adoption of the regulations and that it would more easily permit Provincial Administrations to keep standard regulations up to date if this could be done.

THE PRESIDENT: Thank you Mr. Jackson. I wonder if Mr. Downey would like to comment?

Mr. J. C. DOWNEY, SPRINGS: Mr. President, as we have the Chairman of the Wiring Regulations Committee here I would suggest we ask him to speak to this matter.

Mr. R. W. KANE, JOHANNESBURG: It has been already suggested that, when we issue a third edition (and I think it was Mr. de Beer who made the suggestion), we should follow the overseas practice, with Part I which is a very simple section that covers the pure safety requirements, and Part II tells how to obtain the safety requirements.

The suggestions about the administrative procedure is rather an interesting one. I understand Natal is seriously contemplating altering their local government ordinance to such an extent that automatically any new edition will become the wiring requirements of Natal, and I do think the other Provinces should do the same thing.

When Mr. Jackson said that some people are working to the 1955 edition, some to the 1940 edition and some to the 1960 edition, he did not say that those who are working on the 1940 and 1955 editions, have also taken the best out of the other editions. They are not consistent throughout the country.

THE PRESIDENT: Thank you Mr. Kane. Are there any other comments?

It is agreed then that the report be adopted?

(AGREED).

THE PRESIDENT: The next item is the report of the Recommendations Committee for new Electrical Commodities. Mr. van der Walt is our representative.

## REPORT OF THE RECOMMENDATIONS COMMITTEE FOR NEW ELECTRICAL COMMODITIES

Mr. President, Gentlemen,

A brief summary of how this Committee is constituted and its functions will not be out of place.

1. Representatives.

(1) A.M.E.U. — J. L. van der Walt, Chairman, J. C. Downey.

(2) Mr. R. W. Kane.

(3) South African Bureau of Standards—Mr. A. A. Middlecote, Mr. D. I. Jones.

(4) S.A.I.E.E. Wiring Regulations Committee — Mr. J. C. Fraser, Mr. A. Dannenbaum.

(5) Electricity Supply Commission—Mr. J. W. Barnard, Mr. W. Steen-Stenerson.

(6) Electrical Engineering and Allied Industries Association — Mr. J. Morrison.

(7) Electrical Contractors Association of South Africa — Mr. F. B. Gibson, Mr. J. M. Fraser.

(8) Secretaries — Messrs. Davidson and Ewing (Pty.) Ltd.

## VERSLAG VAN DIE AANBEVELINGSKOMITEE VIR NUWE ELEKTRIESE WARE.

Meneer die President, Menere,

Dit sal paslik wees om 'n kort uiteensetting van die samestelling en funksies van hierdie komitee te gee.

1. Verteenwoordiging.

(1) V.M.E.O. — J. L. v.d. Walt—Voorsitter, J. C. Downey.

(2) Mnr. R. W. Kane.

(3) S.A.B.S. — Mnr. A. A. Middlecote, Mnr. D. I. Jones.

(4) S.A.I.E.I. Komitee vir Bedradingsregulasies — Mnr. J. C. Fraser, Mnr. A. Dannenbaum.

(5) Elektrisiteitsvoorsieningskommissie — Mnr. J. W. Barnard, Mnr. W. Steen-Stenerson.

(6) Elektriese Ingenieurswese en Geallieërde Indutrieë Vereniging — Mnr. J. Morrison.

(7) Elektriese Kontrakteurs Vereniging van S.A. — Mnr. F. B. Gibson, Mnr. J. M. Fraser.

(8) Sekretarisse — Mnre. Davidson en Ewing (Edms.) Bpk.

2. FUNCTION.

The function of this committee is to investigate new electrical commodities *for which no standard specification exists*, and then, after considering test reports, practical installations, etc., only *recommend* to its members that the commodity was found suitable for use. The S.A.B.S. acts as testing authority, only upon requests of the Committee, after an application has been received. Applicants must therefore submit their applications and samples to the Secretaries as well as samples for testing purposes to the S.A.B.S.

It is the responsibility of the applicants to submit the test reports to the Committee.

The Committee may also request the S.A.B.S. to subject the sample to certain tests.

*It must be noted that the Committee does not consider commodities for which a standard specification exists. It is the responsibility of the Engineer to satisfy himself that the commodity offered does conform with the standard specification.*

During the year two meetings were held and members were advised of the decisions of these meetings through the usual news bulletins. Members are advised to record these recommendations and thus obviate unnecessary enquiries.

Members are reminded of the fact that these news bulletins are private and confidential and not for publication. The Committee will appreciate it if members treat it as such.

During the year a number of applications were received for the installation of various makes of apparatus for boiling water, usually of the quick boiling type. The Committee could not consider these as a specification exists for water heaters and members must satisfy themselves that the articles comply.

The Committee continues to provide a useful service to its members which is borne out by the number of applications received.

J. L. VAN DER WALT, *Chairman.*

2. FUNKSIE.

Die funksie van hierdie komitee is om aansoeke vir die gebruik van nuwe elektriese ware *waarvoor daar geen standaard spesifikasie bestaan nie* te ondersoek en nadat toetsverslae, praktiese installasies, ens., besigtig is, *slegs aan lede aan te beveel* of so 'n ware geskik vir gebruik is, al dan nie. Die S.A.B.S. doen die toetswerk alleen op versoek van die komitee nadat 'n aansoek ontvang is. Applikante moet dus hulle aansoeke en monsters aan die Sekretaris stuur, asook monsters aan die S.A.B.S. vir toetsdoeleindes.

Dit is die verantwoordelikheid van die applikant om die toetsuitslae aan die komitee te stuur. Die komitee mag ook die S.A.B.S. versoek om sekere toetse uit te voer.

*Daar moet op gelet word dat die komitee nie aansoeke oorweeg waar daar reeds 'n standaard-spesifikasie vir die ware bestaan nie. Dit is die verantwoordelikheid van die ingenieurslid om toe te sien dat sulke ware wel aan die standaard-spesifikasie voldoen.*

Gedurende die jaar was twee vergaderings gehou en lede was deur die gewone nuusbriewe van die bevindings verwittig. Lede word aanbeveel om hierdie bevindings te bewaar en sodoende onnodige navrae uit te skakel.

Lede word ook daarop gewys dat hierdie aanbevelings privaat en vertroulik en nie vir publikasie is nie. Die komitee sal dit waardeer indien lede hierdie aanbevelings as sulks sal beskou.

Gedurende die jaar was 'n aantal aansoeke vir waterverwarmers (van die vinnige soort) ontvang. Die komitee het hierdie aansoeke nie oorweeg nie, aangesien standaard spesifikasies reeds bestaan en lede moet toesien dat die produkte daaraan voldoen.

Die komitee gaan voort om 'n nuttige diens aan lede te lewer wat uit die aantal aansoeke wat ontvang word blyk.

J. L. VAN DER WALT, *Voorsitter.*

---

Are there any comments?

(AGREED that the report be adopted).

I would like to thank Mr. van der Walt for his report.

We now come to the report on the Electrical Work Planned or in Progress in the Native Areas.

## ELECTRICAL WIREMEN'S REGISTRATION BOARD

Mr. President, Ladies and Gentlemen,

There were twelve meetings of the Board during 1960, one of which was a special meeting to again consider possible amendments to the Act. The Examinations Sub-Committee met on four occasions during the year.

393 applications for registration were considered during the period under review and 148 registration certificates were issued, bringing the total number issued since 1940 to 7,702.

Concerning examinations, 527 candidates wrote the sections of Section A and 15.2% became eligible for the practical examination. 277 candidates presented themselves for the practical examination and 51.6% passed. In both sections of the examination the results are poorer than corresponding results in previous years.

The magisterial area of Umzinto and the municipal areas of Bothaville and Winburg were determined during the year bringing the total number of areas determined to 117 at the end of 1960.

Concerning amendments to the Act the Board has recommended alterations to Section 19 of the Act that should remove the anomally concerning the troubles over testing and connecting premises wired by Government or Provincial authorities. In addition a further amendment proposed excludes elevators from inspection by the local authority. Finally a proposal that all contractors be registered in a determined area has been accepted. It is of course not known when the amendments will be effected.

A certain amount of time has been spent by the Board on the question of Native trainees and the licensing of these. It is more than possible that some form of registration of limited scope for use in Native areas only will result.

I am indebted to the Board for permission to submit this report and also to our Members and Executive for proposing me to represent the Association for a further period of office.

R. W. KANE, Representative.

ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS OF SOUTHERN AFRICA

## ELECTRICITY FOR DOMESTIC PURPOSES BY AFRICAN NATIVE FAMILIES.

### SCHEDULE "A"

| | GRAHAMS-TOWN | QUEENS-TOWN | SOMERSET EAST | WALMER |
|---|---|---|---|---|
| **A. General** | | | | |
| No. of towns'ps or settled com. | 1 | 1 | 1 | 1 |
| No. of dwelling units .. .. .. | — | 1,094 | 329 | — |
| How many dwellings: | | | | |
| Lighting only .. .. .. .. | — | — | None | 160 |
| Lighting and Cooking .. .. | — | 99 | None | Nil |
| Average family income | | £6–£12 | + − £11 | |
| Where no supply available.. | — | R12 to R24 | + − R22 | £12 £24 |
| Lighting supply only .. .. | — | — | — | |
| Lighting and other purposes | — | £20 40 | — | |
| Who is responsible for payment for electricity consumed .. .. | — | Consumer | — | — |
| **B. Town Planning Details** | | | | |
| Any difficulty due to Town Planner's design .. .. .. | Yes | Not unduly | No | No |
| Are street corners splayed .. | Yes | Yes | No | No |
| Do curved streets make erection of O/H mains difficult .. .. | Yes | No | No | No |
| What size sites are provided for load centres.. .. .. .. .. | — | — | None | 25′ x 25′ |
| **C. Financing of Schemes** | | | | |
| Work financed out of the Natives Services Levy .. .. .. .. | — | — | — | — |
| Work financed out of the National Housing Loans .. .. .. .. | Street lighting | Reticulation & Street lighting | — | — |
| Work financed out of the Local Authorities' own funds .. .. | — | Wiring & Sub-Stations | Street lighting ex Beer Hall A/c | Reticulation |
| Work financed out of Other sources.. .. .. .. .. .. | — | — | — | — |
| **D. Design Details** | | | | |
| Are E.H.T. mains O/H or U/G | O/H U/G | U/G | O/H | U/G |
| Are L.T. mains O/H or U/G .. | O/H | O/H | O/H | O/H |
| Where are poles planted .. .. | Near kerb | Near kerb | Near build. line | Near kerb |
| Do you operate with M.E.N. .. | No | No | No | Yes |
| Conductor configuration .. .. | Vertical | Old–Horizon New–Verti. | Vertical | Vertical |
| **D. Design Details**—Continued | | | | |
| Conductor materials .. .. .. | Copper | Copper | Copper | Copper |
| Type of Load centre .. .. .. | Brick kiosks | Brick kiosks | Pole transf. | Pole transfr. |
| Capacity of Load centres .. .. | 30 K.V.A. | 500 KVA. | 25 KVA. | 100 KVA. |
| E.H.T. protection of transformer | Fuse | O.C.B. | Dropout fuse | Fuse |
| Street lighting fittings: | | | | |
| Wattage .. .. .. .. | 60 w. | 60 & 100 w. | 200 w. | 150 w. |
| Spacing.. .. .. .. .. | 450′ | 240′ | 300′ | 500′ |
| Type .. .. .. .. .. | Tungsten | Tungsten | Tungsten | Tungsten |
| Flourescent street light fittings: | | | | |
| Type of Starter | — | — | — | — |
| Do multitube fittings have separate ballasts .. | — | — | — | — |
| Are they high p.f. type .. | — | — | — | — |
| No. of tubes per fitting .. | — | — | — | — |
| Length of tube .. .. .. | — | — | — | — |
| Are street lights provided in every street .. .. .. .. .. | No | Newsec. Yes Old sec. No | No | Yes |
| Approx. cost of street lighting fittings .. .. .. .. .. .. | £4 R8 | £3 1s. 11d. R6.19 | £3 0s. 0d. R6 | £3 10s. 0d. R7 |
| Approx. cost of street lighting wire guards .. .. .. .. .. | — | — | — | — |
| House S/C Type of insulation O/H services .. .. .. .. | — — | O/H P.V.C. | — — | O/H P.V.C. |
| House S/C Type of insulation U/G services .. .. .. .. | — | — | — | — |
| House S/C Size of conductor .. | — | 7/.044 7/.052 | O/H — | 10 S.W.G. |
| House S/C Size of meter/amperes | — | 5, 10 & 20amp. | — | — |
| **E. Tariff.** | | | | |
| For Bulk supply to townships .. | — | Cost | Standard | Cost |

