AN ECONOMIC STUDY OF

THE COMMERCIAL ENERGY REQUIREMENTS

OF SOUTH AFRICA

WITH PARTICULAR REFERENCE TO

THE CONSUMPTION OF COAL AND PETROLEUM

BY

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University of Cape Town

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- PREFACE -

During 1955 an economic study entitled "The World Energy Outlook 1954-1965" was prepared for private circulation amongst the RoyalDutch/Shell Group of Oil companies. The study contained the following comments:-

> "The world's energy resources are coal, oil (including natural gas) and hydro-electricity. In the future nuclear energy will become a major source, but its contribution during the next ten years will be negligible.
>
> Coal supplies are not matching energy demands. The contribution of hydro-electricity is likely to remain relatively small. In these circumstances the bulk of the world's additional energy needs, at least during the next ten years, must come from oil".

The last paragraph of these remarks gave rise to a trend of thought which culminated in a resolve to write this Thesis. If it was true that in the world as a whole coal supplies were not matching energy demands, what was the position in South Africa with its vast reserves of low price coal? Would the bulk of the Union's additional energy needs during the next ten years also have to come from oil? What was the relationship in the Union of South Africa between coal energy and oil energy; what facts were available regarding energy supply and demand; what was the likely trend of consumption during the next ten year period? These were some of the questions which this Thesis set out to answer and, in finding the answers, it became necessary to investigate many aspects of production, distribution and consumption of these two major sources of commercial energy in the Union.

The study has been specifically limited to commercial sources of energy in accordance with the definitions used by the Statistical Office of the United Nations:-[ϕ]

> "Commercial Sources of energy - These include anthracite and bituminous coal, pitch coal, brown coal and lignite; petroleum, shale oil and natural gasoline; natural gas; and hydro and geothermal electric power.
>
> Non-commercial sources of energy - These include peat, bagasse, fuel wood, lumbermill wastes and other fuels that are largely of local significance such as dung, straw, paddy husk and other wood and agricultural wastes".

Very little is known concerning the amount of non-commercial energy used in the Union and such information is not relevant to the original concept of this Thesis. It is known

ϕ Ref.22, Page 99. (Bibliography at end of book).

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however that the Sugar Industry burns bagasse, the Wattle Industry burns spent bark, and so on, but statistics of such consumption are sadly lacking. Furthermore these industries also require coal and/or petroleum fuels for their production and distribution processes. Generally speaking, non-commercial sources of energy are low in calorific value and only of local significance. Commercial sources of energy however are of primary importance to the economic development of the country and a fair amount of statistical information is available concerning the consumption of such fuels.

Coal is mined in the Transvaal, Orange Free State and Natal. Petroleum fuels are mostly imported (some crude oil being refined locally), although there is a modest amount of local production using alcohol blends, torbanite shale and oil-from-coal hydrogenation processes. There are no sources of natural gasoline, natural gas or geothermal electric power in the country, and the amount of hydro-electricity produced is negligible. The study therefore resolved itself into a direct comparison of the roles played by coal and petroleum in fulfilling the commercial energy requirements of South Africa.

Chapter One provides a brief survey of classification standards and calorific values applicable to South African coals. This is followed by a detailed review of the organised methods of production and distribution in the main coal producing areas of the Union. The Chapter ends with a discussion of statistics relating to total coal production and sales.

Patterns of coal consumption are studied in considerable detail in Chapter Two. For this purpose consumption has been considered under eight groups, representing the major coal consuming sectors of the national economy. Hitherto, the Report of the 1946/47 Coal Commission has been the main work of economic reference in regard to the Union's coal energy requirements and, with this as a base, an attempt is made to review the period up to and including 1956. Consumption data are provided for the period 1947 to 1956 and a ten-year forecast of coal requirements up to 1966 has been estimated for each main consuming sector of the economy. This section of the Thesis gathers together for the first time in this form all the available facts and figures dealing with the consumption of coal energy.

Chapter Three covers the South African Oil Industry and gives as much detail as it was possible to obtain regarding the production, importation and distribution of petroleum products. The chapter also shows that it proved virtually impossible to obtain any data relevant to production and/or distribution costs which would enable a comparison to be made between coastal refineries, inland refineries and imported petroleum products.

The consumption of petroleum fuels in the Union is discussed in Chapter Four and certain hitherto unpublished statistical information relating to the demand for such fuels has been included. The data presented in this Section has been so arranged that Tables of petroleum consumption for the years 1947 - 1956 are available for comparison with statistics of coal consumption during the same period. A forecast of demand for the next decade has also been presented to assist in determining the relative roles of oil and coal in the energy market in the Union.

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[4] Ref. 9.

Chapter Five provides a final analysis of South African energy consumption and gives a clear illustration of the part that each fuel is expected to play during the period 1957 - 1966. The Union's total energy requirements are examined in detail and a study is made of the relative costs of coal energy and oil energy in Johannesburg and Cape Town.

The information contained in the following pages has been compiled from a variety of sources with the sympathetic help of a large number of people. It is not possible to mention everyone by name, but it is desired to record a debt of gratitude for the assistance rendered by the various Associations, Companies, Government Departments, Local Authorities and Public Utilities listed in the Annexure to this Preface. Professor H.M. Robertson and Professor W.J. Talbot of the University of Cape Town have offered invaluable help, guidance and criticism throughout the course of the work. My colleagues in the oil industry have assisted nobly in the task of verifying statistical data, and the co-operation of the General Managers of the four major oil companies is gratefully acknowledged.

WILLIAM S.J. GRANT

Cape Town
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ANNEXURE TO PREFACE.

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2. American Consulate General.
3. Atlantic Refining Company of Africa (Pty.) Ltd.
4. Bureau of Census and Statistics.
5. Caltex (Africa) Limited.
6. Cape Town and District Gas Light and Coke Co. Ltd.
7. Department of Commerce and Industries.
8. Department of Mines.
9. Electricity Supply Commission.
10. Fuel Research Institute of South Africa.
11. Geological Survey Office.
12. Government Mining Engineer.
13. Natal Cane By-Products Ltd.
14. Natal Coal Owners Society.
15. National Physical Research Laboratory.
16. Natural Resources Development Council.
17. Sasol Marketing Company Limited.
18. Standard-Vacuum Refining Company of South Africa (Pty.)Ltd.
19. State Information Office.
20. South African Coal, Oil and Gas Corporation Limited.
21. South African Federated Chamber of Industries.
22. South Africa Iron and Steel Industrial Corporation Limited.
23. South African Lighting Association Limited.
24. South African Mutual Life Assurance Society.

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25. South African Railways.

26. South African Torbanite Mining and Refining Company Ltd.

27. The Shell Company of South Africa Limited.

28. Transvaal Coal Owners Association (Pty.) Limited.

29. Transvaal and Orange Free State Chamber of Mines.

30. Vacuum Oil Company of South Africa (Pty.) Limited.

31. The following Local Authorities:-

Aliwal North	Beaufort West
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Pretoria	Queenstown
Springs	Umtata
Upington	Vryheid

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CHAPTER ONE

COAL PRODUCTION AND DISTRIBUTION IN SOUTH AFRICA

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CHAPTER ONE

COAL PRODUCTION AND DISTRIBUTION IN SOUTH AFRICA

1. CLASSIFICATION STANDARDS FOR COAL.

From the earliest days of trade in coal certain names have been in use to distinguish different varieties, such as lignite, bituminous and anthracite. These names, or their local equivalents, have been in common use almost throughout the world and, as a general broad classification, they served their purpose reasonably well. However, with the growth of a specialised fuel technology and the development of heating units designed to burn specific grades of fuel, it became necessary to adopt some more definite means of classifying coal according to its composition and heat value.

Lignite is the lowest ranking coal. It is brown in colour, has a moisture content up to 40% by weight, and disintegrates on exposure to air. Lignite has only about half the heat value, weight for weight, of a good bituminous coal and is therefore more expensive to transport in terms of heat value per ton. Because of this factor lignite and other poor quality coals cannot be used economically at great distances from the mine.

Bituminous coals have been divided into two main classes of which the lower grades, with properties lying between those of lignite and the more volatile bituminous coals, are classified as sub-bituminous (or black lignite). Table 1 shows typical average compositions and heat values for the various classes of coals and it will be noticed both Bituminous and Sub-bituminous coals are again subdivided according to analysis. Sub-bituminous coal, with its much higher heat value than lignite, has important applications in local markets for steam raising purposes, particularly where higher grade coals are remote and costly to transport.

Good quality bituminous coal can be stored for many months with little or no alteration to its composition. For this reason bituminous coal is widely used for industrial and household purposes. This type of coal constitutes about 52% of the estimated current world supply, and certain grades are eminently suitable for the manufacture of metallurgical and blast furnace coke.

Anthracite coals are hard, dense, low in moisture and high in carbon content. As a fuel, anthracite burns with very little smoke and is therefore very popular for domestic heating uses. However as the heat value of a coal is greater when there is a higher proportion of volatile matter to fixed carbon, anthracite as a rule will give less heat per unit of weight than bituminous coal. (See Figure 1).

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[1] See Figure 1.
[2] Ref.14, Pages 213-214.
[3] Ref.17, Page 843.

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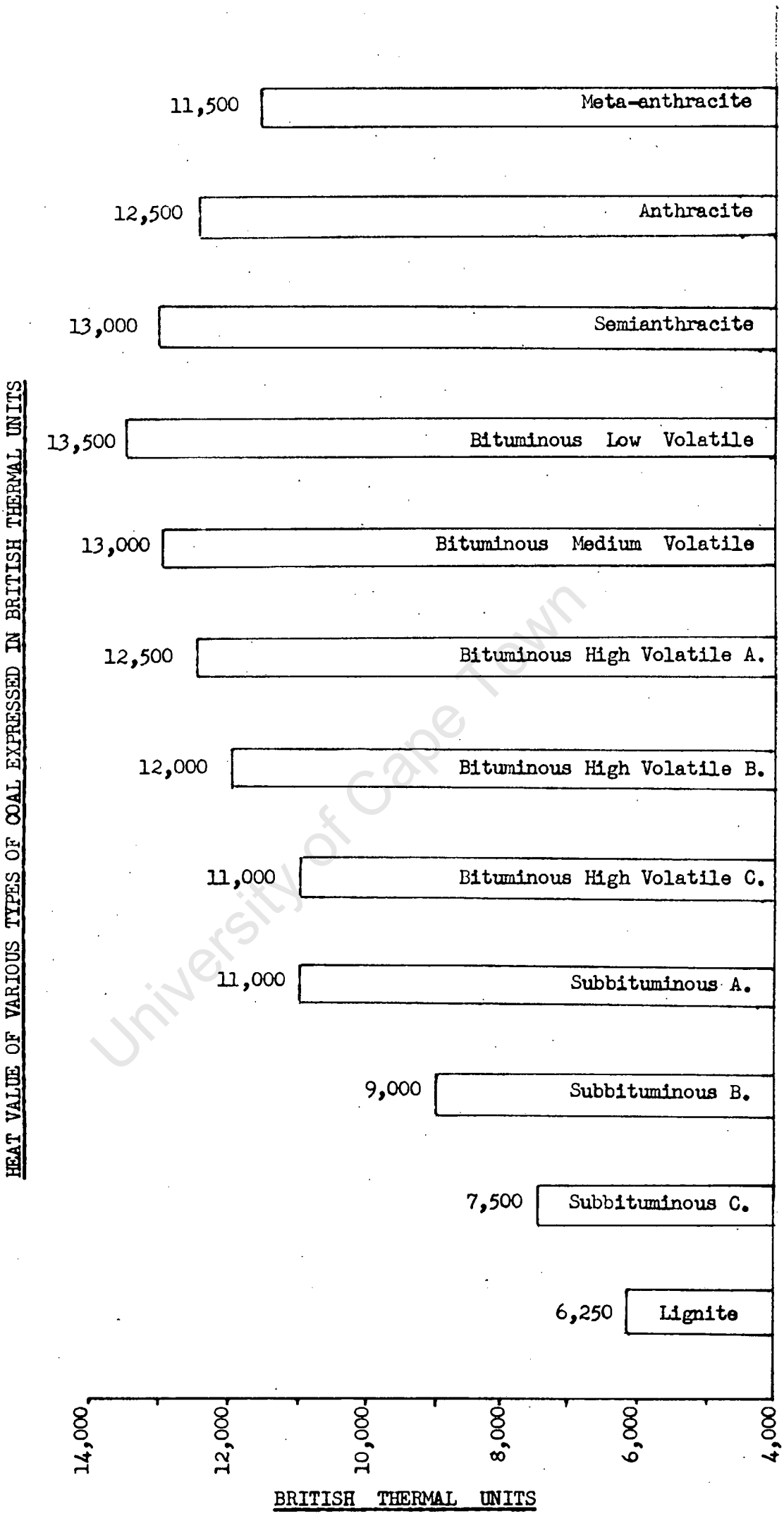

FIG. 1

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TABLE 1 - COAL : HEAT VALUE AND COMPOSITION*

Type of Coal	Total	Percentage Distribution: Moisture	Volatile Matter	Fixed Carbon	Heat Value in British Thermal Units	Calorific Value in lbs/lb
1. Anthracite						
Meta-anthracite	100	4	2	94	11,500	11.86
Anthracite	100	2	5	93	12,500	12.89
Semianthracite	100	2	10	88	13,000	13.40
2. Bituminous						
Low-volatile	100	3	19	78	13,500	13.92
Medium-volatile	100	4	28	68	13,000	13.40
High-volatile						
A	100	3	39	58	12,500	12.89
B	100	10	40	50	12,000	12.37
C	100	18	40	42	11,000	11.34
3. Subbituminous						
A	100	18	40	42	11,000	11.34
B	100	23	36	41	9,000	9.28
C	100	28	35	37	7,500	7.73
4. Lignite	100	43	27	30	6,250	6.44

(* On an ash-free basis) (Ref. 17 Page 843)

Note: Calorific values expressed in lbs/lb units indicate a measure of the number of lbs. of water that can be evaporated by one lb. of fuel at atmospheric pressure and 212 degrees Fahrenheit. The British Thermal Unit is a measure of the amount of heat required to raise one lb. of water through one degree Fahrenheit. Hence in the first example quoted above, one lb. of fuel would (theoretically) liberate heat sufficient to raise 11,500 lbs. of water through one degree Fahrenheit. Approximately 970 B.T.U.'s are required to evaporate one lb. of water at 212° F, hence to convert lbs/lb. units to B.T.U.'s multiply the former by 970.

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Each major coal producing country has developed a coal classification system along the lines of the U.S. Geological Survey ranking shown in Table 1. A standard classification of
ø coals by rank was established by the American Society for Testing Materials in 1939, based on carbon content and calorific value. In the ASTM ranking coals having calorific values of 14,000 B.T.U. or more, and coals with a fixed carbon content of 69 per cent or more, are classified according to carbon content. This covers the range from Bituminous medium volatile onwards to Anthracite. Other coals having a calorific value of less than 14,000 B.T.U. and a carbon content below 69 per cent are classified according to B.T.U. value. This lower ranking covers the range from Bituminous High Volatile "A" coals, down to Lignite.

The A.S.T.M. classification was evolved in 1939, but various authorities in different countries had earlier attempted other forms of classification based on carbon content, moisture
x content, carbon-hydrogen ratio, or other analytical combinations. The Twelfth International Geological Congress adopted a comprehensive classification based on fuel ratios and calorific values, which was probably the forerunner of the A.S.T.M. classifications. However, when the various methods are reviewed, it would appear to be extremely difficult to find an acceptable international classification because of the varying geological conditions under which different coals have developed, giving rise to considerable differences in moisture content, volatile matter, or other constituents. The International Standards Organisation has for some time been considering the preparation of a classification that would be acceptable for all countries, but so far no concrete proposals have been formulated.

It would appear that there is no general classification standard for South African coals. Export and bunker coals are however subject to grading regulations prescribed by the Fuel Research Board and administered by the Fuel Research Institute. The history of these regulations dates from the years immediately after the first world war, when export and bunker coals were in very great demand. More attention was paid to quantity than to quality and serious injury was done to the reputation of South African coal, through the export of low grade varieties. A Commission appointed in October 1920 to investigate these matters recommended that:-

/ "No coal produced within the Union shall be used for export overseas or for the bunkering of steamers calling at South African ports, unless graded and a certificate issued in respect of such coal."

// A Coal Grading Act was passed by Parliament in 1922 and a Fuel
æ Research Board and Fuel Research Institute were established in 1930. The grading of coal is today carried out by the Fuel Research Institute and grading certificates are compulsory in respect of export and bunker coals. Although provision is made in the regulations for the grading of inland coal, it is not compulsory and to date no certificates of this nature have been issued.

ø Ref.18, Page 44 ff.
x See Ref.7, Ch.5.
/ Ref. 9, Page 76.
// Act No.27 of 1922.
æ Ref.20, Paras. 2 - 11.

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South African export and bunker coals are classified mainly on the basis of their heating properties, as follows:-

First Grade	-	Minimum calorific value 12.8 lbs/lb.
Second Grade	-	Minimum calorific value 12.3 lbs/lb.
Under Second Grade	-	Below minimum value for second grade.

In addition certain specifications in respect of size, ash fusion temperature, volatile matter and sulphur content are laid down.

Some typical general analyses of South African coals are given in Table 2. It will be noticed that water content, ash content, volatile matter, calorific values, and ash fusion temperatures are the main points of classification. It is interesting to compare the calorific values shown in this Table with the general averages for North American coals quoted by Ayres and Scarlott, as follows:-

Anthracite	12,700 B.T.U./lb.	(average)
Bituminous	13,000 "	"
Sub-bituminous	9,500 "	"
Lignite	7,000 "	"

From the above figures and from the data given in Tables 1, 2 and 3, it would appear that South African classifications are broadly comparable to the general averages used overseas, and that the standards of quality adopted by the Fuel Research Institute are on a par with standard American practice.

Dr. J.A. Petrick, Director of the Fuel Research Institute, in discussing coal classification systems, makes the point that the application of a Northern Hemisphere classification to coals of the Southern Hemisphere gives rise to some problems, due, inter alia, "to the different period and possibly method of deposition (type of vegetable material, etc.) and the relative proportion of bright to dull coal present in the seams." The Fuel Research Institute has suggested that South African coals could be roughly classified according to Volatile Matter content as determined on the normal air dried basis, e.g:-

Anthracite	6% to 11% V.M.
Low Volatile Bituminous	14% to 17% V.M.
Medium Volatile Bituminous	17% to 23% V.M.
High Volatile Bituminous	Over 25% V.M.

According to this classification, all the Transvaal, Orange Free State and part of the Natal production is of the high volatile bituminous class, whilst production of the first three classes is, so far, confined to Natal. Unfortunately the large variations in calorific values are not shown by a grading of this nature and, for purposes of determining energy content, "ranking" by calorific value is essential.

The 1946/47 Coal Commission accepted the following general standards for classifying South African coals according to calorific value:-

High Grade	-	12.80 lbs/lb. and over
Medium Grade	-	over 12.00 and under 12.80 lbs/lb.
Low Grade	-	over 9.00 and under 12.00 lbs/lb.

/ Ref.21, Page 3
b Ref.22, Pp 317 ff.
x Ref.21, Page 2
xx In private correspondence, reference FRI.26 of 29.1.57.
// Ref. 9, Pages 40 and 44 (To convert lbs/lb units to B.T.U. multiply by 970).

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TABLE 2 - TYPICAL ANALYSES OF SOME SOUTH AFRICAN COALS

Coalfield	Water Content %	Ash Content %	Vol. Mat. %	Calorific Value lb/lb	Calorific Value B.T.U./lb.	Ash Fusion Tem.° C.
1. Vereeniging, N. Free State	6.4	19.0	26.5	10.3	10,000	+1400
2. South Rand	5.7	20.0	26.0	10.2	9,900	1400
3. Ermelo - Breyten	2.5	14.5	31.0	12.1	11,750	1350
WITBANK:						
4. Gas-Coking coals	2.3	11.0	32.0	-	-	-
5. High Vol. (No. 2 Seam)	2.3	13.0	27.5	12.6	12,200	1370
6. Low Grade (No. 4 Seam)	3.3	18.0	26.5	11.3	10,950	1340
NATAL:						
7. High Vol. Bituminous	1.3	14.5	30.0	13.0	12,600	1320
8. Medium Vol. Bituminous	1.1	13.5	21.5	13.5	13,100	1330
9. Low Vol. Bituminous	1.3	18.0	14.5	12.6	11,650	1400
10. Anthracitic Coal	1.5	9.5	9.5	14.0	13,600	+1400

(Ref. 21. Table 3)

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Based on the above classification the weighted average calorific value of coal sold from the major Union coalfields during March 1947 can be summarised as follows:-

ß

Natal coalfields	13.29	lbs/lb.
Witbank - Middelburg	12.53	"
Ermelo - Breyten	12.09	"
Vereeniging area	9.85	"
Springs - Brakpan	9.39	"

x A more detailed analysis of coal sold during March 1947 showed the following figures:-

CALORIFIC RANGE LBS/LB.	PERCENTAGE OF TOTAL PRODUCTION	
1. High Grade Coal		
(a) Natal		
13.50 and over	16.0	
13.00 and under 13.50	77.2	
12.80 and under 13.00	6.8	100%
(b) Transvaal and O.F.S.		
13.00 and under 13.50	4.1	
12.80 and under 13.00	36.3	40.4%
2. Medium Grade Coal		
(a) Transvaal and O.F.S.		
12.50 and under 12.80	6.0	
12.00 and under 12.50	19.9	25.9%
3. Low Grade Coal		
(a) Transvaal and O.F.S.		
11.50 and under 12.00	6.2	
11.00 and under 11.50	-	
10.50 and under 11.00	-	
10.00 and under 10.50	6.7	
Under 10.00	20.8	33.7%
		100%

From the above, it is interesting to note that whilst the whole of the Natal output consisted of high grade coal, only 40.4% of the Transvaal output could be so classified. Furthermore, roughly one third of the Transvaal and O.F.S. output was low grade coal, and the overall proportion of low grade coal below 10.50 lbs/lb calorific value was 27.5 per cent. In succeeding chapters it is hoped to examine output figures in greater detail and to determine the consumption of coal energy by various sectors of the economy. To do this, it will be necessary to convert tons of coal consumed into units of energy, based on the calorific value of the fuel. For this purpose the schedule shown in Table 3 has been compiled from the records of the 1946/47 Coal Commission as giving typical calorific values for South African coals. In compiling this

ß Ibid, Page 81
x Ibid, Para, 309

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TABLE 3 - WEIGHTED AVERAGE CALORIFIC VALUES OF SOUTH AFRICAN COALS ※

CLASS	NATAL COALFIELDS	WITBANK-MIDDELBURG	ERMELO-BREYTON	VEREENIGING AREA	SPRINGS-BRAKPAN
Round Coal	13.22	12.75	12.19	10.70	8.85
Cobble Coal	13.24	12.56	12.10	10.19	-
Nuts	13.42	12.28	12.06	10.31	9.52
Peas	13.28	12.22	11.92	9.55	-
Mixed Smalls	13.04	11.98	12.03	9.51	-
Duff	12.88	11.90	11.70	8.75	8.42
Crushed Coal	-	12.15	-	9.73	9.60
Gas Coal	13.60	13.32	-	-	-
Coking Coal	13.60	12.25	-	-	-
Weighted Average	13.29	12.53	12.09	9.85	9.39

(Ref.9. Pages 78 - 81)

(※ in lbs/lb. To convert to B.T.U. multiply by 970)

N.B. Coal mining operations in the Springs - Brakpan area have now ceased (1956).

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schedule the following facts were taken into account:-

a) The Commission based its findings on a sample of between 80% and 100% of the producing collieries in each area.

b) The sample covered 98.6% of total production for the month of March 1947, and therefore may be said to present a fairly representative picture of the quality position in the Industry as a whole.

c) Since 1947 the operation of the various coalfields has continued along much the same pattern. New collieries have been opened and a small number of older mines have ceased operating, but in general the same weighted average calorific values that were determined in 1947 can be said to be broadly applicable today.

It is proposed to use the figures given in Table 3 as a guide in calculations concerning the energy value of South African coals. The Classes of coal mentioned in this Table are based on screen sizes in common use, and whilst these vary to some extent, the following measurements are applicable to the greater part of commercial coal production in South Africa:

	Size of Screens	
A. Transvaal	Top	Bottom
Cobble	4" (round)	1½" (round)
Round	-	1¼" (round)
Nut	1¼" (round)	¾" (square)
Pea	¾" (square)	¼" (square)
Duff	¼" (square)	0
B. Natal		
Cobble	3½"	1½"
Round	-	1¼"
Nut	1¼"	¾"
Pea	¾"	¼"
Duff	¼"	0

2. OCCURRENCE AND DISTRIBUTION

The main work in this field has been carried out by the Geological Survey Section of the Department of Mines. Most of the

ϕ Quoted by the Fuel Research Institute in private correspondence Ref. FRI dated 29.1.57. See also Ref.23, Paras, 22-25.

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South African coal fields are now well known geologically, and
/ are described in detail in various publications issued by the Department of Mines. A major survey of coal deposits in the Union was undertaken by W.J. Wybergh during the 1920's, and his
ϕ findings are recorded in detail in the three volumes of Memoir No. 19 of the Geological Survey. These findings have been modified from time to time by more recent research undertaken by the Geological Survey and the Fuel Research Institutes, - particularly in regard to estimates of the coal reserves available in each field. The data shown in Table 4 is the latest available information of this nature, based on the estimates of W.J. Wybergh and suitably amended in the light of more up-to-date knowledge of the coal deposits.

(A) TRANSVAAL AND ORANGE FREE STATE

x The principal coal producing areas of the Transvaal and Orange Free State are shown in Figure 2, and the following summary is self-explanatory if read in conjunction with Figure 2 and Table 4 :-

i) Springs - Brakpan - Heidelberg. This area of scattered coal deposits yields steam coal with a calorific value of from 9 to 11.25 lbs/lb. None of it is coking coal and most of the small production is used by local households and thermal power stations. This field is little worked at present owing to the low average calorific value of the coal it contains (only 9.13 lbs/lb) and the availability of better quality coals at other fields.

ii) Witbank - Middelburg - Belfast. This region contains by far the most important coal producing areas in the Transvaal. W.J. Wybergh in his geological survey divided the district into the following fields:-

a) Witbank - covering most of the South Witbank magisterial district and yielding coal with a general average of about 12.5 lbs/lb. calorific value. Production from this coal field is used for export, bunkering, industrial and household purposes, depending on quality.

b) Eastern Witbank - Middelburg - Belfast - The coal in the Eastern Witbank area is similar in quality to the main Witbank field and it is becoming more or less an extension of the main mining area. The Middelburg - Belfast field appears to be a further extension of the same field in an eastwards direction, but the seams are thinner and fewer in number. The region has not yet been fully prospected and only one or two very small mines are operating in the Belfast area, for local consumption.

c) Bethal - Large quantities of coal are known to exist in the Bethal area to the south of the present Witbank field. Probable reserves are

/ For useful geological summary see Ref.10, Pp.214-218
ϕ Ref.6, Volumes 1, 2 & 3.
x Ref.5, Pp's 953-956 Ref.7, Pp's 451-452
Ref.8, Pp's 112-115 Ref.9, Pp's 78-81 and Ch.2 & 3

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TABLE 4

UNION OF SOUTH AFRICA - COAL RESERVES

(In millions of tons of 2,000 lbs)

COALFIELD	ACTUAL	PROBABLE	TOTAL
Transvaal			
Springs - Brakpan - Heidelberg	3,200	-	3,200
Witbank	4,100	3,500	7,600
E. Witbank - Middelburg - Belfast	1,000	-	1,000
Bethal	-	7,000	7,000
Carolina - Breyten - Ermelo	6,200	11,000	17,200
Vereeniging (Tvl. Portion)	184	-	184
Waterberg	17,500	-	17,500
Soutpansberg	-	5,000	5,000
Springbok Flats	-	10,000	10,000
Transvaal Total	37,184	36,500	73,684
Orange Free State			
Vereeniging	2,194	-	2,194
Odendaalsrus	-	1,025	1,025
Vierfontein	181	-	181
Orange Free State Total	2,375	1,025	3,400
Natal			
Klip River	440	1,710	2,150
Vryheid	170	-	170
Utrecht	478	-	478
Natal Total	1,088	1,710	2,798
Union of South Africa Total	40,647	39,235	79,882

N.B. The basis of the estimate in the foregoing table is as follows:-

1. No seam is included which has a thickness of less than 3 feet of clean coal, except to a very limited extent in Natal. There are, however, many such seams in most of the coal-fields, which in the aggregate contain large amounts of coal.

2. "Actual" reserves should be recognised as coal which has been sufficiently prospected to warrant immediate mining where the quality and economic conditions permit.

3. "Probable" reserves, refer to coal, the existence of which is fairly certain, but on which detailed information is lacking.

4. In addition to these reserves there are also vast quantities of low grade coal of less than 10 lbs. per lb. calorific value, which have been omitted from the estimate.

Source References:-
(a) No. 5, Pages 955-6
(b) No. 24, Page 598
(c) Private correspondence with Geological Survey G.S.O. 3/34 dated 6th February, 1957.

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FIG. 2.

MAJOR COAL PRODUCING AREAS OF THE TRANSVAAL AND ORANGE FREE STATE SHOWING THE MAIN COLLIERIES

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ϕ estimated at 7,000 million tons having a general average calorific value of 10.5 to 11.0 lbs/lb.

iii) Carolina - Breyten - Ermelo - This field has been well prospected and latest estimates show the total insitu reserves as some 17 thousand million tons. Present production is mainly of medium grade coal used for railway and domestic purposes.

iv) Springfield - Vereeniging - Coalbrook - There are extensive but comparatively unexplored low grade coal reserves extending over a wide area in the North and North-West of the Orange Free State, and across the border into the Transvaal. The quality of the coal varies considerably, with an average calorific value of 9.0 to 11.0 lbs/lb. In the Vereeniging area alone, the extractable reserves are considered to be at least 2,000 million tons, whilst at Sasolburg to the south, the Government oil from coal project has been sited on proved reserves of over 200 million tons.

x v) Other Transvaal Areas - Coal reserves are also known to exist in the following areas of the Transvaal:-

a) Piet Retief - Wakkerstroom - Coal of variable quality, some of which is high grade, exists in seams and outcrops over great distances. As yet this field is undeveloped.

b) Warmbaths - Waterberg areas - Coal is known to exist both to the south-east of the Waterberg Mountains in the vicinity of Warmbaths, and to the north-west in the vicinity of the Mogol and Palala rivers.

c) Messina - Louis Trichardt - North of the Soutpansberg Mountains is another coal bearing area which is undeveloped and little surveyed. Available evidence tends to show that the coal deposits are of medium to low calorific value.

(B) NATAL.

The known coal reserves of Natal are all classified as
ж "high grade", that is to say possessing a calorific value of 12.80 lbs/lb or more. The geographic situation of the Natal coalfields is shown in Figure 3 and this map, together with Table 4, amplifies the following summary.

vi) Klip River - This well prospected and developed coalfield covers the magisterial districts of Dundee, Klip River and South Newcastle. Coal of variable high quality is mined, but the general calorific

ϕ Ref.5, Pages 953 and 955
ϕ Ref.9, Page 46, Paragraphs 177-182
x Ref.5, Pp 953/4
ж Ref.9, P.43

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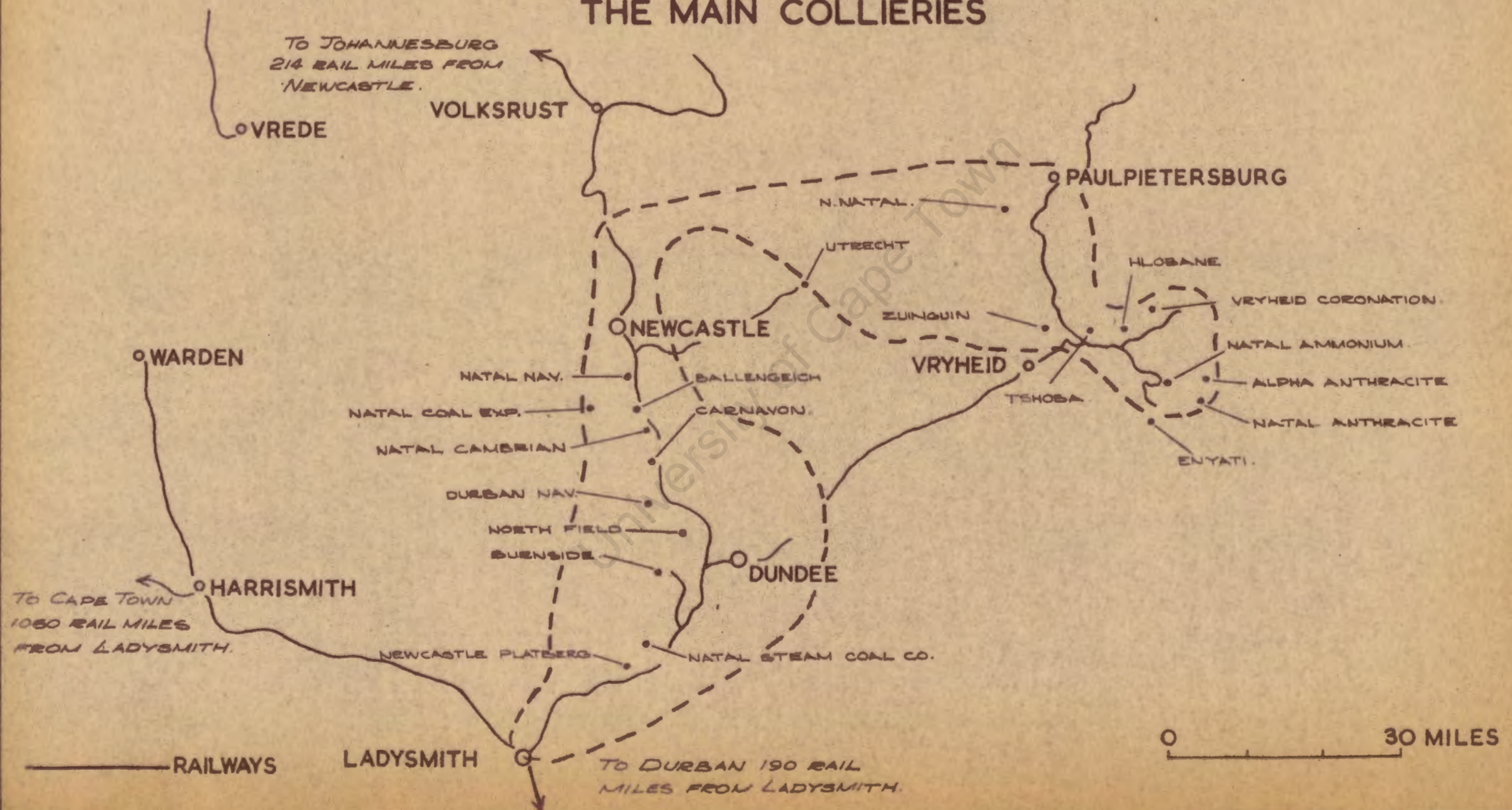
FIG. 3.

THE MAJOR COAL PRODUCING AREAS OF NATAL SHOWING THE MAIN COLLIERIES



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value of steam coal produced is from 12.8 to
ϕ 13.8 lbs/lb. Much of the coal is strongly coking and such deposits are specially valued because South African coals are generally of the non-coking variety. In 1946 it was es-
x timated that the Klip River coalfield contained about 110 million tons proved reserves of straight coking coal. This together with some 50 million tons in the nearby Vryheid coalfield constitutes virtually all the straight coking coal known to exist in South Africa. (Fortunately about 170 million tons of blend coking coal is available in the Transvaal to help eke out this valuable asset).

vii) Vryheid - The Vryheid coalfield lies to the North of the Klip River field and the coals are similar in quality. Extensive mining has re-
ж duced available reserves to some 170 million tons, a large part of which can be classified as anthracite and semi-anthracite. The Klip River field also contains anthracite coal but, in the case of both Vryheid and Klip River, relatively little commercial exploitation of anthracite has hitherto taken place owing to the limited local demand for this type of fuel. Natal anthracite coals for export contain less than 10% Volatile Matter and have a calorific
ϟ value of about 13.6 lbs/lb, (13,190 B.T.U.). These figures compare reasonably well with the ordinary commercial anthracites of Europe and America, but the highest quality overseas anthracites generally possess a Volatile Matter content not exceeding five per cent (See Table 1, Page 4). On this basis the Natal product would probably belong to the semi-anthracitic class in world markets.

viii) Utrecht - The 1946/47 Coal Commission recommended that a long-term programme of exploration should be put in hand in the Newcastle - Utrecht areas with a view to adding to the known reserves of coking coal. This programme is still in hand but, at present, only the area in the neighbourhood of established collieries can be considered as well prospected.