| | GRAHAMSTOWN | QUEENSTOWN | SOMERSET EAST | WALMER |
|---|---|---|---|---|
| For consumers .. .. .. .. | — | Standard Block | — | 3d. (2½c) per unit |
| Is sup. available 24 hours per day | — | Yes | — | Yes |
| Are current limiters used .. | — | No | — | Yes |
| Do you levy a fixed charge: | | | | |
| Lighting only .. .. .. | — | — | — | — |
| Unrestricted use.. .. .. | — | — | — | — |
| Have you a special tariff for African township .. .. .. | — | No | No | — |
| **F. Metering** | | | | |
| Do you meter individual consu. | — | Yes | — | Church and Business |
| Are prepayment meters used .. | — | Yes | — | No |
| Any problems with prepayment meters .. .. .. .. .. .. | — | No | — | Yes |
| **G. Consumption and Demand** | | | | |
| Annual consumption. Fixed tariff — Lighting only .. .. | — | — | — | — |
| Annual consumption. Fixed tariff — Unrestricted.. .. .. | — | — | — | — |
| Annual consumption. Metered—Lighting only .. .. .. .. | — | — | — | — |
| Annual consumption. Metered—Unrestricted use.. .. .. .. | — | — | — | — |
| After diversity demand — Fixed tariff Lighting .. .. .. | — | — | — | — |
| After diversity demand — Fixed tariff unrestricted .. .. .. | — | — | — | — |
| After diversity demand—Metered lighting.. .. .. .. .. | — | — | — | — |
| After diversity demand—Metered unrestricted.. .. .. .. | — | — | — | — |
| How are accounts collected — payable at .. .. .. .. .. | — | Payable at office | — | — |
| **H. Reticulation costs** | | | | |
| (a) **Street lighting reticulation scheme.** | | | | |
| No. of stands in town'p con. | 1,030 | 464 | 329 | 364 |
| Size of stand .. .. .. .. | 40′ x 70′ | 40′ x 60′ 70′ x 80′ | 55′ x 65′ | 50′ x 50′ |
| Cost per stand, street lighting | £1 10s. 0d. R3 | £5 R10 | £1 15s. 0d. R3.50 | — |
| Cost per street lamp erected | £33 7s. 0d. R66.70 | £58 R116 | ± £40 R80 | — |
| (b) **Street lighting and domes. power** | | | | |
| No. of stands in township .. | — | 538 | — | — |
| Size of stands.. .. .. .. | — | 40′ x 60′ 70′ x 80′ | 50′ x 100′ | — |
| A.d.m.d. catered for .. .. | — | — | — | — |

| | GRAHAMSTOWN | QUEENSTOWN | SOMERSET EAST | WALMER |
|---|---|---|---|---|
| Average cost per stand including street lighting.. | — | £15 5s. 0d. R30.50 | — | — |
| **I. Wiring.** | | | | |
| No. of houses wired .. .. .. | — | — | — | — |
| Size of service cable .. .. .. | — | — | — | — |
| Cost of service cable .. .. .. | — | — | — | £15 R30 |
| Cost of meter .. .. .. .. .. | — | — | — | — |
| Cost of limiter, fuses or m.c.b... | — | — | — | — |
| Cost of house wiring (L= light S= socket).. .. .. .. | — | — | — | — |
| Cost of house wiring .. .. .. | — | — | — | — |
| Cost of house wiring .. .. .. | — | — | — | — |
| Cost of house wiring .. .. .. | — | — | — | — |
| No. of sockets per house .. .. | — | — | — | 2 |
| Type and rating of socket outlets | — | — | — | — |
| Are cooker control units provided | — | | | — |
| Wiring system used .. .. .. | — | — | — | Conduit |
| Are lights mounted in centre of rooms .. .. .. .. .. .. | — | — | — | Yes |
| Are lighting switches grouped in one position .. .. .. .. | — | — | — | No |
| Are ceiling switches used .. .. | — | — | — | — |
| **J. Special Features** | | | | |
| Have communal kitch. been used | — | No | — | — |
| Any special service layouts .. | — | No | — | — |
| Any special design features .. | — | No | — | — |
| **K. Maintenance** | | | | |
| Who is resp. for wiring mainten. | — | Consumer | — | Council |
| **L. Bantu artisans and contrac.** | | | | |
| Do native wiremen carry out installation work .. .. .. | — | — | — | No |
| Do native wiremen carry out maintenance work .. .. .. | — | — | — | No |
| Are native contractors permitted | — | — | — | — |
| How many nat. cont. in your area | — | — | — | — |
| Are connection fees charged for individual dwellings.. .. .. | — | £7 10s. 0d. R15 | — | — |
| Other connection fees.. .. .. | — | £10 0s. d. R20 | — | — |
| Wages paid to electrical trainees | | | | |
| 1st Year.. .. .. .. .. | — | — | — | — |
| 2nd Year .. .. .. .. | — | — | — | — |
| 3rd Year.. .. .. .. .. | — | — | — | — |
| 4th Year.. .. .. .. .. | — | — | — | — |
| 5th Year.. .. .. .. .. C = C.O.L.A. | — | — | — | — |
| Wages paid to qual. nat. artisans | — | — | — | — |

## SCHEDULE B.

## WORK DONE DURING THE YEAR 1960.

| | Bloemfontein | Bulawayo | Benoni | Cape Town | Durban | East London | Johannesburg | Port Elizabeth | Salisbury | Sasolburg |
|---|---|---|---|---|---|---|---|---|---|---|
| **HOUSES** | | | | | | | | | | |
| Number wired during 1960 ... | Nil | 592 | Nil | Nil | Nil | 2900 | — | Nil | 842 | 70 |
| Average consumption (Per annum kWh) ... ... ... ... | 1200 | 3588 | 360 | 1440 | — | — | 350 to 650 | 1260 | 960 to 1620 | 348 to 420 |
| After diversity maximum demand kVA ... ... ... ... | — | 1·0 | 0·27 | 0·40 | — | — | 0·2 to 0·4 | — | 0·34 to 0·59 | 0·50 to 0·75 |
| Type of service connection ... | — | overhead | underground | — | — | — | underground | underground | — | — |
| **BUSINESS PREMISES** | | | | | | | | | | |
| Average consumption kWh. ... | 3000 | — | — | — | — | — | 100 to 5000 | — | — | — |
| After diversity maximum demand kVA. ... ... ... ... | — | — | — | — | — | — | 1 to 10 | — | — | — |
| **HOSTELS.** | | | | | | | | | | |
| Total accomodation for Males | — | — | — | 14238 | — | 1136 | 24000 | — | 35000 | 576 |
| Females ... ... ... ... ... | — | — | — | — | Nil | — | 117 | Nil | 165 | — |
| Wiring carried out during the past year for the housing of:— Males ... ... ... ... | — | — | — | Nil | 4000 | — | Nil | 74 housing blocks. | 620 | — |
| Wiring carried out during the past year for the housing of :— Females ... ... ... ... | — | — | — | Nil | Nil | — | Nil | — | — | — |
| Average consumption per capita per annum Males ... ... ... | — | — | — | 144·20 kWh | 39 kWh | 53 kWh | ·022 | — | 336 to 687 | 54 kWh |
| Average consumption per capita per annum Female ... ... | — | — | — | — | — | — | ·022 | — | 72 to 644 | — |
| A.D.M.D. kVA per capita Male ... ... ... ... ... | — | — | — | 0·345 | 0·042 | 0·045 | ·05 | — | 0·06 to 0·162 | 0·03 |
| A.D.M.D. kVA per capita Female ... ... ... ... ... | — | — | — | — | — | — | — | — | 0·33 | — |
| Is electric lighting provided ... | Yes | — | — | Yes | Yes | Yes | Yes | Yes | Yes | — |
| Is provision made for electric cooking?... ... ... ... ... | No | — | — | Plugs provided for 1328 persons | 1–15A plug — 4 men | — | No | — | Yes | — |
| Is provision made for electric water heating? ... ... ... | No | — | — | — | — | — | 1 hostel — Yes | — | Yes | — |
| Is provision made for electric Ironing ... ... ... ... ... | No | — | — | — | — | — | No | — | Yes | — |
| Is full lighting provided? ... | Yes | — | — | — | Yes | — | Yes | — | Yes | Yes |
| Tariff ... ... ... ... ... ... | 1d. per unit | — | — | 1d. per unit | 1·58d. per unit | 1·5d. per unit | — | 1·076 per unit | — | — |
| **TOWNSHIP RETICULATION.** | | | | | | | | | | |
| Cable laid EHT. ... ... ... | — | — | Nil | — | 6·5 miles | — | 3 | — | — | — |
| Cable laid LT. ... ... ... ... | — | — | Nil | — | 6·5 miles | — | — | — | — | — |
| LT. street light mains ... ... | — | — | Nil | — | 15 miles | — | 10 | — | — | — |
| No. of additional street lights | — | — | Nil | — | 515 | — | 220 | 125 | — | — |
| Transformer kiosks ... ... ... | 2 | — | Nil | — | 7 | — | 5 | 1 | — | — |

## REPORT ON ELECTRICAL WORK PLANNED OR IN PROGRESS IN THE NATIVE AREAS

At the 34th Convention it was suggested that this report should be kept up-to-date. The members who had submitted information upon which the 1960 report was based were requested to submit details of any work completed during the past year and copies of the questionnaire were sent to additional members who were thought to have carried out work in their Native Areas. Four new returns were received and these are shown on Schedule A which is in the same form as the returns submitted to the 34th Convention.

Schedule B shows the replies received from authorities who have carried out work during the past 12 months.

G. MASSON.

Is there any discussion, or are there any comments?

Mr. J. E. MITCHELL, SALISBURY: I do feel possibly that the committee this year, instead of asking for further details in regard to actual facts as to what is happening in the various native or African or Bantu areas (whichever province or country you happen to be in) will be asking more for details in regard to what each authority is considering as future policy, and what is likely to be their long-term attitude, both of local government, provincial government, and central government, in regard to the electrification, subsidisation, or extension of electricity supply from the various undertakings. I would like to ask all members who are circulated during the next year to give us as much detail as they possibly can in that regard. So if they can, when they get back, during the first three months, get some more detailed information in regard to future projects and future policy, I think it would help very considerably.

THE PRESIDENT: Thank you Mr. Mitchell. Are there any other comments?

(AGREED that the report be adopted).

I would like to thank Mr. Kane for his support, and I would also like to ask him to submit our thanks to Mr. Masson for the valuable work that he has done.

Gentlemen, I am now going to re-open discussion on Mr. Brod's paper. I would like you to be as brief as possible, and to the point. I think we have established a pretty good record as far as adhering to our time schedule is concerned, and we would not like to spoil that. So if you have anything to say, make it brief and to the point. Thank you.

I have mentioned before that written contributions will be accepted and will be published in the proceedings, as long as they are received on time. Mr. Ewing has informed me that this means provided you let us have your contributions not later than 7th June.

Is there no discussion?

I will then call on Mr. Brod to reply to some of the points raised by contributors.

Mr. E. BROD, SALISBURY: Mr. President, ladies and gentlemen: first of all I would like to express my thanks to Mr. Wilson and Mr. Kane for the very kind words that they said about my paper. I would also like to thank all the other gentlemen who have taken part in the discussion, whose contributions have enhanced any value which the paper might have in the future.

To reply to some of the points made by the contributors:

Mr. Wilson's description of the installation of supervisory equipment in Pretoria, I think brings home very clearly the point which I have been trying to make, that every supervisory system has to be tailor-made to a certain extent to the requirements of the particular distribution system.

No two undertakings work under identical conditions; each distribution system must be laid out first to cater for local requirements, and in a similar way each supervisory control system must be designed to cater for local conditions.

Mr. Kane has queried the question of the cost of the scheme. I would like to assure him that we are not controlling 1200 substations in Salisbury. This is a loose term

which we apply to every transforming point on the system. As I pointed out in my paper, there are in effect 34 control substations which contain high rupturing capacity switch gear and only those of course are supervised and controlled. All the others take care of themselves.

Regarding the question of the justification of the installation of the costly equipment of that kind — I think Mr. Mitchell has already answered some of the points brought up, but I would like to emphasise again that we had a large number of pilot cables available long before we decided to install this system.

In other words, the installation has gone step by step as it was required, and when it was finally decided to install our system, we already had a comprehensive network of cables which reduced the cost very considerably — and incidentally also played no small part in the choice of the system which we adopted.

We also feel that very much better use can be made of the copper, which we invested in our cables and overhead line system by being able to switch in the most efficient lines, and supply every area in the most efficient way.

We therefore feel that we have not overdone the installation, as Mr. Kane possibly tried to imply. We have gone very carefully step by step, and every step was very carefully considered both from the point of view of cost. We feel that, far from overdoing anything, we have done a very wise thing in adopting the system which we have.

Mr. Kane also questioned the advisability of a warning signal before doing any switching operation. Now to me that is rather an unusual feature, which is not adopted in many systems, but we felt that for the added safety of personnel working in substations it is advisable.

The bulk of the switching operations from a central control room will be done for maintenance purposes or during times when new equipment has to be connected to the system.

In those cases there may be, very often, one circuit breaker in a substation out on permit for maintenance purposes, but a fitter working on it or his native helper may be sitting on top of a live breaker in order to clean out the spouts. We felt that we would not like to subject these men to the shock of a closure without giving them fair warning, and a chance to get away if they so wished!

You, Mr. President, have enquired about the use of telemetering current transformers, and, of course, your assumption was quite correct, that the interposing current transformers are of different ratios and are matched to the C.T. ratio required, so that we can use one ammeter only in the control room. But due to the fact that we have various C.T. ratios and we might get readings which are too low on the ammeter, we have a second ammeter with a much lower scale reading, which we can put into circuit by hand, by the flick of a switch, and therefore there is no difficulty in using one single ammeter in effect for all C.T. ratios on the system.