3. CORPORATE ORGANISATION - THE CHAMBER OF MINES

There are some 40 listed coal mines in the Transvaal and another 5 in the Orange Free State. However 99% of the total production comes from about 35 major collieries, the others being merely "holes in the ground" or very small private operators.
// Table 5 lists the more important of the producing mines and it will be noticed that most of them are organised into Groups, the Groups in turn being members of the Transvaal Chamber of Mines.

ϕ Ref. 5, P.954
x Ref. 9, Pp.29-30
ж See Table 4, Page 12
ϟ See Ref. 8, Chs. 6 & 7; Ref. 7, Ch. 6; Ref.30, Page 8
// These groups also control some of the Natal mines.

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TABLE 5

LIST OF MAJOR COLLIERIES IN TRANSVAAL AND ORANGE FREE STATE

1. Anglo American Group
   - *Amalgamated Collieries of South Africa Ltd.
   - *Cornelia Colliery
   - *Schoongezicht Colliery
   - *Springfield Colliery Ltd.
   - *Coronation Collieries Ltd.
   - *Springbok Colliery Ltd.
   - *S.A. Coal Estates (Witbank) Ltd.
   - Blesbok Colliery Ltd.
   - New Largo Colliery Ltd.
   - *Vierfontein Colliery (Pty) Ltd.

2. Rand Mines - Central Mining Group
   - *Witbank Colliery Ltd.
   - *Transvaal Consolidated Land & Exploration Co. Ltd.
   - *Van Dyks Drift Colliery

3. Henderson's Transvaal Estates Group
   - *Tweefontein United Collieries Ltd.

4. Federale Mynboumaatskappy Group
   - *Klippoortjie Colliery Ltd.
   - *Koornfontein Colliery Ltd.

5. Anglo Transvaal Collieries Group
   - *Albion Collieries Ltd.
   - *Consolidated Marsfield Collieries Ltd.
   - *Union Collieries Ltd.

6. Clydesdale Collieries Ltd.
   - *Coalbrook North
   - *New Clydesdale

7. Apex Mines Ltd. (Anglo-French Group)
   - *Greenside Colliery

8. Johannesburg Consolidated Investment Group
   - *Consolidated Collieries Ltd.
   - *Phoenix Colliery Ltd.

9. Transvaal & Delagoa Bay Investment Group
   - *Douglas Colliery Ltd.

10. Tavistock and Witspan Collieries Ltd.

11. Transvaal Navigation Collieries & Estate Co. Ltd. (Anglo-French)

12. *Alpha Consolidated Witbank Collieries Ltd.

13. *Bellvue Colliery Co. (Pty) Ltd.

14. *Kendal Colliery Co. (Pty) Ltd.

15. S.A.S.O.L. (Sigma Coal Mine)

16. South Witbank Coal Mines Ltd.

17. Witbank Consolidated Coal Mines Ltd.

Ref. 19. Page 58
Ref. 3. Page 2
Ref. 25. P.115 - 150

(* Indicates members of Transvaal Coal Owners Association)

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The ordinary membership of the Transvaal and Orange Free State Chamber of Mines (to quote its full title) consists of
ø sixty-five gold mining companies, including 18 Uranium producers, 24 coal mining companies and 13 financial corporations. Each of these companies has its own board of directors, each has its own body of shareholders and each company functions as an autonomous business undertaking. The need for certain services however is common to them all - services that can conveniently and economically be provided on a co-operative basis by a central organisation. To this end the companies are organised into Groups for the provision of various services required by each of the companies within the Group. In addition, the companies and Groups have combined to sponsor and direct the Chamber of Mines to look after their common interests.

x The Group System which operates within the framework of the Chamber of Mines allows groups of gold and/or coal mining companies to associate together under the central administration of a mining/finance corporation. By being a member of a Group, individual mining companies are able to share in the economies of joint facilities in the managerial, secretarial, accounting, buying and technical fields. The Groups in turn share in the economy of the Industrywide operations of the Chamber of Mines.

The evolution of the Group System and the growth of the Chamber of Mines have been complementary. By mutual co-operation through the Chamber, the Groups have extended their system of collective organisation to the benefit of the whole industry. The mining/finance organisation of a Group enables it to provide the services of consultant engineers, consultant metallurgists and other specialist personnel, for the mining companies it represents. The Group System however not only acts as a pool of technical resources, but also as a pool of financial resources. The ability of Groups to attract capital and to organise its investment have been fundamental to the programmes of expansion and development which have been carried out in the past, and which will be needed in the future if the Mining Industry is to keep pace with the country's needs.

The Chamber is the mouthpiece of the mining industry and is responsible for formulating common policies on matters of general interest. These include matters incidental to employment, wages and industrial relationships in general. The Chamber operates recruiting organisations for the large number of native labourers required by the mines and lays down standards for accommodation, feeding and welfare. It operates training schools for White and Black labour and is generally responsible for ensuring that adequate labour, both skilled and unskilled, is available at all times. The operation of a central recruiting organisation is one of the most important tools of this policy and the effect is to virtually eliminate competition for labour on a wage basis between member mines. The prescribed rates of wages are paid by all member companies and, as a result, labour costs of production have been standardized.

The Chamber of Mines provides secretarial, legal, research and other specialist services. It compiles and circulates important statistics. It negotiates industry-wide agreements on labour matters and is the negotiating body representing employers in all discussions with Trade Unions and Government Departments.

ø See Ref. 26.
x Ref. 26, Pp. 2/3.

The Chamber is active in general welfare services, including measures to prevent and control occupational diseases such as miners phthisis. It maintains excellent hospitals and convalescent homes. Sickness benefits and pension schemes are administered through the Chamber, which also operates a Holiday Qualification Voucher System whereby mine workers are able to carry forward their leave privileges from one employer in the Industry to another.

Other matters organised and controlled by the Chamber concern the bulk purchase of supplies and equipment required for mining operations. This process has been developed even as far as the purchase and maintenance of timber lands to provide for present and future requirements of mine timber. Standard forms of contract are negotiated through the Chamber with suppliers of various items for which there is widespread demand by the Industry as a whole. Among the many items of this nature are machines of all types, explosives, steel, timber, coal, meat and other foodstuffs. Chamber officials also collaborate with the Transvaal Coal Owners' Association to ensure adequate supplies of coal for gold mining operations and consult with the Railway Administration regarding truck requirements for transportation of the coal, whenever necessary.

4. PRODUCTION IN THE TRANSVAAL AND ORANGE FREE STATE

The Annual Report of the Department of Mines for the year 1954 shows that 1,968 Europeans and 26,196 Non-Europeans were employed in coal production in the Transvaal. Of these the average numbers employed underground were 662 Europeans and 16,575 Non-Europeans, these figures being respectively 33% and 63% of the total number employed.

Corresponding figures for the Orange Free State were 1,127 Europeans and 7,521 Non-Europeans with an underground labour force of 161 and 5,032 respectively, being 14% and 61% of the total employed in the Industry in that Province.

The average monthly tonnage of coal mined per person at work underground is given as:-

	1954	1953
Transvaal	120 tons p.m.	118 tons p.m.
Orange Free State	85 " "	74 " "

This should be compared with the United States, where the average output under highly mechanised mining conditions is about 150 tons per man-month (the highest in the world) and with the United Kingdom where the figure is about 50 tons per man-month. It should however be remembered that the output of coal per man depends to a considerable extent on natural conditions, as well as on the facilities provided underground. The greater production per man-month of Transvaal mines in comparison with those of the Orange Free State is due in large measure to the thickness and regularity of the Transvaal coal seams, enabling systematic mining operations to be carried on more intensively than in the narrow, faulted seams of the Orange Free State coalfields.

Ref.28, Section I (See also earlier copies for similar information covering previous years).

Ref.17, P.873

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TABLE 6 - TRANSVAAL COAL PRODUCTION AND DISTRIBUTION

(Tons of 2,000 lbs.)

	MARKETABLE PRODUCTION	TOTAL SALES	INLAND CONSUMPTION	EXPORT TRADE	SHIPS BUNKERS
1948	18,396,448	17,873,158	-	-	-
1949	19,461,348	19,030,033	-	-	-
1950	20,330,026	20,040,388	18,259,433	1,599,371	181,584
1951	20,241,587	19,926,926	18,976,561	829,829	120,536
1952	21,492,747	20,869,087	20,598,056	203,148	67,883
1953	21,666,396	21,093,525	20,520,931	531,189	41,405
1954	21,821,653	20,618,675	20,076,192	517,870	24,613
1955	22,948,442	21,672,534	21,390,082	260,534	21,918
1956 *	23,223,000	23,051,000	22,750,000	270,000	31,000
Average Annual Increase 1948 - 1956	2.95%	3.20%	-	-	-
Average Annual Increase 1950 - 1956	2.24%	2.32%	3.64%	-	-

Ref. No. 27

* (Provisional Estimates obtained from Department of Mines)

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Coal production figures for the Transvaal and Orange
x Free State have been summarised for the years 1948 - 1956 in Tables 6 and 7. Prior to 1950 the statistics were recorded in different form and, for this reason, it is not possible to analyse further the Inland Consumption and Export figures on a Provincial basis. However in Chapter 2 when considering patterns of coal consumption it should be possible to analyse the internal market on a Union-wide basis.

An analysis of Table 6 shows that over the years 1948 - 1956 the marketable coal production (i.e.:- excluding Dross) of the Transvaal has increased by an average of just under 3% per annum. Total sales in each year correspond fairly closely to the marketable production figures; the differences being accounted for by changes in pit head stocks and own consumption by the mines. There is little doubt however that both production and sales figures could have been greatly improved during the period, had it not been for a serious railway transportation bottleneck which severely hampered the inland distribution of coal and reduced the export trade to a minimum.

ß The Report of the 1951 Commission of Enquiry into Coal Shortages gives a clear picture of this post-war transportation crisis in the South African Railways and states, inter alia:-

a) "Coal shortages have recurred regularly every winter for the past six years. ... ... Coal shortages in the Union are spreading in time and space" (P.40 Item 16).

b) "The existing coal-mining plant has seldom been used to full capacity and during 1951 was working to some 75 to 90 per cent of capacity based on its labour complement". (P.41 Item 19).

c) "The Railway Administration must improvise all possible additional means of transport when transport shortages occur, even if increased costs are involved". (P.41 Item 41).

d) "It is the Commissions conviction that, unless immediate measures are taken to improve the complete transport system of the Union, the country may be threatened with disastrous disruption of fuel supplies ....." (Page 41 Item 42).

Since 1951 the Railways have embarked on a large scale development and modernisation programme costing many millions of pounds. Measures taken to improve the transportation bottleneck include the carriage of coal by sea from Lourenco Marques to Cape ports, and the payment of a temporary subsidy to enable private road transport operators to carry coal at railway tariff rates between Witbank and the Reef. These short term measures have succeeded in easing the critical coal position but, at best, they can only be considered as giving temporary relief.

Long term development plans of the South African Railways, (which should reach completion by 1960) include the doubling of the main line between the Reef and the port of Durban. Railway lines to the major coal fields are also being doubled and electrified in

x Ref.27, Statement No. 3
ß Ref.23,

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order to give greater carrying capacity. It is probable that coal for the Cape will continue to be shipped from Lourenco Marques, in order to avoid tying-up hundreds of trucks in the long rail haul to Cape Town. Truck shortages lie at the root of the transportation problem, but improved rail facilities will allow a quicker turn around and thus improve capacity. However the protected monopoly position of the S.A.R., coupled with the low railrate on bulk coal, makes it virtually impossible for road transport operators to carry coal by road on an economic competitive basis. In the foreseeable future therefore, it will be necessary to take rail transportation facilities into account when attempting to determine the trend of coal production figures.

A further point shown up by Table 6 is the extent to which the export trade of the Transvaal mines has been seriously hampered by the railway's inability to carry the freight. For the past five years there has been virtually no coal exported, other than to Lourenco Marques for use by the Mocambique Railways, although there is no doubt that a considerable export potential exists. Since the purpose of this study is to determine the internal energy requirements of South Africa, it is not proposed to examine the export position in great detail. It will however be necessary to make due allowances for export and bunker sales when analysing the overall consumption pattern for energy produced from coal. (See Chapter 2).

There is little that can be said about the statistics relating to bunker coal supplied from the Transvaal. It is of course immediately apparent that the downward trend reflects the dwindling number of coal burning vessels still in service, and this trend can be expected to continue. It is proposed therefore to treat bunkers as a non-significant item insofar as estimates of future consumption are concerned.

The Gross Sales of the Orange Free State coal fields are all for Inland Consumption. Orange Free State coal is of low grade and is mostly consumed in steam raising at, or near to, the pit head. The considerable increase in production from 1954 onwards is accounted for by the erection of thermal power stations to serve the Orange Free State gold fields, and by the increasing coal consumption of the mines themselves. The figures given in Table 7 include production from the Sigma Mine at Sasolburg, where the output is wholly used in the production of petroleum products under the Government's oil-from-coal project. The Sasol consumption figures for the years 1955 and 1956 are not however included in the sales statistics and this accounts for the gap between production and sales figures for these years as shown in Table 7. It is interesting to note that the present rated output capacity of Sigma Mine is 2,200,000 tons per annum and that production costs are less than 6/- per ton, compared to the average pit's mouth cost of about 8/- per ton for other Orange Free State mines. (The activities of SASOL are reviewed in Chapter 2 insofar as the conversion of coal energy into petroleum energy is concerned.)

Private correspondence with the Government Mining Engineer GME.151/5/7 Stats. dated 20.12.57. in which he states "An adjustment to the statistics is to be made for 1957 whereby the coal converted into petrol will be included with the tonnages sold, to correct the impression of stocks on hand".

♭ Private correspondence with SASOL, JJSvdS/RVR dated 25.2.57.

♩ Ref. 24, P.604.

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TABLE 7

ORANGE FREE STATE COAL PRODUCTION AND DISTRIBUTION

(Tons of 2,000 lbs.)

	MARKETABLE PRODUCTION	TOTAL* SALES
1948	2,876,938	2,378,195
1949	3,220,617	3,198,001
1950	3,318,118	3,293,691
1951	3,396,710	3,370,205
1952	3,707,084	3,678,185
1953	3,950,281	3,936,038
1954	4,385,886	4,308,287
1955	6,556,575	5,704,515
1956	7,876,665	6,492,970
AVERAGE ANNUAL INCREASE 1948 - 1956	13.42%	13.38%
AVERAGE ANNUAL INCREASE 1950 - 1956	15.50%	11.98%

Ref. No. 27

*All O.F.S. coal is sold on the inland market.

N.B. Production figures for 1955/56 include the output of the Sigma Mine (SASOL). The sales figures for these two years however do not include the tonnages of coal converted into petrol. (See footnote on Page 22.)

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The productive capacity of the five major coal mines serving the Orange Free State area is considered adequate for the next five to ten years and, fortunately, transportation factors do not enter into the picture. The fact that coal production in the Orange Free State has expanded over 100% during the past five years lends support to the view that provision of adequate productive capacity presents no real problem. The tonnage of coal mined annually in the Orange Free State now exceeds that of Natal, but the latter is much higher in calorific value.

To round off the picture presented by Tables 6 and 7, it should be mentioned that the difference between marketable production and total sales figures (excluding Sasol, as mentioned above) is accounted for by stocks on hand and "own consumption" by the mines. Later in this Chapter the provincial figures will all be merged to provide a pattern of supply and demand for the whole Union. It should then be possible to determine long term trends of coal production and consumption, which can be related to the potential output of each major coal producing area.

5. COOPERATIVE SELLING IN THE TRANSVAAL AND ORANGE FREE STATE

The Transvaal Coal Owners Association is a body formed to deal with the marketing of coal produced by member collieries. The Association was originally formed in 1907 at a time when most of the collieries in the Transvaal were engaged in cut-throat competition for internal markets, resulting in very low individual profits and in some instances working losses. The prime motive behind the formation of this co-operative marketing organisation was undoubtedly an attempt to obtain higher profits by monopoly control, but it can be argued in defence of this policy that mining requires much capital for development purposes and, that without profits and dividends to shareholders, further investment capital would not be forthcoming. One of the witnesses to the 1921 Coal Commission, in discussing the reasons for and the effect of the formation of the Transvaal Coal Owners Association stated that it was:-

> "To prevent the cut-throat policy which existed at that time and which would have undoubtedly led to the closing of several collieries, which was against the public interest. And further it was not only from the monetary point of view but from the point of view of the better management of the trade. By coming into the Association you can market in a more advantageous manner. Instead of each colliery going in for the shipping trade and the internal trade, the Association is able to allot the export trade orders to certain collieries who have the necessary quality;

- Private correspondence with Department of Mines, Reference G.M.E.151/13/6 dated 16.4.57.
- This can be abbreviated to T.C.O.A.
- Ref.2, Page 20, Paras. 90-91.
- One comment that comes to mind immediately is that in order to avoid closing several collieries it would probably be necessary to base prices on the costs of the least efficient producers. This could bring about a position of monopoly which would probably be even less in the public interest if efficient producers were not allowed to sell at lower prices.

> the railway trade to other collieries who have the quality required for the railway; and the internal trade, that is for industries, to other collieries who do not enjoy perhaps the same high value of coal. In that way the Association has an enormous advantage in marketing its coal".

Subsequently, this witness stated that another effect of the formation of the Association was that his colliery's (Witbank) trade was steadier, "because before the collieries were in association the outputs used to vary according to the collieries' particular orders, and they must vary, whereas the Association pools all orders and is able to divide the orders equitably among the collieries, and that means they are able to get a steady output." This led, the witness added, "to collieries getting the greatest efficiency out of the labour employed, which was one of the most important benefits of the Association."

6 The Transvaal Coal Owners Association has no control over mining operations. It purchases all the coal produced by member collieries at fixed pit-head prices and arranges disposal to the nearest consumer, in order to keep transport charges to a minimum. After all costs of selling, together with a small commission to cover the administrative costs of the Association, have been deducted from the sales figure, there remains a net surplus (or deficit) on the transaction. Such surplus (or deficit) is distributed between the various collieries on the basis of tonnage sold. The Association represents all but about five of the major collieries in the Transvaal and Orange Free State. (See Table 5, Page 17). The total output of certain collieries is purchased by Escom under long term contract and is thus not available to the commercial market but, excluding this output, about 85% of all other coal produced in the Transvaal is handled by the Association for an agency charge of less than one penny per ton. The few independent producers market their coal direct to coal consumers or through other Agents for export. The T.C.O.A. however does not generally enter the export field until all local requirements have been met, either under contract or by sale at Government controlled maximum prices.

The export market for coal is subject to Government control and since August 1956 there has been a virtual embargo on shipments, other than to Portuguese East Africa. The reasons for this are two-fold, firstly the Government's desire to ensure sufficient supplies for the rapidly expanding internal market, but secondly, and more seriously, the physical inability of the South African Railways to handle the export coal traffic. This problem is being energetically tackled by the S.A.R. in the doubling of mainline tracks to Durban and in the provision of extra trucks, but it is not expected that exports of coal will be resumed on any large scale until 1960 at the earliest. The Transvaal collieries will therefore lose the profits that might otherwise have been obtained by expanding their production for disposal at ruling world prices on the international market.

Export coal is not subject to price control, but it <u>is</u> subject to a form of quality control. The Transvaal Coal Owners Association initiated a method of selling coal on a thermal basis

6 Ref.1, Page 591.

some 50 years ago, based on a guaranteed minimum calorific value
x of 12.5 lbs/lb (12,125 B.T.U.). However since May 1949 the grades of coal for export and bunkering have been fixed by the Fuel Research Board on the following basis:-

First Grade:-	Min. Cal. Value 12.8 lbs/lb.
Second Grade:-	Min. Cal. Value 12.3 lbs/lb.
Under Second Grade:-	Below 12.3 lbs/lb.

The T.C.O.A. previously carried out its own testing and grading, but this function is now performed by the Fuel Research Institute in centralised laboratories. To carry out this testing programme thousands of samples of coal are analysed annually,
ß and the following average calorific values have been compiled for the three main coal producing areas:-

	Witbank District	Breyten District	O.F.S. Vereeniging & Heidelberg Districts
1) Lump Coal	12.8	12.1	10.4
2) Cobble Coal	12.8	12.1	10.4
3) Nut Coal	12.6	11.8	10.3
4) Pea Coal	12.5	11.8	9.6

N.B. (a) Standard coal screens are used for the above sizes, based on the following dimensions:-

Lump Coal	+ 4" round	
Cobble Coal	- 4" round	+ $1\frac{1}{2}$" round
Nut Coal	- $1\frac{1}{2}$" round	+ $\frac{3}{4}$" square
Pea Coal	- $\frac{3}{4}$" square	+ $\frac{1}{4}$" square

(b) The bulk of export and bunker coal from the Transvaal is supplied by selected collieries in the Witbank area. Most of the export coal is routed via Delagoa Bay, but small quantities of bunker coal are railed to Union ports, as necessary.

To illustrate the important role of the Transvaal Coal Owners Association in the marketing of coal, the following com-
/ parative sales figures tell their own story. A further feature of interest is the variation in figures for each consuming source in 1953, as compared with ten years previously.

	1943	1953
1) Supplied by the T.C.O.A.		
To Gold and other mines	2,158,818	2,256,727
" South African Railways	3,189,237	5,291,613
" Mocambique Railways	39,431	25,230
" Cape Province & S.W.A.	392,003	771,795
" L.M. for Export	1,438,051	261,959
" Power Companies & Industries	2,283,361	4,818,865
" Domestic Users	1,268,803	1,532,554
TOTAL	10,769,704	14,958,743

(Continued)

x Ref.5, Page 959
ß Ref.3, Pages 2 and 6. See also Table 3, (Page 9)
/ Ref.4, Pages 25/28

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	1943	1953	
2) Supplied by Non-member Collieries in the area	4,341,284	6,424,461	¤
TOTAL	15,113,988	21,383,204	
3) Percentage supplied by T.C.O.A.	71.5	70.1	

N.B. ¤ This figure includes the output of several mines producing coal for Escom only, under special long-term contracts.

6. PRODUCTION AND DISTRIBUTION IN NATAL

The Annual Report of the Department of Mines for the year 1954 shows that 875 Europeans, 433 Asiatics and 18,354 Africans were employed in coal production in Natal. Of these, the average numbers employed underground were 288 Europeans, 117 Asiatics and 10,188 Africans representing respectively 33%, 27% and 55% of the totals employed.

Table 8 summarises Natal coal production and distribution figures for the years 1948 - 1956. It will be noticed that the annual average rate of production increase over the last six years is only about half that of the Transvaal. (Table 6, Page 20). Inland Consumption figures, on the other hand, show an average rate of increase of 5.28%, which is nearly half as much again as for the Transvaal collieries. The Table shows how the rapid growth in local demand for Natal coals has been met, in part, by transfer of supplies from the dwindling export and bunker trade to internal consumption. The position still remains however that the gap between the annual rate of increase in production and consumption in Natal is very much greater than in the Transvaal. There are several important factors aggravating this position:-

a) The output of bituminous coking coal, which in 1956 amounted to over 1,000,000 tons, is wholly under long term contract to Iscor. Any increase in production of this type of coal would still be reserved for Iscor and would not add to the total available for the general internal market.

b) Much of Natal coal is anthracitic and, whilst the energy content is satisfactory, the percentage of volatiles falls short of that required in a good steam coal. Natal mining must therefore be selective in order to concentrate on bituminous coal for the domestic market. The production of anthracitic coals must of necessity be kept at a minimum until exports are once again possible, but in this connection it is interesting to read in the 1954 Report of the Government Mining Engineer that, "There is a ready export market for anthracite, including peas and duff, and a growing domestic market for cobbles and nuts".

ß Table 8.
¤ Ref.28, Page 66.

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TABLE 8 - NATAL COAL PRODUCTION AND DISTRIBUTION

(Tons of 2,000 lbs.)

	MARKETABLE PRODUCTION	TOTAL SALES	INLAND CONSUMPTION	EXPORT TRADE	SHIPS BUNKERS	COKING COAL
1948	5,208,739	5,163,063	-	-	-	-
1949	5,422,620	5,199,449	-	-	-	-
1950	5,533,657	5,330,499	3,993,091	1,091,604	245,804	846,377
1951	5,719,004	5,470,601	4,521,638	779,636	169,327	850,875
1952	5,735,729	5,490,244	4,782,365	583,095	124,784	869,323
1953	5,754,344	5,540,092	4,801,044	653,618	85,430	837,553
1954	5,606,394	5,417,156	4,948,567	411,739	56,592	869,427
1955	5,890,949	5,683,601	5,343,145	312,550	27,903	982,750
1956	5,940,642	5,800,000*	5,436,716	274,699	26,018	1,046,555
Average Annual Increase 1948 - 1956	1.66%	1.46%	-	-	-	-
Average Annual Increase 1950 - 1956	1.19%	1.42%	5.28%	-	-	3.60%

Ref. No. 27

* (Estimated)

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c) Natal coal mining is expensive in comparison with the Transvaal. A comparison of the average pit's mouth price per ton of coal shows that in 1953 Natal coals sold for just under 14/- per ton, whilst Transvaal coals were offered at a little over 9/4d. per ton. The reason for the higher Natal price is in part due to the higher cost of production, resulting from thin faulted seams which do not lend themselves to mechanisation, and from the fact that the mines are old and the working faces are situated at some distance from the shafts, entailing long walks to work and reduced output time. It has also been suggested that the native labour in Natal is not as physically robust as that available to the Transvaal mines.

For these reasons it is generally felt by the Natal Coal Owners Society that marketable production of bituminous coal in Natal is unlikely greatly to exceed 6,000,000 tons per annum in the foreseeable future. The existing Natal collieries have mining rights over most of the known economically exploitable reserves in the Province, and it is probable that fresh investment capital is more likely to be attracted to the Transvaal, where production costs are lower and where transportation problems both for internal markets and for export are not so acute as in Natal. This supports the view of Dr. F.W. Quass of the Fuel Research Institute, who in 1950 stated as follows:-

> "It may not be possible for Natal to increase and maintain its production of bituminous coal to over, say, 6 million tons per annum, since the reserves of many of its collieries have well-nigh been exhausted. However the Natal coal industry should seriously investigate, by intensive research, every possible means to use the very large reserves of anthracitic coal available in many instances within their collieries' present workings. The use of anthractie for large power-generating stations and synthetic liquid fuel production is, of course, quite feasible. Should markets be developed for these fuel types, the threatened eclipse of Natal as a coal producing province will be postponed for many years . . . . Should such a development not occur, the Transvaal and O.F.S. provinces will have to share the burden of producing the coal (normally supplied by Natal)".

Table 9 lists the nineteen major collieries in Natal and shows that sixteen of them are members of the Natal Coal Owners Society. Broadly speaking the Society looks after the interests of its members in regard to all matters of joint concern which affect production, conditions of employment, industrial legislation, health and welfare, mining regulations, etc, in much the same manner as the Collieries Committee of the Transvaal Chamber of Mines, (although on a much smaller scale). The functions of the Society are wide and varied, and include the formation of a common policy on matters of mutual interest, particularly in the field of labour relations. The Natal Coal Owners Society also handles the bunker

x Ref.24, Page 604.
ϕ Private correspondence with N.C.O.S. dated 8.4.57. (N.C.O.S. - Natal Coal Owners Society).
ж Ref.31, Page 150.
⊬ Ref. 9, Ch. 5.

TABLE 9

MAJOR COAL PRODUCERS IN NATAL

* Vryheid (Natal) Railway, Coal & Iron Company Ltd.

* Natal Navigation Collieries & Estate Company Ltd.
Northfield Colliery
Burnside Colliery
Kilbarchan Colliery

* Durban Navigation Collieries Ltd.

* Enyati Colliery Ltd.

* Newcastle-Klatberg Colliery Ltd.

* Natal Anthracite Co. (Pty) Ltd.

* Natal Coal Exploration Co. Ltd.

* Natal Cambrian Collieries Ltd.
Cambrian Section
Ballengeich Section

* Vryheid Coronation Ltd.

* Utrecht Collieries Ltd.

* Tshoba Coal Syndicate Ltd.

* Natal Steam Coal Co. Ltd.

* Zuinguin Natal Collieries Ltd.

Alpha Anthracite Co. Ltd.

Carnarvon Anthracite Coal Mines (Pty) Ltd.

Natal Ammonium (1946) Ltd.

(* Members of Natal Coal Owners Society)

Source:- Natal Coal Owners Society - private correspondence dated 8th March, 1957.

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trade of Natal collieries, but a glance at Table 8 will show that this trade is dwindling fast, and today represents barely 0.4% of Natal coal production. Apart from bunkers however, unlike the Transvaal Coal Owners Association, it does not act as a sales agency.

The principal selling organisation for Natal coal (and the second largest such organisation in the Union) is Natal Associated Collieries (Pty.) Limited. This Association is purely a marketing organisation, and it confines its activities to the inland market where it controls about 95% of the trade of Natal Collieries. In this respect it differs from the Transvaal Coal Owners Association which controls both inland and export sales for Transvaal producers.

Natal Associated Collieries (Pty.) Limited, is an Association which came into existence on the 1st January 1931 to promote the orderly marketing of coal produced in Natal. The reasons for the formation of the Association, and its Aims and Objects, are similar to that of the Transvaal Coal Owners Association. Like the Transvaal Association, the Natal Associated Collieries does not engage in the retail distribution of coal, but enters into direct contracts with large and small customers throughout the country. The trade thus obtained is distributed amongst members on an agreed basis, each member colliery undertaking to supply its share of the tonnage required. Administrative costs average a little over one penny per ton at the present time. (1956).

Natal export coal is not marketed by any established Association, but is handled by the export agents of the larger collieries, who are the main producers. The tonnage available for export is a fluctuating one which is subject to the following factors:-

a) Government permission - export of coal will normally only be allowed if internal needs are fully met. The reason for this is to ensure that coal supplies are not diverted from the home market, where price control is applied, to the export market where higher profits can be obtained.

b) Transportation bottlenecks between the mines and the coast. The position in this respect has already been examined in Part 4 of this Chapter, dealing with production in the Transvaal and Orange Free State. It was shown that the S.A.R. is engaged on doubling the main line between the Reef and Durban, which should be completed by 1960. This line also serves the Natal coal fields and, until the doubling is finished, there is little hope of coal exports being resumed.

c) Shortage of suitable labour, and low output per man/month due to generally less favourable mining conditions, (thin, faulted seams, igneous intrusions, etc.) This renders mechanisation difficult and hence short-term increases in output are not easy to achieve.

d) International coal prices and the availability of shipping at economic charter rates. These factors are of paramount importance to South African coal exports because of the long sea haul to overseas customers.

6 In 1954 the Natal average was 53 tons per man/month (Ref.28, Section I). See also Part 4 of this Chapter for Transvaal and Orange Free State figures.

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TABLE 10

UNION OF SOUTH AFRICA - COAL PRODUCTION AND SALES

(In tons of 2,000 lbs)

YEAR	TOTAL MINED	WASTE SORTED	TOTAL SOLD
1911	9,931,327	2,263,854	7,594,944
1916	12,281,796	2,042,952	10,007,502
1921	13,658,922	1,736,733	11,396,905
1926	16,820,524	2,545,573	13,734,463
1931	13,847,355	1,853,147	11,639,248
1936	18,837,730	2,477,539	15,996,376
1941	24,115,769	3,535,630	20,213,308
1946	30,317,890	4,301,083	25,634,427
1951	33,660,295	4,302,994	28,767,732
1956 *	41,119,336	4,079,253	35,280,366
Average Annual Increase 1911 - 1956	3.20%	-	3.47%
1936 - 1956	3.98%	-	4.03%
1946 - 1956	3.09%	-	3.25%

(* Provisional figures. The output of Sigma mine - SASOL - is included in Total Mined, but the Total Sold for 1956 does not include the quantity of coal synthesised in the Sasol plant).

Ref. 28 (Page 77)

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Table 8 shows that exports of coal from Natal have dwindled to negligible proportions in the last few years. This is in part due to the rapidly increasing local demand, particularly for Bituminous coals, but also to the fact that although an export market for both Bituminous and Anthracitic coal is known to exist, it cannot be served because of the Railway's inability to provide transport to the coast.

The future export prospects for Natal coal will be reviewed in Chapter 2, but the general feeling of the Natal Coal Owners Society is that full production of Bituminous coal, both coking and non-coking, will be required for inland consumption. The export of anthracitic coal should however, be economically feasible once transportation problems have been solved.

7. UNION PRODUCTION AND SALES FIGURES

Tables 10, 11 and 12 present analyses of coal production and sales figures for the whole of the Union of South Africa. From these output figures, and from the patterns of consumer demand discussed in the next chapter, it should be possible to draw certain conclusions regarding the probable future market in coal, particularly over the next ten years. Detailed examination of this trend is reserved for Chapter 2, but before leaving the production aspect it may be of interest to compare the figures shown in the above three Tables with the earlier predictions of acknowledged authorities in regard to South African coal production.

x The 1946-47 Coal Commission reported as follows:-

> "A careful examination of all the estimates, predictions and general information received, has led to the conclusion that the inland trade may be expected to increase over the next ten years by an amount lying between a minimum of 9,000,000 tons and a maximum of 12,000,000 tons. This rate of expansion approximates to an average annual increase of 900,000 - 1,200,000 tons, as compared with an average increase of 769,279 tons per annum during the period 1938 to 1946. Assuming a mean figure of 10,500,000 tons per annum increase in ten year's time, the total inland trade of the Union at that stage may be expected to be of the order of approximately 32,000,000 tons".

The Commission based its estimates on the 1946 inland trade figure of 21,327,251 tons (See Table 12) and the predicted increase of 10½ million tons would bring this to approximately 32,000,000 tons - the figure shown for 1955. In actual fact the increase over the ten years 1946 - 1956, was a little over 13 million tons - thus exceeding even the highest estimate of the Commission. In fairness however it must be recorded that whilst the Commission was aware of pending developments in the Orange Free State gold fields and in regard to SASOL, it found accurate forecasting of the probable increase in inland demand during the next ten years to be

ß "... extremely difficult ... due to the wide difference of opinion on the anticipated rate of expansion, particularly in the industrial and domestic markets".

x Ref.9, Para.456
ß Ref.9, Para 455

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TABLE 11

UNION OF SOUTH AFRICA - SALES OUTPUT OF COAL BY PROVINCES

(In millions of short tons)

Year	Transvaal	Natal	O.F.S.	Total
1930	7.6	4.5	1.1	13.1
1931	7.0	3.5	1.1	11.6
1932	6.6	2.8	1.2	10.7
1933	7.0	3.1	1.4	11.5
1934	8.0	3.5	1.6	13.1
1935	9.0	4.0	1.6	14.6
1936	10.1	4.2	1.7	16.0
1937	11.0	4.1	1.6	16.7
1938	11.5	4.5	1.6	17.5
1939	12.5	4.2	1.5	18.2
1940	13.1	4.4	1.5	18.9
1941	13.9	4.7	1.6	20.2
1942	15.3	5.0	1.7	22.1
1943	15.8	4.8	1.7	22.3
1944	17.7	5.7	1.9	25.3
1945	17.9	5.4	2.2	25.5
1946	18.0	5.3	2.3	25.6
1947	17.9	5.2	2.4	25.4
1948	18.4	5.2	2.9	26.5
1949	19.5	5.4	3.2	28.1
1950	20.1	5.3	3.3	28.7
1951	19.9	5.5	3.4	28.8
1952	20.9	5.4	3.7	30.0
1953	21.1	5.5	4.0	30.6
1954	20.6	5.4	4.8	30.8
1955	21.6	5.7	5.7	33.0
1956	23.0	5.8	6.5	35.3
Average Annual Increase				
1930 - 1956	4.35%	0.98%	7.07%	3.88%
1936 - 1956	4.20%	1.63%	6.94%	4.04%
1936 - 1946	5.95%	2.35%	3.07%	4.81%
1946 - 1956	2.48%	0.91%	10.09%	3.26%

Ref. 31. Page 147
Ref. 28. (and earlier volumes)

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As regards the Export and Bunker Trade, the Commission found forecasting even more difficult, and contented itself with a review of the difficulties facing these two markets. [a] Bearing in mind the internal transportation problems of the post-war years, and continuing inability of the Railway Administration to provide truckage for coal exports, it is not surprising that the 1956 export figures as shown on Table 12 are only a fraction of the 1945/46 quantities. By and large the Commission's views in regard to both inland and export trade have proven to be realistic and well founded.

Dr. F.W. Quass of the Fuel Research Institute of South Africa, writing in 1950, [b] estimated the future annual sales output figures for coal production, as follows:-

UNION OF SOUTH AFRICA

Year	Estimated Output	Actual Output
	(In million short tons)	
1935	14.5	14.6
1940	19.0	18.9
1945	25.5	25.5
1950	30.0	28.7
1955	35.5	33.0
1960	41.0	
1965	46.0	
1970	51.5	
1975	57.0	

In the above series, the output figures prior to 1950 were actual totals. The estimate for 1950 however was 1.3 million tons too high (See Table 11) and the figure for 1955 was 2.5 million tons in excess. Dr Quass estimated that the 1955 production, by Provinces, would be as follows:-

Transvaal	26.0	million tons
Natal	6.0	" "
Orange Free State	4.0	" "

Reference to Table 11 however will show that the Transvaal output fell short of this estimate by nearly 4½ million tons, whilst the Orange Free State output exceeded expectations by nearly 1¾ million tons. In the case of the Transvaal, lack of transportation facilities for export (already discussed) probably accounted for most of the shortfall as between estimate and performance. In the case of the Orange Free State, the additional output was required for power stations and for the SASOL oil-from-coal plant - this latter being a contingency which Dr. Quass specifically excluded when making his forecast in 1950.

Table 10 shows that over the ten years 1946 - 1956 the total sales output of coal has increased by 3¼% per annum, compared with an average annual rate of increase of nearly 3½% since statistics were first collected in 1911. Table 11 gives a Provincial breakdown to the 1946 - 1956 output figures, and shows that the greatest percentage rate of increase applies to the Orange Free State. This

[a] Ref.9, Para.440-454
[b] Ref.31, Page 149

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TABLE 12 - UNION OF SOUTH AFRICA - DISTRIBUTION OF COAL SALES

(In tons of 2,000 lbs)

Year	Total	Inland	Export	Bunker
1926	13,734,463	9,865,080	2,163,677	1,705,706
1936	15,996,376	13,496,118	1,102,602	1,397,656
1946	25,634,427	21,327,251	3,387,788	919,388
1947	25,414,809	22,123,901	2,587,927	702,981
1948	25,968,462	23,766,656	1,552,951	648,855
1949	27,427,483	24,859,118	1,923,615	644,750
1950	28,664,578	25,546,215	2,690,975	427,388
1951	28,767,732	26,868,404	1,609,465	289,863
1952	30,037,516	29,058,606	786,243	192,667
1953	30,569,655	29,258,013	1,184,807	126,835
1954	30,844,118	29,833,302	929,609	81,207
1955 *	33,060,650	32,437,742	573,087	49,821
1956 *	35,280,366	34,678,458	544,761	57,147
Average Annual Increase				
1926 - 1956	3.19%	4.28%	-	-
1926 - 1936	1.51%	3.18%	-	-
1936 - 1946	4.83%	4.68%	-	-
1946 - 1956	3.25%	4.98%	-	-

Source Ref. 28 (and earlier volumes)
See also Ref. 9. Page 149

(* Provisional)

(See footnote on Page 37).

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is understandable in view of the gold mining and synthetic liquid fuel developments since the end of World War II. What is perhaps more significant however is to notice that the production of low grade coal from the Orange Free State now exceeds the production of high grade coal from Natal. The various factors responsible for this state of affairs have been discussed earlier but, as the Natal output is virtually static, it means that the Union must produce more tons of low grade coal per annum to give the equivalent energy output of fewer tons of high grade coal. Fortunately the low grade coal of the Orange Free State can be used on site for the production of electrical energy, thus avoiding transportation problems.

Table 12 presents an interesting analysis of coal sales, revealing some significant trends. It shows how Export and Bunker sales have dwindled over the past ten years - for reasons which have already been discussed. The Table also shows figures of Total Sales and Inland Sales for selected years, from which the following deductions can be made:-

a) Inland Sales - Over the 30 year period 1926 - 1956 the total sales of coal for inland consumption show an average rate of increase of 4.28% per annum. However, if each ten year period is taken separately the annual average rate of increase is respectively 3.18%, 4.68% and 4.98%. This indicates that in spite of all other factors such as slumps, wars, or the level of exports, the annual rate of increase in inland coal consumption shows an upward trend. Admittedly the trend varies from period to period - for example during the ten years 1926 - 1936 (which included the Great Depression) the annual rate of increase averaged only 3.18%, compared with 4.68% for the wartime period, and 4.98% for the post-war period. The significant feature is the continuing upward trend and, from the point of view of future consumption requirements, the fact that the present average rate of increase in inland sales is nearly 5% per annum.

b) Total Sales - The only difference between the Total Sales figure and the Inland Sales figure is that the former includes Export and Bunker coal. The effect of the inclusion of these figures however, is to materially alter the trend pattern as compared with the Inland Sales analysis. In the first place, the post-war decline in Export and Bunker sales has had the effect of reducing the overall average rate of increase (calculated over the 30 year period 1926 - 1956) to 3.19% per annum, in comparison with the 4.28% shown for Inland Sales. Secondly, the decline in export and bunker sales during the Great Depression period reduced the average rate of increase in Total Sales to 1.51% per annum, which was a much more marked drop than the 3.18% shown for Inland Sales. Thirdly the war-time boom in coal exports caused the average annual rate of increase in Total Sales (4.83%) to exceed the figure shown for Inland Sales (4.68%).

ß Percentage rates of change for Export and Bunker sales were not shown in Table 12 because of the fluctuating nature of the former and because the overall downward trend is immediately apparent. **(See Part 1 of Chapter 2).**

c) Conclusions - From the above comment it would seem that the pattern of Total Sales and the average annual rate of increase in such sales is materially affected by the condition of the Export and Bunker trade. The fluctuating nature of this business makes it difficult to determine a trend pattern for Total Sales which could be projected into the future with any degree of accuracy. On the other hand, if the statistics for the uncertain export and bunker business are removed, the resulting figures for Inland Sales do show a steady percentage progression which could be used to predict possible future demand. A re-arrangement of the calculations of annual average rates of increase (in the following Table) further emphasises the stable nature of the growing internal market for coal:-

	Period	Total Sales	Inland Sales
a)	1926 - 1936	1.51%	3.18%
	1926 - 1946	3.17%	3.93%
	1926 - 1956	3.19%	4.28%
b)	1936 - 1946	4.83%	4.68%
	1936 - 1956	4.03%	4.83%
c)	1946 - 1956	3.25%	4.98%

From the foregoing remarks it is clear that any attempt to predict future sales on the basis of past performance, should depend on an intelligent assessment of the Inland market position in relation to the known trends in this market. It is equally clear that the fluctuating nature of the Export market makes the Total Sales figure an unreliable basis for such predictions. At the present time the inland market accounts for 99% of saleable coal produced, but conditions may be favourable for the resumption of coal exports in the near future. In seeking to determine the possible magnitude of future coal production it will, therefore, be necessary to make a careful assessment for the inland market based on present performance trends and the pattern of consumer demand. To this can be added an appropriate figure for exports, estimated in accordance with available information regarding transportation facilities and overseas markets. These matters will be further discussed in the next Chapter, which deals with trends in consumer demand.

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C H A P T E R T W O

PATTERNS OF COAL CONSUMPTION

1. Export and Bunker Sales.
2. Railway Consumption - Locomotive Coal.
3. Sasol - Oil from coal.
4. Municipal Gas Production.
5. Thermal Electricity - Public Utilities.
6. Coking Coal - Metallurgical and Industrial.
7. Mining Requirements.
8. Domestic, Industrial and General.
9. The overall Union picture.

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CHAPTER TWO

PATTERNS OF COAL CONSUMPTION

1) EXPORT AND BUNKER SALES

From Table 12 it will be seen that the Union's trade in export and bunker coal has dwindled from about 4 million tons in 1946 to about 600,000 tons in 1956. The trade in bunker coal will probably never revive, as the number of coal fired ships on the oceans of the world is dwindling rapidly. For statistical purposes therefore when computing coal consumption figures, the small tonnage of bunker sales likely to arise ex Union ports during the next ten years will be disregarded as a separate entity, but a figure not exceeding 50,000 tons per annum will be included with estimates of future Exports, to cover supplies of Bunkers.

Export and Bunker coal is usually of the high grade variety having a calorific value not less than 12.80 lbs/lb. There is no legal obstacle against the export of "under first grade" coal, provided a certificate of grading has first been obtained, but in practice the calorific value of export coal generally approximates to the following averages:-

Natal coal	... ...	about 13.25 lbs/lb.
Transvaal coal	... ...	about 12.90 lbs/lb.

These average values were established in 1946 but the quality of export coal has not varied significantly, although the quantity has changed considerably during the past ten years.

In the previous chapter it has been shown that the main obstacle to coal exports during the past six years has been the inability of the South African Railways to handle the carriage of coal from the mines to the ports. The Railways problem has been a general shortage of facilities including trucks, tractive power and line capacity. Strenuous efforts to overcome these shortcomings have been made by the Administration and, by 1959/60, the main line from the Reef to Durban will have been doubled. More trucks will have been provided and turn-around time improved, but there are sober grounds for considering that even this large-scale effort may not be sufficient to remove altogether the problem of handling bulk coal and ore consignments from the interior to the coast. South Africa is rich in mineral ores and the export of these products is maintaining a constant pressure of demand for rail transport against the slowly improving capacity of the Railway system.

Table 10 shows that in 1956 approximately 2 million tons more coal was mined than the total of sales and wastage combined. The London Financial Times, in commenting on this surplus, suggested that a resumption of coal exports on a substantial scale was likely, and added:-

> "Although the latter is dependent upon the capacity of the railways to move more coal to the ports, it is estimated that coal exports.....

Ref. 9, Ch. IV.D.

London Financial Times - Friday July 12th 1957 - Page 5. (The figures of 5 million tons by 1960 and 10 million tons by 1965 represent somewhat optimistic totals since annual exports of this magnitude are not possible under present conditions - see comments in following pages).

could reach 5 million tons by 1960 and 10 million by 1965. Internal consumption should reach 40 million tons in the next 3 years, but the country's mines have increased their output from 26 million tons in 1946 to an estimated production for this year of 39 million tons. At £20 million the Union's value of coal output is exceeded only by gold and uranium, among minerals. The present average price at Transvaal pitheads is 10/7d per short ton. Proven reserves are conservatively estimated to be 70,000 million tons".

A study of the possible position of Transvaal coal in the European market during the next few years shows that, in competition with American coal, the following comparative cost pattern emerges:-

1. American coal of approximately 14 lbs/lb calorific value, c.i.f. European port. 140/- per ton

2. Transvaal coal of approximately 12.8 lbs/lb calorific value:-

Transvaal pit head price	11/- per ton
Railage to Lourenco Marques	21/- " "
Sea Freight to European Port	80/- " "
	112/- per ton

See Ref. 32, Section 16, Table 14. These calculations are based on 1956 figures but the subsequent decline in Ocean Freights has considerably reduced the c.i.f. costs of american coal in Europe and South Africa may have to look more to Eastern markets. The Economist of May 23rd 1959, pages 757/8 indicates that coal from the U.S.A. is now being landed in European ports at prices well below those given here. However, it still appears that South African coal, if available for export in sufficient quantities, would be competitive in the European market. With the help of Mr. George Young, Shipping Editor of the Cape Times, it has been possible to obtain the following information in regard to the export of coal from South Africa in competition with coals from America to Europe.

(a) The present average freight from U.S. to U.K. would seem to be about $4\frac{1}{2}$ per ton giving a landed cost in Europe of about $14\frac{1}{2}$ per ton of coal. This is in line with the expected range of prices given in the Economist of May 23rd 1959.

(b) An Italian freighter the CROCE MARINA is proceeding to Durban to load anthracite for Genoa at a freight rate of 39/- per ton or approximately $5\frac{1}{2}$. The Durban/Genoa freight rate is probably typical of the rate that would apply from Lourenco Marques to European ports so that $5\frac{1}{2}$ from South Africa to Europe can be taken as a fair current rate (July 1959).

This means that it would cost South African exporters approximately $1 (7/-) more to freight coal to Europe than American exporters. As indicated above, on the basis of 1955/56 figures South African coal would land in Europe at a price advantage of about 28/- per ton. Using the current freight position this price advantage would be reduced to about 21/- per ton, but even under today's conditions South African coal could apparently still be economically and competitively exported to Europe. This bears out the optimism expressed by the Transvaal Coal Owners' Association and the Natal Coal Owners' Society that exports of coal could definitely be resumed once the Railways were in a position to handle the traffic. (See following pages).

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The price advantage to Transvaal coal on the quoted 1956 figures is in the region of 28/- per ton, or about 20% of the U.S.A. selling price in Europe. This would provide ample scope for price adjustment on account of the lower calorific value and higher ash content of the South African coal. Natal semi-anthracitic coal, having a higher pithead price, would perhaps have less price advantage in European markets, but because of the higher market value of anthracite there should still be a worth-while differential in favour of the South African product.

The export market is clearly one which could be profitably exploited, with considerable financial benefit to South Africa's balance of payments position. It can be assumed that the Government and the Railway Administration are aware of this fact, but the problem is to attempt to forecast the probable pattern of coal exports over the next ten years.

In the previous Chapter it was seen that the demand for bituminous coal in Natal is now sufficient to absorb all production from the Natal coalfields. Furthermore, the higher production costs would make it difficult for such coals from Natal to compete with Transvaal coal on an export basis. In general it would seem that there is very little possibility of Natal collieries being able to produce sufficient bituminous coal to allow a resumption ϕ of exports. There is however a good chance of developing an export market in anthracitic coal, considerable quantities of which are presently dumped or burned because of lack of transport to the coast. Labour shortages and difficult mining conditions in Natal will however probably restrict the amount available for export to a maximum of about 1 million tons per annum, and even this figure may be difficult to achieve if the internal market continues to expand.

In July 1956 it was estimated that the following tonnages of Natal anthracite could be exported if transportation facilities were available:-

x

Country	Quantity, long tons per annum
Angola	18,000
Kenya	24,000
Belgian Congo	30,000
France	240,000
Italy	240,000
Holland	120,000
Japan	45,000
Sundry	13,000
Total	730,000

The value of this export market was estimated at £2,500,000 and considerable thought has since been given to ways and means of overcoming the transportation bottleneck. One suggestion was to operate a fleet of heavy duty diesel trucks from the Collieries in the Vryheid area to the coast. Alternative routes were proposed, one along the main national road to Durban, and the other via Piet Retief and across Swaziland to the Portuguese railhead at Goba. Yet another proposal has now been put forward and that is to operate a fleet of Le Tourneau heavy duty cross-country Transporters between Vryheid and Sordwana Bay, on the Natal North Coast, a distance of about 125 miles.

ϕ Ref.28, Page 66
x Ref.33, Pps. 62-64

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"The Le Tourneau Transporter has a payload of 35 tons and can pull "dead" trailers carrying a further substantial load which weight depends upon the nature of the terrain; thus a unit comprising one Transporter and one large or two smaller "dead" trailers should carry 70 to 75 tons along the proposed route from the Natal Collieries to Sordwana Bay.

"The lack of harbour facilities at Sordwana Bay, could, it is suggested, be overcome by the erection of a prefabricated harbour unit. These are manufactured by R.G. Le Tourneau Inc. in America and can accommodate the large ocean-going cargo ships necessary for carrying coal to Europe. It is believed that such a prefabricated harbour could be erected ready for service within a few months. The installation would include unloading devices, belt conveyors, bins, devices for discharging the coal rapidly into the holds of each ship etc., and the structure could be either a permanent one or a temporary one.

"The present suggestion is that the Transporters used for this project would be geared to a maximum speed of 16 miles an hour which would, because of their characteristics, enable them to average 12 miles per hour without difficulty. For purposes of calculation, however, an average speed of 10 miles an hour is assumed. The round trip between Vryheid and Sordwana, a distance of about 250 miles, would take 25 hours; allowing seven hours for loading, unloading, changing operators, and checking the Transporter and trailers, 32 hours would be required to transport each load of 70 tons to Sordwana Bay. With 26 working days each month and by operating day and night shifts, each unit comprising one Transporter and two trailers could transport 1,365 tons of coal per month.

"It has been suggested that 61 units would be required in order that 83,250 tons of coal could be moved through Sordwana in a month".

The above scheme would require an investment of millions of pounds in Transporters and Harbour facilities, and it is unlikely that either the Collieries or the Government would be prepared to foot the bill at a time when vast sums are already committed towards improving existing rail services to the coast. The proposal is however indicative of the importance attached to the export market and underlines the constant pressure which is being brought to bear upon the South African Railways Administration in an effort to obtain an early removal of the export embargo.

Whilst the Natal anthracite producers are hoping for a resumption of exports from Durban, the Transvaal collieries are pressing for a renewal of their profitable export trade via the port of Lourenco Marques. The export market in bituminous coal is virtually the prerogative of the Witbank coal mines, who have the advantage of vast reserves, thick seams, and comparatively

Ref. 33, Pps. 62-64

During 1957/58 the Government gave serious consideration to the construction of an ore and coal export port at Sordwana Bay, but early in 1959, following the announcement of a heavy operating deficit on the South African Railways it was decided to drop the project for the time being.

easy mining conditions, which allow a maximum of mechanisation. Wages are low, coal deposits are extensive, and pithead cost is the cheapest in the world. Even after allowing for rapidly increasing domestic consumption figures, it is considered that the Transvaal could possibly reach an export capacity of about 3 million tons of bituminous coal per annum, - but it will be several years before the S.A.R. is in a position to handle this volume of export traffic.

Any estimates of future coal exports must of necessity take into account the likelihood of overseas markets being available for South African coal. Table 12 shows that the Union has been able to export fairly substantial quantities in earlier years but these export markets must have been adversely affected from 1951 onwards by the Railways' inability to carry coal for export purposes. Can these markets be recovered or, can alternative markets be obtained for South African coal by the time the Railways are once again in a position to resume export services? From the pressure which colliery owners are continually exercising towards a resumption of exports it would seem that they are confident of being able to resume their export trade once the green light is given to them by the Government, notwithstanding the progress of competitive atomic power projects in various overseas countries. During private discussions with senior S.A.R.&.H. officials regarding the progress of railway and harbour development plans it was intimated that by about 1959/60 the Railways should be in a position to handle all the coal and ore export traffic that was offered. It would seem therefore that reasonable prospects for a resumption of coal exports should be possible about that time.

An approach was made to the Natal Coal Owners' Society and to the Transvaal Coal Owners' Association to ascertain whether they could forecast the probable trend of coal exports but, beyond expressing the view that a gradual build-up was anticipated, neither body was able to provide annual estimates. The Natal Coal Owners' Society felt that anthracite exports would build up to a figure somewhat less than one million tons per annum, but the Transvaal Coal Owners' Association felt that large overseas markets could be obtained and that the only limit to the export possibilities for Transvaal Coal was the ability of the Railways to handle the traffic.

In order to frame any estimate of future exports it therefore became necessary to make some sort of arbitrary assessment based on the views of the two Associations, plus the views of the Railway authorities in regard to carrying capacity, plus some allowance for the possible state of world markets for coal and other forms of competitive energy. Before setting down any likely estimates however several charts were prepared showing the decline in bunker and export coal sales from 1947 to 1956 and providing for various assumed rates of increase in coal exports during the next decade. After close examination of many schedules the following arbitrary estimate of coal exports during the period 1957 to 1966 was adopted as being reasonably in line with the probable and expected trend.

ESTIMATED COAL EXPORTS 1957 - 1966
(Tons of 2,000 lbs)

Year	Transvaal	Natal	Total
1957	250,000	250,000	500,000
1958	250,000	250,000	500,000
1959	300,000	400,000	700,000
1960	600,000	500,000	1,100,000
1961	900,000	600,000	1,500,000
1962	1,100,000	700,000	1,800,000
1963	1,300,000	700,000	2,000,000
1964	1,500,000	800,000	2,300,000
1965	1,750,000	850,000	2,600,000
1966	2,000,000	900,000	2,900,000

The above figures include a nominal amount of about 50,000 tons per annum for Bunkers at Union ports, as this seems to be in line with the present low rate of demand for such services. (See Table 12, Page 36). Coal for bunkering purposes is, in effect, exported and for purposes of discussion in this section the two categories have been joined. Export and Bunker sales during the period 1946 - 1957, together with the above estimates for the next decade, have been plotted in the form of a semi-logarithmic trend chart in Figure 4. The curve on the left represents the downward trend in exports due to the railways inability to handle the traffic, plus the decline in bunkers due to the reduction in the number of coal burning vessels calling at Union ports. The former is a temporary phenomenon which should be restored when railway troubles have been overcome. The latter is a permanent drop in bunker requirements which, in theory, leaves more productive capacity and more truckage available for the carriage of export coal.

The curve on the right of Fig. 4 represents the anticipated trend of exports (including a small provision for bunkers, as mentioned above) during the next ten years. It will be noticed that the estimates presume a minimum figure of about 500,000 tons in 1957/58 and that exports will rise gradually from 1959 onwards as the carrying capacity of the railway system improves. The reason why no sudden increase has been estimated for, say, 1960 onwards is that prudence dictates a measure of caution in accepting the somewhat optimistic hopes of coal producers in regard to the availability of overseas markets. The estimates have been conservatively framed in the belief that export of high grade coal will be resumed by about 1960, but that it will take some years to build up the trade that has been lost during the past ten years. The current slackening of international trade and the likelihood of a drawn-out recovery period were also taken into account when assessing the likely pattern of future export sales.

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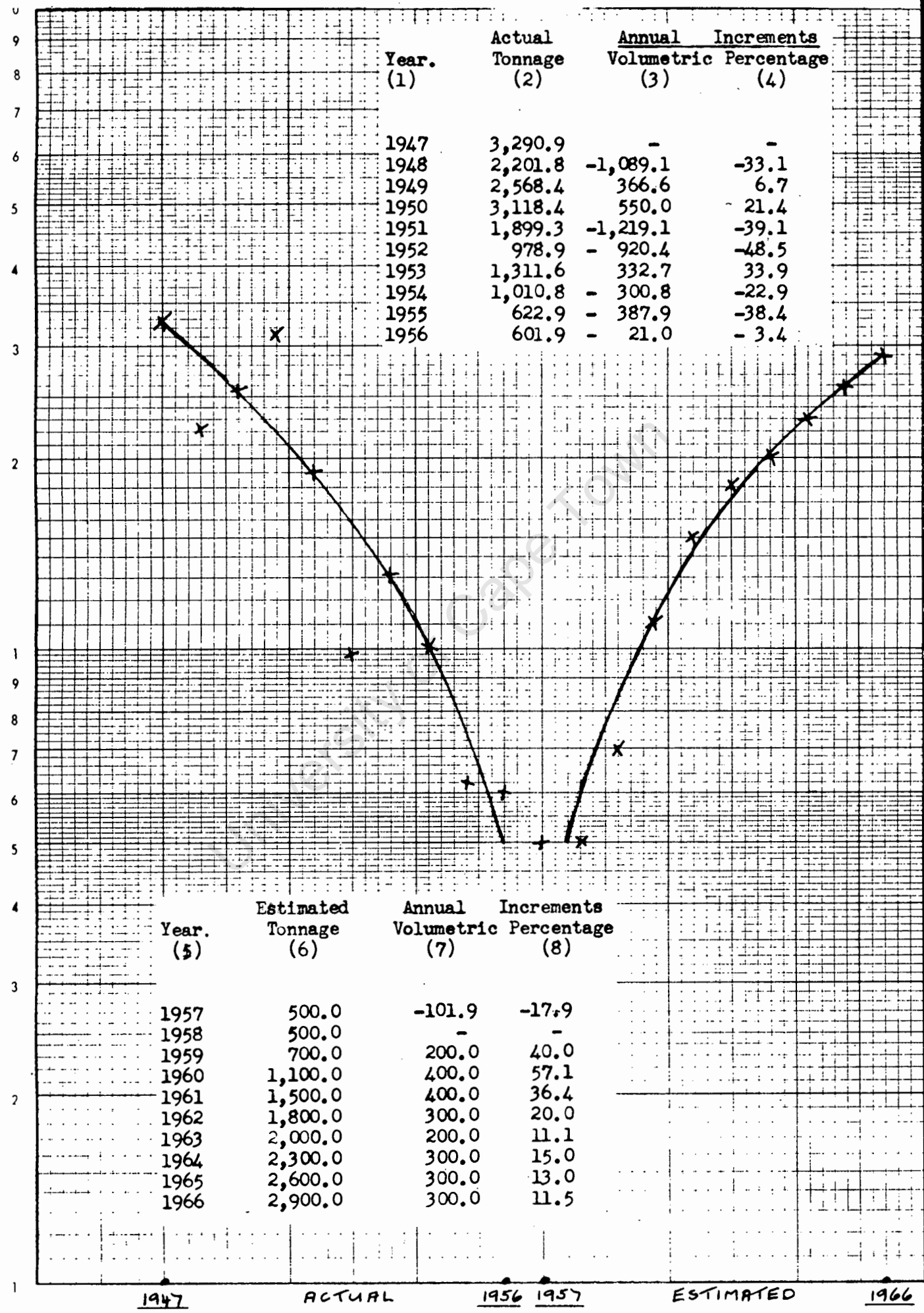
FIG. 4 COAL REQUIRED FOR EXPORT & BUNKER PURPOSES

CONSUMPTION TREND 1947 - 1966

(Thousands of short tons)



Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	3,290.9	-	-
1948	2,201.8	-1,089.1	-33.1
1949	2,568.4	366.6	6.7
1950	3,118.4	550.0	21.4
1951	1,899.3	-1,219.1	-39.1
1952	978.9	- 920.4	-48.5
1953	1,311.6	332.7	33.9
1954	1,010.8	- 300.8	-22.9
1955	622.9	- 387.9	-38.4
1956	601.9	- 21.0	- 3.4

Year. ($)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	500.0	-101.9	-17.9
1958	500.0	-	-
1959	700.0	200.0	40.0
1960	1,100.0	400.0	57.1
1961	1,500.0	400.0	36.4
1962	1,800.0	300.0	20.0
1963	2,000.0	200.0	11.1
1964	2,300.0	300.0	15.0
1965	2,600.0	300.0	13.0
1966	2,900.0	300.0	11.5

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Thus far it has been assumed that the bulk of the export trade would be in high grade coal, but it is worthwhile considering whether there is any possibility of selling medium quality coal in overseas markets. Writing in 1951, the Commission of Enquiry in regard to Coal shortages expressed its views in the following terms:-

6

> "From the point of view of economics in so far as the coal mines are concerned, there can be no doubt that the assured and bulk internal market is the foundation on which the production of coal rests. At the same time there is an alluring export market with greatly enhanced prices at the present moment to be had for the taking. For the national economy too, it seems imperative that everything should be done to capture and tie for all future times as large a slice of this market, producing foreign exchange to the Union, as is possible. By international standards the quality of South African coal is good but not the very best, and until quite recently only the highest possible grades have been exported. It is only recently and during the post-war years that lower grade coal has been mined and increasingly exported on its assessed merits. We cannot find ourselves in agreement with the conclusions of the Coal Commission (1946/47 - Paragraph 387 of its report) namely, "that the export of low grade coal will, in the long run, do more harm than good to the coal-shipment trade of the country". Our conclusion is, of course, based on the essential assumption that the lower grades of coal exported will be contracted for according to full specification as to the physical and chemical properties. The export of lower grades of coal and the continued demand therefor from overseas are to our mind sufficient proof of the feasibility of such exports".

There would seem to be considerable merit in the above suggestion that the export of lower grades of coal should be based on appropriate contract specifications but, where the ratio of pithead cost to transportation cost has reached a ratio of 1 to 11 (as in the case of coal exported from the Union), it follows that it will pay the importer to take the best quality coal available. Over 90% of his cost is for transportation and, ton for ton, the importer will obtain more energy from higher grade coal at no extra transportation cost. For this reason therefore, it is felt that coal of high calorific value will continue to be the main export grade in the years to come.

2) RAILWAY CONSUMPTION - LOCOMOTIVE COAL

The South African Railways are very large consumers of locomotive coal and, in fact, the Administration is the largest individual purchaser of coal in the Union. Table 13 gives details of purchases of locomotive coal over the past 20 years, and it will be noticed that consumption of Transvaal Coal has increased during that period from 3 million tons in 1938 to over 6 million tons in 1957. In contrast, the consumption of locomotive coal from Natal has shown only a slight increase, notwithstanding

6 Ref. 23, Paragraph 131.

TABLE 13

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PURCHASES OF LOCOMOTIVE COAL BY THE S.A.R. & H. ADMINISTRATION

	TRANSVAAL	NATAL	TOTAL
	(Tons of 2,000 lbs)		
1937/38	3,089,300	765,700	3,855,000
1938/39	3,082,900	624,200	3,707,100
1939/40	3,171,700	694,200	3,865,900
1940/41	3,259,200	657,100	3,916,300
1941/42	3,549,400	685,000	4,234,400
1942/43	3,731,500	724,900	4,456,400
1943/44	3,678,400	698,600	4,377,000
1944/45	4,097,900	637,800	4,735,700
1945/46	4,254,200	630,400	4,884,600
1946/47	4,491,300	648,900	5,140,200
1947/48	4,770,200	670,300	5,440,500
1948/49	4,967,600	661,000	5,628,600
1949/50	4,908,000	655,000	5,563,000
1950/51	4,940,100	643,900	5,584,000
1951/52	5,038,900	841,600	5,880,500
1952/53	5,521,500	805,600	6,327,100
1953/54	5,479,000	818,800	6,297,800
1954/55	5,872,100	719,100	6,591,200
1955/56	6,161,200	778,100	6,939,300
1956/57	6,263,100	813,800	7,076,900
1956/57 Percentages	88.5%	11.5%	100%
Average annual rate of increase:-			
1938 - 1957	3.8%	-	3.2%
1943 - 1957	3.8%	-	3.3%
1948 - 1957	3.1%	-	3.0%
1953 - 1957	3.2%	-	2.8%

(Ref. 9 Paragraph 322; with figures for later years obtained from SAR)
(See also Ref. 38, Page 146, and earlier volumes).

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ϕ the fact that inland consumption of bituminous coal in Natal has risen steadily during the post-war years. Production of this type of coal cannot be increased to any material extent because of the faulted nature of coal seams in that region and also the fact that coal with coking qualities is reserved for Iscor. Furthermore, because Natal bituminous coal is more expensive than Transvaal coal, it cannot compete on a price basis for railway contracts in other Regions. In general therefore the tendency is for Railway consumption of Natal coal to be localised in and around the Provincial area. It is anticipated that this will continue to be the case during the next ten years, and that the consumption of Natal locomotive coal will probably not vary much from the present level of 800,000 to 850,000 tons per annum. In fact, with the progressive electrification of the Natal system, the long-term trend is probably towards a falling off in the need for locomotive coal in that Province. Table 13 shows that based on 1956/57 requirements, Natal only supplied 11½% of the total locomotive coal consumed by the S.A.R., the balance of 88½% being obtained from the Transvaal. The decreasing share of the total represented by Natal coal will, in due course, bring this figure down to below 10%, with over 90% of the Administration's annual coal requirements being provided by the Transvaal.

The main consideration of the Railway Administration when purchasing coal is the calorific value, and the basis of purchase is the amount of heat supplied. The greater the calorific value per lb. of coal the greater the amount of heat available in locomotive fireboxes for steam raising purposes. A further consideration is the ash content of the fuel, which should be reasonably low if clinkering troubles are to be avoided. In general a high calorific value is accompanied by a low ash content and vice versa, so that the Railway's needs are best met by the purchase of high grade coal.

From time to time tests have been carried out on medium grade and anthracitic coals, but the former lack sufficient heat value for modern firebox designs, whilst the latter are deficient
ϕ in volatile matter. The best all-round results are obtained from bituminous coal with a calorific value of 13.00 lbs/lb., which is superior to all other lower grade coals. The Administration's coal purchases vary in calorific value between relatively narrow limits, but satisfactory results are apparently obtained from coals of 12.50 lbs/lb and, on occasion, even 12.00 lbs/lb calorific value. The following analysis of coal purchased during 1946/47 shows that 83% possessed a calorific value of 12.20 lbs/lb or more:-

ANALYSIS OF COAL PURCHASED BY THE S.A.R. 1946/47

Calorific Value lbs/lb.	Tons Purchased	Percentage of Total	Cumulative Percentage
13.20 and above	161,800	3.1	-
x 13.00 and under 13.20	421,300	8.2	11.3
12.80 and under 13.00	908,000	17.7	29.0
12.50 and under 12.80	1,353,200	26.3	55.3
12.20 and under 12.50	1,432,100	27.9	83.2
12.00 and under 12.20	645,800	12.6	95.8
Under 12.00	218,000	4.2	100%
TOTALS	5,140,200	100.0	

ϕ See Table 8 Page 28 and Chapter 1
ϕ Ref.9, Para. 329
x Ref.9, Page 87

It will be noted that over 50% of the 1946/47 purchases fell within the calorific range of 12.20 to 12.80 lbs/lb, and in this connection it should be realised that if any substantial reduction in calorific value should take place, considerably greater tonnages of coal would need to be transported between the collieries and the various railway coaling depots situated all over the country, in order to provide the necessary heat units forlocomotive steam raising. To put it another way, one ton of coal having 12.80 lbs/lb calorific value gives the equivalent in heat units of 1.06 tons of coal having only 12.00 lbs/lb calorific value. This in itself may seem small, but if multiplied by 5 million tons it would mean that over 300,000 extra tons of coal would need to be transported by the S.A.R. to the various coaling depots. Hence the use of lower grades of coal would involve the S.A.R. in considerable operating trouble and expense which, in the long run, could only lead to higher transportation charges to producers and consumers alike. There is therefore a very good case for providing the S.A.R. with as much high grade bituminous coal as possible.

The South African Railways Administration is faced with the major problem of transporting coal to all parts of the Union. Not only must coal be carried for Industrial and Domestic use, but also for the use of the Administration's own locomotives. The 1951 Coal Commission quoted the following example which, although now out of date, serves to illustrate not only the need for transporting large quantities of coal, but also the need to position adequate supplies of coal en route, to feed the locomotive fireboxes:-

ƀ "The following considerations regarding the conveyance of coal by rail are illuminating:-

(a) The coal consumption of the three power stations in Cape Town amounts to approximately 1,800 tons per day;

(b) to meet this daily requirement in Cape Town, approximately 60 trucks or 3 train loads of 20 trucks each have to be discharged daily at this point;

(c) The average time taken to rail coal from Transvaal or Natal coal areas to Cape Town is about 10 days;

(d) at any given moment, therefore, 30 trains are on the way from the coalfields to Cape Town conveying coal to that destination;

(e) these trucks have to be returned either empty or loaded, requiring a further 30 trains on the return journey at the same moment.

To sum up, at any given moment of the day 60 train loads involving approximately 1,200 trucks are in transit to or from Cape Town alone to keep the power stations in that city supplied with their fuel requirements. We have been advised that these power stations

ƀ Ref.23, Page 30, Para.136

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will consume 1,150,000 tons by 1955. This would mean that the number of trains required to convey this coal would have to be almost 6 per day, involving 2,400 trucks at any given moment".

It should be remembered that the above comment was made in 1951 and, since that time, the Administration has found it necessary to convey coal by sea from Durban and Lourenco Marques to Cape ports in order to supplement the rail service and to maintain its own supplies.

The General Manager of the Railways Organisation, Mr. D.H.C. du Plessis, in an address to a group of visiting American businessmen during 1956, made the following remarks:- /

"In 1939 the South African Railways carried 29,855,000 gross tons of revenue-earning traffic, the earnings for the year amounting to £32.6 million. Seven years later, in 1946, that is during the first post-war year, the tonnage had risen to 41,619,000 and the revenue to £53.2 million - in other words by some 39 and 63 per cent respectively. By 1952 the figures had increased to 57,164,000 and £100.6 million - a percentage increase of 37 and 89 on the 1946 record - and details for the past four years are as follows:

1953: 60,341,000 tons, £102,489,000 - increases over the preceeding year of 5.6 and 1.9 per cent.