Mr. Downie also queried the question of cost and I feel that my previous remarks should have given him an answer. I hope I have done so.

Mr. Murray Nobbs has also raised the question, "Does it pay?"

Well, I would like to say this in reply: we had to have some alarm system as I mentioned before, because we could not rely on reports from consumers to tell us that something was wrong with our system. Due to the fact that the pilot cable system was available, the simplest alarm system which was offered to us on open tender was adopted, and it was really only incidental that this system was so comprehensive that it could easily be extended for remote operation; and we waited 5 years before deciding to install the remote operation system, after our experience with the alarm system.

Very recently overhead line regulations were promulgated in the Federation, which force us to maintain all overhead line equipment and associated equipment every three years. That is a comparatively short time and requires the very frequent shut-down of lines and substations for maintenance purposes. We felt that without remote switching facilities, the time consumed by these switching operations would be

excessive, especially as we are trying to eliminate all overtime work on maintenance as far as possible without interfering with the convenience of consumers.

We therefore feel that the comparatively small amount that we spent on the supervisory control system is well justified.

Mr. Sibson asked whether the installation of the control system would possibly change our ideas about ripple control. My answer to that must be "No" — because we feel that these two systems are complementary and not contradictory. But there is a fundamental difference. A supervisory system, essentially, always must operate one circuit breaker, one device, on the system and no other. A ripple system on the other hand must, at the flick of a switch, operate a very large number of relays or switching devices, and therefore you cannot do with one system what has to be done with another one.

But I would like to add this, and that is that in installations where ripple control is affected by de-centralised injection, the command for the operation of ripple control can very easily be given over the supervisory control system. It simply means the adding of another circuit breaker to the whole equipment, and that will possibly be done in Salisbury should we decide to install further ripple control.

Mr. Simpson asked what happened when several alarms were sounding in the control room, and having only a common diagram, not more than one display can be given at the same time.

Well we looked into this question very carefully before we installed it, and we found that the fears that you cannot see immediately what is happening on the whole system are more theoretical than practical.

In practice, faults involving a large number of sub-stations are extremely rare. What usually happens is that you get a lightning strike somewhere in the system, and possibly two or three breakers trip out. By the time you get your first display on the common diagram, all these breakers have already closed on the auto-reclosing relays, and therefore you know that everything is fine.

But should a cable fault cause the tripping of two breakers on two ends of the cable through the pilot operation, then, of course, two alarms will go off in the control room—or possibly only one alarm, but two lights will start flashing in the substation windows. The whole procedure takes such a short time, that no hardship is caused, and, very often, by looking at which two substations show trips, they know already that it must obviously be the cable interconnecting those two. Therefore the common diagram is, in our opinion, still the best method of displaying a large number of substations.

The last speaker was Mr. Muller, and he questions the reliability of this system. All I can say at this stage is that our supervisory system has been in operation now for five years, and its record of reliability has been quite beyond our expectations. It hardly ever gives any trouble whatsoever, very occasionally (as I mentioned in my paper) you get sticking contacts on one relay. This is remedied within half an hour or so. It rarely takes much more, even if you have to go out to the substation. And we have every confidence that the remote switching system which we are installing now will give us an equal record of reliability. We have every confidence in the equipment that we have installed.

I have endeavoured to answer all the questions, and hope to have done so, Mr. President. Thank you very much.

THE PRESIDENT: Thank you Mr. Brod. I think you will agree, gentlemen, that Mr. Brod has covered all the points raised very well and very comprehensively.

Now, by popular demand I think, we open the discussion on Mr. von Ahlften's paper.

MR. G. GERBER, JOHANNESBURG: Mr. President, Gentlemen: I am in the fortunate position to have been able to have discussions with executives of the Federal Power Board, The Rhodesia Congo Border Power Corporation, and the Electricity Supply Commission on the trend of cutting down peaks and improving thereby the load factor in Municipal Electricity undertakings, and I am pleased to be able to inform you that all three authorities welcome wholeheartedly the steps taken to improve the load factor.

I come therefore to the conclusion that the comments made by Mr. Milton on this subject are his personal views, and I regret that they were of such a negative nature.

I recently spent a few weeks in Europe investigating reports on economics regarding tariffs and on methods of how to improve load factors with the aid of load shedding equipment, also called ripple control.

The investigations covered installations with a total network capacity well over 5,000 MW on over 200 plants in 14 different countries, with a total of one quarter million controlled loads.

The result of this investigation is very encouraging indeed. In one instance alone, viz. in Dunedin in New Zealand, the annual saving will be £220,000 on a network capacity of 200 MW with the aid of controlling about 28,000 hot water geysers. Most of these savings will be used to keep down the charges of electricity to the consumers. This is, to my mind, a positive approach to the problem of keeping down the ever-increasing tariffs, or even reducing the tariffs.

Mr. Milton's statement that the supply authorities will lose 15/9d. per KW revenue if the Municipality achieves that saving when reducing its peak, is only correct when looking at the picture over a very short period. We, however, must look at the problem on a national scale and on long term. It is quite true, theoretically speaking, that if all municipalities install load shedding equipment at the same time without giving the supply authorities warning in good time, the tariffs would have to be temporarily increased for a short period to compensate for the loss of revenue from the unused but readily available plant. However, when this plant is used to its full capacity the supply authorities would be able to reduce the tariffs to even below the original tariffs, as the load factor would then be improved by 10% to 20%.

In practice this problem is much simpler, as only a few municipalities install ripple control equipment every year, as seen from statistics over the last 14 years, and therefore the supply authorities have only a small adjustment to make in regard to future plant and installations, including distribution equipment.

Now looking at it from the municipal undertakings' point of view, the savings with the aid of ripple control can be considerable, regardless of whether power is generated by them or purchased from the supply authority. This is due to the following possibilities:

(a) reducing the maximum peak demands,

(b) being in a position to sell more cheap electric power at night; used for thermal storage heaters, as mentioned by Mr. Muller; operating pumps; introducing the 5 KW geyser which is switched on during the night only. (By the way, this geyser is very popular in Europe.)

(c) Considerable savings on distribution systems, such as cables, transformers, switch gear, etc. thanks to reduced peaks.

(d) Saving on cable and installation expenses on street lighting schemes, as mentioned by Mr. Lees.

It is therefore in the interests of all concerned to drive towards improving the load factor. Cheap electricity improves the standard of living on the home market, and makes us more competitive on the export market.

I will be thankful to you if you could accept these few remarks in the spirit they are made — in the spirit of positive and creative thinking for the future, which means to try continuously to sell electricity to the consumer as cheaply as possible.

THE PRESIDENT: Thank you Mr. Gerber.

I wonder if any of the affiliates interested in generating plant will have anything to say to that?

Mr. E. E. DE VILLIERS, CARLETONVILLE: Mnr. die President, dames en here: Dit was met gemengde gevoelens dat ek besluit het om nieteenstaande — die afgevaardigdes is sekerlik net soos ekself op hierdie tydstip alreeds haastig om na ons tuistes terug te keer, en ons tyd ook baie beperk is — tog 'n paar woorde uit te spreek oor die referaat van mnr. von Ahlften. Ek sal myself dus beperk tot 'n paar kort aanmerkings, en dit veral na aanleiding van kommentaar wat gelewer was deur vorige sprekers, en wat na my beskeie mening 'n bietjie onregverdig was.

Eerstens wil ek daarop wys dat die skrywer as stadselektrotegniese-ingenieur van 'n stadsraad wat sy elektrieseteitsverspreiding grootmaat van Escom aankoop om self in die uitvoering van sy pligte alleenlik bepaal het by die ekonomiese belange van sy stadsraad en die publiek wat deur die geagte lede van die stadsraad verteenwoordig word. Dit is immers die plig van enige werknemer van 'n stadsraad en ek wil dus die skrywer geluk wens daarmee.

Hierby wil ek ook byvoeg dat ek oortuig is dat mnr. von Ahlften in sy aanbeveling aan sy stadsraad om vragbeheer in te stel baie deeglik op die saak ingegaan het en geen selfsigtige motiewe daarop nagehou het nie, maar dit self ook op 'n breëre vlak van nasionale belange oorweeg het.

Dit is vir my baie duidelik dat die instelling van vragbeheer op 'n verspreidingsnet soos die van Sasolburg, en immers ook aan netwerkstelsels soos Vanderbijlpark, Benoni, en andere, deur die groot besparings wat teweeg gebring word, beide aan kragaankope en kapitaal uitleg 'n baie groot mate moet bydra tot die voordeel van die betrokke plaaslike gemeenskap.

Mnr. die President, ek wil dit graag aan u stel dat enige stappe wat gedoen word om by te dra tot die geluk en ekonomiese selfstandigheid van indiwidue, of hulle gemeenskap, in 'n hoë mate, of hoe 'n geringe mate ook al, uiteindelike bydrae is in nasionale belang, en ek wil die skrywer gelukwens dat dit blykbaar ook sy standpunt was.

Mr. President, I will continue in English: I want you to bear with me if I am not as voluble as our Quizmaster. I must, however, make it clear, that the comments of some contributors sounding a note of warning on the indiscriminate application of load control, without very careful study of the system load curve, and the due consideration of probable future improvements in load factor, such as was cited by Mr. Giles of East London, must be kept in mind. I cannot dispute this.

My contention is that I cannot agree that in an area where the supply given by Escom to the municipality is a mere proverbial drop in the bucket compared to the immense supplies given to large industrial concerns, and mines in the area — control of such municipal load to cut down the maximum demand by a mere MW or two could have the effect on the generating capacity of the large power stations being operated by Escom to meet such a large load.

It would consequently be very interesting to learn what proportion of the output of say Escom's Highveld and Vierfontein generating stations is absorbed by municipal electricity undertakings, and what proportion by mines and industries.

I think such figures would amply illustrate my point. I therefore cannot agree with the statement that in such cases load control savings will ultimately be nullified by increased bulk supply tariffs to the municipalities.

I agree however that the onus of the control of load of individual consumers should, where possible, be placed in the hands of the consumers themselves, and this can possibly be effected, if found economical, by penalising consumers who prefer not to have their particular loads shedded, or reduced during peak periods, by the installation of additional equipment on the consumer's premises.

Manufacturers and supply authorities should seriously consider this aspect.

I feel that the correct approach in the matter is that very large generating authorities such as Escom and the Federal Power Board should be less concerned about the activities of their relatively small municipal consumers who could, in many instances, by better co-operation with the generating authority, and by giving more thought to their individual load factors supply the answer to alleviating the worries of the generating authority and improve their overall load factor.

Mnr. die President, ek wil dan tenslotte myself aansluit by vorige sprekers om mnr.

von Ahlften hartelik te bedank vir sy wel deurdagte referaat, en die ongetwyfelde harde werk wat hy gedoen het om dit in so 'n duidelike vorm en in soveel besonderheid om ons voor te dra.

Maar meer as dit, mnr. die President, wil ek net herhaal dat die beginsels waaronder mnr. von Ahlften die instaleering van 'n vragbeheerstelsel aan sy raadse elektrisiteitse net instaleer het navolgens waardig is. Dankie mnr. die President.

TEA ADJOURNMENT.

*On Resuming*:

THE PRESIDENT: Before we resume there are a few announcements.

(CONVENTION ANNOUNCEMENTS FOLLOWED)

We will now continue with the discussion on this very profound discussion on when to cut and where to cut!

Mr. M. A. DE LANG, STANDERTON: Mr. President, it was with considerable interest that I listened to the paper by Mr. von Ahlften.

For many years consumers have been charged on a 2-part tariff so designed to promote as far as possible a high load factor. An enormous amount of research work has been done in attaining this object, and it is clear that a number of municipalities have already taken the necessary steps to apply all available means to spread their loads over 24 hours.

It must necessarily be disheartening to hear that this will result in an increase in ESC tariff, and it would be interesting to learn whether this is the policy of the Electricity Supply Commission of the Union.

Mnr. die President indien dit die geval is, dan is dit my mening dat ESCOM daardie beleid moes inkorporeer het in sy verklaarde tarief en in afwesigheid daarvan voel ek dat ons effens mislei is. So 'n uitkyk moet noodwendig pessimisties wees aangesien die jaarlikse natuurlike verhoogde lading sonder meer die geringe lading wat bespaar word deur beheer van spitsbelasting sal opneem.

Afgesien van die feit dat doeltreffendheids maatreels nou die belofte van verhoogde tarief inhou, en gevolglik nie as in belang van van die nasionale ekonomie beskou kan word nie, behoort munisipaliteite steeds te poog om sulke doeltreffendheids maatreels aan te wend.

Ek dink mnr. die President dat hierdie kongres behoort 'n vroeë amptelike verklaring in verband met hierdie aangeleentheid by Escom te versoek. Dankie.

Clr. S. DE JONG, SASOLBURG: Mr. President, I am sorry to have short circuited Mr. Milton, but I am sure he would like to repair same!

I wish to associate myself with various previous speakers in congratulating Mr. von Ahlften on the paper he has presented to this convension.

Although I speak as a layman on elecctricity in all its AC and DC aspects, but as far as load control and ripple control goes, I feel more at home because my board discussed the various aspects and implications at length with Mr. von Ahlften before we instructed him to go ahead with the installation.