1954: 62,445,000 tons, £113,077,000 - increases of 3.5 and 10.3 per cent.

1955: 63,071,000 tons, £130,775,000 - increases of 1.0 and 15.6 per cent.

1956: 65,253,000 tons, £137,809,000 - increases of 3.4 and 5.3 per cent.

On the basis of information obtained from various sources, including organised Commerce and Industry, and after careful analysis of trends, our departmental operating and statistical experts estimated that during the financial year ended 31st March 1956, some 70,419,000 tons of revenue-earning traffic would be available for transport by rail. It will, therefore, be seen that during 1955/56 the South African Railways was unable to transport about 5 million tons of traffic, offering.

The excess traffic that we cannot handle comprises mainly manganese ore, chrome ore, coal and iron ore for export. It has been estimated that during the succeeding four years the total tonnages available for transport by rail, including some 10 million tons of non-revenue-earning traffic, will increase as follows:-

1956-57	=	84,000,000	(5.5 per cent increase)
1957-58	=	85,300,000	(1.6 per cent increase)
1958-59	=	86,400,000	(1.3 per cent increase)
1959-60	=	87,250,000	(1.0 per cent increase)"

/ Ref.37, Pages 2 - 3

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To carry the increased traffic anticipated during the next few years additional energy will be required for locomotive traction purposes. The present problem is to estimate how much extra coal will be required for steam locomotives, but since extra tonnage does not necessarily mean additional operating milage, it would be interesting to review the picture on a ton/mile basis.

/ In an informative article published in June 1957, J.C. Laight of the University of the Witwatersrand comments on some aspects of post-war railway expansion in the Union. He goes to considerable trouble to compile a basic index of traffic on a ton-mile basis and estimates that over the ten year period 1946/47 to 1955/56 there has been an increase of some 57 per cent. This would imply an average rate of growth of about 5% per annum in ton/miles operated, but Table 13 (Page 48) shows that total coal consumption during the post-war period has been increasing at an average rate of a little less than 3% per annum. Coal consumption is admittedly not necessarily proportional to ton/miles carried, but an interesting fact revealed by Table 13 is that during the last few years the average annual rate of increase in coal consumption by the S.A.R. has shown a tendency to decline gradually - and this during a period when the railways have been almost swamped with traffic. The main reason for this state of affairs is to be found in the process of electrification which is being applied to the more heavily taxed portions of the Railway network, but it may also be a reflection of the shortage of locomotives and rolling stock during the period. Electric power is supplied to the S.A.R. from Escom, and hence as the figures for locomotive coal consumed annually by the S.A.R. might be expected to show a gradual tendency to level out during the years, so the coal requirements of Escom for the generation of traction electricity should show a steady upward trend.

/ The long term plans of the Railway Administration involve a gradual switch-over from coal to electricity wherever this can be economically achieved. In the 1955-56 Report of the
x General Manager of the Railways, it is stated that out of a total of 12,000 track miles in the Union some 1,800 miles have already been electrified, and work is proceeding, or has been authorised, on a further 930 track miles. A much more revealing indication of the importance of the electrification programme however is the statement that the number of ton-miles operated under electric
= traction increased to 10,562 million during the year. When this figure is compared to the 20,106 million ton-miles operated in the carriage of freight during the same period it will be noticed that even after allowing, say, an estimated ten per cent for passenger traffic, the portion carried by electric traction is now rapidly approaching 50% of the total ton-miles operated. The advantages of electric traction versus steam traction, insofar as coal consumption is concerned, can be illustrated in the following manner:-

a) <u>Electric Traction</u>

On Page 94 of the Report of the General Manager of Railways for 1955-56 it is stated that electric power consumption per ton-mile operated, amounted to approximately 0.0666 of a unit. Table 18 (Page 71) shows that it takes an average of less than 2 lbs of coal to generate one unit of electricity. However if 2 lbs is accepted

/ Ref.34, Page 115
/ Ref.37, Page 4.
x Ref.38, Pp.91 and 204
= Ibid, Pages 92 and 100

as a reasonable figure, 0.0666 of a unit per ton-mile can be expressed as approximately equal to 0.133 lbs of coal per ton-mile.

b) Steam Traction

Figures for coal consumption per ton-mile under steam traction are not given directly in the General Manager's Report but, on Page 100, it is stated that just over 20,000 million ton-miles was operated in freight transit during 1955-56. This does not include passenger transit and, in any case, a portion of both goods and passenger traffic was hauled by electricity. However if a fairly generous estimate of 21,000 million ton-miles is assumed to be approximately correct for all steam hauled traffic (goods and passenger), and if this figure is divided into the total locomotive coal consumption of just under 7 million tons for the year (Table 13), we get:-

$$\frac{7,000,000 \times 2,000}{21,000,000,000} = \frac{\text{lbs of coal}}{\text{ton-miles}}$$

$$= 0.666 \text{ lbs of coal per ton-mile}$$

c) Conclusions

The above very rough approximations show that, in terms of coal consumption per ton-mile, the relative ratios of electric traction to steam traction are of the order of 0.133 to 0.666, or say roughly 1 to 5 in favour of electricity. If the more efficient power stations (with coal consumption of about 1.5 lbs per unit generated) were taken as a base for electricity calculations, and if a more accurate figure of total ton-miles operated under steam traction could be obtained, the relative ratios of coal consumption might be shown as nearer to 1 : 7 in favour of electric traction. This represents a major saving to the Administration, not only in the cost of coal supplied, but more particularly in the rolling stock required to haul locomotive coal to various depots throughout the System.

The main factor affecting the coal requirements of the railways is the number of steam engines in service, as the amount of coal used for other than locomotive purposes is very little when compared with total consumption. During the past few years many new steam engines have been placed in service, and a further 60 are on order and should have been delivered by the end of 1958. Significantly, it would appear that no further large orders for steam engines have been placed for delivery after 1958, and it would seem that the S.A.R. is relying on the fast developing electrification programme to release sufficient steam locomotives for normal incremental and replacement purposes in other sections.

During the past ten years the average annual rate of increase in S.A.R. consumption of locomotive coal has been about 3% (Table 13). The overall increase during the period 1946 - 56 was in the region of 37.7% and the Administration states that "it is not considered that the pattern will materially alter during the next ten years"[6]. However, it is a fact that electrification is proceeding on the busiest sections of the railway system and that in due course the major portion of ton-miles operated per

[6] Private correspondence RS3/100/125 dated 21.10.57.

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annum will be under electric traction. Table 13 shows that over the last few years the average annual rate of increase in coal consumed by the S.A.R. had dropped to 2.8%, but this is probably only a temporary phase due to the shortage of steam engines. However there should come a time when the Administration's coal needs begin to show a reduced annual rate of growth, particularly if no further steam locomotives are ordered in future years.

When framing estimates of railway coal consumption for the period 1957 - 1966 it was not possible to obtain any official comment from the Administration other than the previously mentioned indication that "it is not considered that the pattern will materially alter during the next ten years". However, it was possible to amplify this estimate to some extent during private discussions with senior railway officials and the following pattern emerged:

a) The gradual introduction of electric and diesel locomotives is not expected to result in the redundancy of steam locomotives. The Administration's needs are such that all locomotives will be fully employed irrespective of type of traction.

b) Steam locomotives are normally kept in service for a great many years and when their main line "life" is over they continue in service as shunting engines, or on branch lines. In view of this fact and having regard to the many steam engines purchased since the war, it was felt that the rate of scrapping of obsolete locomotives during the next ten years would not be such as to materially affect coal consumption figures.

c) The Administration needed all the engines it could obtain - steam or electric or diesel - to maintain current services and to provide for normal expansion in traffic. There was, therefore, no reason to suppose that the annual demand for locomotive coal would vary significantly from past figures and it should indeed continue to increase each year as train loads increased and operating conditions were improved.

d) Nevertheless, it could be anticipated that the rate of increase in annual coal consumption would eventually begin to drop if no new steam engines were purchased. The consensus of opinion, however, was that the next five years would show little change and that thereafter the drop would be gradual.

With the above views in mind a trend chart was prepared, Figure 5, showing the trend of consumption during the past ten years and the likely pattern for the next decade. In view of the definite opinions of the various railway officials that the

[6] One such official to whom I am specially indebted is Mr. A.G. Tungay, who was also the Secretary of the 1946/47 Coal Commission

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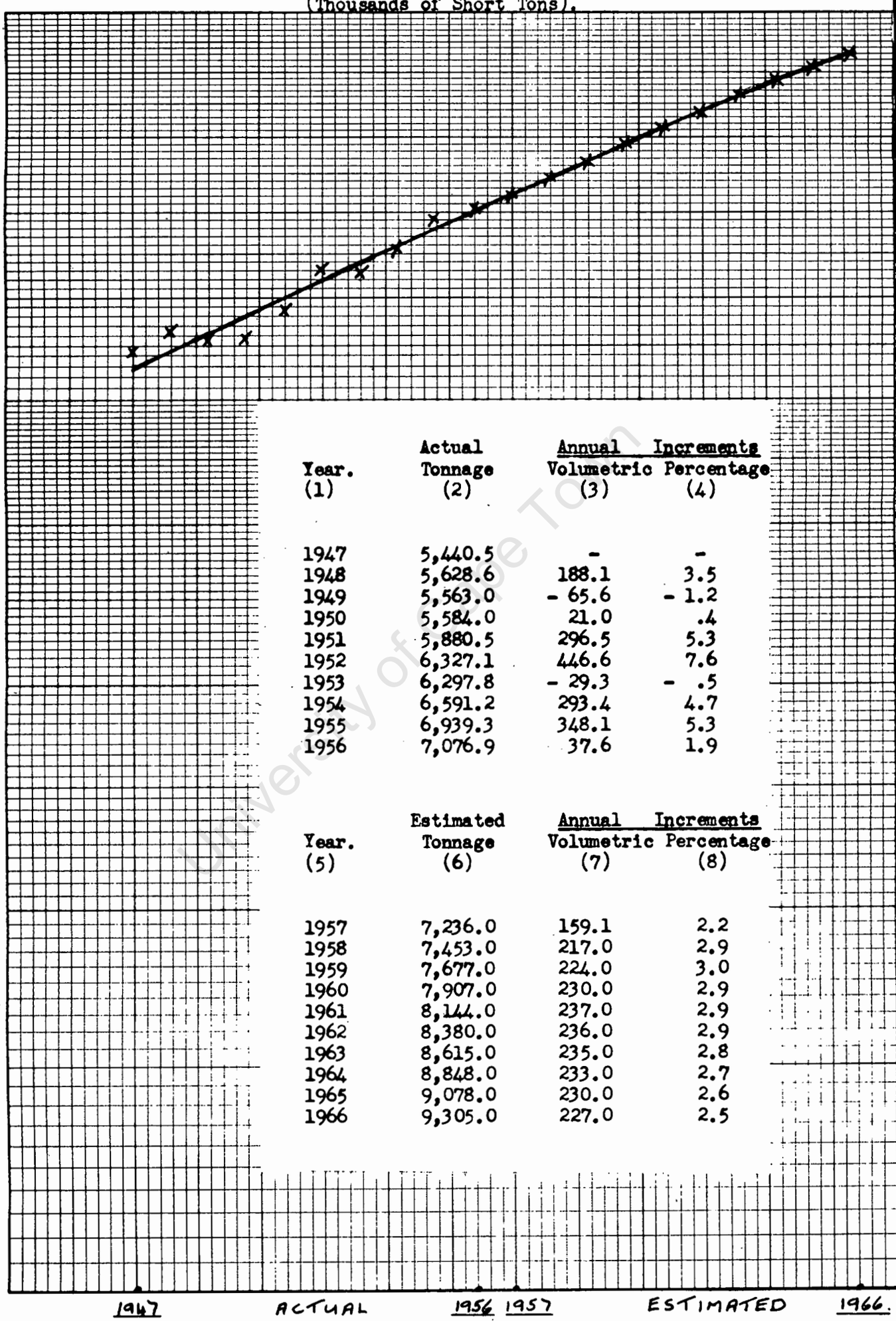
FIG. 5 COAL REQUIRED FOR THE SOUTH AFRICAN RAILWAYS

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons).



Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	5,440.5	-	-
1948	5,628.6	188.1	3.5
1949	5,563.0	- 65.6	- 1.2
1950	5,584.0	21.0	.4
1951	5,880.5	296.5	5.3
1952	6,327.1	446.6	7.6
1953	6,297.8	- 29.3	- .5
1954	6,591.2	293.4	4.7
1955	6,939.3	348.1	5.3
1956	7,076.9	37.6	1.9

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	7,236.0	159.1	2.2
1958	7,453.0	217.0	2.9
1959	7,677.0	224.0	3.0
1960	7,907.0	230.0	2.9
1961	8,144.0	237.0	2.9
1962	8,380.0	236.0	2.9
1963	8,615.0	235.0	2.8
1964	8,848.0	233.0	2.7
1965	9,078.0	230.0	2.6
1966	9,305.0	227.0	2.5

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next few years would show very little change in locomotive coal consumption the trend chart was extended to 1962 at approximately 3% per annum increase. Thereafter, as a measure of prudence, it was assumed that the rate of growth in demand for locomotive coal would begin to tail-off by about 0.1% per annum, as more and more electric and diesel locomotives came into service. This is reflected in the slight curvature at the right hand end of the trend line shown in Figure 5. Translated into physical units, the following tabulation summarises the estimated coal consumption of the S.A.R. for the next decade:

CALENDAR YEAR	ESTIMATED COAL CONSUMPTION Tons of 2,000 lbs.
1957	7,236,000
1958	7,453,000
1959	7,677,000
1960	7,907,000
1961	8,144,000
1962	8,380,000
1963	8,615,000
1964	8,848,000
1965	9,078,000
1966	9,305,000

(Average calorific value 12.50 lbs/lb.)

3) SASOL - OIL FROM COAL

The Suid-Afrikaanse Steenkool -, Olie -, en Gas Korporasie Beperk is situated at Sasolburg in the North-Eastern Orange Free State, fifty miles from Johannesburg and 17 miles from Vereeniging. The 3,000 morgen site lies atop of a large coalfield close to the banks of the Vaal River, thus providing both coal and water for the production processes. Johannesburg and the concentrated marketing area of the Witwatersrand is within easy distance.

It has been estimated that 665 million tons of low grade coal deposits are available in the vicinity, of which at least 300 million tons can be economically extracted. There are three main coal seams, the upper one, which occurs at an average depth of 370 feet, has a thickness of about eleven feet and is to be mined first. The middle seam, at about 420 feet, is some 24 feet thick; and there is a third irregular seam ranging in thickness up to about ten feet. Analysis of these coal deposits gives a calorific value of 8,400 B.T.U./lb with a volatile matter content of 23% and fixed carbon of 44%. Sigma colliery has been established as an integral part of the Sasol undertaking to exploit these vast coal reserves. The mine can produce some 7,000 tons of coal per day using modern mechanised methods, and a belt transportation system conveys the output to the crushing plants and thence by mechanical conveyor to the Sasol storage bunker, a mile and a half away. The bunker, which is the largest of its kind in the Southern Hemisphere, has a capacity of 29,000 tons.

Ref.35, Page 3
Ibid, Page 4

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The Capital needs of the Sasol undertaking were originally estimated at £20 million. This figure was subsequently revised to £40 million, and the latest official estimate is now £48 million. This expenditure is supposed to bring the plant to full-scale operation, when it should produce some 71,000,000 imperial gallons of products per annum. These include:-

	Product	Production p.a. (Approx.)
1.	Petrol	55,000,000 imp. gallons
2.	Diesel Oils	6,500,000 " "
3.	Liquified Petroleum Gas	300,000 " "
4.	Ethanol	3,000,000 " "
5.	Propanol	1,500,000 " "
6.	Butanol	500,000 " "
7.	Acetone	200,000 " "
8.	Methyl-ethyl-ketone	250,000 " "
9.	Aromatic solvents	1,400,000 " "
10.	Creosote	1,000,000 " "
11.	Road prime	500,000 " "
12.	Pitch	1,000 short tons
13.	Crude phenols	5,000 " "
14.	Ammonium sulphate	50,000 " "
15.	Paraffin waxes	18,000 " "

The Corporation's products are marketed by the Sasol Marketing Company Limited, a wholly owned subsidiary. Most of the petrol produced by the Sasol Refinery is distributed by the Sasol Marketing Company through its own pumps in the Reef areas, the balance being sold through normal trade channels by agreement with the major oil companies. In the latter case the petrol is processed to individual company requirements.

Liquified petroleum gas, (L.P.G.) is sold through distributors who market this product in cylinders of convenient size. This gas is an efficient and convenient source of heat for farms, holiday-makers, laboratories, and for some industrial applications.

Ethanol, Propanol and Butanol are alcohols used in the production of chemicals, insecticides, paints and synthetic rubber. Acetone, Methyl-ethyl-ketone, and the aromatic solvents (Benzol, Toluol, and Xylol) are also used for paints, insecticides and disinfectants. Phenols, like alcohols, have wide application in the chemical industry, particularly where plastics are concerned.

Creosote is universally used as a wood preservative, whilst pitch has many industrial applications including the manufacture of floor and roof coverings. The various grades of Paraffin wax are used for matches, polishes and for processed food cartons.

It will be seen from the above summary that the products derived from coal have many and varied applications. The original idea of converting South African coal into petrol was based on the desire to utilize local resources of energy to the fullest possible extent and thus to conserve foreign exchange used for petroleum imports. Up to the present no deposits of oil have been located in the Union, but large quantities of coal have been prospected, and

Ref.36, Page 10
Ref.35, Page 8
See also SASOL Annual Report for the year ended 30th June 1956

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much of the low-grade coal, unsuitable for normal commercial purposes can be used in the synthesis of petrol and diesel oil. However it has yet to be proved that the processes employed at Sasol are economic, because in the two years of operation to date there have been a succession of stoppages at the plant and there is still no sign that all the production troubles have been overcome. It can be mentioned that although the rated annual petrol production capacity of the plant is 55,000,000 gallons, during 1956 only about 6½ million gallons were produced. The plant was again shut down for a few weeks during February 1957, but it is reported that it may be operating at about 50% of capacity by the end of 1957. Whether the planned output of product will ever be achieved may be problematical. It is perhaps significant that spokesmen for the Corporation have toned down previous expressions of confidence in the profitability of the enterprise and that the Chairman, Dr. F.J. du Toit, has remarked that, "the use of coal as a raw material for the chemical industry may, in the end, be even more important than the production of gasoline".

From the point of view of coal consumption, there are two factors to consider. On the one hand, the Sigma colliery is equipped to mine some 7,000 tons of coal per working day, whereas, on the other hand, the capacity of the Sasol processing plant is given as a maximum of 5,500 tons daily. Since neither the mine nor the plant is working at rated output, and bearing in mind the production troubles that the plant is still experiencing, the problem of estimating forward coal consumption over the next ten years is indeed difficult. It is known that in 1955 the Sigma mine produced 1,119,000 short tons of coal, and in 1956 the output rose to 1,230,000 tons. The Corporation has indicated that the present effective capacity of the mine is in the region of 2,200,000 tons per annum, but none of these figures seem to have any basic value for forward estimating. Having regard to all the circumstances, and the absence of any published information regarding the actual ratio of coal consumed to the output of products, there was no alternative other than to ask Sasol for their own estimates of future coal consumption.

In their reply (Ref. 1701/1 dated 4th October 1957) Sasol gave estimates for the years 1957 to 1960 and stated that "We can unfortunately give no estimates for the years after 1960 as too many uncertain features enter into the picture". In order to provide a complete tabulation up to 1966 it has been necessary to assume that the 1960 figure will continue as a minimum annual consumption up to the latter date. The Sasol coal consumption picture, based on the above information, can therefore be summarised as follows:

S A S O L

Year	Coal Consumption (Short tons = 8,400 B.T.U./lb)	
1955	1,119,000	(Actual)
1956	1,230,000	"
1957	1,700,000	(Estimated)
1958	2,000,000	"
1959	2,500,000	"
1960 (and up to 1966)	3,000,000	"

/ Petroleum Press Service - May 1957 - Page 194
ß "Sasols Sad Story" - Petroleum Press Service - January 1957.
x Ref.36, Page 10.
¤ Private correspondence with Sasol dated 25.2.57.

If allowance is made for some 200,000 tons per annum used for steam and power generation at the Sasol plant, the aforegoing Table assumes that the present rated consumption of coal for synthesis will have been achieved by 1959. It should not however be inferred from this that the rated output of petroleum and chemical products will also be achieved. All available evidence at the present time tends to indicate that the output of synthesised products per ton of coal processed, is somewhat different from the original planning, and only time will show whether the project can become economically self-supporting.

4) MUNICIPAL GAS PRODUCTION

There are five gas undertakings in the Union supplying gas in municipal areas for heating, lighting, cooking and industrial purposes. Table 14 gives figures of annual gas coal consumption during the 20 year period 1937 - 1956, together with estimates of tonnage required for the ten years 1957 - 1966. Other details are as follows:-

a) Johannesburg Municipal Gas Works

This is the largest of the five undertakings and it accounts for some 70% of all coal consumed in the production of town gas. Hitherto a gas coking coal of the semi-bituminous swelling variety has been used, supplied from the Witbank coal field and having a calorific value of about 12.5 lbs/lb. However as all available deposits of coking coal are now being reserved for Iscor the supply of high grade gas coking coal will be severely limited in the future. It is envisaged that existing plant will continue to operate using a lower quality semi-coking coal, but increased demand will have to be met by the introduction of a plant designed for the complete gasification of a non-swelling variety of coal. Equipment for this purpose is now being erected at the Johannesburg Gas Works, and it is anticipated that the ratio of semi-coking coal to non-coking coal consumed in the production process will be as 2 to 1 by 1962. By that date the plant will be consuming some 100,000 tons of semi-coking coal and about 50,000 tons of non-coking coal per annum, the nett effect being to conserve 150,000 tons of good coking coal for use by Iscor.

The main drawback to the use of semi-coking and non-coking coals in Gas production is that the output of coke as a by-product will be affected. Gas coke is partly used in the generation of cheap water gas, and partly sold for local consumption. The lower grades of coal now used for gasification will have little direct effect on the production of coal gas, but will adversely affect by-product revenues. This may, in the future, necessitate an increased price for gas supplied to consumers, since by-product revenues help to offset production costs.

/ Private correspondence AGM/LB dated 1.10.57.

b) Cape Town and District Gas Light and Coke Co. Ltd.

Gas supplies in the Cape Town area are provided by a public limited company with works at Woodstock. Table 14 indicates that the annual coal consumption is showing a smaller rate of increase than Johannesburg and, to some extent, this is a measure of the slower industrial development tempo in the Cape. To some extent also it is a measure of the different approach to the distribution problem as between a municipal and a private undertaking. The former possesses every facility (including wayleave over road areas) for the expansion of distribution throughout the municipal area, and is usually better able to finance such expansion from loan funds. A private company not only has to pay for wayleave rights for the laying of pipelines, but has to give much more serious consideration to the question of profitability when contemplating the expansion of its distribution facilities. The question of relative prices is also an important factor and, in general, if energy from town gas is less expensive than electrical energy in the Johannesburg area, in Cape Town the converse is probably true - at any rate insofar as domestic consumption is concerned.

c) Port Elizabeth Municipal Gas Works

The Gas Works at Port Elizabeth produces a Town's Gas consisting of a mixture of coal gas, water gas and producer gas. During the period 1947 to 1955 considerable quantities of Gas Oil were consumed, with relatively small quantities of coal. From 1956 onwards however the use of Gas Oil as a raw material has been discontinued following the erection of a new coal carbonisation plant at the Works. In general, a coal carbonisation plant requires a higher capital investment and consequently carries higher depreciation charges, than other forms of gas generation. The raw material coal, is however much cheaper in terms of cubic feet of gas produced, particularly when by-product coke is used for the generation of water gas for admixture with the coal gas. Port Elizabeth obtains supplies of coal for carbonisation from Natal, such coal having a calorific value approximating to 13.00 lbs/lb. The City Gas Engineer preferred not to estimate future coal consumption beyond 1960, but accepted the author's estimates shown in Table 14 as reasonable, provided no additional plant was installed during the period.

d) South African Lighting Association Limited - Grahamstown

The Gas Works at Grahamstown is the smallest public utility of its kind in the Union, and the coal consumption figures do not show any marked variation

Private correspondence DET/JMP dated 23.9.57.
Private correspondence CFP/DP/57/7/0 dated 12.10.57.
Private correspondence dated 24.9.57.

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TABLE 14

CONSUMPTION OF COAL IN GAS PRODUCTION

(Tons of 2,000 lbs)

Year	Johannesburg	Cape Town	Port Elizabeth	Grahamstown	Springs	TOTAL
1937	34,660	18,950	5,970	2,090	-	61,670
1938	42,750	17,900	5,620	2,100	-	68,370
1939	46,960	17,200	5,370	2,360	-	71,890
1940	48,060	17,580	5,990	2,470	-	74,100
1941	50,120	19,380	6,230	2,600	-	78,330
1942	55,820	20,800	7,130	3,290	-	87,040
1943	59,340	23,500	7,900	3,370	-	94,110
1944	58,670	24,000	8,630	3,460	-	94,760
1945	65,460	23,000	9,420	3,760	-	101,640
1946	72,380	19,650	10,040	4,280	-	106,350
1947	72,710	21,800	10,060	4,230	-	108,800
1948	78,870	21,900	11,590	4,500	-	116,860
1949	98,930	20,600	9,940	4,220	-	133,690
1950	99,190	19,700	9,520	4,690	-	133,100
1951	103,290	24,400	11,640	4,920	-	144,250
1952	110,860	25,400	10,580	5,220	-	152,060
1953	118,960	23,000	7,770	4,740	1,800	156,270
1954	115,980	25,500	8,920	4,600	3,300	158,300
1955	111,370	26,900	12,730	4,440	3,000	158,440
1956	120,800	25,300	14,580	4,400	3,450	168,530
Average Annual rate of increase 1937 - 1956						5.4%
FORWARD ESTIMATES						
1957	112,600	26,500	15,000	4,400	5,500	164,000
1958	120,000	27,000	15,000	4,500	9,500	176,000
1959	130,000	27,500	15,000	4,600	9,900	187,000
1960	135,000	28,000	15,100 *	4,700	10,200	193,000
1961	140,000	28,500	15,300 *	4,800	10,400	199,000
1962	150,000	29,000	15,500 *	4,900	10,600	210,000
1963	160,000	29,500	15,700 *	5,000	10,800	221,000
1964	170,000	30,000	15,900 *	5,100	11,000	232,000
1965	180,000	30,500	16,100 *	5,200	11,200	243,000
1966	190,000	31,000	16,300 *	5,300	11,400	254,000

(* Authors Estimates - see comment on Page 60)

Source References

1937 - 1946 Ref. 9 Para. 77

1947 - 1956) Compiled from figures submitted by individual
1957 - 1966) Gas Companies in private correspondence.

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from year to year. In the past a good quality gas coking coal was obtained from Natal but, as this grade of coal is now reserved for Iscor, a semi-coking coal of about 12.00 lbs/lb calorific value is being used. It is estimated that coal consumption may increase by about 100 tons per annum from 1957 onwards, but this would merely restore consumption to 1952 levels by 1956/66. There is little likelihood that additional capacity will be required within the next ten years.

e) Springs Municipal Gas Works

The Gas Works at Springs commenced operations in 1953. A medium grade non-coking coal of 11,400 B.T.U's per lb is used, there being abundant quantities of such coal in and around Kendal, (approximately 50 rail miles distant). The gas produced is carburetted water gas, i.e. gas made from coal in a generator and enriched with Gas Oil which is "cracked" in a carburettor and mixed to give a gas with similar characteristics to coal gas. The advantages of such a plant are that it can be started-up or shut-down at short notice, and also that lower grades of coal can be used. Furthermore the initial capital cost of a water gas plant and the time taken for erection, is much lower than in the case of coal carbonisation. The operating cost however, when using oil for gas enrichment, is higher than similar water gas generators operated in conjunction with a coal carbonisation plant from which by-product coke can be obtained. At Springs the relative costs of electrical energy and town gas are in favour of the latter, and a steady expansion of demand is anticipated during the next ten years.

It will be noted from the above remarks that two categories of coal are in demand for gas production. The first is a good quality coking coal, rich in volatile matter and gas yielding qualities, and with well developed coking properties. Unfortunately this type of coal is comparatively scarce in the Union, and available supplies have now been reserved for Iscor. As a result Gas producers are having to use coal which, whilst still rich in gas yielding qualities, possesses inferior coking properties.

The second type of coal is one which is not required for coking purposes, but which must still possess a high gas yield. This type of coal can be used in a Water Gas plant, such as the one at Springs, and can also be used in a "complete gasification" type of carbonising plant. The latter consists of a gas manufacturing process in which a non-coking coal is completely consumed, leaving only ash and clinker of little or no value as a by-product. The complete gasification process is likely to be applied in South African gas manufacture for all future additional or replacement capacity, because of the restrictions on the use of coking coals for such purposes.

Private correspondence G/1 dated 7.10.57.

The problem of conservation of coking coal and its effect
ϕ on gas production was considered at some length by the 1946/47 Coal Commission. At that time the total annual coal requirement for gas production by the four gas works in the Union was 106,000
ℓ tons, which was expected to rise to 254,000 tons per annum by 1956. In the event, as Table 14 shows, the 1956 total was only 168,530 tons and the Commission's estimate of 254,000 tons is not likely to be achieved for yet another ten years - until 1966.

It will be noticed that the average annual rate of increase in coal consumed by Gas Works over the period 1937 - 1956 was 5.4 per cent, but whereas the increase in total consumption over the first ten years (1937 - 1946) approximated to 70%, that for the second ten year period (1947 - 1956) was only some 55%. This would seem to indicate a diminishing rate of growth in annual coal requirements for gas production. If 5.4% is considered as the average annual rate of increase over the next ten years, a total of some 280,000 tons of coal would be needed in 1966, compared with the figure of 254,000 tons shown in Table 14. The latter figure was compiled from estimates made by the individual Gas Companies and is a carefully reasoned assessment of their coal requirements during the period. On the balance of probabilities it is considered that the Companies' own estimates are likely to prove reasonably accurate and that about 254,000 tons of coal at an average calorific value of 12.00 lbs/lb will be required for municipal gas production in 1966. It is perhaps significant that over the ten year period 1957 - 1966 the anticipated increase in total consumption approximates to the 55% of the previous ten year period, notwithstanding the fact that there are now five major consumers instead of four.

When the figures for total coal consumption shown in Table 14 for the period 1947 to 1966 are plotted on semi-logarithmic graph paper, the trend line shown in Figure 6 results. This curve shows clearly that the steep post-war rise in annual coal consumption levelled off somewhat during the period 1953 to 1955, but is expected to rise again under the influence of demand from the new gas producing equipment installed at Johannesburg, Port Elizabeth and Springs. It is probable that when the new equipment reaches peak production the pattern may repeat itself - that is to say a further levelling off period, until such time as additional productive capacity is installed at one or another of the major centres. It would seem however that this will not be necessary until after 1966.

x 5) THERMAL ELECTRICITY - PUBLIC UTILITIES

Electricity is not in itself a new source of energy, but is a very convenient form into which existing energies can be changed. Electricity gives added utility of form, time and place to energy resources and allows for more flexible and widespread use of existing energy forms. The conversion of water power to electricity enables the kinetic energy of water to be transmitted over hundreds of miles in its new form. Without this energy conversion the effective use of water power would normally be limited to those structures which could be erected on the power site, the waterfall.

ϕ Ref.9, Pps. 23, 39, 71
ℓ Ibid, Para. 80
x Discussion centres around the coal requirements of Escom and Local Authorities in generating electricity for resale. The small amount of coal consumed by private power stations, (e.g. in mining), is included under appropriate consumer headings elsewhere in this Chapter.

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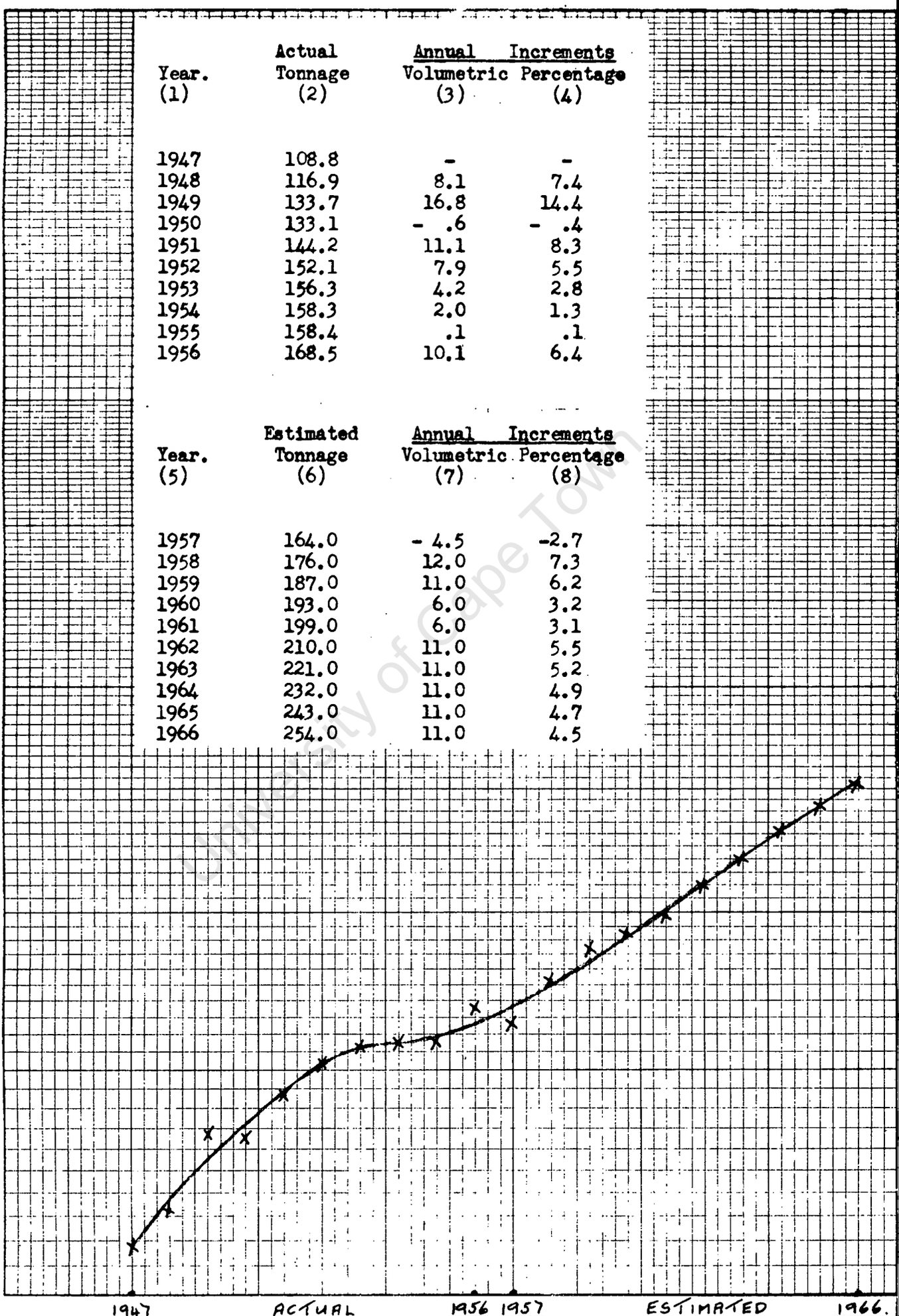
FIG. 6 COAL REQUIRED FOR GAS PRODUCTION

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	108.8	-	-
1948	116.9	8.1	7.4
1949	133.7	16.8	14.4
1950	133.1	- .6	- .4
1951	144.2	11.1	8.3
1952	152.1	7.9	5.5
1953	156.3	4.2	2.8
1954	158.3	2.0	1.3
1955	158.4	.1	.1
1956	168.5	10.1	6.4

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	164.0	- 4.5	-2.7
1958	176.0	12.0	7.3
1959	187.0	11.0	6.2
1960	193.0	6.0	3.2
1961	199.0	6.0	3.1
1962	210.0	11.0	5.5
1963	221.0	11.0	5.2
1964	232.0	11.0	4.9
1965	243.0	11.0	4.7
1966	254.0	11.0	4.5



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In similar manner the use of coal energy, oil energy (or even atomic energy), through the medium of steam for the production of electricity gives a new form to the basic energy which vastly improves its quality and usefulness in hundreds of applications. The direct application of steam power to machinery is a cumbersome process, but electricity is flexible, divisible and immediately available at the turn of a switch. Energy in the form of electricity represents probably the most convenient application available to man. Wherever electricity has been introduced to provide light, heat and power, better living conditions and improved technological developments have resulted. The direct transmission of water power or steam power as mechanical energy could reach only a relatively few feet, compared to the miles that can be spanned by electricity. Hence industries and households no longer need to provide their own source of heat and power - energy can be supplied from a central electricity station, using modern methods which are cheap, efficient and convenient. Countries with adequate water resources can harness the energy contained in falling water for the production of electricity. In
b Switzerland and Norway, for example, virtually all electricity is produced from water power, whilst in Sweden, Austria, Italy, Japan and Canada, hydro-electricity accounts for the major portion of total output. In countries without water power, electricity is produced by thermal power stations which generally use coal as the basic source of power. However, fuel oil, natural gas, or atomic power, can also be used to generate steam for the production of electricity in areas where such products are economically available. The question of whether coal, oil, natural gas or atomic power is used as the basic fuel is really one of economic availability, depending upon which is the cheaper and more efficient fuel for the purpose in the area concerned.

In South Africa, natural sources of potential water power are few, and those one or two sites which are known to exist would require large amounts of capital for development. Furthermore rainfall is irregular and big storage dams would be required to provide the constant flow necessary for continuous electricity production. However vast quantities of coal are available, and the relative cheapness of such supplies has resulted in the large scale construction of coal-fired thermal power stations for the production of electricity. It is interesting to note that
f of the ten top ranking countries for electricity production in 1948 South Africa was tenth in total output but sixth in per capita consumption in the free world, viz:

	Country	Output of Electricity (Billion kilowatts)	Kilowatts per capita	Capita Rank
x	1. United States	336.6	2,290	3
	2. United Kingdom	46.5	930	5
	3. Canada	44.6	3,457	2
	4. Japan	33.6	416	8
	5. Germany	31.3	-	-
	6. France	27.6	674	7
	7. Italy	22.7	297	9
	8. Sweden	14.3	2,073	4
	9. Norway	12.4	3,875	1
	10. South Africa	9.3	788	6

b Ref.17, Page 969
f See also Ref.22, Page 85. This relative ranking was maintained for 1949 and 1950, but unfortunately it has not been possible to locate later statistics.
x Ref.40, Page 604.

The earliest electricity undertakings in South Africa were positioned to serve the larger Municipalities and the transportation systems at main centres of population. The capital cost of these projects was high in relation to the number of potential consumers, but several privately owned utilities were successfully operated in addition to a number of municipal undertakings. Noteworthy amongst the former were the Victoria Falls and Transvaal Power Company Limited, and the De Beers Undertaking at Kimberley. In 1948 and 1949 respectively the assets of these undertakings in the Union were absorbed into Escom.

The Electricity Supply Commission (Escom) was formally
/ constituted in 1922 with the passing of the Electricity Act. The main duties of the Commission in terms of the Act are to establish, acquire and operate electricity undertakings and to co-operate with existing undertakings in order to provide a cheap and abundant supply of electricity wherever required. The Act stipulates that the Commission must operate as far as practicable neither at a profitnor at a loss.

The power stations controlled by Escom constitute by far the largest group of undertakings in the Union, but large municipal undertakings are in existence at Bloemfontein, Cape Town, Johannesburg, Port Elizabeth and Pretoria. With the exception of the small hydro-electric power station at Sabie and one or two stand-by diesel units in rural areas all Escom stations are coal-fired, thus converting the primary energy contained in coal, through the medium of steam, into the more convenient form of electrical energy.

The 1946 /47 Coal Commission dealt at some length with the problem of coal for power station consumption. According to figures submitted to the Commission the total amount of coal sup-
/ plied to power stations in the Union during 1946 was 7,162,000 tons. The best available information for 1956 shows that Escom consumed 10,530,700 tons (Table 15) and that Thermal power stations operated by Municipalities consumed 2,453,800 tons (Table 16) making an approximate total of 12,984,500 tons, showing an overall increase of 81 per cent over the 1946 figure.

Table 15, which gives the coal consumption figures for
x Escom, was compiled from statistical data given in the Annual Reports. However, in the case of the Cape Western Undertaking a "pooling" arrangement operated between the Cape Town Municipality and Escom during the period, in terms of which the operation of all power stations in the area was a joint venture, the output being directed to either party's consumers as required. The coal consumption figures shown for Escom's Cape Western Undertaking in Table 15, and for the Municipality of Cape Town in Table 16, have therefore been apportioned in relation to the actual requirements of each contributor to the "pool", rather than in accordance with the nominal ownership of any particular power station. On balance, during the period 1947 to 1956, the Cape Town Municipality assisted Escom by supplying current from Table Bay and Dock Road power stations. However with the construction of Hex River (1952) and Salt River No. 2 (1955) the position has now been reversed, and Escom will be supplying current to Cape Town for the next few years, until the Municipality's new power station at
¤ Athlone comes into operation. The formal pooling arrangements ended in May 1957.

/ Act. No. 42/1922
/ Ref. 9, Para. 334
x Ref. 41, Statement 5
¤ In other regions "pooling" arrangements exist for the supply of current between Escom and the larger municipalities during peak periods. These facilities do not involve the joint operation of power stations as in the Western Cape.

TABLE 15 - COAL CONSUMED BY THE ELECTRICITY SUPPLY COMMISSION 1947 - 1956

(Actual coal consumption in tons of 2,000 lbs.)

UNDERTAKING	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	Average Calorific Value (B.T.U./lb)	Average Annual Rate of Increase
Cape Western	144,000	158,000	176,000	190,000	213,000	251,000	262,000	291,000	352,000	384,000	11,700	11,51%
Cape Northern ϕ	-	-	*50,000	54,100	61,500	65,700	71,700	77,500	80,500	84,500	12,200	7.79%
Border	47,200	60,400	62,500	69,800	78,500	88,900	100,900	118,700	136,000	129,000	11,300	11.82%
Natal (Southern and Central)	575,000	623,900	646,800	683,700	738,500	797,600	881,000	972,900	1,066,900	1,131,300	11,700	8.33%
E. Transvaal, Rand and Orange Free State	-	-	5,234,800	5,795,200	6,101,100	6,438,500	6,692,200	7,249,200	8,156,500	8,751,900	9,500	7.62%
TOTALS:	-	-	6,170,100	6,792,800	7,192,600	7,691,700	8,007,800	8,709,300	9,793,900	10,530,700	10,000*	7.94%
Annual rate of growth	-	-	-	10.09%	5.89%	6.94%	4.11%	8.76%	12.45%	7.52%		

(* Estimated) (ϕ Figures for 1947/48 not comparable - see text).

(Source: Ref. 41, Statement No. 5; Ref. 39, Table No. 1; and private correspondence with Cape Town & Escom 30/9/57).

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TABLE 16 - COAL CONSUMED BY MUNICIPAL ELECTRICITY UNDERTAKINGS 1947 - 1956

(Actual coal consumption in tons of 2,000 lbs.)

UNDERTAKING	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	Average Calorific Value (B.T.U./lb)	Average Annual Rate of Increase
Alival North	4,100	4,860	5,470	5,900	5,530	5,580	6,080	6,000	6,010	6,640	12,600	5.50%
Beaufort West	4,200	4,300	5,000	5,550	5,920	6,190	8,660	8,420	8,800	8,910	11,600	8.72%
Bloemfontein	45,530	53,160	64,220	66,690	77,350	86,590	93,730	102,800	114,230	102,260	11,000	9.39%
Cape Town	290,000	330,000	360,000	350,000	385,000	420,000	425,000	430,000	450,000	470,000	11,800	5.51%
Cradock	4,620	4,660	4,790	5,470	6,220	6,590	7,100	8,970	9,740	10,380	12,200	9.41%
George	4,300	5,000	5,610	6,730	7,450	8,580	9,620	10,370	10,350	11,480	12,200	11.53%
Grahamstown	10,000	10,000	11,100	11,800	12,780	14,740	16,060	18,540	20,720	22,810	12,100	9.60%
Johannesburg	379,980	413,390	474,130	550,060	629,210	727,190	832,890	842,320	891,910	896,710	11,300	10.01%
Kroonstad	7,990	9,570	10,460	11,060	7,600	5,370	6,100	9,460	12,100	12,220	12,100	4.83%
Oudtshoorn	5,500	6,500	8,020	7,920	8,310	9,760	11,420	13,200	13,790	13,850	12,500	10.81%
Pietersburg	9,440	8,860	9,800	11,360	11,630	12,720	11,480	16,120	19,430	21,380	12,000	9.48%
Port Elizabeth	133,750	147,440	164,290	187,630	202,720	223,920	246,600	251,410	268,040	285,630	11,500	8.80%
Pretoria	193,340	211,030	241,650	279,040	296,900	318,100	433,770	484,360	522,180	508,420	11,500	11.34%
Queenstown	8,650	9,510	10,430	11,460	12,700	14,620	16,420	15,420	15,290	15,210	12,200	6.47%
Umtata	-	-	-	-	-	4,400	5,600	5,780	6,680	6,750	12,000	11.29%
Upington	4,380	4,500	4,530	4,560	5,010	5,170	5,340	5,950	6,090	7,900	12,400	6.75%
Vryheid	4,010	4,690	5,660	5,960	7,000	8,520	9,000	11,000	14,000	16,990	12,500	17.40%
17 Smaller Towns*	16,650	18,410	20,770	22,820	25,230	28,170	32,170	33,600	35,850	36,260	12,000	9.03%
TOTALS:	1,126,490	1,245,880	1,405,930	1,544,010	1,707,060	1,906,210	2,177,040	2,273,720	2,425,710	2,453,800	11.500*	9.04%
Annual rate of growth	-	10.60%	12.85%	9.82%	10.56%	11.67%	14.21%	4.44%	6.68%	1.16%		

(* Estimated)

(Compiled from figures submitted by the above Undertakings)

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Coal consumption figures for the Northern Cape and Witwatersrand areas have not been shown in Table 15 for the years 1947 and 1948. In the first case, the De Beers Power Station at Kimberley was not taken over by Escom until the end of 1949 and, in the second case, the assets in the Union of the Victoria Falls and Transvaal Power Company Ltd. were only absorbed by Escom on 1st July 1948. The 1946 and 1947 figures for Escom coal consumption would therefore have little relevance to succeeding years, in view of the abnormal increase in 1949. Figures for subsequent years reflect the normal rate of growth (including additional capacity) and it is interesting to note that a 10% average rate of increase in the sale of electrical energy (Table 17) has been brought about by an 8% average increase in coal consumption (Table 15). The actual figures are 10.34% and 7.94% respectively, indicating an improvement in power station operating and thermal efficiencies over the years. (See Table 18).

The 1946/47 Coal Commission considered the then increasing demand for pea coal for power station use and noted that it had
ß become necessary to supply mixed smalls, duff and crushed coal, to maintain supplies. Since that time the position has deteriorated both in regard to quality and quantity of coal supplied to power stations, although new plant installed during recent years has been designed to operate on the lower grades of coal now available. Coal of only moderate calorific value is an expensive fuel for power stations situated hundreds of miles from the coal field, as railage rates are constant, irrespective of grade. In 1946,
ƒ for example, the delivered cost of coal at Cape Town was 25/9d per ton (of which 80% represented railage costs), whilst in 1956 the average cost was 42/3d per ton delivered. Since railage costs represent a large proportion of total energy costs under such conditions, it is obviously advantageous to rail only the best quality coal. This is even more important when viewed in the light of the fact that a 10% depreciation in calorific value involves burning more than 10% additional coal. Poor quality coal can be separated from good quality coal by sorting and washing, and the Price Controller apparently recognises this by laying down
x basic controlled prices which differentiate between coals above 12.00 lbs/lb calorific value and those below. There is also a differential between duff coal (9/2d to 9/8d per ton) and all other bituminous coal (11/4d to 11/9d per ton) at Transvaal pithead prices.

The higher price of 11/9d per ton applicable to coal having a calorific value above 12.00 lbs/lb should help to encourage the production of selected coal of uniform high quality and correct size classification. However certain large consumers of coal such as the South African Railways, the Gold Mines
æ and power stations have found it necessary to offer an inducement of one penny per ton extra in price for each additional 0.1 lbs/lb unit increase in calorific value of coal delivered. This lends emphasis to the advantages to be gained by using coal of the best possible quality, even at a slightly higher pithead cost. On economic grounds it would probably be well worth while to pay a little more for selected pea coal of high calorific value for railage to, say, Cape Town, as the little extra on total cost would probably be returned handsomely in greater generating efficiency.

ß Ref. 9, Pages 90 - 91
ƒ Ref. 41, Statement 9
x G.N.552 in G.G.5852 dated 12.4.57.
æ Ref. 57, Page 22.

TABLE 17 - ANALYSIS OF SALES OF THERMAL ELECTRICAL ENERGY BY ESCOM 1947 - 1956

(Thousands of KWH)

YEAR	TRACTION (1)	%	BULK (2)	%	MINING (3)	%	INDUSTRIAL (4)	%	DOMESTIC (5)	%	TOTAL (6)	ANNUAL RATE OF GROWTH
1949	517,506	8.7	920,343	15.5	3,556,839	59.9	846,776	14.3	95,069	1.6	5,936,533	-
1950	524,025	7.9	1,106,456	16.7	3,892,330	58.7	990,657	15.0	113,946	1.7	6,627,414	11.64%
1951	539,367	7.5	1,260,677	17.6	4,098,522	57.0	1,149,942	16.0	134,409	1.9	7,182,917	9.38%
1952	554,830	7.1	1,459,453	18.7	4,326,732	55.4	1,337,692	17.1	130,953	1.7	7,809,660	8.73%
1953	584,498	6.9	1,640,011	19.3	4,730,066	55.7	1,402,126	16.5	134,935	1.6	8,491,636	8.73%
1954	619,208	6.6	1,839,011	19.4	5,311,267	56.2	1,539,886	16.3	142,212	1.5	9,451,584	11.30%
1955	689,736	6.4	2,047,614	19.1	5,971,698	55.6	1,880,527	17.5	156,611	1.4	10,746,188	13.70%
1956	739,744	6.2	2,282,174	19.3	6,439,300	54.5	2,187,102	18.5	174,026	1.5	11,822,346	10.01%
Average Annual Rate of Increase	5.24%		13.85%		8.85%		14.52%		9.02%		10.34%	

(Source Ref. 41, Statement No. 4)

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One of the arguments advanced by producers against the marketing of selected coal, is that the washing and sorting process would produce a large amount of unsaleable duff. Large quantities of duff are dumped annually, but today there are a number of power stations built near the coal fields and designed to burn an unsorted mixture of peas, nuts and duff coal. The demand for "mixed small" coal in these areas so far exceeds the supply that it is now common practice to crush round coal to smaller sizes of nuts, peas and duff.

Generating authorities are naturally anxious to obtain the maximum possible heat energy from the coal consumed, but calorific value is only one part of their problem. The other is that most of the boilers at the older power stations, and in particular at the coastal undertakings, are not designed to burn crushed coal. The expense of re-designing and rebuilding existing boiler houses would be prohibitive, but the screening and washing of crushed coal to eliminate duff and improve average calorific values would apparently be an economic proposition to producers only if a greater price incentive could be offered for washed and sorted coal. The position of producers in this respect has been summarised by Dr. P.N. Lategan and Dr. A.J. Petrick of the Fuel Research Institute, in the following self-explanatory paragraphs:

> "Improvement in the calorific value of the sales product from a given raw coal can only be obtained by increasing the discard during preparation, i.e. by effecting separation in the washer at a lower specific gravity.
>
> From a number of tests conducted at the Institute on bulk samples of commercial sizes of coal, it would appear that, on the average, an increase of 0.1 lbs/lb unit in calorific value is accompanied by a yield loss of roughly 4 per cent.
>
> If this coal be valued at 100d per ton, the loss incurred by washing at a lower specific gravity to produce a better sales product would be about 4d per ton on coal discarded to the dump for every 0.1 lbs/lb unit gain in the calorific value of the sales product.
>
> Under such circumstances, a lower grade colliery improving the quality of its coal from 11.9 to 12.1 lbs/lb in calorific value might thus lose 8d saleable coal to attain a 5d gain in the allowed pithead price of the coal offered for sale.
>
> One must therefore, conclude that there is no real incentive to clean coal beyond the limit of separating out stone and very poor coal so as to obtain an acceptable sales product. Even in this case, the operating cost of a preparation plant of, say, 1s. to 2s. per ton of throughput is a big item in the production cost where the pithead price of the coal is only about 11s. per ton. Furthermore since a large proportion

Ref.9, Para.461
Ref.57, Page 22.

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TABLE 18 - ESCOM POWER STATION OPERATING STATISTICS - YEAR 1956.

	Units Generated	Units Sent Out	Coal Burned Tons (2,000 lb)	LBS OF COAL Per Unit Generated	LBS OF COAL Per Unit Sent Out	Average Calorific Value of Coal (B.th.U.)	B. Th. U. PER UNIT Generated	B. Th. U. PER UNIT Sent Out	OVERALL THERMAL EFFICIENCY % Generated	OVERALL THERMAL EFFICIENCY % Sent Out
Brakpan	90,637,156	82,763,872	111,758	2.466	2.701	10,080	24,860	27,230	13.7	12.5
Central, Kimberley	82,958,100	74,726,900	84,498	2.037	2.262	12,180	24,810	27,550	13.8	12.4
Colenso No. 1 and No. 2	594,999,050	560,389,120	442,218	1.486	1.578	11,930	17,730	18,830	19.2	18.1
Congella No. 1 and No. 2	809,592,975	750,133,309	551,487	1.362	1.470	11,650	15,870	17,130	21.5	19.9
Hex River	216,685,000	205,444,070	125,520	1.159	1.222	11,570	13,410	14,140	25.4	24.1
King William's Town	8,310,050	7,848,812	8,490	2.043	2.163	12,590	25,720	27,230	13.3	12.5
Klip	2,651,570,266	2,474,278,848	2,190,677	1.652	1.771	9,580	15,830	16,970	21.6	20.1
Rosherville	176,580,695	166,346,408	277,318	3.141	3.334	9,840	30,910	32,810	11.0	10.4
Salt River No. 1	39,835,232	34,477,200	27,322	1.952	2.256	11,650	22,730	26,330	15.0	13.0
Salt River No. 2	385,707,600	365,244,365	224,546	1.110	1.173	11,670	12,950	13,690	26.3	24.9
Simmerpan	50,767,565	47,741,957	89,619	3.531	3.754	9,870	34,850	37,050	9.8	9.2
Taaibos	1,737,459,628	1,601,003,719	1,114,059	1.282	1.392	9,300	11,920	12,950	28.6	26.3
Umgeni	303,775,800	284,854,290	187,551	1.235	1.317	11,260	13,910	14,830	24.5	23.0
Vaal	1,738,801,327	1,685,714,335	1,413,356	1.580	1.677	8,960	14,160	15,030	24.1	22.7
Vereeniging	744,873,258	722,716,224	863,420	2.229	2.389	9,000	20,060	21,500	17.0	15.9
Vierfontein	1,880,803,521	1,758,287,089	1,401,498	1.490	1.594	9,270	13,810	14,780	24.7	23.1
West Bank No. 1 & No. 2	139,696,500	130,793,987	120,490	1.725	1.842	11,730	20,230	21,610	16.9	15.8
Wilge	1,003,919,562	929,539,514	640,452	1.276	1.387	9,870	12,590	13,600	27.1	25.1
Witbank	718,007,209	664,547,752	649,760	1.810	1.955	11,230	20,330	21,950	16.8	15.5

(Ref; 41 Statement No. 5)

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of the cost of operating the plant will be made up of capital and finance charges, it can be appreciated that, unless an incentive exists to provide coal of a high grade, the colliery will be inclined to choose the cheapest and simplest preparation lay-out capable of producing saleable coal".

The coal consumption figures for Escom over the past ten years are given in Table 15, and reference to Table 18 gives interesting information for the year 1956, showing the operating statistics of each power station. It will be observed that the consumption of coal in lbs per unit generated varies from a little over 1.1, in the case of newer power stations such as Hex River and Salt River No. 2, to over 3.0 in the case of older stations such as Rosherville and Simmerpan. (This latter was closed down in 1957). Similarly the two first named power stations show thermal efficiencies of over 25% whilst the latter two operated at 11.0% and 9.8% respectively.

Table 17 provides an interesting analytical study. It will be noticed that the units supplied for electrical traction (all to the S.A.R.) show an average rate of increase of 5.24%, equivalent to a total increase of 43% over the period. These figures should be compared with those for locomotive coal consumption given in Table 13, Page 48, from which it can be seen that the average annual percentage rate of increase in the consumption of electrical energy for traction purposes is greater than the average annual percentage rate of increase in the use of locomotive coal. However 6.26% of Escom's 1956 coal consumption (Table 15) represents only some 660,000 tons of coal used to produce traction electricity, compared to the 7,000,000 tons consumed by steam locomotives, (Table 13). Bearing in mind the fact that electric traction probably accounts for between one-third and one-half of the total ton-miles operated at the present time, the relative coal consumption figures for electric and steam operation reflect the vast superiority in tractive efficiency of the former.

The column headed "Bulk" in Table 17 records the sale of electricity by Escom to various local authorities for their own reticulation purposes. Many smaller municipalities purchase current in bulk in this way, but there are also a number of larger customers, noteworthy being Durban, Pietermaritzburg, Kimberley and East London. Other municipalities with their own power stations sometimes prefer to purchase their additional needs from Escom, rather than to extend their own capacity at relatively high cost. The coal consumption figures for Grahamstown in Table 19 reflect a position of this sort, where the existing power station will continue to operate at maximum capacity and additional needs will be met by bulk purchase of current from Escom.

The figures for the consumption of electrical energy by the mining industry (Table 17) show that 54.47% of 1956 production was for this sector of the national economy. The small output of hydro-electricity from Sabie power station was also devoted to mining. (1956 figure 6,000,000 units). It is significant that whilst Escom is thus aiding the mining industry, the consumption of the mines in turn allows Escom to obtain economies of large scale production, the benefits of which ultimately reach the domestic

b A Coal Preparation Pilot Plant has been established near Pretoria in which research will be undertaken on methods of economically washing and sorting coal, to provide various grades and sizes with as little waste as possible. See Ref.57, Page 20.

f See analysis in Part Two of this Chapter.

consumer in the form of lower electricity costs.

Industrial and Domestic consumption (shown in columns 4 and 5) together accounted for some 20% of 1956 electricity production by Escom. However the 1.47% shown for Domestic consumers only covers those areas where Escom has its own reticulation network. The majority of domestic consumers are provided with electricity from municipal reticulation systems, and in Table 17 the major portion of units shown in column two is probably re-sold for domestic consumption in urban and rural centres.

The average annual rates of increase in the consumption of electrical energy, as shown in Table 17 for the years 1949 to 1956, tell their own story. As already mentioned, the conversion from steam to electrical traction by the S.A.R. proceeds steadily, but the long term nature of the project is emphasised by the comparatively low rate of increase in electrical energy consumed. The 13.85% shown for "Bulk" and the 9.02% shown as "Domestic" should be considered together, and these figures reflect the increasing use of electrical energy in the larger cities, plus the addition of further consumers as the Escom bulk distribution network spreads across the country to the smaller inland towns. The average annual rate of increase for Mining (8.85%) and for Industry (14.52%) shows the steady development of the Union's primary and secondary sources of industrial wealth and reflects the considerable post-war expansion of the latter. It should of course be remembered that the figures shown in Table 17 are for Escom only, and that there are other power stations operated by the larger municipalities. The Escom output however represents 80% of the total production of electrical energy in the Union, and Escom probably supplies most of the needs of transport, mining and heavy industry.

Statistical data for coal consumption by municipal electricity undertakings is given in Tables 16 and 19. There are seventeen municipal undertakings operating coal fired power stations which each send out over five million units per annum (1946) and a further seventeen such stations sending out less than five million units per annum. To obtain coal consumption figures a questionnaire was addressed to the major municipal consumers and their replies (100%), in terms of actual coal consumption over the past ten years and anticipated requirements for the next ten years, are collated in the above Tables. Coal requirements for the seventeen smaller undertakings were estimated on the basis of units generated in 1956 at an average coal consumption of 2.5 lbs per unit. Since the consumption of these smaller undertakings represents only about 1½% of the total, figures for earlier and later years were estimated on this basis.

It will be seen from Table 16 that the total coal consumed by municipal electricity undertakings in 1956 was a little less than 2½ million tons. When this is added to the figure of a little over 10½ million tons shown for Escom in Table 15, it gives a total of some 13 million tons of coal used in the production of thermal electrical energy during the year. This represents about 37% of all the coal sold during 1956.

6 Ref.42, Section 10, Tables A & D.

TABLE 19 - ANTICIPATED COAL CONSUMPTION BY MUNICIPAL ELECTRICITY UNDERTAKINGS 1957 - 1966

(In tons of 2,000 lbs)

UNDERTAKING	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	Average Annual Rate of Increase
Alival North	6,800	7,200	7,600	8,000	8,400	8,800	9,200	9,600	10,000	10,400	4.83%
Beaufort West	9,700	10,500	12,000	13,000	14,500	16,000	17,500	19,000	20,500	22,000	9.53%
Bloemfontein	110,000	119,000	128,000	138,000	149,000	160,000	173,000	187,000	202,000	218,000	7.90%
Cape Town	450,000	420,000	445,000	505,000	555,000	615,000	640,000	660,000	685,000	710,000	5.20%
Cradock	11,400	12,300	13,200	14,200	15,200	16,400	17,600	18,900	20,400	21,900	7.52%
George	12,700	13,900	15,300	16,800	18,500	20,000	21,500	23,300	25,000	27,000	8.74%
Grahamstown	23,500	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	24,000	0.23%
Johannesburg	895,300	967,000	1,044,000	1,117,000	1,195,000	1,267,000	1,343,000	1,423,000	1,508,000	1,593,000	6.65%
Kroonstad	12,300	12,500	13,000	30,000	32,000	35,000	40,000	45,000	50,000	55,000	18.11%
Oudtshoorn	14,500	15,300	16,000	16,800	17,700	18,600	19,500	20,500	21,500	22,500	5.00%
Pietersburg	24,000	28,000	30,000	32,000	35,000	38,000	40,000	44,000	48,000	53,000	9.17%
Port Elizabeth	303,700	321,900	341,200	361,200	383,400	406,400	430,800	456,700	434,100	513,100	6.00%
Pretoria	554,400	560,000	575,000	600,000	648,000	700,000	756,000	816,000	880,000	950,000	6.17%
Queenstown	17,800	18,700	20,300	21,800	23,600	25,500	27,500	29,700	32,100	34,600	7.66%
Umtata	5,900	7,400	9,000	7,700	8,300	8,800	9,800	10,500	12,000	13,500	9.63%
Upington	9,300	10,000	10,000	12,000	12,000	12,000	13,000	14,500	17,000	19,000	8.26%
Vryheid	23,700	27,500	30,800	33,900	37,300	40,000	44,000	48,500	53,000	58,400	10.54%
17 Smaller Towns	37,300	38,600	41,000	44,300	47,600	51,100	54,400	57,700	61,300	65,200	6.40%
TOTALS:	2,522,300	2,613,800	2,775,400	2,996,200	3,224,500	3,462,600	3,680,300	3,907,900	4,153,900	4,415,600	6.42%
Annual Rate of Growth	2.79%	3.63%	6.18%	7.96%	7.62%	7.38%	6.30%	6.17%	6.29%	6.30%	

(Compiled from estimates submitted by the above Undertakings)

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Table 16 shows actual coal consumption figures for municipal undertakings and it will be noticed that the average calorific value of the coal consumed is higher than that for Escom (Table 15) and also that the average annual rate of increase, based on total figures, is higher for municipalities than for Escom (9.04% compared to 7.94%). The higher calorific value of coal is necessary because the municipal power stations are, for the most part, smaller units which are not designed to burn lower grades and, in any case, are so situated that railage costs are a vital component of total coal charges. In such circumstances, as already mentioned, it is not profitable to burn low grade coals. The higher average annual rate of increase in municipal power generation is probably due to post-war industrialization of South Africa with its accompanying rapid growth in the urban centres of population supplied by these various Municipalities.

It is significant that the actual average annual rate of increase of 9.04% shown in Table 16, is replaced by an estimated average annual rate of increase of 6.42% in Table 19. From this it would appear that the municipalities concerned do not expect the tempo of expansion of the past ten years to be maintained over the next ten years. However, an estimated expansion of 6½% per annum will still call for a considerable increase in electricity production, reflecting an anticipated 75% increase in coal consumption by municipal power stations over the 10 year period.

Table 19 is also interesting in that it represents a composite picture of the anticipations of 16 of the larger municipalities in regard to probable electrical energy output over the next ten years. The expectations of individual cities show marked divergence, but this was to be expected as local planning varies from region to region. It is however both interesting and informative to see how the overall average annual rate of increase of 6.42% in coal consumption compares with the anticipations of Escom.

The pattern of coal consumption by Escom during the post-war period is shown in Table 15, but analysis of the position of individual undertakings and their likely future power requirements reveals the following:-

a) Cape Western - Salt River No. 1 was the sole power station belonging to Escom in this area until 1952. In that year the Hex River plant came into operation at Worcester and this was followed by Salt River No. 2 in 1955. It is envisaged that the additional capacity thus provided will be sufficient to cater for the needs of the Western Cape for at least the next ten years, and that no new power station construction will be needed during this period. The possible extension of electrification of the railway line from Touws River to Beaufort West may, however, affect the position from about 1962 onwards. Having regard to the additional generating capacity now available in the Western Cape and the improved thermal efficiency of the new power stations, an average annual rate of increase in coal consumption of between 7% and 8% seems likely over the next ten years.

Grahamstown has been omitted, as this city expects to purchase its increased needs in bulk from Escom. The overall average rate of increase (6.42%) in coal consumption will not be materially affected.

Based on information contained in the Annual Report for 1956 (Source Ref.41) and from private correspondence with Escom (dd. 19.9.57.)

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b) Cape Northern - The Central Power Station at Kimberley is one of the older and less efficient units in the Escom system (see Table 18). However there is no suggestion of its replacement within the next few years and it is expected that it will continue to operate at optimum capacity. Additional power will be available from the Rand and Orange Free State Undertaking during the second half of 1958, when the 132 kV interconnector system is completed. This will relieve the load on the Central Station and provide for future expansion needs in the area.

c) Border Undertaking - Additional generating capacity has reffently been installed in the West Bank Power Station, and a 66 kV interconnector system now links Kingwilliamstown with East London. This will allow the older and less efficient Kingwilliamstown plant to be operated for peak loads only, thus obtaining an overall saving in the figure of lbs of coal consumed per unit generated in the Undertaking. Enquiries have been issued for a third set of turbo-generators and boilers to be installed in the West Bank No. 2 Power Station at East London around 1960. The rate of development of the Border Undertaking over the next ten years may possibly be a little less than in other areas, an average figure of between 6% and 7% per annum being anticipated by Escom.

d) Natal Undertakings - Extensions at Colenso and Umgeni power stations are already in hand, but Escom envisages the need to provide a new power station by about 1960-62. The choice of site for this new power station will depend largely upon the cost of coal in Natal; as compared to the cost of coal at a site in the Transvaal plus the required interconnecting transmission system to carry the power to Natal. The Natal coal producers may prefer to retain their present reserves for future export purposes, in which case the new power station would probably be built in the Transvaal. However, if the prospects for coal exports are not considerably brighter by 1960, the Natal collieries may make a favourable bid for the new station to be built in the Dundee/Vryheid area. Such a move would have considerable effects on the growth of secondary industry in Northern Natal. Bearing in mind the large cooling requirements of a modern power station the Dundee/Vryheid area with adjacent sources of both coal and water, would seem to offer several possible sites for Escom's new project.

e) Eastern Transvaal, Rand and Orange Free State - These undertakings cover the major mining and industrial areas of the country and together they account for over 80% of the total consumption of electricity in the Union. The Rand/Orange Free State Undertaking supplies the existing mines and cities of the Witwatersrand, whilst in the Orange Free State mining and residential demand continues

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to grow. Additional generating plant has been installed in the new power stations Vierfontein, Wilge and Taaibos and further extensions are contemplated. The new Highveld Power Station, which is expected to be in service by the end of 1958 is to be expanded to an installed capacity of 360,000 KW. The rate of increase in demand in the Rand and Orange Free State areas is such that new power stations are in the design stage even before other new stations have progressed much beyond excavations for foundations.

The Eastern Transvaal is now sharing in the mining development boom with a new goldfield in the Bethal area. In addition, electrification of the S.A.R. main line between Witbank and the East Rand is scheduled for completion by 1960. Having regard to the fact that about five years is required to build and bring into service the first units of a major power station, a large new project has been authorised in the Eastern Transvaal, to be known as the Komati Power Station.

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"Komati Power Station is required to meet the future power requirements of the Rand and Orange Free State Undertaking and the Eastern Transvaal Undertaking. The existing installed capacity in the power stations of these Undertakings is approximately 2,000,000 kW, and a further 420,000 kW will be added to the total by the year 1960. In this instance therefore, Escom contemplates a station of 1,000,000 kW capacity, to provide for the growth of load on these systems from 1961 onwards.

The location of a power station of this size is usually settled by the sources of water and coal. Escom is at present abstracting large quantities of water from rivers on the Transvaal Highveld - the Vaal River, the Olifants River and the Wilge River - and will abstract even greater quantities when the new power stations Vierfontein, Taaibos, Highveld and Wilge are fully developed. It was not possible to obtain any further water from these rivers for power purposes and it was therefore necessary to obtain water from another river and, in consultation with the Department of Water Affairs, it was found that the nearest adjacent water supply source was the Komati River. The Department of Water Affairs is, at the request of Escom, now constructing a dam on the Komati River at a point approximately eight miles north of Carolina.

ϕ Ref.41, (1956) Pages 7 - 8

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There are several proved coal deposits which could provide coal for the proposed station for 25 to 30 years. The mining companies that own these coal deposits have been invited to submit offers for the supply of coal to the Komati Power Station and the siting of the power station must await the replies of these mining companies.

It is contemplated that Komati Power Station will be built with 100 MW units, using a steam pressure of 1,200 lbs. per square inch and a temparature of 950°F. Under these steam conditions a thermal efficiency of 28.5 per cent is expected. Komati Power Station, when it is fully developed, is likely to cost about £55,000,000. The period of construction may extend to 12 or 15 years.'

The general opinion of Escom authorities is that the next ten years will see a continued high level of electrical development, calling for an average rate of increase in coal consumption at power stations of approximately 8.0% per annum. Table 15 shows that over the past ten years the rate of increase averaged 7.94% per annum so that, in effect, Escom expects the present high rate of development to be maintained in the future. Having regard to the continued expansion of the power distribution network, and bearing in mind that the Natal and Northern Cape Undertakings will probably soon be linked to the Eastern Transvaal, Rand and Orange Free State system, it would seem that the day is not too far distant when all Escom Undertakings will be interconnected. The distribution network for electrical energy is steadily spreading across the Union from cities to towns, to dorps and even to individual farms. The South African Railway system is being gradually electrified and here again it is possible to foresee the day when most of the main line traffic will be hauled by electric traction.