Immediately I would like to state that I am surprised that this paper has evoked such wide controversy and raised so much contention. To me it brings home forcefully the vast difference in power supply problems, inter alia, with which large or urban local authorities and smaller or rural municipalities are confronted, with problems both technical and economical in nature.

I was struck immediately by the absence of criticism in the technical implication of such a control system, by speakers from national as well as urban undertakings. There appeared to be, however, a more subjective consideration of the economics of such a load control system, insofar that it could negatively affect the cost of bulk supply of electricity.

Please allow me therefore Mr. President to attempt, as a councillor delegate, to offer an objective view, subjective too, on this matter, as far as local authorities in smaller centres are concerned.

I listened with attention to Mr. Milton's views, and found it easy to associate myself completely with his view point, had I been in his position; and those of other undertakings who generate their own power and have to offset same.

Local authorities, city councils, and municipalities have to administer the affairs of cities and towns effectively and efficiently. In order to effect this, heads of departments are instructed and compelled to keep down costs of essential services in order to assume that indirect taxation of ratepayers and consumers is kept low without the lowering of efficiency.

Since 1952 there has been a rise of 34% in the cost of bulk supply of electricity by the Electricity Supply Commission. One remembers that, a few years ago, when the demand for power still exceeded supply, Escom compelled local authorities, without their own generating plants, to keep peak loads as low as possible; as well as to reduce loads by at least 10% when instructed.

Now supply apparently is catching up with demand, and some local authorities are finding ways of keeping these peak loads down to an even keel, they are committing sin. This sounds to me paradoxical and not a little confusing.

My board and councils throughout the country are concerned primarily with supplying electricity to consumers as cheaply as possible. Ripple control at Sasolburg has effected in the first year of operation a saving of R12,000 (or £6,000) in bulk supply bought from the supplier. This saving has been passed on to the consumer in the form of a reduction of 10% in cost of current, as stated by the author in his paper. The fact that unit cost of electricity has been raised by the Commission during the past year is purely co-incidental.

Local authorities are also not profit-making undertakings, insofar as profits are canalised into less profitable branches controlled by them, or, as had happened in the undertaking under discussion, in the form of, say, dividends to the consumers of electricity. The function of municipal electrical engineers, Mr. President, I repeat, is purely to ensure a high degree of efficiency in their departments, as economically as possible, to their employers.

In my experience, there has always been healthy co-operation between bulk suppliers and local authorities. These local authorities fully appreciate the vast problems confronting the supply commission, and other large self-generating concerns, and they have to effect a parallel between supply and demand. However, one considers it only fair that these national undertakings, as well as large local authorities, try to appreciate the difficulties of smaller centres and their responsibilities to their ratepayers.

As has been remarked by other speakers, the saving effected through the application of load control; appears to be minimal if not negligible. To my mind, however, the crux of the matter lies in the remark that the saving of so many shillings per kilowatt represents a similar loss to the supplier. I sincerely hope that I shall be proved wrong in this assumption.

Smaller municipalities consider their problems in the electrical engineering departments as important and as urgent as the big ones consider theirs. This applies to both the technical and economical side. Once this fact is accepted at these A.M.E.U. conventions, the delegates of smaller local authorities will rapidly rid themselves of, as I have noticed (I hope erroneously, Mr. President), a sense of frustration, and will be encouraged in future to present their problems to the Convention in the knowledge that these will not be passed over lightly.

Mr. W. H. MILTON, ESCOM: Mr. President, ladies and gentlemen: It astounds me that there can have arisen such a misunderstanding from the statements which I have made. I seem to have evoked a tremendous amount of discussion through that misunderstanding.

I was given the privilege of reading through what I have said previously, and I found, and still find nothing wrong with it.

I tried to bring home to the audience the factors which must be taken into account when dealing with load control. I mentioned that, in one particular case, the load control which had been introduced (and I looked to the gentleman on the platform responsible), had in no way benefitted the cost of power production *at that stage*.

In other words, this problem of load control is one which must be dealt with timeously. If you are running your own generating plant, and you find some means of introducing load control, I submit to you that it is completely useless to spend the money on that load control at the same time that you bring in your new generating plant to meet a load which was expected and which will not arise — if you introduce your load control.

From that point of view, money spent at the wrong time on load control is wasted money. It could be well deferred until the time arrives when you are considering your next plant extension, when you can say to yourselves, "Now look, if we can cut this peak by 10% or 15% we can defer that set for one, two or three years." Then you would say, "Well let's go for load control." Certainly.

But if you said, "Well, we may not get it in time; let's put in a new set," you can probably then take on additional load up to 25% on top of the load that you are already supplying. The cost of supplying that peak load is not increased by reason of its being a peak load, because the plant is there to meet it. You may save a little bit in your distribution, but usually your distribution network is also timed in advance for peak load.

Now anyone who puts in control equipment immediately upon putting in additional generating plant to meet the load that is going to be cut off, is wasting money.

That was the point that I tried to emphasise.

In the particular case of East London (I'll come out now with the name!) we were planning, as we have to, some four years in advance of a load being reached, in order to meet that expected peak load. On the basis of the KVA to be sold during the next ensuing five years, we designed a tariff which took into account the cost of additional generating plant, which was then being put in, and which would come into service during those five years.

East London then cut its peak. Now imagine what happens. We could have deferred that generating plant extension. But once you've placed your orders if you go to the manufacturers and say "Now, look Bill, defer that set a year; we don't want it yet," he says, "Sorry, it's in my production programme. What cancellation fees are you going to pay?"

Well one doesn't pay cancellation fees, because the savings then aren't equalled by the reduced revenue that you are going to get. You naturally have to go ahead, put the plant in, and if the peak is cut, the supply or generating authority doesn't get the revenue expected. That is where the trouble lies.

The whole point that I tried to emphasise was this: that if you are going to go in for load control, let the supply authority, if you're not your own generating authority, know what you intend doing and when you intend doing it. Because everyone dealing with generating plant must plan at least four years ahead if he is to keep pace with developments. It is useless to leave a man working in the dark on an expectation of load which will not arise, and then turn round to him and say, "Look, your electricity is awfully expensive."

So it is a matter of timing, and advising the local authority what you intend to do. You will find when you read my contribution given earlier, that I strongly supported load control. I went so far as to say that every effort should be made towards making people pay for their peaks because when they do pay for their peaks and they can control those peaks, they will have reduced them to the benefit of all concerned.

In connection with the Ladysmith statement, I mentioned that the saving there of 15/9d. might have been a saving of 15/9d. per KVA to Ladysmith, but it was not a saving to Escom until we reached the stage where we can take advantage of that lesser load. Once again it is a timing factor. The lost 15/9d. per KVA, considered against our total revenue involved no change in tariff.

And that, I think you will find also, with those dealing with their own generating plants — if any one of their consumers cuts his load, the load on the substation supplying him may be very appreciably reduced, appreciably reduced, but if he has already built his substation for that peak load before the reduction, there is no saving to the supply authority.

In Mr. Muller's case, Bloemfontein, when he mentioned his conditions, he pointed out that, by going to storage heating, a 400 KVA substation was able to supply a 400 KVA load during the day, and available to supply 400 KVA at night. If that space heating had been done on a day basis, during office hours, an 800 KVA substation would have been necessary.

But I submit to Mr. Muller if he had provided the 800 KVA substation, and those people had then gone to night heating, he would have saved nothing on his substation. So it's all a matter of timing.

As far as Escom in the Union is concerned you will find, as I previously stated, that we welcome every effort being made towards load control — in other words towards the reduction of peaks. We are not against it in any way. I went so far as to interject that if people wished to instal some of these aero engines for cutting their peaks we would not prevent them from doing so—that it would be welcomed.

On the other hand, I also sounded another note of warning—that from the point of view of generating plant, the time of the peak that is being shed in comparison with the time of the peak on the generating system is also important. You do not always necessarily save in generating plant to the extent to which you cut your peak. That is due to the diversity of the peak loads.

Now I hope I have made the position thoroughly clear — but at no time did I say that Escom was against the installation of load control.

If you deal with the Rand Undertaking, from which most of these municipalities are supplied, you can imagine the relative savings when I point out to you that the peak is over 2,000 MW and when you start talking of saving 1 MW on 2,000 MW it is not very much on generating plant capacity, but the importance arises with the distribution network.

In the distribution network that 1,000 MW of reduced load is important in that the network capacity is then available for the sale of that 1,000 MW to somebody else.

Or your network can be built on a lighter basis; you save in substations, etc. So that there is a maximum saving when generating plant is affected by the cut peak, and a minimum saving when only the substation is affected.

But in all cases there is definitely a saving whenever you regulate your peak load, and I think that we, gentlemen, responsible for the supply of power at as cheap a rate as possible must do everything we can to encourage load control. The problem must be viewed in its true perspective.

There is another point. Mr. Simpson said it seemed I had changed my views, he was referring to a point of discussion which I had had with him in relation to annual maximum demand charges as compared with monthly maximum demand charges.

In any supply authority's undertaking, it must always be remembered that 100% load factor load continuously throughout the year is not as advantageous as so many people think.

If you have a 100% load to supply throughout the year, you are required to maintain 100% standby to that load, if you wish to give continuity of supply, which means you cannot take plant out for any minor maintenance job, at any time, throughout the year unless you have standby.

If you have a variation in your load, as most of us have, as between winter and summer, it is a very useful variation, in that you can plan your maintenance programme on the basis of a minimum generating plant in your station.

Of course, if you only have two sets in your station it doesn't matter very much, but where you have a large number of sets it is a matter of great importance. It means that you can ensure a heavy maintenance programme during your light loaded period of the year, and a minimum maintenance programme during your heavy loaded period of the year.

Anything which is done to "flatten" the load to a constant load throughout the year, that is month by month with no seasonal variation, is not necessarily advantageous.

So that there is a difference there. We do encourage an improvement of load factor, but that improvement of load factor is such that you will still maintain a seasonal difference in load. Your monthly load factor goes up appreciably; your annual load factor is therefore likewise improved, but anyone who tries to shift his winter load over to his summer load to maintain an even load, is not necessarily acting entirely financially to his advantage.

Thank you Mr. President.

Mr. G. J. MULLER, BLOEMFONTEIN: Mr. President, I think Mr. Milton is rather too optimistic when he thinks we can wipe out the complete difference between winter and summer. I am fairly optimistic myself, but I have told my council I have no hope of doing all that.

Mr. President, I love hearing Mr. Milton —he always comes out right in the end!

I want to put a little suggestion to Mr. Milton, and, if we have the time, perhaps he might reply to that.

Mr. Milton has some difficulty with these municipalities that cut their bills, and I found out in the interim that these municipalities are really (I am not sure whether this is so, but I think they are) evening peak people, and that happens to be when the commission are on their lowest level. In other words they are his off peak consumers. I had wondered whether Mr. Milton would consider, round about Christmas, introducing an off peak tariff for these people who are off peak consumers!

Mr. R. W. BARTON, WELKOM: Mr. President, Mr. von Ahlften asked a few questions about the actual loads shed in the experience of other undertakings. I have a couple of notes in that respect.

At Welkom we find that we shed half the connected load in most cases, and when we pick it up again we pick up the full load. Now it doesn't mean to say you save, of course, half your water heater load as far as maximum demand is concerned. We find that we work on an hour and a half shut down period for each consumer. That has not given any rise to complaints, except from a friend of mine up the road who complains on principle whether we shut him off or not.

He is of course the neighbour of the man who complained when we put a street light outside his front gate; and complained again when we forgot to switch it on.

But in general this hour and a half period seems to be quite in order, and in fact we are thinking of extending it to two hours. The result of working on an hour and a half — we have our relays divided into three groups, the one group comes off and after an hour and a half the remaining two groups come off and the first group goes on again, for the reason that we pick up twice the load which we shed.

The average size of water heaters in Welkom is 30 gals. (3 KW) and we save then ½ KW per relay installed. I don't think we'll ever get a higher figure than that; in fact as we instal more relays that figure will tend to drop off, and it is for this reason that we have come to regard ripple control in Welkom as far as maximum demand is concerned, as rather a secondary aspect of the situation.

The main function I think of ripple control is on street lighting, because there, when the street lighting system is complete in Welkom we will have saved something like £150,000 in cable costs; in other words that saving will entirely pay for the ripple installation.

In addition we have reduced our design as far as distribution cables and substation are concerned, from five KW per consumer down to 3½. In other words we save quite substantially on mains, and I feel that is the chief function of ripple control.

At the moment we have only 1500 relays on water heater, for reasons which I won't go into at the moment, and the saving on that is 750 KW which is not a great deal really when you consider the full load on the system is about 18 MW at present.

Mr. G. B. HEUNIS, STANDERTON: Mr. President, I think Mr. Milton has left the conference at the moment and we are at a loss as to know whether we can expect an increased or a reduced tariff if we apply load shedding.

With regard to the standby plant required if 100% load factor is provided, I think the solution would be to couple up with a country north of the equator so that we can balance our summer loads with their winter loads, but of course, in that case we would require the approval of the commonwealth and we might run into a lot of trouble then!

Mr. P. A. GILES, EAST LONDON: Mr. President, and members of the Convention, I do not intend to enter into a controversy with the Electricity Supply Commission, because Mr. Milton is not in the hall. The difficulty with East London as far as the Commission is concerned I think well known to you all.

The municipality at East London is I think the largest consumer on the single station operated by the Commission, and anything that East London does has a very marked effect on the finances of the border undertaking.

For the record, I should say that in 1953 when we installed the ripple control in East London it was not with the intention of embarrassing the Commission. The idea primarily was to permit the installation of high wattage water heaters.

Mr. Milton did mention in his previous remark that the practice in the early days was to have a low wattage 30 gallon storage water heater fitted out, a 500 watt element which was suitable for that particular part of Southern Africa, and we found to our consternation that the bright boys on the Reef, in conjunction with the Bureau of Standards had fixed that the wattage for these 30 gallon water heaters should be 3.000 watts.

One can imagine that contemplating the six times increase in the costs for water heating was something that the council would not face, so the idea was that something in the nature of a service to the consumer should be formulated and the ripple control system was installed.

The secondary effect intended was the hope that we would be able to introduce a tariff on the basis which has been discussed overseas, a firm tariff and a non-firm tariff to control peak loads.

Mr. Simpson, Durban, mentioned that he had introduced a similar type of tariff, but actually the consumer could choose whether he remained firm or otherwise. I thought that if the non-firm portion was to be of any use at all, it should come under the control of the municipality—but that tariff has not yet been evolved.

I would like to congratulate Mr. von Ahlften on a very excellent paper and a very fine presentation of the facts.

In East London at the moment there are 3.519 water heaters controlled. The faults that take place are, I think, in the region of somewhere about 4% per annum, measured against the total number installed and the actual maintenance cost is 4/- per annum per relay. That figure does not include the capital cost charges on the system.

THE PRESIDENT: Thank you Mr. Giles for your contribution.

Mr. A. A. MIDDLECOTE, BUREAU OF STANDARDS: Mr. President, there is just a small point I would like to mention which isn't directly concerned with ripple control, but in view of some of the statements made, one should always bear it in mind, and that is when switching hot water cylinders, you do come back to the old point of buying to a regional specification.

There are quite a considerable amount of cylinders still being made that have rather a larger watt loss than we allow in our specification.

With the standard watt loss, provided there is no draw off, you shouldn't drop the temperature for water over about 6 to 8 hours by more than about 3 or 4 degrees centigrade. This is now the case when you have, shall we say, a few bits of corrugated cardboard (which we have seen in this country I might say) as insulation between the inner and outer cylinder. There was one municipality that had quite a few of the so-called corrugated cardboard insulators in hot water cylinders.

In a case like that your drop over 6 hours would be considerably more than 4°. So I think in bearing in mind the use of ripple control for the control of hot water cylinders, it must go hand in hand with ensuring that the standard of the hot water cylinder installed is adequate. Remembering that in any case it is an economic proposition to buy a cylinder with a lower watt loss because of the economies.

THE PRESIDENT: Gentlemen, I think this matter has been well aired, and I would now ask Mr. von Ahlften if he would like to reply to some of the points raised by contributors at this stage.

Mr. J. K. VON AHLFTEN, SASOLBURG: Mr. President and Gentlemen, as my time was rather limited to reply to all the various comments and contributions made to this paper I would now like to take the opportunity of doing so in writing.

The first point which struck me as being unusual in a paper of this nature was the absence of any discussion on the technical implications of audio-frequency remote control injection. It would therefore appear that the technical difficulties which have confronted us in the past in this respect have been successfully overcome. The question now seems to be an economic one both from the Bulk Supply Authorities and Bulk Consumers view point, and in this respect Mr. Milton's comments need special consideration.

The first impression gained from Mr. Milton's comments was that although the shedding of waterheater load during peak periods will mean a saving in electricity charges to the Bulk Consumer this may not necessarily be the case for the Bulk Supply Authority. This viewpoint is apparently based on the assumption that in the absence of close co-operation between supply authority and consumer when load is reduced, this will lead to over capitalization on generating and distribution plant with a possible increase in Bulk Supply Tariffs to cover increased loan charges. This of course is quite an acceptable argument when the approach to this problem is purely individualistic. In my opinion however this is not quite sufficient for a subjective view on this question of whether to shed load during peak periods or not as close co-operation between Supply Authority and consumer (as far as the Electricity Supply Commission is concerned) has always been of the very highest standing as far as my knowledge goes, and the timely notification of expected demands for ensuing years does therefore ensure parallel capatalization of Supply Authorities and consumers plant when load shedding is applied.

I think this was the crux of Mr. Milton's comments and one that is reasonable to understand and to be appreciated if the national economy is to benefit as well as when peak loads are being reduced. As far as self-generating local authorities are concerned the advantage of load shedding lies in the fact that the investment of large sums of capital money in increasing station capacity can be postponed to a time when all the plant can be utilised to its full capacity, in other words, money can be spent in direct proportion to the expected load growth.

I think there were a few other points raised which may not have been answered and in this respect I refer to Mr. Lee's comments on the effect load shedding will have on the after diversity demand per house when load shedding is applied. It appears to be normal practice at present to adopt an a.d.m.d. of 4 Kilowatts per house when designing reticulation systems for all-electric Townships. In Sasolburg the reticulation system has been designed for an a.d.m.d. of 3 Kilowatts per house, therefore allowing for the expected savings on capital investment when load shedding is applied. Up to date the actual recorded a.d.m.d. per house was found to be 2.5 Kilowatts with load shedding which means that a safe margin for expected future increases in the a.d.m.d. is well catered for. This is an important point to keep in mind, when introducing load shedding equipment so that future distribution systems are not overated when the waterheater load is to be shed during peak load periods. Another point raised was the question of shedding the load of the thermal type of storage heater which is commonly used for the spaceheating of large offices and buldings. This of course

could lead to a substantial reduction in the peak loads taken by such appliances and would possibly justify the installation of a remote control system. The domestic water-heater is however still the one appliance to be found in practically every modern home today and therefore also the most economical load to be shed during peak load periods.

The question of introducing low-cost peak-load generating plant as advocated by some speakers may find its applications in large undertaking who generate their own power, but I am of the opinion, that by large, most undertakings who are bulk consumers of electricity will find it more economical to introduce remote control equipment as various other applications exist apart from the business of keeping the peak loads down, which will justify the installation of such a system.

Finally Mr. President and Gentlemen although I agree to a certain extent with the popular belief that the man who uses electricity should pay for it, it should still be our aim to make this essential service available to our consumer at the most reasonable and competitive price. We should also not forget that the use of Gas for domestic and industrial purposes is becoming evermore popular, and may well one day again become a real competitor to contend with.

In conclusion I feel gratified at the reception the paper has received and the discussions which have ensued which must undoubtedly have increased the value such a paper might have had. I have only one regret and that is that the smaller undertakings did not avail themselves of the opportunity of adding to the discussions when the paper was presented.

Mr. S. McCRACKEN, JOHANNESBURG: The President has expressed a desire to have the views of a manufacturer of turbine plant as distinct from the majority of contributions to this Paper which have been concerned, in general, with distribution and consumer problems.

In his contribution Mr. Mitchell stated, quite correctly, that the initial installation of relays on a municipal undertaking had a very marked effect on the peak loading but as more relays were installed the effect became less pronounced until a point was reached where the addition of further relays had very little or no effect on the load curve of the undertaking. The position as thus stated for a municipal undertaking can be compared with the position which will arise on a large system such as the Rand Undertaking of Escom where there is a large basic load provided by the Mining and Industrial community, and whilst in isolated sections the application of load control to a small municipality will have marked local effect, its total reaction on the loading of the large power stations on the Rand will hardly be noticed and for this reason cannot be expected to have any effect on the future planning of power station capacities. In those areas where the load is predominantly domestic then I would say that the effect on the local power station would, if anything, be advantageous as there is then more prospect of the plant operating on steady rather than peaky loads. Such steady loads are to be preferred both from the view point of efficiency and maintenance, and under these conditions the plant will undoubtedly give optimum performance.

Whilst, therefore, for reasons stated above, peak load control is unlikely to have much effect on the larger power station planning for this country, it will undoubtedly delay the purchase of distribution transformers and switchgear, and we have already had very strong evidence of this from Mr. Milton.

Apart from any savings which could result from delayed purchase of generating plant and/or main transformers it is possible by means of centralised control to operate with a reduction in the amount of generating plant actually running and synchronised.

The British Electricity Authority in its latest report states that within two minutes of the conclusion of a popular T.V. programme the demand on the system consistently increases by approximately 600 MW. presumably due to almost simultaneous switching on of kettles, kitchen lights, etc. If sufficient water-heaters were subject to centralised control this peak could be completely cancelled with a pronounced saving due to reduction in generating plant in operation.

Mr. H. J. GRIPPER, KNYSNA: Mr. President, may I add my thanks to the Author for presenting this paper. It is clear from the amount of discussion that the interest in the subject has not flagged since Mr. Mitchell read his paper to the 27th Convention held at Johannesburg in 1953.

Several manufacturers have entered the field since that time and improvements must follow the experiences gained. Improvements, not only in the equipments themselves, but even more so in the techniques of application and adaptation used by Supply Authorities who adopt the idea of remote control by this, or similar methods.

There is always the school of thought which maintains that the control of any portion of a consumer's load by the Supply Authority is restrictive and therefore wrong in principle. It *can* be applied in a restrictive manner of course and those Authorities who have done this under the powers given them in their bylaws without taking the consumers into their confidence or providing alternative tariffs for those who do not, or will not see the value of these controls, are to be blamed entirely if the system does not come up to expectations.

However, if we consider only the control of street lighting, the equipment pays for itself while control of water heaters is only one of many other uses to which it can be put. Here the Supply Authority should set about the introduction of the scheme by stressing that it is out to give a specific service to the community, in this case the supply of *hot water*. If the consumer does not get this, his complaint must be attended to immediately.

To illustrate this form of service, I beg leave to quote an extract from the paper entitled "Efficiency in Municipal Electricity Supply Undertakings" which I gave to our 23rd Convention at Port Elizabeth in 1949. (A subject to which you, Mr. President referred in your address to this Convention.) I quote: —

"An example of service . . . which cost very little but created a valuable degree of 'goodwill' in the case of new consumers in a National Housing Scheme, was the connecting up of the hot water geyser in each home some 12 to 24 hours before the meters were connected and the keys handed over to the tenants. This meant that all services, including hot water, were immediately available to the consumer when he moved in."

Few, if any of the types of receiving relay such as are installed in consumers' premises operate entirely unnoticed. In some cases however, it has been said that they have a nuisance value. This, I have found, applies only when the consumer has set himself against the principle from the start, aided and abetted by illmeaning and interfering parties with other axes to grind.

Mr. von Ahlften has had the advantage of introducing his control system in a new undertaking but, nevertheless I see he has had some of the inevitable complaints which nearly always turn out to be groundless. He has also learnt that golden rule which, put very bluntly, reads: — "If you must monkey about with consumer loads or tariffs, do so in the first instance in that season of the year when consumption is naturally falling off."

In the table given in section 4.3 of the paper, I note that load shedding has resulted actually in a slight *increase* in units sold over 24 hours in both summer and winter, compared with the corresponding consumption without load shedding. Is this possibly due to raising the water heater thermostat settings prior to introduction of the controls?

I have read several articles and pamphlets describing this type of equipment in Europe, Australia and South Africa and they all state that the frequency to be adopted should be determined only after a close analysis of the distribution system on which it is to be used. The Author says the same, yet one and all come to the conclusion that the frequency should be 1050 cycles per second; Is this a pure coincidence?

Not only is this frequency actually the 21st harmonic of the 50 cycle system, but other harmonics occur comparatively close to it in the "harmonic spectrum". The 23rd harmonic (1150 c.p.s.), which is only $9\frac{1}{2}\%$ removed from the selected frequency, actually caused trouble in Sasolburg.

Here it is of interest to observe that Messrs. Brummer and Schoeman in their paper appearing in the December 1960 Proceedings of the South African Institute of Electrical Engineers show that the S.A.R. rectifiers produce harmonics with rapidly diminishing voltage intensity down to only 1.3% for the 11th harmonic so that it is surprising to find that the 23rd harmonic can interfere with any "ripple control" system.

Surely it would be better to select an operating frequency, in the first place, which lies *between* two odd harmonics of the 50 cycle fundamental and then in a region where the percentage spacing from the neighbouring harmonics is reasonably high. For example, between 1050 (21st) and 1150 (23rd) the gap is only 9½% while between 550 (11th) and 650 (13th) it is 18%.

The higher frequency selected by the suppliers of the Sasolburg equipment would be severely attenuated in the case of central injection on a large system with several step-down transformers, but I appreciate that there may be something to be said for multiple injection covering smaller sections of a system per equipment. However, is this merely making a virtue of necessity in this case?

In section 2.4 the Author admits some loss of signal strength through condensers used for power factor correction. This loss would be reduced if a lower frequency had been selected although, since the signals are impressed on the system between all phases and neutral while most P.F. corrective and cable capacitance occur between phases, the drainage of ripple signal strength is possibly more imaginary than real.

In section 2.3 the Author says that the equipment using the "Selector Principle" proved to be the "least likely to cause inconvenience to consumers" in Sasolburg. I should be interested if he could enlarge upon this point.