The expectations of Escom and Local uthorities in regard to coal requirements for electrical generation over the next ten years are summarised in the following Table. Escom's needs have been based on their own assessment of an overall average 8% per annum increase over the 1956 figure of 10,530,700 tons (Table 15). The requirements of Local Authorities have been taken from Table 19 which gives a tabulated summary of expectations in regard to municipal coal consumption for power generation. These figures represent the assessed expectations of the men-on-the-job and, having regard to the above brief review of the situation viz-a-viz power generation, it is felt that the following tabulation provides a realistic picture:-

COAL REQUIRED FOR ELECTRICITY GENERATION
(Tons of 2000 lbs)

YEAR	ESCOM	LOCAL AUTHORITIES.	TOTAL
1957	11,373,000	2,522,000	13,895,000
1958	12,294,000	2,614,000	14,908,000
1959	13,277,000	2,775,000	16,052,000
1960	14,340,000	2,996,000	17,336,000
1961	15,487,000	3,224,000	18,711,000
1962	16,725,000	3,463,000	20,188,000
1963	18,064,000	3,681,000	21,745,000
1964	19,509,000	3,908,000	23,417,000
1965	21,069,000	4,154,000	25,223,000
1966	22,755,000	4,416,000	27,171,000

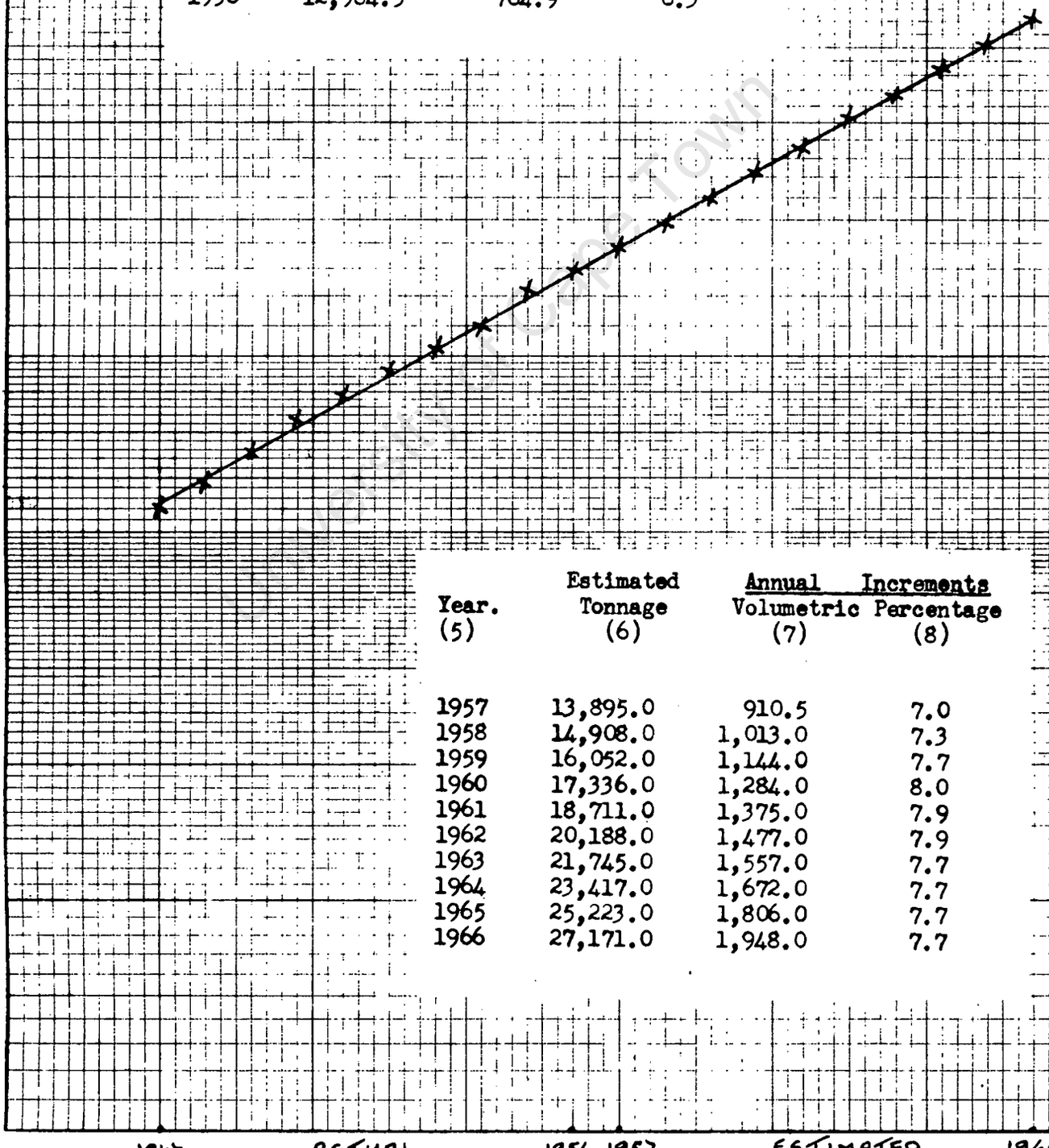
ƀ Private correspondence with Escom dated 19.9.57.

FIG. 7 COAL REQUIRED FOR ELECTRICAL GENERATION

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	6,416.5	-	-
1948	6,958.9	542.4	8.5
1949	7,576.0	617.1	8.9
1950	8,336.8	760.8	10.0
1951	8,899.7	562.9	6.8
1952	9,597.9	698.2	7.8
1953	10,184.8	586.9	6.1
1954	10,983.0	798.2	7.8
1955	12,219.6	1,236.6	11.3
1956	12,984.5	764.9	6.3



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	13,895.0	910.5	7.0
1958	14,908.0	1,013.0	7.3
1959	16,052.0	1,144.0	7.7
1960	17,336.0	1,284.0	8.0
1961	18,711.0	1,375.0	7.9
1962	20,188.0	1,477.0	7.9
1963	21,745.0	1,557.0	7.7
1964	23,417.0	1,672.0	7.7
1965	25,223.0	1,806.0	7.7
1966	27,171.0	1,948.0	7.7

1947 ACTUAL. 1956 1957 ESTIMATED. 1966

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It will be noticed from the above figures that the overall increase in coal consumption by Escom is about 100%, compared to a 75% increase on the part of local authorities. This is considered to be a fair reflection of the part that each is likely to play in meeting the demand for electrical energy during the next ten years. Local authorities will have to meet a steadily increasing need in their own already established areas but Escom, in addition to catering for normal annual increases in demand, is also pioneering the distribution of electricity into areas which hitherto have been without bulk power supplies.

In order to assess the value of the forward estimates of coal required for electricity generation a trend chart was prepared (Figure 7) showing actual consumption during the past ten years, as well as estimates for the next decade. In the chart, coal requirements for the period 1947-56 have been obtained by adding the totals shown in Tables 15 and 16. For the years 1947 and 1948 in Table 15 tonnages of 5,290,010 and 5,713,020 (respectively) were allowed, these figures being calculated so as to maintain the 7.94% annual rate of increase shown on the right of the Table. The annual tonnage figures thus obtained for 1947-56 are shown on the left of Figure 7 and to them have been added the estimates for the next decade, as given on the previous page. It will be noticed that the straight line trend of the first ten years is continued by the estimates for the second ten years, thus indicating that the trend of coal consumption for the production of electricity is expected to follow a constant upward pattern for at least the period of this review.

In the opening remarks of this Section it was mentioned that in 1948 South Africa ranked tenth in total output and sixth in per capita consumption of electrical energy in the free world. The above brief review of supply and demand factors in the production of electrical energy shows that the Union is well committed towards the long term utilization of part of its vast reserves of coal energy in the more convenient and more easily distributed form of electrical energy. In this respect the position is analogous to that of Canada and the Scandinavian countries where abundant water power is converted into hydro-electricity. There is however the significant long-term difference that coal, when used up, cannot be replaced, whereas water power is a self-replenishing source of energy.

South Africa is the fortunate possessor of one other source of mineral energy in the form of Uranium Oxide extracted from processed gold ores. This mineral is used in the production of atomic energy and, so far, the atomic process has been mainly developed as an alternative form of heat for steam raising purposes in the production of thermal electricity. Escom is fully aware of the potentialities of atomic energy in the generation of electricity, but the economic use of such a process hinges entirely upon the question of relative cost. The position can perhaps best be summed up in the following extract from the Escom 1956 Annual Report, dealing with the use of nuclear energy for the generation of electricity.

6 "USE OF NUCLEAR ENERGY FOR THE GENERATION OF ELECTRICITY

Of the new developments in the power supply industry none holds out greater promise for the future, nor attracts greater public interest, than the use of nuclear energy for the generation of electricity.

Escom power stations which are now being developed or are on the drawing board as definite future stations, are all coal-burning stations. This decision rests upon the conditions that prevail at present in South Africa; inter alia -

(i) the fact that South Africa possesses large reserves of coal which can be exploited at a comparatively low cost;
(ii) in the case of the power systems in which the cost of transporting coal adds greatly to the cost of coal, the feature that at present the base load is relatively small;
(iii) the extra capital cost of nuclear power stations;
(iv) the fact that much of the present engineering in nuclear power stations is experimental.

None-the-less Escom is vitally interested in these new developments, and indeed the members of the Commission consider it essential that Escom should take every opportunity of keeping in touch with these developments.

In August 1955, representatives of the South African Government including the Chairman of Escom Dr. J.T. Hattingh, attended the International Conference on the Peaceful Uses of Atomic Energy which was held in Geneva, Switzerland. The General Manager of Escom Mr. G.R.D. Harding, also attended this Conference. During 1956, from the 17th - 23rd June, the Chairman as a representative of the Union Government and the General Manager as the official delegate of the South African National Committee of the World Power Conference attended the 5th World Power Conference held in Vienna. At this Conference a number of papers were presented on the use of nuclear energy for power generation.

In January 1957, a Commission of Enquiry into the Application of Nuclear Power in South Africa was appointed, under the Chairmanship of Mr. D.D. Forsyth; and Mr. I. de Villiers, Chief Engineer (Electrical) of Escom, was appointed a Member of the Commission of Enquiry.

Escom has submitted information in the form of replies to a questionnaire framed by the Commission, and may be called upon to give further evidence.

The Findings of the Commission of Enquiry will be awaited with the greatest interest".

6) COKING COAL - METALLURGICAL AND INDUSTRIAL

There are two main varieties of coking coal to be found in the Union of South Africa. One is a straight coking coal found in

6 Ref.41 (1956) Pages 6 - 7

Natal, which is capable of producing a good quality metallurgical coke. The other is a blend coking coal, mined mainly in the Transvaal, which has poor coking properties but which can be blended with varying proportions of good coking coal to produce a coke of metallurgical quality.

ß The 1946/47 Coal Commission considered the question of coking coals from all aspects and found that 'the proved reserves of both straight and blend coking coals in the Union are remarkably small in relation to the total reserves of all classes of x coal available'. According to estimates prepared by the Commission in 1946, some 160 million tons of straight coking coal were available in Natal and about 170 million tons of blend coking coal in the Transvaal. However, apart from the Durban Navigation Colliery, where over 100 million tons of straight coking coal was available, most of the other deposits of straight and blend coking coals were distributed amongst a number of pits, often being exploitable only as part of the normal run-of-the mine production.

The Commission had, as part of its Terms of Reference, a mandate to investigate the necessity for conserving coking coal, with particular reference to the future needs of the Union's iron ∠ and steel industry. The problem was studied in considerable detail and estimates were obtained of the future coke require- ¤ ments of Iscor, which showed that during the forty year period after 1946 some 75 million tons of coking coal would be required, rising to 143 million tons over a 60 year period. These figures were based on a two-to-one ratio of blend coking coal to straight coking coal.

To secure the future needs of Iscor, the Commission considered placing an embargo on certain coals for other than coking purposes, but rejected the suggestion in favour of long- # term contracts between Iscor and major coal producers. One such agreement for a twenty year period was concluded in 1946 between Iscor and the Durban Navigation Colliery for the supply of straight coking coal, and other agreements with Transvaal producers safeguarded the supply of blend coking coals for an estimated 55 year period. In 1954 the Durban Navigation Colliery was purchased outright by Iscor, which thus secured for its own use all the reserves of high grade coking coal available at this mine. Presumably future policy will be to eke out the consumption of this good coking coal by mixing with maximum quantities of blend coking coals from the Transvaal and, in this way, to prolong the life of domestic reserves of coking coal for as long as possible.

e Writing in 1954, Dr. J.A. Petrick, Director of the Fuel Research Institute of South Africa, commented on the findings of the 1946/47 Coal Commission and made the following points:-

a) The Commission estimated that available reserves would be sufficient to provide full security for Iscor's future requirements for the following periods of time:-

ß Ref.9, Para.102
x Ibid, Page 29
∠ Ref.9, Part 2, Chapter 3
¤ Ibid, Para.201
Ibid, Paras. 228 - 233
e Ref.21, Page 4.

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Straight coking coal ... ... 60 years
Blend coking coal ... ... 55 years

b) The Commission similarly estimated that available reserves would cover the full requirements of all other users of coke for 35 years.

c) The position in 1954, eight years after the Commission's findings, was that the reserves of blend coking coal in Witbank No. 5 seam were being used only for gas and coke production (mainly Iscor) but the reserves of blend coking coal in Witbank No.2 seam were still being mined and sold as steam coal. In Natal, in 1954, the output from Durban Navigation Colliery was reserved for Iscor and Vryheid Coronation Colliery was also using its whole output for coke production. The position with other producers of coking coal was unchanged, and, 'as in the past, at least 60% of coking coal produced is being used for purposes other than coke production'. Dr. Petrick went on to say that if all the coking coal being produced by Natal Collieries was to be turned into coke there would be an over-production of this commodity.

The 1946/47 Coal Commission found that about two-thirds of
ß the coking coal produced in Natal during 1946 was sold for purposes other than coke production, and it would appear that much the same sort of situation is applicable today. The main reason for this "wastage" of coking coal reserves is that in many of the Natal mines such coal occurs in underground seams and pockets of relatively small size and is produced as run-of-the mine coal, it being considered too expensive a proposition to sort, wash and sell this coal for coking purposes only, in competition with major coke producers such as Durban Navigation and Vryheid Coronation Collieries. A further complication is that it is not possible to abstain from mining coking coal, where it occurs as run-of-the mine production, without seriously interfering with output schedules and increasing the cost of producing other grades. Such coking coal cannot be reserved 'in situ' and if reserved for coking only, after having once been mined, there would be, as Dr. Petrick has already pointed out, an over-production of this type of coal.

In the Transvaal, the blend coking coals of Witbank No. 5 seam are now being used mainly for gas and coke production, it being not too difficult to separate most of the output from this seam from normal run-of-the mine production. According to
ƒ the 1946/47 Coal Commission the exploitable reserves of blend coking coal in No. 5 seam amounted to 110 million tons, with a further 60 million tons available in Witbank No.2 Seam. However the output from this latter seam is apparently still being mined and sold for steam raising purposes, for reasons similar to those mentioned above in the case of Natal. It would seem therefore that unless some
x other deposits of coking coal are discovered in the future, the

ß Ref.9, Para.56

ƒ Ibid, Para.105

x There are reports of as yet undetermined deposits of weakly coking coals in the remote Waterburg coalfield. Wankie Colliery in Southern Rhodesia has considerable reserves of coking coal but at a higher price than Union coals.

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continued exploitation of part of the Natal and Transvaal reserves of this type of coal for steam raising purposes must seriously
/ affect the estimates of the Coal Commission that these reserves would last for 55/60 years.

The problem of sorting and washing coking coal from run-of-the mine production is likely to receive more detailed attention
x in future, as a Coal Preparation Pilot Plant has now been opened near Pretoria under the auspices of the Fuel Research Institute. Research is also being carried out into the preparation of a substitute for metallurgical coke using anthracite coal as a base. This latter work is however still in the experimental stage and, as such, cannot yet be taken into account when determining future coke requirements.

The main consumer of coke in the Union is the iron and steel industry, with Iscor's steel works at Pretoria and Vanderbyl Park as the principal customers. Lesser quantities are required by African Metals Corporation Ltd. (Amcor) for use in their blast furnaces at Newcastle, Natal. Outside the iron and steel industry small quantities of coke are used by the explosives industry, by carbide works, and by the general trade. Part of the latter requirement however is met from by-product coke produced by local gas-works.

Table 20 gives details of coal consumed in the production of coke during the twenty year period 1937 to 1956. It will be noticed that during the past ten years the annual rate of increase in coal consumption has been 7.27%, giving an overall increase of nearly 100% during the period. Available information
ß indicates that this rate of expansion will be continued into the next decade, and that by 1966 the Union's requirements of straight and blend coking coals will have reached about 5,000,000 tons per annum.

In this connection it is interesting to study the remarks made by the Chairman of Iscor, Dr. F. Meyer, when he reviewed the
// affairs of the Corporation for the year ended June 1957. His principal points were as follows:-

a) During 1956 Iscor produced 1,534,000 tons of steel, a rise of 4¾% on the previous years total. This figure represented 66% of total Union supply.

b) Other Union producers contributed a further 10% of total supply, the balance of 24% being imported from overseas sources.

c) The Union's total supply of rolled and drawn steel products from local and overseas sources during 1956 amounted to 1,814,000 tons. This was 210,000 more tons than in 1955.

d) In order to reduce still further the need for imported steel the rated capacity of Iscor plant is to be increased by about 900,000 ingot tons, to a total of some 2,350,000 ingot tons per annum.

/ Dr. J.A. Petrick comments on the reserve position in similar terms in Ref.21, Pp.4 & 5.

x "South Africa's Coal Preparation Pilot Plant", an article by P.J. van der Walt, F.W. Collins and L.W. Needham published in "Coal and Base Minerals - June 1957".

ß Private correspondence with Iscor CP/M dated 21.11.57.

// Ref.43, Pp 1 - 4.

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This considerable expansion of Iscor's steel producing capacity will necessitate a commensurate increase in the consumption of coking coal. At present the Pretoria works of the Corporation have coke oven capacity sufficient to meet blast furnace needs, but at Vanderbyl Park coking capacity is not sufficient to meet blast furnace requirements and large scale expansion is in hand. When completed, the total coke oven capacity of Iscor will have been doubled.

In an attempt to obtain reasonably accurate estimates of future coke requirements Iscor, Amcor (African Metals Corporation) and the Natal Coal Owners' Society were approached. The General Manager of Iscor in his reply (dated 21.11.57.) gave full details of the estimated coke production for each year up to 1966 but ended his letter by saying: "It will be appreciated if you will treat this information as confidential and not publish it in such a way that it can be directly identified or associated with the Corporations' activities". This stricture precludes the possibility of publishing separate figures for Iscor along the lines of those published in Table 20.

As far as Amcor and the Natal Coal Owners' Society could judge, the requirements of coke from Natal Coke producers would continue more or less as in the past decade but there was a marked degree of reluctance to provide any estimates for publication. Table 20 shows that during the period 1947-1956 the output of Natal coke increased at an average rate of 8.43% per annum, but in order not to compromise the position of Iscor it is not possible to show the separate estimates that were made for coke from Natal producers.

In the tabulation which follows, the estimates supplied by Iscor and the estimates calculated for Natal coke producers (covering the needs of Amcor and general trade requirements usually supplied from this source) have been shown as one composite total. The relatively large annual increases in coke production during the first three years are due to the gradual expansion of output from Iscor, where the additional coking facilities are expected to be completed by 1959. In converting coke to coal the average yield of coke per ton of coal has been taken as 67%, as this is in line with current output performance figures.

Estimated Future Consumption of Coking Coal
(tons of 2,000 lbs)

Year	Coke	Coking Coal
1957	1,820,000	2,716,000
1958	2,390,000	3,567,000
1959	2,760,000	4,119,000
1960	2,840,000	4,239,000
1961	2,920,000	4,358,000
1962	3,010,000	4,493,000
1963	3,100,000	4,627,000
1964	3,200,000	4,776,000
1965	3,310,000	4,940,000
1966	3,430,000	5,119,000

[6] Ref.24, Page 633
[4] Private correspondence with Iscor Ref.CP/M dated 21.11.57.

FIG. 8 COAL REQUIRED FOR COKING PURPOSES

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	1,306.6	-	-
1948	1,405.6	99.0	7.6
1949	1,689.7	284.1	20.2
1950	1,775.1	85.4	5.1
1951	2,072.0	697.9	16.7
1952	2,130.5	58.5	2.8
1953	2,220.9	90.4	4.2
1954	2,060.7	-160.2	- 7.3
1955	2,321.1	260.4	12.6
1956	2,457.4	136.3	5.9

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	2,716.0	258.6	10.5
1958	3,567.0	851.0	31.3
1959	4,119.0	552.0	15.5
1960	4,239.0	120.0	2.9
1961	4,358.0	119.0	2.8
1962	4,493.0	135.0	3.1
1963	4,627.0	134.0	3.0
1964	4,776.0	149.0	3.2
1965	4,940.0	164.0	3.4
1966	5,119.0	179.0	3.6

The calculated estimates of coking coal consumption for the period 1957-66 and the figures of total coal carbonised during the previous decade (Table 20) have been plotted in the form of a semi-logarithmic trend chart in Figure 8. The trend revealed by the actual tonnages of coal carbonised in each of the years 1947-56 was not easy to determine, but the chart does show very clearly how the additional coking capacity to be installed at Iscor will result in a new high level of consumption for the years 1959 onwards. It is not suggested that annual coal consumption figures will show exactly the same rate of progression as illustrated in Figure 8. It is far more likely that the erratic and fluctuating pattern of the previous decade will be repeated but the actual annual figures, whether they be above or below the trend line, are expected to conform to the averages indicated in trend 2.

7) MINING REQUIREMENTS

It is historical fact that the basis of South Africa's mineral wealth from gold and diamonds depended to a large extent on the fortunate occurence of plentiful supplies of coal within reasonable reach of the mines. The energy contained in these coal deposits allowed the early pioneers to adopt mechanical methods for mining, crushing and sorting the ores, and also permitted deeper and safer operations with the use of powerful hoists, pumps and ventilation fans. The original motive power for these devices was steam, generated in a coal fired (or sometimes wood fired) boiler. It is thus easy to understand the very close relationship that existed between coal mining and other mining operations in those early days.

The same close relationship exists today because, notwithstanding the growing use of petroleum products as energy resources in mining operations, the bulk of mechanical energy (as distinct from muscular energy) is still supplied from coal, mainly in the form of steam and electricity. It would be interesting to make a rough comparative study of the relative importance of electricity, steam-coal and petroleum as forms of energy used by the mining industry and, for this purpose, the year 1954 provides the latest comparable statistics for all three energy forms.

The Annual Report of the Electricity Supply Commission for the year 1954 shows that a total of 5,316,823,178 units was sold to the mining industry. This figure includes 5,556,426 units of hydro-electricity supplied by the Sabie Undertaking (being only 0.1% of the total). Statement No. 4 of the Report shows that 99% of the electricity consumed by the mining industry was supplied by the Eastern Transvaal, Rand and Orange Free State Undertakings. The same Statement also shows that the number of units thus consumed represented about 70% of the total units sold by Escom from these Undertakings during 1954. If this figure of 70% is applied to the 7,249,200 tons of coal consumed by Escom in the Eastern Transvaal, Rand and Orange Free State Undertakings during 1954 (Table 15) it shows that a realistic estimate of coal consumption in the production of electricity for the mining industry during that year would be 5,074,400 tons. This is equivalent to a conversion factor of about 0.95 tons of coal per 1,000 KWH, which should be

Ref. 5, Page 952; Ref. 4, Page 15; Ref.11, Page 158.

Ref.41 (1954), Page 96

x Certain mines have their own generating plants, but these have been ignored for present purposes on the grounds that the addition to coal consumption over and above the Escom figures would be slight and would not materially alter the picture.

/ be compared with the 0.6/0.9 figures given as a rough world-wide approximation by the United Nations Organisation.

ϕ The Annual Report of the Department of Mines for the year 1954 shows that 2,457,398 tons of coal and 3,738 tons of coke were consumed by the mining industry during that year. This represents a total of some 2,463,100 tons of coal (the yield of coke being taken as 65 tons per 100 tons of coal) most of which was used for steam raising purposes. However, after making due allowance for a small amount of coal consumed by private electricity plants on certain mines, it can clearly be seen that the consumption of coal by Escom in the generation of electricity for mining purposes during 1954 was more than double the quantity consumed directly by the mining industry in steam raising.

The position in regard to petroleum fuels consumed by
x the mining industry during 1954 is summarised in the same Annual Report which shows a total of 7,391,970 gallons. At an approx-
≈ imate weighted average of 280 gallons to the ton this represents some 26,400 tons having an equivalent of roughly 39,600 tons of coal.

The foregoing approximate analysis of energy used in mining during the year 1954 can be summarised in the following Table:-

ENERGY USED IN MINING - 1954

Type	Quantity	Approximate Coal Equivalent
1. Electricity	5,316,823,200 KWH	5,074,400 Tons
2. Coal and Coke	2,461,100 Tons	2,463,100 Tons
3. Petroleum Fuels	7,391,970 Gallons	39,600 Tons

The important part played by coal as a source of energy for the mining industry is now clearly evident, firstly in the production of thermal electricity and secondly as steam coal in various applications. The role of petroleum fuels is almost negligible in comparison. In studying the reasons for this state of affairs an analysis of relative costs and calorific values should provide useful information.

// The Annual Report of the Transvaal and Orange Free State Chamber of Mines for the year 1955 gives details of all stores consumed by members of the Chamber during that year. Table 21 summarises the position in regard to the consumption of coal, electricity and petroleum fuels by gold mines, and gives an interesting statistical picture. The gold mining industry was selected for this analysis on the grounds that:

a) it is the largest and most widespread of mining ventures in the Union,

b) it purchases large quantities of electrical energy and energy fuels at various places, thus including a good sample of delivery charges as well as basic energy costs,

/ Ref.22, Page 106 (Note 3). All except three of the power stations serving the major mining areas of the Union were built before 1949/50 and all, without exception, are using coal of a lower calorific value than that normally used by power stations overseas.
ϕ Ref.28 Table No.9 Items 22/23
x Ibid, Items 191 - 196
≈ Ref.22, Page 106 (1½ tons of petroleum to 1 ton of coal)
// Ref.44, Pp. 102 - 106

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TABLE 21 - COMPARISON OF PRIME COSTS OF ENERGY USED IN GOLD MINING, 1955.

FORM OF ENERGY	QUANTITY OR WEIGHT	VALUE £	UNIT COST (AVERAGE)	ENERGY CONVERSION FACTOR	ENERGY COST PER 1,000 B.T.U.
1. COAL (Tons of 2,000 lbs.)	1,959,365	2,084,873	0.128d per lb.	12,000 B.T.U. per lb.	0.010 pence
2. ELECTRICITY (Megawatt-hours)	5,503,721	8,824,839	0.385d per KWH	3,400 B.T.U. per KWH	0.113 pence
3. PETROLEUM					
(i) Fuel & Power Oil (Imp. Galls.)	2,058,839				
Converted to tons of 2,240 lbs	7769.4	212,990	2.937d per lb.	19,200 B.T.U. per lb	0.153 pence
(ii) Motor Gasoline (Imp. Galls.)	887,492				
Converted to tons of 2,240 lbs	2844.5	148,628	5.599d per lb.	20,500 B.T.U. per lb	0.273 pence

(Ref. 44 Pp. 102 - 106)

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c) the statistical data is accurate and readily available.

d) the Chamber is sufficiently powerful to obtain in general the most desirable form of energy for its members, based on considerations of efficiency and cost.

Table 21 shows that, in terms of prime costs, coal is by far the cheapest source of energy. However in order to utilise the energy contained in coal it is necessary to provide some form of heat exchanger to convert the calorific content to an energy form capable of doing work. This usually means the provision of steam raising plant and appropriate steam operated machinery, the cost and operation of which would add materially to the low prime cost of coal energy. There is the added disadvantage that this form of energy application is relatively static, in that it can only be applied over comparatively short distances.

Electrical energy, in this instance, represents the conversion of energy contained in coal to the much more mobile and convenient form of electricity. It costs eleven times as much as coal in prime cost, but can be more readily distributed and used than steam. Electricity can be carried over long distances and utilised as power through electric motors. It can also provide heat and light. Steam can provide power and heat over comparatively short distances, but not light (unless first converted to electricity).

Table 22 gives figures of coal consumed by the mining industry during the period 1947 to 1956. Official figures for the latter year have not yet been made public, but an estimate has been given based on the fact that the overall Union position reflected in this Table shows an average rate of decrease of about 2% per annum. This in itself is somewhat unusual, and the mining industry would appear to be the only major industry which is showing a decrease in its annual rate of coal consumption. The decrease is mainly due to progressive electrification, particularly at new mines, and to the use of petroleum fuels at those places where bulk electricity cannot as yet be supplied. It is anticipated that the present trend towards lower coal consumption by the industry will continue during the next decade and, in this connection, it is interesting to study the trend of coal purchases by the Chamber of Mines - the largest purchasing organisation in the mining industry - mainly on behalf of the gold mines.

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COAL PURCHASES BY THE CHAMBER OF MINES

Year	Coal Consumed (Tons of 2,000 lbs)
1946	2,214,582
1947	2,111,147
1948	2,067,793
1949	2,060,846
1950	2,056,939
1951	1,950,061
1952	2,005,430
1953	2,031,008
1954	1,976,482
1955	1,959,365
1956	1,915,880

Overall Trend 1.44% p.a. decrease

ß Figures supplied by the Chamber of Mines in private correspondence PRD/ACB/MEC dated 25.11.57.

TABLE 22 - COAL CONSUMED BY THE MINING INDUSTRY

(In tons of 2,000 lbs.)

	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956
TRANSVAAL MINES										
Gold	2,146,773	2,104,477	2,095,362	2,097,664	1,991,443	3,587,291	2,038,770	1,955,365	1,928,024	
Diamond	5,513	6,500	6,567	8,815	6,672	15,265	15,540	7,627	9,254	
Coal	214,812	217,085	233,239	225,492	225,319	83,544	84,068	60,400	84,654	
Others	114,815	122,175	119,326	96,167	105,379	106,547	115,061	104,042	99,747	
Total	2,481,913	2,452,777	2,454,494	2,428,138	2,328,813	3,792,647	2,253,259	2,127,434	2,121,679	
O.F.S. MINES										
Gold	4,427	10,682	12,223	31,192	69,337	83,252	67,336	59,436	77,731	
Diamond	12,647	14,137	21,161	36,567	39,418	39,749	47,691	39,894	46,994	
Coal	21,558	18,777	22,616	24,257	24,239	17,392	1,557	7,027	8,216	
Total	38,632	43,596	56,000	92,016	132,994	140,393	116,584	106,357	132,941	
CAPE MINES										
Diamond	85,672	92,341	80,767	42,988	39,036	38,079	34,561	25,645	30,859	
Others	16,448	24,482	30,744	26,647	33,517	68,260	58,282	63,513	35,400	
Total	102,320	116,823	111,511	69,635	72,553	106,339	92,843	89,158	66,259	
NATAL MINES										
Coal	213,746	224,329	191,403	212,687	224,315	148,119	156,783	134,449	91,566	
UNION TOTAL:	2,836,611	2,837,525	2,813,408	2,802,476	2,758,675	4,187,498	2,619,469	2,457,398	2,412,445	2,364,000*

(Source: Dept. of Mines, Annual Reports, Table No. 9)

(* Estimated)

Average rate of decline in total consumption = 2% p.a.

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Both these figures and those given in Table 22 (which were obtained from the Annual Reports of the Department of Mines) show a slight drop in 1951 coal consumption by the Transvaal gold mines, followed by a rise in 1952. There is however a serious discrepancy between the 1952 figure shown above and that shown in Table 22. From the trends, the figure of 3,587,291 tons shown in Table 22 is suspect and should be considered as far too high. During 1951 there was a transportation crisis in the Union as a result of which coal supplies could barely be maintained, and it is very likely that certain mines had to draw upon reserve coal stocks during that year. On the other hand the 1951 figures given in Table 22 would seem to indicate that only the Transvaal gold and diamond mines were materially affected and, even then, only to the extent of some 100,000 tons when compared to the previous year. This hardly seems sufficient justification for an additional 1½ million tons alleged to be "consumed" during 1952. If this quantity was in fact purchased for stockpiling purposes (which seems doubtful) there is even less justification for showing it as "consumed" during that year.

The matter was raised with the Department of Mines which indicated that it was not possible to look into the records or to comment on the abnormally large 1952 total. In view of the more or less "normal" coal consumption figures given by the Chamber of Mines in the above tabulation it would seem that a discrepancy of at least one million tons exists in the figures for 1952 as quoted in Table 22. Due allowance for this will need to be made in any calculations involving the 1952 figure for coal consumption by the mining industry and it is to be hoped that the Department will in due course be able to re-check these statistics and issue an explanatory note.

With the exception of the disputed 1952 figures, the gradual downward trend in total coal consumption by the mining industry is clearly apparent from Table 22. There would appear to be no foreseeable reason why this trend should change during the next ten years, and the following tabulation of future consumption has been based on an expected gradual decline in coal consumption averaging about 2% per annum. This is in line with the trend over the previous ten years.

ESTIMATED FUTURE COAL CONSUMPTION
BY THE MINING INDUSTRY

(Tons of 2,000 lbs)

Year	Quantity
1957	2,317,000
1958	2,270,000
1959	2,225,000
1960	2,180,000
1961	2,137,000
1962	2,094,000
1963	2,052,000
1964	2,011,000
1965	1,970,000
1966	1,931,000

/ This is corroborated by the Chamber of Mines own figures shown above.
x Private correspondence GME.151/5/7Stats. dated 19.12.57.
ƀ This view was also expressed by officials of the Department of Mines during private discussions.

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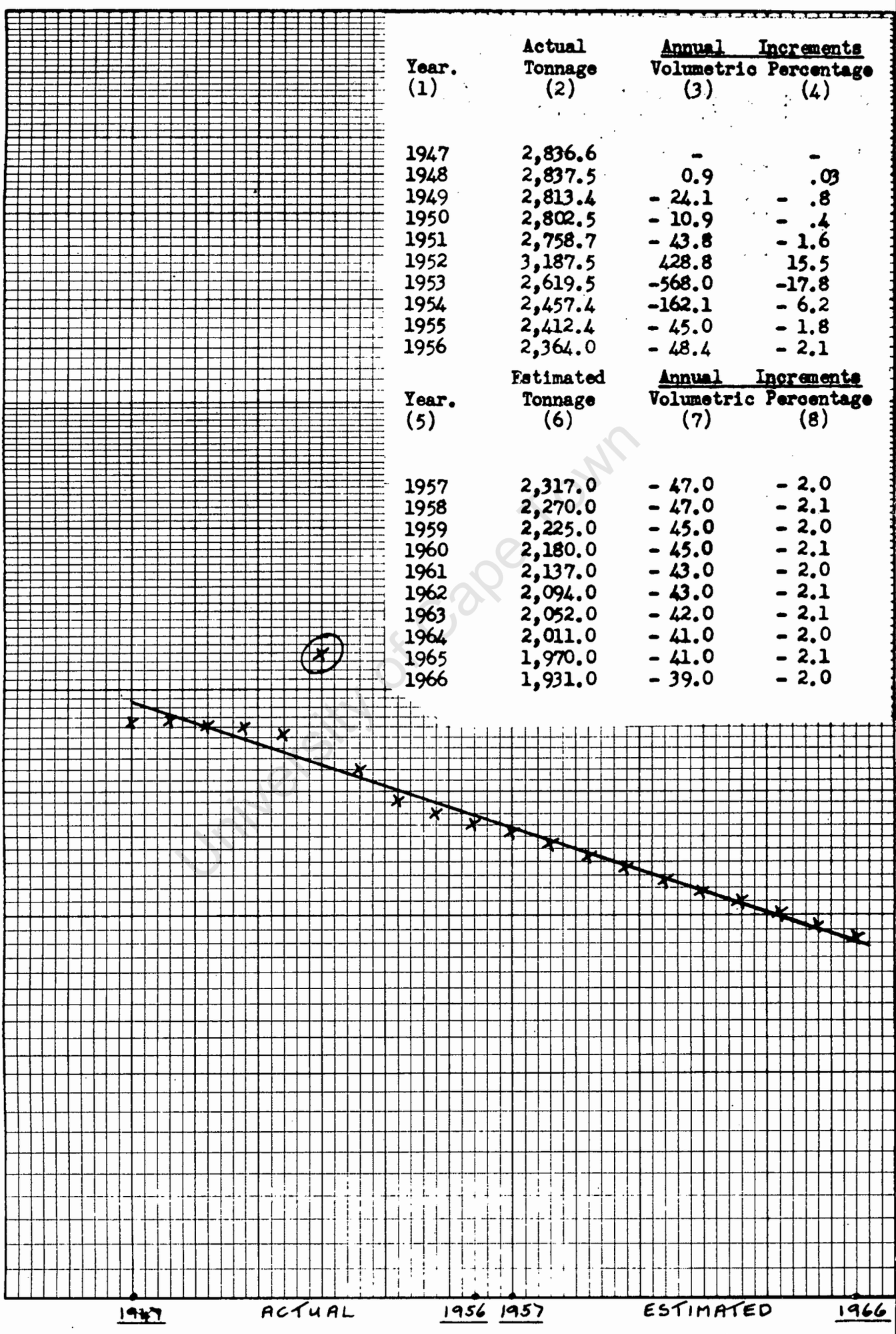
FIG. 9 COAL NEEDS OF THE MINING INDUSTRY

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	2,836.6	-	-
1948	2,837.5	0.9	.03
1949	2,813.4	- 24.1	- .8
1950	2,802.5	- 10.9	- .4
1951	2,758.7	- 43.8	- 1.6
1952	3,187.5	428.8	15.5
1953	2,619.5	-568.0	-17.8
1954	2,457.4	-162.1	- 6.2
1955	2,412.4	- 45.0	- 1.8
1956	2,364.0	- 48.4	- 2.1

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	2,317.0	- 47.0	- 2.0
1958	2,270.0	- 47.0	- 2.1
1959	2,225.0	- 45.0	- 2.0
1960	2,180.0	- 45.0	- 2.1
1961	2,137.0	- 43.0	- 2.0
1962	2,094.0	- 43.0	- 2.1
1963	2,052.0	- 42.0	- 2.1
1964	2,011.0	- 41.0	- 2.0
1965	1,970.0	- 41.0	- 2.1
1966	1,931.0	- 39.0	- 2.0



The above estimates for 1957 - 66 together with actual consumption figures for 1947 - 56 (taken from Table 22) have been plotted in the form of a semi-logarithmic trend curve in Figure 9. It will be noticed that, with the exception of the disputed figures for 1952, the observed trend for 1947 - 56 follows a declining pattern which has been continued by the estimates for 1957 - 66. The figures quoted for this latter period represent average estimates, although in any one year the actual consumption figure might be a little above or below the trend line.