In conclusion, I should like to know whether Mr. von Ahlften has found that the receiving relays in Sasolburg are prone to damage from lightning surges, particularly the non-linear resistors and, in the case of those used for street light control, whether the figure of £12 per relay includes for special weatherproof construction?

*Comments on contribution by Mr. H. J. Gripper*:

The question whether the control of any portion of a consumer's load is restrictive or not is one that can be debated upon at length, but the primary object with any form of load shedding should be to achieve economic savings not only to the advantage of the Supply Authority but to the consumers as well, and in Sasolburg it has been possible to affect a 10% reduction in electricity tariffs to the consumers as a result of load shedding. No consumer has ever objected to any form of load control being carried out upon his premises because they have been kept well informed and generally realise that the control over the water heater load is to the advantage of the entire community. I therefore think it is a question of keeping the consumers informed of what our intentions are, which creates a high degree of goodwill.

The slight increase of 1% and ½% in units sold respectively over 24 hours in both summer and winter, as shown in the table in Section 4.3 of the paper, is most probably due to diversity as it can hardly be expected that the exact same number of units will be sold over any 24 hour period even if the peak loads are near identical. Water heater thermostat settings were, however, not altered at all prior to introducing load shedding equipment, and I don't think this will ever become necessary.

The question of which frequency to adopt for audio-frequency injection has been fully covered in the paper. The choice of the higher frequencies is, however, governed by the fact that it will be more economic to overcome possible interferences in the network at the higher frequencies as would be the case at the lower frequencies as was also subsequently established by practical experience with the Sasolburg Remote Control Installation. Although signal attenuation will be greater at the higher frequencies with an increase in transformer stations, this can be overcome by decentralisation of transmitters, which any case will become necessary at any frequency as the network grows, if the system is to function correctly in the remote ends of the network.

It is a known fact today, that in those installations requiring different frequencies for the various functions to be performed by the receiving relays, that mutual interference between these frequencies is one of the major causes of mal-operation of the receivers. In the "Selector Principle" however, only *one* frequency is necessary to carry out all the required functions which practically elemi-nates the possibility of mal-operation of the receivers. It is therefore most unlikely that the consumers will be inconvenienced in this respect.

In conclusion the question of damage to receiving relays due to lightning surges is an interesting one. The entire distribution system in Sasolburg is, however, by means of underground cables so that trouble from this source has not yet arisen, but in our Bantu Township, where the L.T. reticulation system is by means of O.H. lines, one relay was recently damaged by lightning. When inves-tigating this fault it was however found that the particular phase connected onto this relay had not been provided with the necessary lightning arrestor. All the other lines how-ever, had appropriate lightning arrestors installed and during the past two summer seasons no relay failures have occurred on these lines. So it would appear that on adequately protected O.H. lines the incidence of relay failure due to lightning surges, should should be minimal. And finally, as the surge absorption effect of the relays becomes cumulative as more relays are being installed, this will also help to eliminate the effect lightning surges might have on the receivers.

In the case of relays used for streetlighting control, these are housed in the bottom base openings of the concrete streetlighting stan-dards, so that the provision of a special weatherproof box is not required. The figure of £12 per relay installed is therefore also quite correct for the remotely controlled streetlighting installation.

THE PRESIDENT: Thank you Mr. von Ahlften.

Ladies and gentlemen, I am now going to re-open the discussion on Mr. Langford's paper.

As there is no further discussion, I will ask Mr. Langford to reply to the points raised by contributors in the discussions the other day.

Mr. C. E. R. LANGFORD, JOHANNES-BURG: Mr. President, ladies and gentle-men: I am very grateful for the way in which my paper has been received, and appreciate the kind remarks made by Mr. Simpson and Mr. Milton.

Mr. Milton was quite correct in saying that the pictures I presented of the costs of integrating a hydro scheme with existing thermal schemes were not quite complete because of modifications that might be necessary to existing networks. The figures I quoted in the paper included for the trans-mission necessary to bring the power from the hydro site to existing systems and no allowance was made for any reinforcement that might be necessary within the system. I doubt, however, whether this would have much effect on the overall economics.

He also mentioned that the capacity of Oranjedam at 500 M.V.A. exceeds the present demand of the Cape Western Under-taking, which is 400 M.V.A. This enables me to bring out a very important point.

Consideration of the development of hydro electric power in South Africa is a fairly long-term project. Kariba, I believe, was talked about for 22 years before the decision was made to proceed with it. While it is hoped that discussions on South African schemes will not last as long as this, it must be remembered that no scheme for this country is very far advanced. As far as Oranjedam is concerned, it has only been looked at in a very preliminary way to see whether it appears practicable. This has been confirmed broadly, but from now on there is a great deal of work to be done. In my view, the very earliest that Oranjedam could come into being is 10 or 12 years from now. The rate of development in the Cape Western Undertaking is such that the demand in 10 or 12 years will be in the order of 800 or more megawatts. With this order of demand, Oranjedam would not be too large a project. In addition, 10 or 12 years from now a good deal of the thermal plant which is at present in operation will very likely no longer be serviceable. It is, therefore, a question of long-term planning and correct integration.

Mr. Muller, Mr. Gill and Mr. Murray Nobbs raised the question of silt. Although I did not mention silt in my talk, it is dealt with in the paper.

Silt, undoubtedly, is a problem, but it is one that can be tackled. It is often said that silt in South Africa is worse than anywhere in the world; that is not the case. The silt on the Nile is infinitely worse than any silt in our South African rivers, and Egypt is going ahead with many schemes, including the High Dam at Asswan and they are not unduly worried about silt.

There are quite a number of ways in which it can be dealt with in the Union, and probably the most important, as mentioned by Mr. Murray Nobbs, is the control of erosion. This would go a long way towards dealing with the problem, but at best soil conservation must necessarily be a long-term project.

In my opinion, silt in this country has become a problem, not so much on account of the silt burden itself, but the way in which water has been utilised. By storing water for long periods to cater for the worst possible drought that **might** be experienced, gives time for the maximum amount of silt to be deposited in a storage reservoir. (Incidentally, this also results in excessive evaporation losses which are more serious than silt difficulties.) If there was better utilisation of the water so that flow is maintained, the incidence of deposit of silt would be greatly reduced. It is in this respect, and also in respect of the large amount of dead storage inherent in high dams for hydro electric works, that these works can be of great service towards improving the overall utilisation of a river.

A further point Mr. Milton mentioned was the question of utilising break-pressure. He spoke about the Steenbras reservoir at Gordon's Bay. I am particularly glad that he did mention this, because I feel on our very doorstep in Johannesburg there is a glaring example of neglect in this respect. Here we have Vaal Dam which creates a head of about 120 feet, and through which a large volume of water has to pass annually. This flow cannot be stopped and it seems criminal to see all this energy being dissipated when it could so easily be used.

I think the fault lies with engineers in South Africa who so readily say "Oh well, coal is so cheap." If this argument is countered, the next remark is "Well, there is so little power." I feel that no matter how small the amount of power, if it is cheap enough it should not be neglected.

This is very well illustrated in Scotland, where the north of Scotland Hydro-Electric Board is feeding into a vast grid. Most of their hydro stations supply only peak load and run perhaps for as little as two hours a day. At all these stations they have to let compensation water pass down the river when the main plant is not working, but this trickle is not wasted. In every case, the compensation water is put through a turbine, and in many cases, where they have 10 or 20 MW of normal hydro plant installed, the compensation water goes through a 500 KW set. If it is cheaper, the 500 KW is worth using, no matter how large the system is into which it is fed.

I feel that today it might well be possible to install hydro turbines, possibly an automatic station, on Vaal Dam and produce units at a cost less than the pure coal costs on the Rand Undertaking at the moment.

Several people have asked about pumped storage. This is an application that could well be found of great service in South Africa, particularly in the areas where coal is cheap. The principle of pumped storage has been referred to by Mr. A. E. Powell in the paper he delivered to the A.M.E.U. Convention held in Johannesburg in 1959.

I do feel myself that more attention should be paid to the possibilities of pumped storage in certain parts of South Africa, but this has to be in conjunction with thermal plant, and does not really affect the utilisation of our water resources.

Mr. Milton was quite correct in taking me to task about my costs of generation in the Cape Western Undertaking, but I would hasten to add that I did work my figures out from the Escom published report, but as he rightly surmised, I erred in the allocation of the capital charges which I had to split arbitrarily between generation and transmission.

I have understood Mr. Muller of Upington to say that hydro electric work might interfere with irrigation. This, I fear, is a view commonly held in South Africa. The approach has been that the waters we have in South Africa must be used for irrigation and nothing else. I stressed at the beginning of my paper that the primary use of water is to support the population, but my contention is that the proper approach to hydro electric works and hydro electric engineering will greatly enhance the value of the water that we have in the country. Having generated our electricity, we still have all our water, in a form which is much easier to use for irrigation or any other need.

The salient point is that, in water flowing from a greater height to a lesser height, we have a raw material which can readily be converted into a saleable commodity — electricity — and the sale of this electricity can generate the capital that is so essential for the development of the rivers.

I am afraid that Mr. Gripper's very interesting comment on the possibility of tidal power at Knysna is somewhat beyond the scope of my investigations. Thank you.

THE PRESIDENT: Thank you Mr. Langford.

There will now be an apportunity for all delegates, engineer members, affiliates, and visitors to raise any matter under "General".

If there is any point of interest, or any suggestion you'd like to make, I'd like you to come forward.

Mr. W. H. MILTON, ESCOM: Mr. President, ladies and gentlemen: I'm sorry that at a rather crucial point I had to run away; a trunk call came through which I had been waiting for all morning, and I was sitting at the back to start with and missed a little bit of what was said through that.

Mr. Muller asked a question, and I know I am a little out of order, but if you will permit I would like to reply to Mr. Muller.

This question of off peak tariffs is one which is not easily answered.

To my way of thinking we are not sufficiently far advanced in our total loading in Southern Africa to introduce these off peak tariffs without possibly making trouble for the future.

I have in mind one of the large towns in Natal where they introduced an off peak tariff because they had a suitable valley for it, and later appealed to Escom to know whether we couldn't reduce our tariffs because the off peak period was now a peak period, and new consumers had to be charged full rates where the other fellows were getting beneficial rates.

Insofar as the off peak period on the Rand Undertaking is concerned, it is not so easy to specify what that is. We used to say from 7 a.m. to 4 p.m. was the peak period, and anything outside that was virtually off peak. But nowadays with the mines operating as they do, our peak period lasts longer, so that it is not so easy to say what is exactly off peak.

The other thing was that in connection with East London — I was rather hurried — the particular point I wanted to bring out was that in spite of the fact that we were very much embarrassed by what happened there due to the regulation of the peak and the lesser development which occurred, we nevertheless did not raise our tariffs in consequence. We rather took the sticky end of the stick and held it.

An examination of the East London performance as far as the Year Book is concerned will amply demonstate what can and did happen. If you look at peak load statistics only, East London looks as if it's in the doldrums, but if you have a little bit more care and study units, you'll find that East London is not in the doldrums.

THE PRESIDENT: Thank you, Mr. Milton.

Any further items under "General" gentlemen?

Mr. R. M. O. SIMPSON, DURBAN: I would like to put a question through you, Mr. President, to the convention on the very thorny problem of licensing of wiremen.

One Natal municipality has insisted on the licensing of wiremen individually, and not the Contracting Firm.

The Local Branch of Contractors' Association discussed this matter with me and pointed out the difficulties that contractors were experiencing in that, whilst work was slack they employed the minimum of staff, but when they were fortunate in suddenly getting a job that required them to employ another electrician, before he could be used on the job they were compelled to experience the delays in waiting for the licence to be approved.

As a point of interest I would like to know whether there are any other municipalities represented here today that insist on licensing wiremen?

THE PRESIDENT: Thank you Mr. Simpson.

Mr. R. W. KANE, JOHANNESBURG: We do not licence wiremen, but we do see, if we can, that the contractors employ licenced wiremen.

Mr. R. M. O. SIMPSON, DURBAN: Let me make that clear — it is a municipal licence I am talking about!

THE PRESIDENT: Does anyone else want to speak on the matter raised by Mr. Simpson?

If not, is there any other matter under "General" members would like to raise?

Mr. J. L. VAN DER WALT, KRUGERSDORP: Mr. President, you did not rule a previous speaker out of order, so I presume I will be out of order too. Really this should have come up under the report of the affairs of the S.A.B.S. — the various committees' works.

Has any progress been made with the promulgation of the safety specifications?

THE PRESIDENT: I wonder if Mr. Downey could give us the answer to that.

Mr. J. C. DOWNEY, SPRINGS: That is just the sort of thing I'd expect from my friend Mr. van der Walt!

Mr. President, the safety specifications are being promulgated, but it will probably take a few months yet before they are finalised.

Mr. G. A. LOTTER, LOUIS TRICHARDT: Mr. President, gentlemen: some twelve months ago, it was mentioned in the paper that Escom were going to build a new station in the vicinity of Ellisras (North Western Transvaal).

Yesterday it came forward in Mr. Langford's paper that there was no industrial load of any description round about the Limpopo River. I would just like to find out from, perhaps, Mr. Milton, whether this station is still going to be built, and if so when will it be started? Especially bearing in mind that there is no industrial load in this area.