It is worth noting that although the direct consumption of coal by the mining industry is showing a declining trend, the indirect consumption of coal energy in the form of electricity is increasing. Table 17, Column 3 (Page 69) shows that electricity supplied for mining purposes has increased at an average rate of 8.85% per annum during the period 1957 - 66 and it is reasonable to assume that this trend will continue.

8) DOMESTIC, INDUSTRIAL & GENERAL

The previous seven sections of this Chapter have dealt with patterns of consumer demand for coal under the following headings:-

1. Export and Bunker Sales
2. Railway consumption - locomotive coal.
3. Sasol - Oil from coal.
4. Municipal Gas Production.
5. Thermal Electricity - Public Utilities.
6. Coking Coal - Metallurgical & Industrial.
7. Mining Requirements.

These headings represent the major consumer groupings for which coal consumption data is directly obtainable - albeit with difficulty in some instances, but nevertheless obtainable. There remains a somewhat vague and indeterminate group of consumers centred in the domestic and general industrial spheres of activity. Statistical records of this group which would help in determining patterns of coal consumption are conspicuously absent, although by a process of arithmetical deduction it is possible to arrive at an approximate overall figure for each of the past ten years. Table 23 shows the coal consumption figures for various sectors of the national economy as already determined in the earlier portions of this Chapter. The Inland Sales figures and the Total Sales figures are those published by the Government Mining Engineer and shown in Table 12 (Page 36). If the total of items 1 - 5 is subtracted from the known total of Inland Sales (Item 7) the balance can be attributed to "Domestic, Industry and General" as shown under item 6, and this represents the amount of coal consumed by households, by secondary industry and by a host of general consumers in various economic categories. This admittedly vague and somewhat unsatisfactory grouping has been given the generic title of "Domestic, Industrial and General" to conform to the heading used by Government Departments in published figures of coal consumption statistics and it includes, inter-alia, the following:-

a) Domestic consumption by householders for cooking and/or heating purposes.

[6] Ref.24, Page 602

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TABLE 23

UNION OF SOUTH AFRICA - ANALYSIS OF COAL CONSUMPTION 1947 - 1956

(Tons of 2,000 lbs)

	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	Average Annual Rate of Increase
1. Railways	5,440,500	5,628,600	5,563,000	5,584,000	5,880,500	6,327,100	6,297,300	6,591,200	6,939,300	7,076,900	2.97%
2. Gas	108,800	116,900	133,700	133,100	144,200	152,100	156,300	158,300	158,400	168,500	4.98%
3. Electricity ϕ	*6,416,500	*6,958,900	7,576,000	8,336,800	8,899,700	9,597,900	10,184,300	10,983,000	12,219,600	12,984,500	8.15%
4. Coking	1,306,600	1,405,600	1,689,700	1,775,100	2,072,000	2,130,500	2,220,900	2,060,700	2,321,100	2,457,400	7.27%
5. Mining	2,836,600	2,837,500	2,813,400	2,802,500	2,758,700	3,187,500	2,619,500	2,457,400	2,412,400	*2,364,000	(2.00%)
6. Domestic, Industry & General #	6,014,900	6,819,200	7,083,300	6,914,700	7,113,300	7,663,500	7,778,700	7,582,700	8,386,900	9,627,200	5.37%
7. INLAND SALES	22,123,900	23,766,700	24,859,100	25,546,200	26,868,400	29,058,600	29,258,000	29,833,300	32,437,700	34,678,500	5.12%
8. Export & Bunker	3,290,900	2,201,800	2,568,400	3,118,400	1,899,300	978,900	1,311,600	1,010,800	622,900	601,900	(17.20%)
9. Sasol ∠	-	-	-	-	-	-	-	-	(1,119,000)	(1,230,000)	-
10. TOTAL SALES:	25,414,800	25,968,500	27,427,500	28,664,600	28,767,700	30,037,500	30,569,600	30,844,100	33,060,600	35,280,400	3.71%

(∠ Sasol consumption figures for 1955 and 1956 were not included in Sales statistics issued for those years)
(ϕ Public Utilities only) (* Estimated) (# Derived as a residual of 7 less 1 to 5)

Compiled from data given in Chapters 1 & 2

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b) Similar consumption by Hospitals, Institutions, blocks of flats and offices.

c) The requirements of several secondary industries which consume comparatively large quantities of coal eg:- cement production, brick making, carbide works, glass making etc.

d) The needs of many other industries using coal for steam power and/or heating purposes, or possibly in private locomotives for internal haulage.

e) The miscellaneous needs of Government Departments, Local Authorities and various official or semi-official organisations. This category includes such typical examples as coal used by Iscor for purposes other than coking; coal consumed by the S.A.R. for purposes other than steam raising in locomotive fireboxes; and general coal consumption by the Public Works Department in a multitude of official uses.

The overall annual coal consumption figure for this large group of miscellaneous consumers can be summarised as follows:-

Year	Total Inland Sales	Domestic Industrial & General	Percentage of Total
1947	22,123,900	6,014,900	27.19
1948	23,766,700	6,819,200	28.69
1949	24,8 9,100	7,083,300	28.49
1950	25,546,200	6,914,700	27.07
1951	26,868,400	7,113,300	26.47
1952	29,058,600	7,663,500	26.37
1953	29,258,000	7,778,700	26.59
1954	29,833,300	7,582,700	25.42
1955	32,437,700	8,386,900	25.86
1956	34,678,500	9,627,200	27.76

There are several interesting features about the above tabulation. In the first place it will be noticed that the post-war increase in consumption (expressed as a percentage of total inland sales) reached a peak in 1948 and thereafter began to decline. Secondly, the percentage of inland sales attributable to "Domestic, Industrial and General" showed a steady fall year by year until 1954, and then turned upward again. Thirdly, the physical quantity of coal sold per annum for this category of consumption remained around the 7 to 7½ million tons figure during each of the years 1949 to 1954, notwithstanding a considerable increase in the volume of Total Inland Sales. There are several observations to be made and deductions to be drawn from this statistical pattern:-

a) It is known that in the post-war years the Union suffered from an acute transportation shortage, which extended with varying degrees of severity from about 1949 to 1954. The

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Extracted from Table 23.
See Ref. 23
As far as the export of coal and other ores is concerned the transportation crisis is not yet over (1957) but the internal rail distribution system no longer appears to leave demands noticeably unsatisfied.

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measures taken by the Railways to improve the transportation of coal gave priority to major national consumers such as Iscor and Escom, but minor industrial and domestic consumers were frequently unable to obtain their full coal requirements. As a result many domestic consumers either went without coal or else switched to wood, electricity, or paraffin, as alternative forms of energy. Certain industrial and commercial concerns probably adopted a similar policy, particularly at the coast where imported petroleum fuels were better able to compete with coal on account of the high freight costs and railage delays involved with the latter product.

b) The supply of coal to many "Industrial, Domestic and General" consumers was thus artificially curtailed during the years 1949 to 1954, causing the percentage share of this group in the total inland market to fall rapidly from about 28½% in 1949 to 25½% in 1954. However even if there had been no transportation crisis an analysis of the trends shown in Table 26 indicates that the consumption of coal by households and by industry as a percentage share of the total market may be expected to fall gradually and be replaced by electricity. There is thus a long-term tendency towards a decreasing rate of growth in coal consumption for "Domestic, Industry and General", irrespective of short-term complications caused by any transportation crisis.

c) During 1955 and 1956 the internal transportation position was materially improved and the distribution of coal returned more or less to normal. However reference to Table 23 will show that the consumption of the major users (who had hitherto been receiving priority in any case) remained fairly constant, but that consumption by "Domestic, Industry and General" rose by about two million tons in two years. Total Inland Sales rose by about five million tons during the same period. This sudden rise in coal consumption can be attributed to the normal annual increase by major consumers, plus an extra-ordinary increase in consumption and stock-piling on the part of those customers who had been suffering from inadequate coal supplies during the past five years. Included in this latter category is a large proportion of the consumers classed as "Domestic, Industrial and General".

d) The nett effect of this easing of the coal supply position was to bring about an extraordinarily large 1956 coal consum-

Table 26 is discussed in Part 9 of this Chapter

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TABLE 24

COAL CONSUMPTION - DOMESTIC, INDUSTRY AND GENERAL

(Tons of 2,000 lbs)

YEAR	TOTAL INLAND SALES [1]	DOMESTIC INDUSTRIAL & GENERAL	PERCENTAGE
(1) ACTUAL			
1947	22,123,900	6,014,900	27.19
1948	23,766,700	6,819,200	28.69
1949	24,859,100	7,083,300	28.49
1950	25,546,200	6,914,700	27.07
1951	26,868,400	7,113,300	26.47
1952	29,058,600	7,663,500	26.37
1953	29,258,000	7,778,700	26.59
1954	29,833,300	7,582,700	25.42
1955	32,437,700	8,386,900	25.86
1956	34,678,500	9,627,200	27.76
(2) ESTIMATED			
1957	35,828,000	9,500,000	26.52
1958	38,274,000	9,900,000	25.87
1959	40,560,000	10,300,000	25.39
1960	42,555,000	10,700,000	25.14
1961	44,649,000	11,100,000	24.86
1962	46,865,000	11,500,000	24.54
1963	49,160,000	11,900,000	24.21
1964	51,584,000	12,300,000	23.84
1965	54,154,000	12,700,000	23.45
1966	56,880,000	13,100,000	23.03

([1] excluding Sasol)

(Taken from Tables 23 and 25)

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ption figure for "Domestic, Industry and General" which raised the annual level of consumption to a new "plateau" in terms of percentage share of the total inland market. From this new higher level of demand the long term trend towards a gradually decreasing percentage share of the total internal market is expected to continue, as shown in Table 24.

6 Table 24 is an extract from Tables 23 and 25. It has already been shown how Table 23 was compiled as a summary of all the actual coal consumption figures for the period 1947 - 1956, determined and discussed under individual headings in this Chapter. Table 25, covering the next decade, was constructed on a similar basis using the forward estimates already prepared for each energy consuming sector. The forecasts for item 6, "Domestic, Industry and General", were particularly difficult to make as very little factual information was available regarding coal consumption in this category. It was felt that the unusually large increase in coal consumption during 1956 would not be repeated, and that the 1957 figure would, if anything, be slightly lower, because of a general easing in the economic activity of the Union. However, taking the 1956/57 figures as a base (or new "plateau" as described in (d) above) it was considered that the annual rate of increase during the next decade would not exceed the average of 400,000 tons per annum recorded for the previous ten years. In reaching this decision due regard was paid to the fact that domestic and industrial coal consumption during part of the first ten year period was hampered by inadequate rail transport facilities. It was however felt that the growing preference for electricity would have a similar restraining influence on domestic and industrial coal consumption during the next decade, and that coal requirements during this period would follow the earlier pattern. The 1957 - 1966 estimates were calculated accordingly and are shown in Tables 24 and 25 (Item 6).

The foregoing discussion, culminating in the estimates of coal consumption for the next decade, is portrayed in a consumption trend chart, Figure 10. This Chart shows the actual coal consumption figures for the period 1947 - 1956 and clearly illustrates the increasing consumption in the post-war years 1947 - 1949, followed by a drop in 1950 - 1951 due to the Union's internal transportation crisis. In 1952 coal consumption increased slightly, but for 1952, 1953 and 1954 there was very little variation in annual figures - again due to the internal distribution problems mentioned above. The improvement in the Railway's carrying capacity during 1955 and 1956 is reflected in the marked upturn in coal consumption figures for those two years and, as the transportation crisis has now ended, it is reasonable to assume that this improvement can be maintained. Had there been no transportation crisis affecting the carriage of coal for this category of consumer, it is felt that there would have been a gradual annual rise in consumption from 1948 to 1956 which would more or less have agreed with trend line 2. However, because there was such a crisis, the consumption of coal by this category was, in effect, artifically curtailed to the position shown by trend line 1. The new "plateau" reflected by trend line 2 is thus considered to be the true state of the market for "Domestic, Industrial and General" coal under conditions of adequate internal transportation, and it is on this basis that the forecasts for the next decade have been founded.

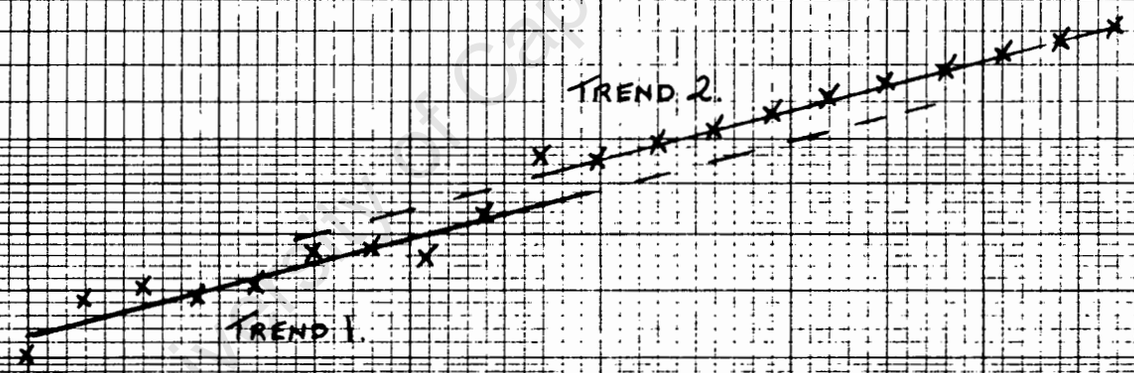
6 Tables 23 and 25 are analysed in Part 9 of this Chapter

FIG. 10 COAL REQUIRED FOR DOMESTIC, INDUSTRY & GENERAL PURPOSES

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	6,014.9	-	-
1948	6,819.2	804.3	13.4
1949	7,083.3	264.1	3.9
1950	6,914.7	-168.6	- 2.4
1951	7,113.3	198.6	2.9
1952	7,663.5	550.2	7.7
1953	7,778.7	115.2	1.5
1954	7,582.7	-196.0	- 2.5
1955	8,386.9	804.2	10.6
1956	9,627.2	1,240.3	14.8



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	9,500.0	-127.2	-1.3
1958	9,900.0	400.0	4.2
1959	10,300.0	400.0	4.0
1960	10,700.0	400.0	3.9
1961	11,100.0	400.0	3.7
1962	11,500.0	400.0	3.6
1963	11,900.0	400.0	3.5
1964	12,300.0	400.0	3.4
1965	12,700.0	400.0	3.3
1966	13,100.0	400.0	3.1

1947 ACTUAL 1956 1957 ESTIMATED 1966

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It is most unfortunate that no detailed statistical information is available which would facilitate closer examination of coal consumption under this heading. There are considerable differences between major industries in regard to their coal needs and some, such as Cement, Glass, Brick and Clay Products etc., probably account for a lion's share of the coal consumed. An attempt was made to obtain coal consumption statistics from certain industries but with no success, as a veil of secrecy seems to surround information of this nature, accompanied by a
ß marked degree of "statistical reluctance" on the part of the firms concerned.

The 1946/47 Coal Commission apparently found similar difficulty in obtaining statistics of industrial and domestic coal consumption, armed though they were with all the powers of a Statutory Commission. In paragraph 342 of their Report the Commission states that "Separate statistics are not available in respect of the Transvaal indicating the tonnage of coal supplied for industrial and domestic use. . ." They go on to quote estimates of domestic consumption in the Johannesburg area only, but not even an estimate is given of the industrial demand of the Witwatersrand. Further on, in paragraph 346, the Commission was able to quote some (incomplete) information concerning the Inland market in Natal and the following comparison between 1946 and 1956, whilst of local interest, is not of very much help in the wider context of the Union as a whole:-

x COAL SALES BY NATAL ASSOCIATED COLLIERIES

	1946 Tons	1956 Tons
South African Railways	687,000	800,000
Power Stations and Gas Works	967,000	1,336,000
Industries	617,000	1,129,000
Households, Hospitals, etc.	220,000	323,000
Coking (Iscor)	172,000	400,000
COMPARATIVE TOTALS:	2,663,000	3,988,000

N.B. The above figures represent sales by N.A.C. only, and do not include non-member collieries nor quantities of coal used for coking at the mines, (1956 figure 1,178,000 tons).

In an effort to obtain any available data that might help in analysing the coal consumption pattern of domestic and industrial consumers, an approach was made to every likely source of reliable information. The following summary of replies shows only too clearly that nothing is known of this aspect of coal consumption, which certainly does not appear to be receiving the attention that it deserves.

/ 1) S.A. COUNCIL FOR SCIENTIFIC & INDUSTRIAL RESEARCH -

Dr. E.C. Halliday, the Director of the National Physical Laboratory replied as follows:-

"On the question of finding out how much coal is used by households, by "combination households" such as blocks of flats and hotels, by commercial buildings, and by light

ß A term used by the Federated Chamber of Industries to denote the unwillingness of most commercial and industrial concerns to divulge any information about their activities.

x Ref.9, Paragraph 346 and private correspondence with Natal Coal Owners' Society CMBT/PMB dated 15.11.1957.

/ Private correspondence NPRL Af/X/1 dated 18.11.57.

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industry, the answer is that almost nothing is known at the moment. . ."

/ 2) THE FUEL RESEARCH INSTITUTE - stated with regret that "no data such as you require are available in the Institute, probably for the reason that these data are not easily obtained". They went on to suggest that if the known coal consumption of the major consumers was deducted from the known total coal production, the balance could be regarded as "Domestic, Industrial and General". (This was in fact the method ultimately adopted, except that the Total Inland Sales figure was used rather than the Total Coal Production, to avoid distortion caused by irregular and fluctuating coal export figures).

x 3) THE GOVERNMENT MINING ENGINEER - was able to give only coal production figures and had no coal consumption data.

xx 4) THE TRANSVAAL COAL OWNERS' ASSOCIATION - stated that information regarding domestic and industrial consumption was not available, and that it was not practicable to analyse past records in view of the vast amount of time and effort that would be necessary. The Secretary also expressed doubt, during personal discussions on the issue, as to whether his records of sales transactions would give sufficient data to enable "end users" to be accurately determined. It was pointed out that local coal retailers were responsible for many thousands of sales annually to both industrial and domestic consumers and that legislation would probably be necessary before full statistical data could be obtained.

// 5) THE DEPARTMENT OF COMMERCE AND INDUSTRIES and the BUREAU OF CENSUS AND STATISTICS both indicated that no facts and figures of domestic and industrial coal consumption were available.

/ 6) THE COAL ALLOCATIONS COMMITTEE of the South African Railways was approached for assistance, but the Committee is mainly concerned with the maintenance of coal supplies to major industries and to regional consumers. No statistical data for "Domestic, Industrial and General" coal consumption are available, and the Committee does not deal with details of this nature.

/// 7) THE SOUTH AFRICAN FEDERATED CHAMBER OF INDUSTRIES was approached as a last resort, in an effort to obtain a picture of the coal requirements of industrial and domestic consumers by regions. A letter of enquiry was forwarded to each of the eight regional Chambers of Industries, but the replies that were received indicated that information of this nature was not available and that statistics of regional coal consumption were not maintained by the Chambers.

/ Private correspondence FRI 26 dated 7.11.57
x Private correspondence GME 151/5/7 dated 11.11.57
xx Private correspondence JBd.MeL dated 14.10.57
// Private correspondence 177/26/ dated 18.12.57
/ Personal visit and letter RS3/100/125 dated 21.10.57
/// Private correspondence with regional Chambers of Industries dated 22.1.58.

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The above catalogue of "nil returns" from various bodies who could be expected to contribute at least partial information, lends emphasis to the remarks made earlier concerning the almost complete absence of any statistical data for coal consumption by light industries, by households, and by many "general" consumers.

9) THE OVERALL UNION PICTURE

It is now possible to draw up a composite demand picture for South African coal, based on the needs of consumers. Table 23 shows, in comparative form, the consumption data for various sectors of the national economy over the past ten years as discussed and analysed in the eight previous sections of this Chapter. The astonishing progress of thermal electricity production is clearly evident, showing a one hundred per cent increase in coal consumed per annum as between 1947 and 1956, and representing some 38% of all inland sales during the latter year.

Table 25 shows in similar comparative form the estimated coal consumption for the next ten year period and, once again, the remarkable increase in coal requirements for electricity production is self evident. By 1966 it is estimated that 47% of all inland coal sales will be needed for thermal electricity production by public utility companies and, if the few private producers are included, it would not be unreasonable to claim that about half of the coal sold in the internal market of the Union during 1966 will be converted into the energy form of electricity. This study does not go beyond that date, but with the long-term electrification programme of the S.A.R. and the growing use of electricity by light industry and domestic consumers, there would seem to be every reason for thinking that the major use of South African coal in the future will be for the production of electrical energy - at least until the time that atomic power plants are able to compete on an economic basis.

Other interesting facts that emerge from a study of Tables 23 and 25 are as follows:-

a) Firstly, the relatively insignificant part played by coal gas in the energy pattern of the Union. By 1966, the amount of coal required for gasification purposes represents less than one half of one percent of the total inland coal sales.

b) Secondly, the comparatively rapid rise in coking coal requirements per annum, being over 100% between 1956 and 1966. Bearing in mind that the known reserves of coking coal are only expected to last for some 55/60 years from 1946 this would imply that by 1966 the reserves will be about one-third depleted.

c) Thirdly, the gradually decreasing quantity of coal required annually by the mining industry is significant evidence of the change-over to electricity. This is the only sector of the economy where there is an actual physical nett decrease in consumption per annum.

ϕ There is a marked trend throughout the world for primary fuels to be converted into the energy form of electricity before being supplied to the ultimate consumer (See Ref.55, Pages 1 and 14)

ℓ Ref.21, Page 4

TABLE 25

UNION OF SOUTH AFRICA - ESTIMATED COAL CONSUMPTION 1957 - 1966

(Tons of 2,000 lbs)

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	Average Annual Rate of Increase
1. Railways	7,236,000	7,453,000	7,677,000	7,907,000	8,144,000	8,380,000	8,615,000	8,846,000	9,078,000	9,305,000	2.83%
2. Gas	164,000	176,000	187,000	193,000	199,000	210,000	221,000	232,000	243,000	254,000	4.98%
3. Electricity ø	13,695,000	14,908,000	16,052,000	17,336,000	18,711,000	20,188,000	21,745,000	23,417,000	25,223,000	27,171,000	7.74%
4. Coking	2,716,000	3,567,000	4,119,000	4,239,000	4,358,000	4,493,000	4,627,000	4,776,000	4,940,000	5,119,000	7.30%
5. Mining	2,317,000	2,270,000	2,225,000	2,180,000	2,137,000	2,094,000	2,052,000	2,011,000	1,970,000	1,931,000	(2.01%
6. Domestic, Industry & General	9,500,000	9,900,000	10,300,000	10,700,000	11,100,000	11,500,000	11,900,000	12,300,000	12,700,000	13,100,000	3.63%
7. INLAND SALES	35,828,000	38,274,000	40,560,000	42,555,000	44,649,000	46,865,000	49,160,000	51,584,000	54,154,000	56,880,000	5.27%
8. Export & Bunker	500,000	500,000	700,000	1,100,000	1,500,000	1,800,000	2,000,000	2,300,000	2,600,000	2,900,000	21.57%
9. Sasol	1,700,000	2,000,000	2,500,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	-
10. TOTAL SALES:	38,028,000	40,774,000	43,760,000	46,655,000	49,149,000	51,665,000	54,160,000	56,884,000	59,754,000	62,780,000	5.73%

(ø Public Utilities only) (Average annual rate of increase given for comparative purposes only - see Table 23)

Compiled from data given in Chapters 1 & 2

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d) Note that the anticipated increase in the total inland market between 1956 and 1966 amounts to about 63%, or roughly two-thirds more than the 1956 total. This finding is really the core of all the discussion which has taken place in this Chapter and represents a major prognostication in regard to the Union's future energy requirements. Note also that Table 25 shows an annual average rate of increase in Inland Sales during the next decade of 5.27%. When compared to the past trends shown in Tables 12 and 23, the figure of 5.27% would seem to be fair and reasonable.

e) When the estimates of coal exports and the needs of Sasol are added to those of the inland market, the anticipated 1966 total of coal sales is about 80% above the 1956 figure. This is almost double the increase recorded over the previous ten years 1946 to 1956, but a comparison of Tables 23 and 25 will show the significant difference between the actual Export and Sasol sales during the earlier period, and those expected during the coming ten years. Export and Sasol needs together will account for nearly 10% of the anticipated 1966 production if the estimates given in Table 25 are fulfilled.

At this stage it would be interesting to attempt a reconciliation between statistics of coal output and demand during the past decade, and to compare these figures with those estimated for the coming ten year period. Relative comparisons in terms of annual average rates of increase, can be made from the following data:-

ITEM:	PERIOD	SOURCE	RATE OF INCREASE.
a) Sales output.	1946-1956	(Table 11)	3.26% p.a.
b) Inland Sales	1946-1956	(Table 12)	4.98% p.a.
c) Inland Sales	1947-1956	(Table 23)	5.12% p.a.
d) Total Sales	1947-1956	(Table 23)	3.71% p.a.
e) Inland Sales (estimated)	1957-1966	(Table 25)	5.27% p.a.
f) Total Sales (estimated)	1957-1966	(Table 25)	5.73% p.a.

In the first place, Sales output for 1946 - 1956 (Item a) can be related to Total Sales 1947 - 1956 (Item d) the difference between 3.26% and 3.71% being accounted for by the difference in base year for the two calculations.

Secondly, Inland Sales 1946 - 1956 (Item b) can be related to Inland Sales 1947 - 1956 (Item c) the difference between 4.98% and 5.12% being again due to the different base year. Inland Sales for 1947 - 1956 (Item c) can then be compared with estimated Inland Sales 1957 - 1966 (Item e). This comparison shows an average annual rate of increase of 5.12% for the first decade compared with an estimate of 5.27% for the second decade, the improvement being mainly due to anticipated increases in coal consumption for electricity production.

/ See Table 26.

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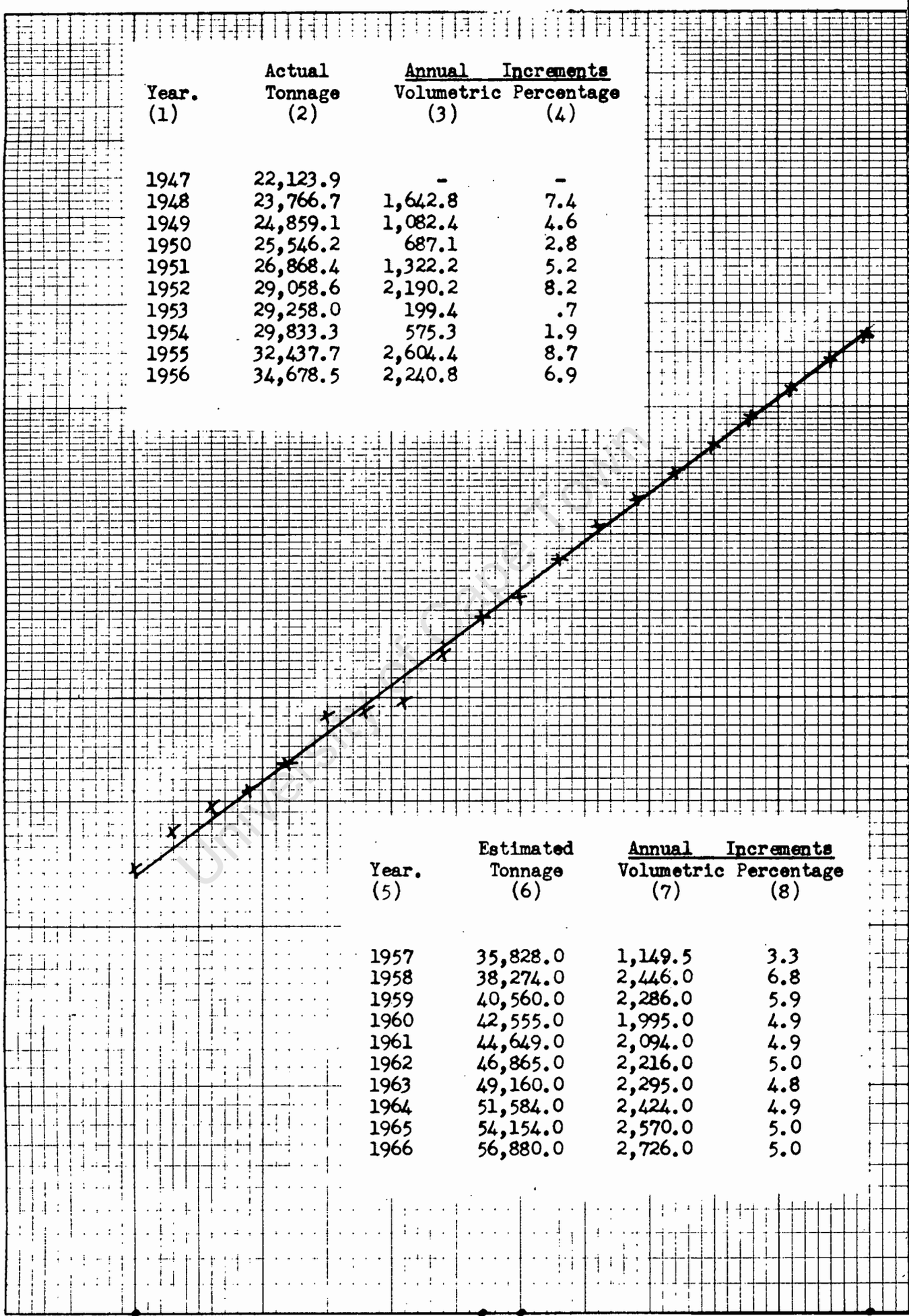
FIG. 11 UNION OF SOUTH AFRICA - INLAND SALES OF COAL

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons)

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	22,123.9	-	-
1948	23,766.7	1,642.8	7.4
1949	24,859.1	1,082.4	4.6
1950	25,546.2	687.1	2.8
1951	26,868.4	1,322.2	5.2
1952	29,058.6	2,190.2	8.2
1953	29,258.0	199.4	.7
1954	29,833.3	575.3	1.9
1955	32,437.7	2,604.4	8.7
1956	34,678.5	2,240.8	6.9



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	35,828.0	1,149.5	3.3
1958	38,274.0	2,446.0	6.8
1959	40,560.0	2,286.0	5.9
1960	42,555.0	1,995.0	4.9
1961	44,649.0	2,094.0	4.9
1962	46,865.0	2,216.0	5.0
1963	49,160.0	2,295.0	4.8
1964	51,584.0	2,424.0	4.9
1965	54,154.0	2,570.0	5.0
1966	56,880.0	2,726.0	5.0

Thirdly, Total Sales 1947 - 1956 (Item d) can be related to Total Sales 1957 - 1966 (Item f), the former showing an average annual rate of increase of 3.71% compared with 5.73% for the latter. The difference here is due to the fact that in the first decade Export and Bunker Sales were dwindling and, furthermore, no consumption by Sasol is included in the total; whereas in the second decade Export Sales are expected to improve and coal consumption of up to 3,000,000 tons per annum has been allowed for Sasol. Bearing in mind the close relationship between the Inland Sales' rates of increase (Items c and e) it is obvious that the discrepancy between Total Sales' rates of increase (Items d and f) is solely due to the variation in coal consumption figures for Exports and for Sasol as between the first ten-year period and the second. A close study of Tables 23 and 25 will serve further to illustrate this point.

The consumption trend for Inland Sales of coal is shown in Figure 11, using data taken from the above two Tables. It will be noticed that the trend for the period 1947 - 1956 is a straight line, and that the forward estimates for 1957 - 1966 continue on the same upward slope. This indicates expectations of a steadily expanding market at a constant <u>average</u> percentage rate of increase. The word "average" has been underlined here to stress the fact that the future trend line is based on average estimates, although, in any one year actual Inland Sales figures might be above or below this trend line (as in the previous decade). It is worthy of note that the annual totals of Inland Sales shown in Table 25 were built up from a series of estimates, partly subjective and partly objective, using the best available information in each case. The fact that the end result continues the trend of the previous ten years, notwithstanding variations in demand by certain sectors of the economy, is considered to be a reasonably accurate portrayal of inland consumption patterns. The distinction between Total Sales of coal and Inland Sales of coal, is that the former includes the latter plus Export, Bunker and Sasol requirements. The trend chart for Total Sales is shown in Figure 12 and when this is compared with Figure 11 the distortion due to falling export and bunker sales in the first ten-year period is clearly apparent. The anticipated rising trend in exports, plus the steady consumption needs of Sasol give a straightening out tendency to the curve during the second decade. However it is not intended to dwell on Total Sales patterns, as this study of commercial energy requirements in the Union is based on Inland consumption figures. Figure 11 is therefore the more important diagram for our purposes, Figure 12 being inserted mainly for general interest and to complete the statistical picture provided by Tables 23 and 25.

A comparative distribution of coal consumption at five year intervals between 1946 and 1966 is given in Table 26. The figures for the years 1951, 1956 and 1966 were taken from Tables 23 and 25 which in turn summarise the data collected in Chapter Two. The figures for 1946 were taken from exactly the same sources as the 1947 - 1956 material used in this Chapter, and are thus directly comparable. The 1946 figures cannot however, be compared to those given in the Union Year Book, as the basis of compilation and percentage calculation are different in each case. There are also certain unaccountable differences between some of the figures given in the Year Book and those quoted by other authorities.