Mr. W. H. MILTON, ESCOM: Mr. President, ladies and gentlemen, Mr. Lotter: I'm afraid I know nothing of this station. It is probably one of those fictitious stations that somebody tried to capitalise on some time ago and then blamed Escom for putting up land values which weren't realised!

THE PRESIDENT: With regard to the point raised by Mr. van der Walt, I wonder if Mr. Middelcote would like to give us some idea of what the effect is going to be in regard to the promulgation of these safety specifications.

Mr. A. A. MIDDLECOTE, PRETORIA: Mr. President, the position at the moment is that when the specifications are initially dealt with they will be printed in the Government Gazette, giving everyone a period of comment to ensure that the specifications themselves are completely workable.

This will be followed, after a few months, by a confirmation of the compulsory nature of the specification. Then there will be a period of grace to allow commerce to adjust their supplies to the requirements of the safety specifications.

There has been a delay lately but that has been due, unfortunately, to discussions on the principles of the Bureau of Standards and its position with regard to compulsory specification, but this matter has now been cleared up.

THE PRESIDENT: Thank you Mr. Middlecote.

Mr. H. J. GRIPPER, KNYSNA: Mr. President, on the point mentioned, if these specifications are issued for comment and advertised in the Government Gazette, might I ask our secretaries whether it is going to be possible for them to give us warning of that?

I find, maybe this is only in the smaller municipalities, that the Town Clerk watches the Provincial Gazette with an eagle eye, but he may leave the Government Gazette or put someone else to go through that later on, when it may be too late. I hope that members may get warning of this.

THE PRESIDENT: That point, Mr. Gripper, will be borne in mind.

Is there anything else under "General"?

Mrs. KRAFT, JOHANNESBURG: Mr. Chris Downie of Cape Town mentioned yesterday this question of publicity between municipalities, and rather than a private circular of the A.M.E.U. I would like to repeat now what I have said to individual municipal engineers, that the S.A. Electrical Review & Power Magazine would be very glad to get any news items, not only about personalities, but about the various undertakings.

THE PRESIDENT: Thank you Mrs. Kraft.

Well, gentlemen, if there are no other matters you wish to raise, I think we will adjourn for lunch.

(CONVENTION ANNOUNCEMENTS FOLLOWED).

CONVENTION ADJOURNED.

*On Resuming at* 2.30 *p.m.*

Members' Forum Continued.

QUESTION No. 13: "Should not 'service centres' or showrooms be encouraged by Electricity Undertakings in this country in the same way as they are officially encouraged in the United Kingdom and elsewhere in the interests of the public and consumers of electricity?

Are Municipal Electricity Undertakings doing enough to make consumers feel that they can come to us for advice and assistance in connection with any matter involving the use of electricity and electrical equipment?

Mr. MORRISON (Johannesburg) submitted that in Europe, and particularly in Britain where there was very severe competition from the gas organisations, it was necessary for the electrical undertakings to establish service centres, and local showrooms.

In the European townships of Southern Africa similar competition did not exist. However, in Native Townships the trend was to use bottled gas, thus a very substantial potential market for electricity was being lost.

Mr. Morrison suggested that as in the United Kingdom the A.M.E.U. should give serious consideration to the establishment of an Electricity Department Association for the promotion of electrical cooking and heating in these townships, and thought it could well come under the aegis of the A.M.E.U. in its establishment.

Mr. E. E. DE VILLIERS (Carltonville) mentioned that the public took many of their electrical problems direct to Councillors, who unfortunately did not always refer them to the engineers concerned. Mr. De Villiers felt that the full co-operation of Councillors would enable engineers to do a lot more for the public.

Mr. R. M. O. SIMPSON (Durban) agreed with the points raised by Mr. Morrison in regard to Native Townships, but pointed out that in South Africa anything to do with the administration of these Townships required the approval of the Minister.

Mr. Simpson referred to the considerable quantities of bottled gas produced in Durban which were being sold to Natives at a cost far in excess of electricity. He suggested the problem was basically one of educating the Native not only in the use of electricity, but in the purchase of the correct type of electrical appliances at the most reasonable prices.

In Durban, an assisted purchase scheme for appliances to allow Natives to purchase with the help of Council had been proposed, but this had not received the blessing of the authorities. In order to deter Natives from buying all sorts of poor quality second-hand appliances, Mr. Simpson envisaged the need for a central showroom, preferably with a demonstrator, who could guide the Bantu in acquiring and using the most economical electrical appliances.

Mrs. R. GAILEY (Ladysmith) mentioned that some years ago, an electrical showroom was opened, but it was subsequently closed owing to the outcry by private enterprises. Mrs. Gailey wondered if the Municipality had acted wisely in this matter, and thought that another showroom might be in the best interests of the public.

Mr. J. L. VAN DER WALT (Krugersdorp) suggested one should consider whether one wanted to increase the sale of electricity. He thought showrooms were a good thing, providing one was looking for consumers. Some Municipalities were not. Mr. van der Walt presumed the questioner meant that the showrooms would also have a combined hire purchase scheme. Mr. van der Walt agreed that such a scheme might promote sales of electricity, but warned it could also effect tariff structures.

Mr. L. R. F. OBERHOLZER (Brakpan) posed the question were Municipal electricity undertakings doing enough to make consumers feel that they could come for advice and assistance in connection with any matter involving the use of electricity and electrical equipment. Mr. Oberholzer thought the solution to the problem was not to attract more consumers, but to educate them in the correct usage of electricity, and this could be done by having filmlets, which could be displayed at cinemas, clubs, etc.

QUIZMASTER thought there was a need for an establishment to promote the use of electricity by selling appliances. However, he felt the main function of such a centre was to foster goodwill between the consumer and the authority.

There were, the Quizmaster continued, many dealers on the European market showing appliances that could be sold, with prices, but very few of these gave service to the consumer or became a liaison between the consumer and the supply authority.

The Quizmaster intimated it was the duty of Municipal engineers to sell electricity, and he referred to the greater productivity and higher standard of living which would ensue.

Referring to Mr. Morrison's remarks on Native Townships, he agreed that some form of Service Centre run by the Municipality would pay handsome dividends in sales.

Mr. H. J. GRIPPER (Knysna) emphasised the need to maintain the best public relations possible with consumers, but expressed doubt as to whether showrooms would be well received by the trade in Southern Africa. Advice and assistance to the consumer was, however, essential. Mr. Gripper suggested arrangements might be made by the Town Treasurer for allowing consumers to pay their accounts at centres where advice could be given.

QUESTION No. 20: In several of the larger centres, facilities have now been provided by the Technical Colleges for the training of Engineering Technicians. Would members please comment on their experience regarding the training and employment of Engineering Technicians as a means of alleviating the shortage of engineers?

Mr. J. L. VAN DER WALT (Krugersdorp) suggested the question was a bit premature, because the course, a four-year one, had at most been running for only two years.

Mr. L. R. F. OBERHOLZER (Brakpan) associated himself with Mr. van der Walt's remarks, and sought assurance that the course included practical training. This point was confirmed.

QUIZMASTER called upon Mr. van der Walt to give a resume of the actual course.

Mr. J. L. VAN DER WALT (Krugersdorp) informed the meeting that the course had been instituted at the instigation of the Department of Education, Arts and Science, so it was Union-wide. Candidates were required to have a sound general education, and the intention was to select the best first year apprentice, who would then attend technical classes for four months in the year continuously. The remaining eight months would be devoted to practical training.

College fees were a matter for negotiation between employee and employer.

Mr. van der Walt stated that at the end of the fourth year, the student would sit for the Higher National Diploma in Engineering which was roughly equivalent to a third year B.Sc. (Eng.). Consideration was also being given to an additional correspondence course to enable students to reach degree standard.

Mr. J. DOWNEY (Springs) advised anyone who wished to procure a brochure on the course should leave his name with the Secretary.

Mr. H. J. GRIPPER (Knysna) asked whether it would be correct to exclude non-whites from this training scheme.

Mr. MIDDLECOTE (Pretoria) referred to the problem of demarkation between an engineer and a technician. He felt one had to decide where the term technician ended and engineer began.

Mr. L. R. F. OBERHOLZER (Brakpan) noted that adults with no experience of the electricity industry could avail themselves of the training.

QUIZMASTER opined that only those academically qualified who were taking practical training would be admitted to the course.

Mr. W. H. MILTON (Escom) suggested that the men who failed to reach degree standard at University were often wasted. These were often good types who could be thoroughly trained and usefully employed as assistants to engineers.

Mr. Milton quoted his own organisation as an example where highly paid officials were being overburdened with work, which could well be undertaken by lesser trained staff, none of whom were at present available.

Mr. C. LOMBARD (Germiston) referring to Mr. Oberholzer's observation regarding adults availing themselves of the course, Mr. Lombard advised there were, in fact, two courses, namely one for adults and the other for trainee technicians.

QUIZMASTER called upon Mr. Sibson to give a resumee in regard to the position in the Federation.

Mr. A. R. SIBSON (Bulawayo) advised the Forum that the apprenticeship legislation in Southern Rhodesia provided for practical and theoretical training of craft apprentices and technician apprentices. The course followed for technicians was that of the City and Guilds Institute, and was thought to last approximately 18 weeks per annum.

Referring to South Africa, Mr. Sibson maintained the course there was unnecessarily high for a technician, because anyone attaining the equivalent of a third year B.Sc. (Eng.) degree might just as well study the extra 12 months required to become a technologist. He continued, in Britain the rough proportion of engineers and technologists to craftsmen was about one technologist to six tenhnicians. By setting too high an examination standard, one limited the number of passes, and if six technicians were required for every one engineer, the standards set should take some cognizance of the proportion.

Mr. J. YODAIKEN (Que Que) asked who decided which of the apprentices were suitable for training as technicians in Southern Rhodesia.

Mr. A. R. SIBSON (Bulawayo) replied that the position was somewhat fluid at present but that there was little doubt the sorting would be done in the major colleges, probably by means of examination.

Mr. R. W. KANE (Johanesburg) mentioned that in Johannesburg youngsters who had received the practical training were sent on this course. The students were allowed £200 out of which they had to pay their own fees and keep themselves. Unlike apprentices who were paid whilst at college, these students felt their loss of earnings, and considered themselves to be out of pocket.

Mr. R. M. O. SIMPSON (Durban) giving the position in Natal said the Durban University had recently started a "sandwich course" and he hoped the Municipality would select suitable candidates shortly.

Mr. VAN DER WALT (Krugersdorp) mentioned that apprentices were required to attend evening school one night per week, during the period of practical training. He stressed that the course was very stiff, for which only the best apprentices should be selected.

QUIZMASTER thanked everyone for their contributions to the Forum.

THE PRESIDENT: Mr. Quizmaster, ladies and gentlemen: I think it is obvious that they were dissatisfied with the first spell, that is why they called on you again to have another go at it; but in all seriousness Mr. Quizmaster, I think that the popularity of the Forum is attributable to you, and I thank you once again for running it in your usual competent way.

(CONVENTION ANNOUNCEMENTS FOLLOWED)

CONVENTION ADJOURNED.

*On Resuming at* 4.00 *p.m.*

THE PRESIDENT: Mr. Mayor, ladies and gentlemen: we are now reaching the closing session of this Convention, and His Worship the Mayor and the ladies have joined us.

Before I call on those responsible for the formal addresses at the conclusion of the Convention, there will now be an opportunity for those who wish to do so to address the Convention.

Mr. F. STEVENS, LADYSMITH: Mr. President, when I first arrived at Livingstone one of the first impressions I gained was the excellent street lighting and I asked Mr. Beasley how he managed to get the money from his council to put in such street lighting. He gave me an explanation, but when I arrived at the meeting this afternoon, I think I found the real one. Immediately outside here you have got poles spaced at 120 yards apart and I am wondering whether he hasn't perhaps taken out every other pole and electric light fittings to finance it that way!

THE PRESIDENT: Thank you Mr. Stevens.

Does anyone else wish to speak?

I now call on Mrs. Gayley to express, on behalf of the ladies, their appreciation for the hospitality extended to them at this Convention.

Mrs. GAYLEY, LADYSMITH: Mr. Mayor, Mr. President, ladies and gentlemen: It is a source of great pride and pleasure for me to have been entrusted with this very important task, and that is to say "Thank you" to the A.M.E.U. and to Livingstone for the wonderful arrangements they have made for the entertainment of the ladies.

Unfortunately I have not been able to attend all the functions arranged, for the simple reason that for the purposes of this Convention, I am not a lady!

With your permission, I would like to digress just for a moment. Mr. President, I would like to say thank you to you and to the members of this Convention for making me feel so much at home. I was made to feel just another delegate, and although a number of the discussions were right over my head, and more technical than was possible for me to understand, I must say that by and large, I enjoyed the convention very much indeed.

I was most impressed with the keen interest shown by all the engineer delegates in the discussions which took place, and I feel that local authorities must benefit by this exchange of ideas.

Now, I feel that I must get back to the primary reason for my getting to my feet.

Hier moet ek weer noem dat dit vir my 'n besondere eer is as ook 'n genoeë om namens die dames vir u, die burgemeester, die burgemeester se vrou, en die inwoners van Livingstone, hartelik te bedank vir hulle gasvryheid en hulle moeite. Niks was uitgelaat om te verseker dat almal, of al die dames, ten minste, hulle ten volste te geniet het nie. En ek wil ons waardering daarvoor uitspreek.

Livingstone, as I think all the ladies found, is brimful of interest, of magnificent scenery, and we are most grateful to you, Mr. Mayor, to your very charming Mayoress, and to the Council and people in Livingstone for making our stay here such a memorable one.

We women always find it a boon to get away from our household chores and from the daily grind. You have ensured that we have been supplied with wonderful entertain ment and with very sincere hospitality, and I must say to you that we appreciate both very much indeed.

I am sure there is not a lady present who doesn't say with me "May the next Convention in Livingstone be in the very near future, and may we all be lucky enough to be present at such a Convention." (Applause.)

Before finishing off I would like to call on Mrs. Mitchell to say in poetry form what she thinks of this Convention.

Mrs. J. MITCHELL, SALISBURY:
Just a few thoughts on the 1961 Convension, with grateful thanks from all the 'ordinary' ladies.

How we ladies love to be
At Conventions by the sea.
But this year in the Federation
Has brought forth some moderation
In behaviour, from when in Durban,
Where certain ladies were disturbin'.

Last year "May" placed her face in space
And joined the CAN-CAN girls
All dressed in frills and lace.
Her SURNAME, by the way, is "DOWNEY"
But this tale sure is not "BAL-OW-NY".
"If JACK lights up the town," she said,
"Then surely I can paint it red."

This year we thought at least that someone,
Maybe after SIX MARTINI
Correctly clad in her Bikini,
Would have entertained us all
With TIGHT-ROPE ACT across the FALL.

Now some of us came here by air,
And luggage weight we did declare.
So now we know that OUTER SPACE
Means — WEARING what's NOT IN THE CASE.

Here we get no mental cramps
No extra cost on threepenny stamps.
No extra on the beer that once
Was cheaper when not using RANDS.

Those who to KARIBA went
Would be glad of their intent
To see the great and mighty RIVER
Which, like the famous 'babbling brook',
WE HOPE goes 'on and on for 'iver.'

There is one thing that is alarming
The water's surface is becalming
To the men who for the fishes seek.
They want to sail, not have to walk on
A solid mass of vegetation.
So 'WEED' welcome all suggestions
To clear Kariba of such congestions.

Hippos, Crocs, Giraffe — no fake —
Feet of Ciné film we take
When on the Launch, and at the Island
Monkeys chatter, aren't they sweet?
Where's that cake I meant to eat?

We all to the Opening Session went
And to the FORUM, with intent
To hear our men give LIGHT on CURRENT things.
We heard lots of fables about TEN-CORE CABLES,
Of how to put over the new TARIFF TABLES.
They discussed the old tag about a TIME-LAG —
NOW we know what is meant by CHIN-WAG!

Just to be more serious though,
We feel you really ought to know
How much we do appreciate
Being here, at every date.
Listening to and sharing sincerely
Our husbands' Engineering, yearly.

We want you all to love your OHMS
Not like the GOVERNOR that sometimes ROAMS.
So we have a high STANDARD the BUREAU would envy
To keep our men happy when working with frenzy.
We wish to assist you, and like a flower,
Help you ENJOY and not KILL-A-WATT HOUR.

To the President and his Wife — GOOD WISHES,
A Year of Office most propitious.
Our thanks to our HOSTS and ALL we would mention
Who have given the ladies such charming attention.
They've really EXCELLED their good intention
In giving us such a GRAND CONVENTION.

THE PRESIDENT: Thank you Mrs. Gayley, and thank you Mrs. Mitchell. I'm sure you'll all agree that Mrs. Mitchell's poem will be a valuable addition to our proceedings. (Applause.)

I now call on Mr. Arthur Tilley to speak on behalf of the affiliates.

Mr. A. C. TILLEY, JOHANNESBURG: Mr. President, I think it is most unfair to call on me after having two brilliant speakers like that.

I was out with Railwaymen last night, so I am going to read my notes today!

I am invited to thank you, Mr. President, but before doing so I'd like to give you a little fatherly advice. If you had a public relations office, I'd have learned before Monday this week that members were only charging 20% more now than they did many years ago. I now feel more friendly towards Percy Giles, and I'm going to buy him a really good cigar!

On Tuesday I heard how your members interfered in the daily lives of their customers, by cutting off their hot water so painlessly. You should put some members in parliament. Jimmy Mitchell should be Minister of Power so that we could defend Escom.

Not being a town councillor, Mr. President, I must be brief — so now thank you on behalf of affiliates and visitors for perfect supervisory control of our comforts and our pleasures. (Applause.)

THE PRESIDENT: Thank you Mr. Tilley. I will now call upon His Worship the Mayor.

HIS WORSHIP THE MAYOR: Mr. President, ladies and gentlemen: I would first like to apologise for the absence of my wife here this afternoon, but there is no need to tell you why: she has another engagement elsewhere. She is very, very sorry indeed, that she could not be here with you, and I will certainly take back to her the very dear sentiments that you have all expressed with regard to your stay here in Livingstone over this week. I'm sure she will be very proud to know that you have all enjoyed yourselves.

Now to you Mr. President, I would like to say, I wish you a very successful year of office, and I hope in the very near future you will be able to come back and hold another Convention here with us in Livingstone.

To all of you — some of you whom I have only just met for the first time and to you whom I have known for a number of years — I wish you all lots of luck, Godspeed, and I hope to see you all in the very near future.

May I say just one word that will create a feeling of friendship, that we will meet again sometime and may I use the word "Totsiens".

THE PRESIDENT: Thank you very much, Mr. Mayor. I will now call on Clr. Paintin of Germiston to thank Livingstone for its hospitality.

Clr. J. R. PAINTON, GERMISTON: Mr. Mayor, Mr. President, ladies and gentlemen: this is endeed a great pleasure to me this afternoon to say thank you to the people of Livingstone on behalf of the delegates at this Convention.

As this is the first time that I have ever had the honour of representing Germiston at an Electrical Undertakings Convention, I can give you the assurance I have learnt a lot — I won't say "technically" because I know much about it — but what I simply did was this: when these electrical chappies got very technical I looked at some of the other councillors and I did the same as they did, I put on an intelligent look, and no-one was any the wiser.

Mr. Mayor, as a fellow councillor, I'm sure you will appreciate some of my impressions of this Convention.

I have heard talk of AC's and DC's but I am one of those unfortunate people — I come from another sort, the LC's — they're very nice people — liquor consumers! I won't mention which towns or cities they came from.

I notice in all this discussion there were discussions on many interesting things, but when these chaps got round to discussions on kilowatts and megawatts and "what-have-you" — I just didn't know where I was, and unfortunately my engineer being President, I had to rely on fellows, for instance, like our vice-president, with his big cigar, so I didn't get very far.

The previous speaker mentioned an item with regard to PRO's and I feel that that is really the job that councillors from the different cities and towns come here for. Their function I would say is mostly as public relations officers, whereby they can do their towns and cities such a lot of good.

We learn to meet each other and understand each other while these technical chappies are talking ohms and things, and I personally sincerely hope that I will have the opportunity of meeting a number of these people again.

There was one small problem I solved here, and it is something that has intrigued me for many years, why East London was called "the fighting port." Now I have found it out, it is the amount of port wine they drink!

Mr. Mayor, I realise that with a big Convention like this we must have stretched your resources pretty badly, and I sincerely hope that we haven't overbalanced your budget. I realise that in the long run this will do the city of Livingstone a lot of good.

We were wonderfully entertained in many ways.

The trips up the river, the trips to the power station where we saw something that we had all read about (and we do admire the people who did that wonderful job of work), your cocktail party, and many other things.

I want to just mention one thing though: while up here I learned something about public transport. I think this goes for most councillors, and perhaps the engineers as well — we travelled on your buses backwards and forwards quite often, and with the different discussions I heard quite a few things. Now in our public transport system in Germiston we are always running at a loss, but I think I have come to the correct reason why we run at a loss and you don't. Evidently your buses haven't got springs and shock absorbers!

There is another small point, I realise how we in Germiston save money in transport; I am satisfied after a certain performance on Monday night after the cocktail party, that we don't need bus conductors any more, because there was a certain councillor, and the way he rings that bell! I am sure we just need a town or city councillor on the bus and don't need conductors!

I don't want to miss anyone Mr. Mayor, but I want to formally thank you, your good wife, your council, and your citizens of Livingstone for the most wonderful time you have given us. I do not want to forget the ladies who supplied the tea at the breaks —the back room ladies. They have all done a wonderful job of work and I sincerely hope that if any of you, Mr. Mayor, or any of your citizens are down Germiston way, you will kindly call in and see us and we will do our very best to reciprocate. There is just one small word of warning, if you come down to Germiston it has been said that a certain person from the Federation had trouble when he came our way, with the notices, and road signs.

On the boundary of our city, we have "Germiston." That is for this purpose: our neighbours bask in our glory and so we have put that there to show where Germiston commences and ends, but this particular person went down there — I don't know what mode of transport he used. He said he passed this town, and he passed that one, and he passed the other. Well, I don't know how he missed Germiston. I think he must definitely have been in a plane and missed Jan Smuts Airport.

Mr. Mayor thank you very much, thank you everyone; and on behalf of the delegates we wish you well, and hope to see you again one of these fine days.

THE PRESIDENT: Thank you Clr. Painton.

Mr. Mayor, ladies and gentlemen, we have now come to the end of our proceedings. I think that you will all agree that this has been a very pleasant and happy Convention. Amongst other things we have been privileged to see two of the world's outstanding sights, the one provided for us by nature, and the other man-made.

On behalf of the A.M.E.U. it is my pleasant duty to officially thank the Federal Power Board for permitting delegates to this Convention to visit Kariba and for the courtesy shown to the delegates during these visits.

I shall be very grateful if Mr. Peterson would convey this association's appreciation and thanks to the Federal Power Board and its officials at Kariba. (Applause.)

As in the case of most conventions, we have had our share of gremlins, and when Clr. Main drew my attention the other day to a slight typographical error it reminded me of what happened in a small town where the citizens decided to open a small hydro-electric station.

This, of course, was big news in the town, so the editor of the local paper decided to make it the topic of his main news story, but just as the paper was to go to press the news came through that the village banker, some 80 years old, had married his secretary. This was big news indeed, and the editor stopped his presses, took out the story of the hydro station, inserted the picture of the banker and his new wife, and started the presses again. But in his haste the editor overlooked one little detail. As a result, when the paper hit the streets, above the picture of the elderly banker and his bride appeared the words "Old Power House Resumes Operations."

It will be appreciated that holding a convention in Livingstone presented many problems and difficulties, and I would like to add my personal thanks to those of Clr. Paintin to the Livingstone Town Council, not only for making it possible to hold this Convention in Livingstone but also for all that has been done, to make us comfortable and for our entertainment.

The bulk of the work in connection with this Convention has naturally fallen on the shoulders of Mr. Bill Beasley, and I have great pleasure in thanking him, especially, on behalf of the A.M.E.U. for all that he has done to make this Convention a success.

I would like to add my personal thanks, as Bill Beasley has had to carry much of the burden that would normally have fallen on my shoulders.

My thanks are also due to Mr. Beasley's staff who have done such a splendid job of work, and here I would like to mention in particular, Mr. Barnett, in charge of the recording and public address system, and Mrs. Douglas, and Messrs. Cook, Blake, Payze and Crosby, who were in attendance at the information desk and in the foyer. (Applause.)

As usual, Mrs. Simms has coped at high pressure with the enormous amount of transscription work, and our thanks are due to her, too.

May I also express my gratitude to the members of the Executive Council who have given me so much encouragement and support. Cr. Paintin has been a staunch friend, and I am also grateful for the assistance given to me by my Council.

Words can hardly express what I owe to Mr. Dick Ewing, our Secretary. He has put in an enormous amount of work behind the scenes to make this Convention a success, and to see that things are running smoothly. He has been a real friend and counsellor. And I thank you very much indeed, Dick, for all that you have done.

Dames en here, die sukses van 'n konvensie hang grotendeels af van die gees wat deur die afgevaardigdes geskep word, en in hierdie opsig het u amal die deel bygedra om hierdie konvensie so suksesvol te maak.

Baie dankie daarvoor en ook vir die aanmoediging en bystand.

Last but not least, I would like to thank my wife for her encouragement and moral support and, may I add, tolerance? (Applause.)

I hope that you all had an enjoyable time, and that you have derived much benefit from our deliberations.

Mr. R. M. O. SIMPSON, DURBAN: Mr. President, you have very ably gone through all the list of thanks, and have thanked everybody; you have thanked your own councillor, you have thanked the Mayor of Livingstone, the Power Board, Mr. Ewing, Mr. Beasley, and the council of Livingstone, but there is one thing that you cannot do, and I am sure that the Convention would wish me to do this, and that is, on their behalf, to thank *you* for the very able way in which you have conducted this Convention. (Applause.)

THE PRESIDENT: Thank you very much indeed Mr. Simpson.

I now officially declare this Thirty-fifth Convention of our Association closed, and wish you all a safe journey home.

Dames en here, ek verklaar nou dat hierdie Vyf-en-dertigste Konvensie van ons Vereniging afsluit en vertrou dat u almal u tuistes veilig sal bereik.

Baie dankie. Thank you.

CONVENTION ADJOURNED.

Printed by
JOHN O. RODD (PTY.) LTD.
JOHANNESBURG