6 References given under appropriate headings in Parts 1 to 8 of Chapter 2

4 Reference 28, P.602

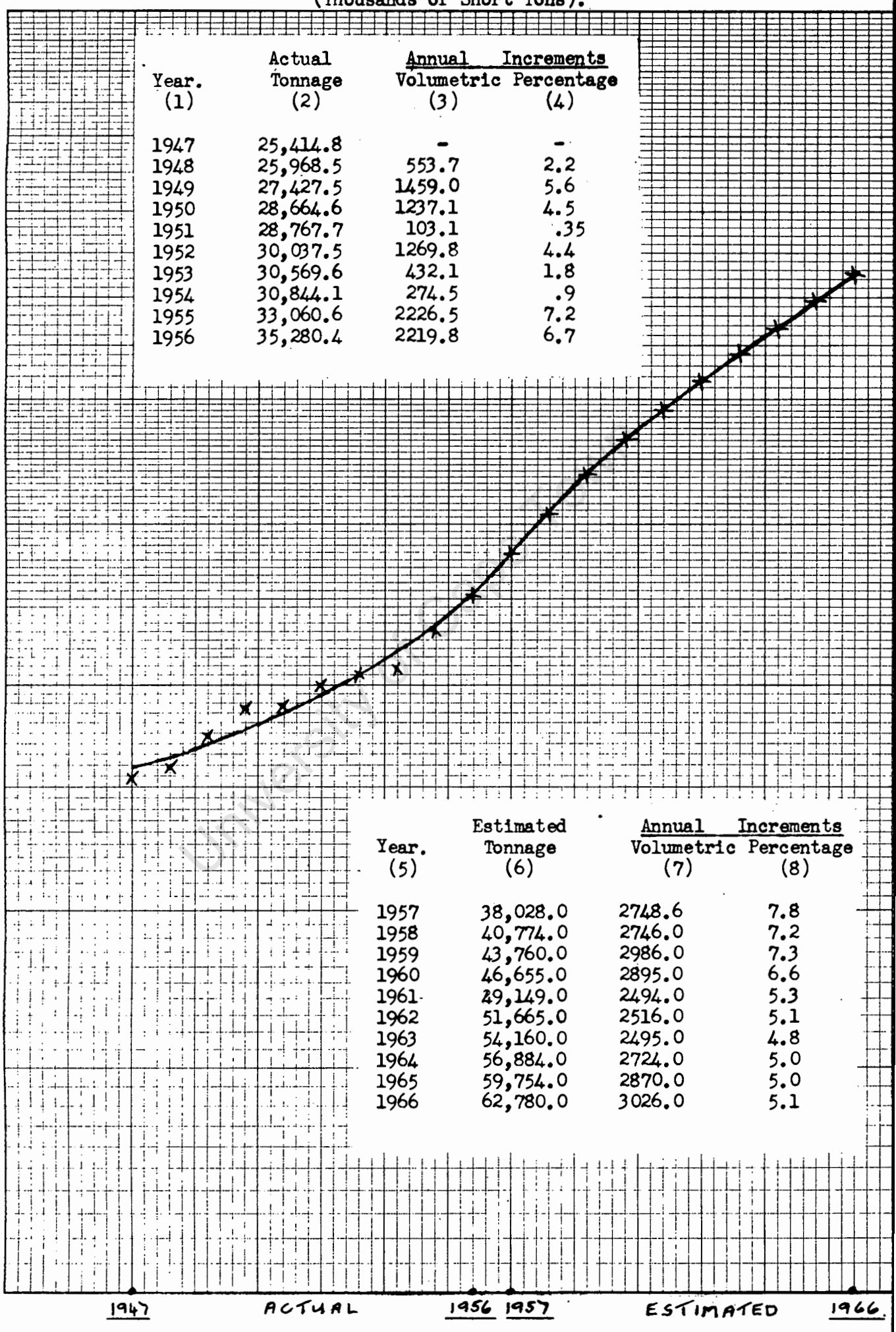
FIG. 12 UNION OF SOUTH AFRICA - TOTAL SALES OF COAL

CONSUMPTION TREND 1947 - 1966

(Thousands of Short Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	25,414.8	-	-
1948	25,968.5	553.7	2.2
1949	27,427.5	1459.0	5.6
1950	28,664.6	1237.1	4.5
1951	28,767.7	103.1	.35
1952	30,037.5	1269.8	4.4
1953	30,569.6	432.1	1.8
1954	30,844.1	274.5	.9
1955	33,060.6	2226.5	7.2
1956	35,280.4	2219.8	6.7

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	38,028.0	2748.6	7.8
1958	40,774.0	2746.0	7.2
1959	43,760.0	2986.0	7.3
1960	46,655.0	2895.0	6.6
1961	49,149.0	2494.0	5.3
1962	51,665.0	2516.0	5.1
1963	54,160.0	2495.0	4.8
1964	56,884.0	2724.0	5.0
1965	59,754.0	2870.0	5.0
1966	62,780.0	3026.0	5.1



For example:-

i) Reference to Table 13 (Page 48) will show that the 1946 figure given in the Year Book for S.A.R. is really for 1945/46 (i.e. nine months of 1945 and only 3 months of 1946).

ii) The Year Book figure for Mining in 1946 does not agree with the Government Mining Engineer's Report for that year.

iii) The Year Book figure for Bunkers and Exports in 1951 does not agree with that quoted by the Government Mining Engineer, neither does the 1951 Total Sales Figure.

x

The statistical data given in this Thesis have at all times been taken directly from the authorities concerned and the references have been quoted. It has, however, been noticeable that on occasions statistics provided by one Government Department have not agreed with those given by another Department.

The figures shown in Table 26 for "Electricity" represent the coal consumed by major public utilities (Escom and Municipalities) in the country. The figures given in the Year Book presumably include coal consumed by private generating units owned by Mining or Industrial concerns. It was felt that, for purposes of comparative studies of consumer demand for energy, such coal consumption by privately owned power stations (i.e. not intended for resale) should be left with the sector to which it belonged. Consequently in this Thesis only coal consumption by major public utilities has been considered under the heading of "Electricity" and, once again, it makes direct comparison between Table 26 and the Union Year Book not possible.

ƀ

It is interesting to note the long-term trends for coal consumption shown in Table 26. Only Electricity and Coke show a rising percentage share of the total inland market, coal consumption under all other headings showing a decreasing percentage share, even though the physical tonnage consumed may still be rising each year. It should be noted that the improvement in inland coal transport by rail resulting in an upward surge of demand under "Domestic, Industrial and General" during 1956, tends to give an incorrect reflection of the total overall trend in this sector. Reference to Part 8 of this Chapter will show that the trend pattern was directed towards a slowly decreasing percentage share of the total inland market, and offers an explanation of the sudden temporary upward surge in 1956.

The coal consumption data given in Tables 23, 25 and 26 represent a broad statistical analysis of the pattern of consumer demand for coal in the Union. Table 23 gives actual consumption over a ten-year period, and Table 25 estimates consumer demand for the succeeding ten years. The figures of tons of coal consumed can be more accurately compared by means of a comparison of calorific values in Terms of "British Thermal Units". However, there is not much to be gained for our present purposes in converting all the coal consumption figures shown in Tables 23 and 25

x See Ref.28, Table 12.
ƀ See Part 5 of Chapter 2.

TABLE 26 - DISTRIBUTION OF COAL CONSUMPTION

(Millions of tons of 2,000 lbs)

	1946		1951		1956		1961		1966	
	Tons	Per Cent	Tons	Per Cent	Tons	Per Cent	Tons	Per Cent	Tons	Per Cent
1. Railways	5.14	24.11	5.83	21.89	7.08	20.42	8.14	18.23	9.31	16.37
2. Electricity (Public Utilities)	6.30	29.55	8.90	33.13	12.98	37.43	18.71	41.90	27.17	47.77
3. Mining	2.89	13.55	2.76	10.28	2.36	6.80	2.14	4.79	1.93	3.39
4. Gas Production	0.11	0.52	0.14	0.52	0.17	0.49	0.20	0.45	0.25	0.44
5. Coke Production	1.23	5.77	2.07	7.71	2.46	7.09	4.36	9.77	5.12	9.00
6. Domestic, Industrial & General	5.65	26.50	7.11	26.47	9.63	27.77	11.10	24.86	13.10	23.03
7. INLAND SALES	21.32	100%	26.86	100%	34.68	100%	44.65	100%	56.88	100%
8. Export & Bunker	4.31		1.90		0.60		1.50		2.90	
9. Sasol	-		-		(1.23)+		3.00		3.00	
10. TOTAL SALES:	25.63	-	28.76	-	35.28 +	-	49.15	-	62.78	-

(+ Sasol consumption for 1956 was not included in official figure of Total Sales)

Source References:- Tables 23 and 25 (see also text of Chapter 2, Part 9)

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from tons of coal into British Thermal Units of energy, and then comparing the energy consumption of one Sector with the energy consumption of another. This can be much more readily (albeit roughly) accomplished as a direct comparison of tons of coal, without using the astronomical quantities of B.T.U's that would be given in the alternative method. It is, however, important to remember that the tonnage of coal consumed is only a rough and ready comparison of energy content, and that due allowance should be made for comparative energy values of different types of coal.

As a typical example of the significance of energy content in a detailed analysis of coal consumption, it is proposed to compare the 1956 figures for Railways and Electricity as shown in Table 23. The approximate ratio of coal consumption is 7,000,000 tons to 13,000,000 tons, but the Railways use a higher grade of coal than Escom and due allowance should be made for calorific value in any accurate comparative study. For the purpose of demonstration it is proposed to assume that the average calorific content of S.A.R. coal is 12,000 B.T.U./lb, whilst that of coal used for electricity production is 10,000 B.T.U./lb. These are assumed figures and should be taken as illustrative rather than factual, but they demonstrate the importance of energy content in the following manner:-

1. DIRECT RATIO OF COAL CONSUMED:

Railways 7,000,000 tons (App.)
Electricity 13,000,000 tons (App.)
Ratio: 7 : 13 or 1 : 1.86

2. RATIO BASED ON ENERGY CONTENT:

Railways 7,000,000 tons x 2,000 lbs x 12,000 B.T.U.

$= 168 \times 10^{12}$

Electricity 13,000,000 tons x 2,000 lbs x 10,000 B.T.U.

$= 260 \times 10^{12}$

Ratio: 168 : 260 or 1 : 1.55

In this example a direct ratio of coal consumed of 1.0 to 1.86 is reduced to one of 1.0 to 1.55 when the energy value of the coal is taken into consideration. In other words, although the production of electricity accounts for about 86% more coal than that used by the Railways, in terms of energy only 55% more is consumed.

Comparisons of this nature are significant features of energy economics, particularly when alternative fuels are under consideration. Tons of coal can be roughly compared to tons of coal but, as we have seen, if detailed comparison of energy content is required the calorific values must be taken into account. It is quite another matter to attempt comparison between gallons of petroleum and tons of coal, because this can only be done through the medium of some common factor, such as the British Thermal Unit.

The following Chapters will contain an analysis of the position of petroleum products in the Union of South Africa, and the

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main units of measurement will be tons or gallons of the various fuels. Different petroleum products possess different calorific values, in similar manner to various grades of coal, but again a rough and ready comparison of gallons to gallons will be sufficient for most purposes. However, when the final detailed analysis of coal and petroleum in the South African economy is discussed in Chapter Five, it will be necessary to express the energy content of the fuels in terms of British Thermal Units, in order to provide a common basis for measurement and comparison.

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C H A P T E R T H R E E

THE SOUTH AFRICAN OIL INDUSTRY.

1. Natal Cane By-Products Limited

2. S A T M A.

3. S A S O L.

4. Standard-Vacuum Refinery - Durban.

5. The distribution of imported petroleum.

6. Cost and supply aspects.

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CHAPTER THREE

THE SOUTH AFRICAN OIL INDUSTRY

1. NATAL CANE BY-PRODUCTS LIMITED

The activities of this company in the field of motor fuels dates back to 1916, when patent rights were acquired for the production of Natalite Motor Fuel for South Africa. Natalite Motor Fuel was a mixture of Industrial Alcohol and Ether, suitably denatured to comply with Excise regulations, the alcohol originally being obtained by the purchase of a local Durban distillery. The cost of denaturing the fuel was considerable and, as output was limited during the period of the first world war, the price of Natalite was much higher than ordinary petrol. During the post-war period and up to 1927 Natalite was able to compete with petrol in the local market and indeed managed to hold successfully a Government Railways Motor Fuel Contract against competitive tenderers for over five years.

In 1927 it was realised that a straight alcohol fuel would no longer be able to compete with petrol on a price basis, in view of rising costs of the former and lowered price of the latter. Consequently extensive experiments were carried out with alcohol-petrol mixtures culminating in the marketing of Union Motor Spirit early in 1928. This product originally required a large percentage of Ether in the mixture to effect the necessary stability of alcohol and petrol but, by 1930 improved processes allowed the production of a motor spirit containing roughly 50% of denatured alcohol and 50% of petrol, plus certain additives known only to the Manufacturers. In 1933 the alcohol production process was further improved and factory capacity doubled.

The position today is that Natal Cane By-Products Ltd. produces and markets about 2,000,000 gallons of Union Motor Spirit per annum, being roughly a 50/50 alcohol-petrol blend. Although a rebate of 3d. per gallon in Excise duty has been conceded for motor fuels containing 50% of locally produced alcohol, the product obtains no concessions in rail rates and for that reason distribution is confined mainly to Natal. Current comparative retail prices in Durban (March 1st 1958) are as follows:-

Product	Price	Octane Rating
Premium Grade Petrol	3/1½d. p.g.	about 90
Regular Grade Petrol	2/10d. p.g.	" 80
Union Motor Spirit	2/8d. p.g.	" 100

The Company has two reselling outlets in Johannesburg and one each at East London, Port Elizabeth and Cape Town. These are maintained mainly for the convenience of motor racing clubs, as the product sells at each point for considerably more than ordinary petrol because of the high railage charges involved

6 Information obtained by private correspondence with Natal Cane By-Products Limited, reference JBL/EF dated 20.3.58.

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in the conveyance of motor fuel in drums. The rail charges from Durban to Cape Town, for example, are about 1/1½d. per gallon and Union Spirit sells there for 3/10d. per gallon.

Production of Union Motor Spirit is restricted in relation to the quantity of the main raw material - molasses - available from Natal Sugar Estates. Part of the molasses is required for the manufacture of other alcohol products such as methylated and rectified spirits, absolute and industrial alcohols, ethers etc. ƀ These are essential industrial products, the demand for which is rising each year. Consequently notwithstanding the gradually increasing acreage of sugar cane production, the annual output of Union Motor Spirit is unlikely to vary very much in the foreseeable future. Two million gallons per annum represents less than one half of one percent of the total South African petrol consumption in 1956 (See Table 31) and hence the production of Union Motor Spirit can hardly be said to be of material consequence to the total supply of liquid fuels. Nevertheless it is of interest to realise that the alcohol blend of Natal Cane By-Products Limited was probably the pioneer effort in utilising local resources for the production of a liquid motor fuel.

2. S A T M A R

The South African Torbanite Mining and Refining Company Limited is a public company managed by the Anglo-Transvaal Consolidated Investment Company Limited and the British Burmah Petroleum Co. (S.A.) (Pty.) Ltd. Satmar, as the company is commonly known, was formed in 1934 to produce oil from torbanite shale in the Ermelo district of the Eastern Transvaal. The torbanite is found in association with a deposit of coal but in general there is a clear demarcation between the two products, thus enabling relatively "clean" torbanite to be supplied to the retorting plant.

The oil yield of the deposit varies widely - from a low ƒ of less than 20 gallons per ton in poor areas to a high of about 120 gallons per ton in rich areas. Most of the high grade deposits have now been worked out however, and the remaining body of economically workable shale is not expected to last for more than two or three years.

The torbanite shale is crushed to small sizes before being x fed to the retorting units, where it is heated to about 500°C. This treatment evaporates the oil which is led off as a vapour, condensed into a crude oil and then transported in rail tank wagons to the SATMAR refinery at Boksburg. The large supply of medium-grade coal overlying the torbanite deposit provides an adequate fuel for retort heating, and a surplus is generally available for the local market. Production figures for torbanite, for crude oil and for coal during the past four years are given in Table 27. Although the quantity of torbanite mined and retorted has fallen sharply, improved technological processes have enabled the average yield of oil in gallons per ton to be slightly increased.

ƀ See Ref.24, Page 532 for latest production figures.
ƒ Ref.58, Page 428 (tons of 2,000 lbs)
x Ibid Pp.432 - 436

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TABLE 27 - PRODUCTION OF TORBANITE CRUDE OIL BY SATMA: 1954 - 1957

	1954	1955	1956	1957
1. Torbanite mined (tons of 2,000 lbs)	288,296	307,394	287,775	185,722
2. Torbanite retorted (tons of 2,000 lbs)	285,899	308,031	290,585	185,972
3. Crude Oil produced (gallons)	8,514,814	8,938,773	9,052,428	6,112,621 *
4. Yield of Oil (gallons per ton)	29.7	29.0	31.2	32.9
5. Coal and waste mined (tons of 2,000 lbs)	463,016	450,992	514,030	394,995

Ref. 25, Page 356 (See also 1957/58 volumes)

* The Refinery throughput in 1957 totalled 13¾ million gallons, being made up of torbanite crude oil, imported crude oil, and cracking stock obtained from Sasol.

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The Boksburg Refinery of SATMAR is designed to produce a spirit for incorporation in a gasoline blend, and also to produce
ß bitumen for road-making. The torbanite crude oil has an average specific gravity of 0.908 at 60°F and gives the following typical yield when processed:-

Crude pressure distillate	50% by volume
Naptha and kerosine solvents	2% " "
Bitumen (100 pen)	39% " "
Fuel Oil	2% " "
Gas and loss	7% " "

The naptha and kerosine solvents are used for outback bitumens and the fuel oil is used to supplement the gas firing in the furnace. The crude spirit is further treated with sulphuric acid and caustic soda, and then redistilled to give a finished spirit having an octane number of about 57. This torbanite finished spirit is then blended with alcohol and benzole to give a marketable motor spirit with an octane number of about 80. The alcohol is produced within the Union as a by-product of the sugar industry (or SASOL) and the benzole is a by-product from the Iscor coke ovens at Pretoria and Vanderbyl Park. No details are
£ available of the actual quantities of alcohol and benzole used in blending SATMAR petrol but the following quantities of these products were produced during the years 1950 - 1953:-

Year	Benzole	Alcohol
1950	2,069,200 galls.	2,198,499 galls.
1951	2,733,500 "	3,321,316 "
1952	2,896,300 "	3,236,013 "
1953	2,917,000 "	3,855,156 "

Notes

(1) The gallonage of Benzole shown above is that produced
x by Iscor as a coke oven by-product, between 40% and 50% of which was used in the production of motor fuel.

(2) The alcohol gallonage shown above represents only that portion of total by-product production from the sugar industry used in the manufacture of motor spirit - mainly by Natal Cane By-Products Limited (Union Spirit) and by SATMAR.

(3) No later data is available as yet, and no information can be obtained as to the quantity of alcohol supplied by SASOL to SATMAR for blending purposes during recent years.

ß Ref.59, Pp.575/6
£ In private correspondence dated 28.2.58 SATMAR indicated that it was not their policy to disclose such information.
// Ref.24 Pp.532 and 601. See also Ref. 5, Page 958
x Private correspondence with Iscor dated 29.4.58.

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6 In the Annual Report for 1957, the Chairman reviewed the position of SATMAR from a financial and operating point of view, and the following points emerged:-

(a) In September 1956 the rate of production of torbanite crude oil was reduced, and quantities of imported crude oil were brought by rail tank wagon from Durban to maintain an adequate refinery throughput. The higher costs were offset to some extent by the larger combined volume processed.

(b) During 1956 - 1957 the refinery processed torbanite crude, imported crude, and cracking stock received from SASOL. Throughput reached 13¾ million gallons, but the refinery was not working to full capacity. (Probable capacity about 15 million gallons per annum).

(c) The torbanite deposits at Ermelo will probably reach the end of their economic life within two or three years. Notwithstanding much active prospecting no further economically exploitable deposits have been found.

(d) The Board of Directors is considering a scheme for the modernisation and expansion of the Boksburg Refinery to enable it to operate profitably on imported crude only. (The Chairman did not give any further details).

(e) The total production of SATMAR petrol was purchased by Sasol Marketing Company Limited, in terms of an agreement which gives the latter company full right to market the product under its own brand name, Sasol.

(f) Notwithstanding the lower production of torbanite crude oil and the higher costs of processing imported crude, the company apparently made satisfactory profits and distributed a 10% dividend.

The Sasol Marketing Company at present purchases the full output of the Boksburg Refinery at an agreed price, so that Satmar is sure of a market for its products and needs only to produce at a figure which ensures a margin between production costs and the selling price to the Sasol Marketing Company. The current output of blended gasoline (including benzole and alcohol) is estimated to be between 9 million and 10 million gallons per annum, produced by refining torbanite crude oil and imported crude oil. This level of output should remain fairly constant for the next few years, until the economic reserves of torbanite shale are exhausted. Thereafter it would seem, from the Chairman's Report, that the future method of operation and the probable level of output of the Refinery are, as yet, undecided.

Ref.60 Pp. 4 - 7

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3. S A S O L

In part 3 of Chapter 2 the Sasol oil-from-coal project was reviewed in some detail and it was there shown that the rated output of the refinery included some 55 million gallons of petrol and about 6½ million gallons of diesel oil per annum. It was also mentioned that the plant was not yet operating at rated capacity. Chapter 2 however was mainly concerned with the question of coal consumption, but in this Chapter the South African Oil Industry will be reviewed with particular reference to output and distribution details.

The Sasol production process consists basically of the gasification of coal by steam and oxygen into carbon monoxide and hydrogen. This raw gas is then processed into hydro-carbons and by-product chemicals, using equipment similar to that found in a conventional refinery. There are two main synthesis processes in use at Sasolburg. The American Kellogg synthesis plant, together with the refining and working-up units, produces a hydro-carbon gasoline with various alcohols and ketones as the main by-products. The German Arge synthesis plant, together with its refining and working-up units, has about one-third of the capacity of the Kellogg plant and produces most of the diesel oils and waxes.

There is very little factual information on which to base estimates of product output from the Sasol refinery. It is known however that the Kellogg synthesis system has been giving trouble and operating only at about 35% of designed capacity. It is also known that this part of the project was designed to produce about two-thirds of the product volume and over 60% of the total income. There are reasonable grounds for hoping that by about 1961 Sasol should be able to achieve maximum output of petroleum fuels, although it would seem that this might require greater quantities of coal for synthesis than was originally envisaged. Furthermore, certain alterations which are now being made to the plant should make it possible to maintain continuous production by that date. However, insofar as the period up to 1966 is concerned, the estimated production of motor fuels from the Sasol Refinery is as follows:-

SASOL PRODUCTION IN MILLIONS OF GALLONS (ESTIMATED)

	MOTOR GASOLINE	DIESEL OIL
1956 (actual)	6.5	0.5
1957 (estimated)	25.0	2.5
1958 (estimated)	30.0	4.0
1959 (estimated)	35.0	4.5
1960 (estimated)	45.0	5.5.
1961 (and up to 1966)	50.0	6.5

See Chairman's Annual Report for 1957.

See Chapter 2, Part 3 and Table 25 Item 9. According to information obtained from Sasol, coal consumption will reach a maximum from 1960 onwards, but petrol production will increase slightly in 1961 when continuous operation should be possible.

There is no published information on which to base estimates of Sasol's probable output. The above figures have been compiled from information gleaned during personal visits to Sasol and from Oil Company anticipations viz-a-viz the likely competitive position of Sasol in the Union Market.

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The Refinery will also produce about 2,000,000 gallons per annum of various furnace oils when in full operation.

The distribution of the above products (together with petrol produced by Satmar) is in the hands of the Sasol Marketing Company Limited. This is a wholly owned subsidiary of the Sasol Organisation, established in November 1952, which at present op-
ƀ erates from depots at Boksburg, Langlaagte, Pretoria and Potchef-stroom. In due course, as the throughput of Sasol refinery in-creases, it is proposed to enlarge the area of distribution by using depots located at:-

Lichtenburg	Western Transvaal
Rustenburg	" "
Warmbaths	Northern Transvaal
Potgietersrust	" "
Standerton	Eastern Transvaal
Davel	" "
Witbank	" "
Kroonstad	Orange Free State
Welkom	" " "
Bloemfontein	" " "

The main method of distribution adopted by the Sasol Marketing Company is to deliver by bulk road lorry within a radius of 30 miles from each bulk depot. Taking Sasol as the centre, a distribution network based on the above depots would encompass a delivery area having a North-South axis of about 400 miles, and an East-West axis of some 250 miles, covering parts of the Southern Transvaal and Northern Orange Free State. It would appear that the Sasol Marketing Company does not envisage serving all the outlying towns in this area, as their list of proposed depots covers only the districts of highest total sales potential. A small gallonage of petrol will however be despatched in drums to the North Western Free State, the Northern Transvaal and the Eastern Transvaal. A review of the actual distribution arrange-ments adopted by the oil industry in South Africa is given in Part 5 of this Chapter when considering the marketing of imported pet-roleum fuels. It should be accepted that the information given there in regard to methods of operation is also applicable to the Sasol Marketing Company.

ƒ When Sasol reaches full production it is envisaged that the importing oil companies will purchase about 25,000,000 gallons of petrol per annum from the refinery. Each company will blend the petrol with its own additives and market under its own brand name. The balance of Sasol's petrol production - some 30,000,000 gallons - plus approximately 10,000,000 gallons produced by Satmar,
x will be distributed by the Sasol Marketing Company through its own pumps in the areas mentioned above. Out of this total of 40,000,000 gallons per annum it is envisaged that eventually about 12,000,000 gallons will be distributed in the Orange Free State and the balance in the Transvaal.

At present (April 1958) Sasol petrol is being supplied to the importing Oil Companies only at the rate of some 5,000,000 gallons per annum but the Sasol Marketing Company is distributing about 30,000,000 gallons per annum in the Transvaal and Orange Free State. (This latter figure includes Satmar production).

ƀ Information obtained from private correspondence with Sasol Marketing Company Limited, dated 17th April 1958.

ƒ Ibid.

x By arrangement with the importing oil companies Sasol may instal one of its own pumps at each service station, even though most of them are nominally "one-brand" stations.

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/ The current output of diesel fuel from the Sasol refinery is about 4,000,000 gallons per annum, of which two-thirds is supplied to the importing oil companies and one-third distributed directly by Sasol Marketing Company, mainly on the Reef. About 1,000,000 gallons of various furnace oils is also marketed by Sasol Marketing Company.

The area of distribution of Sasol petrol is limited by economic considerations involving transfer costs, i.e. the cost of transporting the product by rail and/or road from Sasolburg to distant customers. The position in this respect will be studied in some detail as it typifies some of the problems faced by inland refineries when marketing im competition with coastal refineries or imported petrol. The Sasol oil-from-coal project was brought into limited production in 1955, at a time when four importing Oil Companies (of long standing in Southern Africa) were actively engaged in serving the South African market. A price structure had been established by these companies which in general showed minimum prices at coastal ports and a gradually rising price structure in the interior, based on coast price plus rail or road transfer costs. The establishment of a refinery at Sasolburg almost in the heart of the country, posed a delicate problem of distribution economics viz:-

1. When delivering to the East (i.e. towards Durban) the Sasol Marketing Company is faced with gradually increasing transfer costs as it goes nearer to the coast. On the other hand the established price structure for petroleum fuels shows a falling price range from the interior to the coast. Hence the Company is not only unable to recover its transfer costs in the delivered price to customers, but also suffers an actual loss in receipts as between the price at Sasolburg and the price to the distant customer. As a typical example consider the position at Davel, some 170 rail miles east of Sasolburg:- /

a) Price of petrol at Sasolburg = 3/0½d per gallon

b) Price of Sasol petrol at Davel = 2/11½d per gallon

Less bulk railage from Sasol = 3¼d per gallon

c) Nett return = 2/8¼d per gallon

d) Difference between (a) and (c) = 4¼d per gallon made up of 3¼d railage and 1d in loss on lower delivered price at Davel as compared to Sasolburg. These costs represent a loss of profit to Sasol in comparison with the position of importing oil companies who recover their transfer costs from the coast to Davel in full. x

/ Private correspondence with Sasol Marketing Company dated 17.4.58.

/ Examples based on Sasol's wholesale prices for regular grade petrol which are 1d per gallon less than those of importing companies. (Railage rates determined from Ref.61, plus Supplement No. 2 (special Port Rates) where applicable, and using the S.A.R. Official Table of Milages).

x The reverse applies at Sasolburg and nearby (Reef) towns where Sasol reaps the benefit of the importing oil companies' price structure (based on coast price plus railage charges) i.e. the importing oil companies' transfer costs are part of Sasol's net receipts in respect of such sales.

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2) When delivering from Sasolburg in the Orange Free State areas, Sasol Marketing Company is faced with competition from oil companies operating inland from coastal ports. Here again they are faced with a falling price structure as they draw nearer to the coast - which operates to Sasol's disadvantage. [6] Consider the following examples of the position at Kroonstad and Bloemfontein, in relation to the known Sasolburg price of 3/0½d per gallon:-

	Kroonstad	Bloemfontein
Price of petrol delivered per gallon	3/-	3/-
Less bulk railage from Sasol per gallon	1¾d	4d
Nett Return per gallon	2/10¼d	2/8d
Marketing Cost to Sasol per gallon	2¼d	4½d

The cost to Sasol shown above is the difference between the price obtained for selling a gallon of petrol at Sasolburg (3/0½d) and the nett return at Kroonstad or Bloemfontein. In the former case the cost is made up of 1¾d in railage and ¼d per gallon in loss on lower delivered price at Kroonstad as compared to Sasolburg. At Bloemfontein the cost to Sasol consists of 4d in railage and ½d per gallon loss on the lower delivered price at this point.

3) The position of Sasol Marketing Company in relation to bulk deliveries made to the west or north is more favourable, as here they are distributing away from the coast into areas of higher delivered prices, where they can reasonably expect to recover part of their transfer costs. However because of the tapering nature of rail freights with distance, it is still cheaper per ton-mile to rail over a longer distance from the coast than it is to rail the same freight over a shorter distance between points inland. To illustrate this fact take bulk deliveries of petrol by rail to Lichtenburg in the Western Transvaal as a typical example;

i) ex Lourenco Marques = 498 miles at 98d/100 lbs
= 3.94d/ton/mile

ii) ex Sasolburg = 163 miles at 38d/100 lbs
= 4.66d/ton/mile

In other words Sasol must pay 0.72 pence more per ton/mile to rail bulk petrol for 163 miles, than the importing oil companies have to pay to rail bulk petrol for 498 miles. The principle of tapering rail rates, or differential rate - schedules as they should more properly be called, ...

[6] Ibid

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/ "takes account of all differences in cost and utility calculations for each individual mile or group of miles . . . In fact, railroad transportation is produced - within broad limits - under decreasing costs. The first mile costs relatively more than the second, the second more than the third, the third more than the fourth, and so on".

Antonio de Viti de Marco in making the above statement goes on to explain that,

/ ". . . about 75 per cent of railroad expenditures are fixed - that is, independent of distance - and 25 per cent are variable - that is, they decrease (per ton/mile) with distance. . . . in order to find the cost per mile, the first type of expenditure must be divided by the number of miles traversed, while the second must be multiplied by that number".

This explanation of the pure theory of differential rate schedules, when considered in relation to Sasol's distribution problems, serves to illustrate how it is that the importing oil companies will again have a relative cost advantage in deliveries to the Western and Northern Transvaal. The following examples are typical:-

	Rustenburg	Warmbaths
Price of petrol delivered per gallon	3/1¾	3/2¼
/ Less bulk railage from Sasol per gallon	3d	3d
Nett return per gallon	2/10¾	2/11¼
Loss of Profit to Sasol when compared to selling price at Sasolburg (3/-½d per gallon)	1¾	1¼

The foregoing discussion emphasises some of the more important points affecting the small Sasol inland refinery in competition with major marketing companies importing their petrol from the coast. The much greater scale of business done by the major oil companies in the Union results in their setting the price pattern for internal distribution, notwithstanding the fact that imported petrol pays 1/- customs duty per gallon (or 11½d excise
x duty per gallon if refined locally) whereas the petrol produced by Sasol pays duty at the rate of only -/7d per gallon. This is a major cost advantage to Sasol which is doubtless the main reason why they are able to absorb the relatively heavy distribution costs outlined above. Originally it was intended that Sasol should pay the same excise duty as Stanvac (11½d per gallon) and the fact that it was found necessary to grant Sasol partial exemption is probably indicative of the fact that Sasol's production costs are higher than those of the importing oil companies. Information regarding production costs is a closely guarded secret but, it

/ Ref. 62, Pp.94-95
/ S.A.R. Railage rates, op cit, Ref. 61 etc.
x April 1958 figures

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would seem that without the rebate of duty which is presently enjoyed, Sasol's oil-from-coal production could probably not compete on an economic basis with imported petroleum products. Nevertheless, Sasol would be of considerable strategic importance to the Union should international unrest interfere with the normal flow of imported petroleum products.

4. STANDARD-VACUUM REFINERY - DURBAN

The Standard-Vacuum Refining Company of South Africa (Pty.) Limited, commenced construction of the Union's first major oil refinery early in 1952. The plant took two years to build, at a cost of some £7,000,000 and came "on stream" in January 1954. The site chosen for the refinery was at Wentworth, about seven miles south of Durban, and some of the considerations which affected the choice of this location for the plant were:

a) The refinery was designed to handle crude oil received in ocean tankers from the Middle East oilfields, and to distribute some of the refined products by ocean tanker to ports in the Union or in other African territories. It was therefore essential that a good harbour should be available having adequate berthing facilities for ocean tankers and sufficient room for future expansion. In view of the volume of products to be handled it was also desirable to link the tanker discharge berths and the refinery by pipeline, for easy transfer of products in both directions.

Durban Harbour is capable of handling most of the ocean tankers at present in service, and has a well laid-out tanker berthing area capable of further development. Durban is also the first port of call in South Africa for tankers from the Middle East, thus oil freights to the refinery would always be at a minimum. The route between Durban and Wentworth was reasonably flat and could be linked by pipelines. No expensive rights of way were involved. The first requirements in regard to obtaining supplies of crude oil at low cost could therefore be met by bringing tankers to Durban and discharging the crude oil via pipeline to Wentworth.

b) The second requirement of the Stanvac refinery (in order of processing, not necessarily in order of importance) was a good site with all requisite facilities. Wentworth was a broad stretch of semi-marshland, well away from the more populous areas of Durban and the area of the site made available for the refinery was just under 300 acres - sufficient for all foreseeable needs. Major refinery components and contractors heavy equipment could be shipped to Durban and taken by road to Wentworth with a minimum of trouble and expense. The Durban Municipality undertook

6 Details obtained by personal visit and from private correspondence with Stanvac, code reference 4320 dated 2.4.58 and 16.5.58.

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to provide about one million gallons of water per day, an electrical supply of 6,250 kilowatts, and the necessary drainage for plant effluent. A small but important point was that the prevailing wind blows away from the city and hence would tend to remove the inevitable refinery odours with least discomfort to the citizens of Durban.

c) One of the major problems of refinery location is an adequate and competent labour supply. Hand in hand with this problem is that of housing and recreational facilities for the staff. The Stanvac refinery site at Wentworth was close to a major city with supplies of both skilled and unskilled labour. Furthermore there were no problems of climate, of housing or of recreation - Durban could supply all the facilities that were needed. This in itself was an important factor affecting choice of location.

d) Thus far we have considered problems of location dealing with access to raw materials (crude oil), the provision of all necessary manufacturing (refining) facilities, and the supply and housing of competent labour. It remains to consider the important question of distribution facilities for the finished goods - in this case the output of refined petroleum products. From Wentworth the various products are distributed in one or more of the following ways:-

i) By pipeline to the tanker loading berth for ocean transit to other ports.

ii) By rail, in bulk or in drums or in tins, for distribution to the Reef and other interior areas.

iii) By road, in bulk or in drums or in tins, for local delivery in the Durban area.

It has already been shown that the Wentworth site was capable of easy connection to the harbour by pipeline, therefore no problems arose over the ocean transport of refined products. The rail service to the interior however could have been a serious bottleneck had not the South African Railways been engaged on extensive development works between Durban and the Reef. It was a relatively simple matter to link the Wentworth site by a branch line to the main South Coast Line. From there, trucks were routed via the Congella marshalling yard to the main Reef line and the interior. Congestion at Congella, which was acute in the early days of refinery operation, has now been eliminated by providing a new Bay-head marshalling yard, and the doubling of the main Durban-Reef railway line is nearing completion. Without these extensive railway improvements the refinery site at Wentworth, for all its other advantages, might have been untenable on account of lack of adequate transportation facilities to interior markets.

ϕ See Part 5 of this Chapter for a review of internal distribution arrangements.

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One of the more important locational advantages is that the rail link between Durban and the Reef is shorter than from any other Union port. Comparative rail distances are as follows:-

Durban to Johannesburg	486 miles
East London to Johannesburg	666 "
Port Elizabeth to Johannesburg	713 "
Cape Town to Johannesburg	951 "

The greater Witwatersrand area accounts for about 50% of all petroleum products consumed in the Union and, by locating near Durban, Stanvac had the assurance that there was no cheaper South African route from the coast to this major internal marketing area. Furthermore, Durban and its environs are also comparatively large market areas which should grow in importance in the future. The established pricing system in the Union allowed Stanvac to recover its distribution costs when delivering inland from Durban, and there was probably very little additional cost involved (as compared with costs borne by other importing companies) when making ocean tanker deliveries of refined products from Durban to other ports in Southern Africa.

Local deliveries are made by bulk road tankers which load up with product at the refinery, or at the oil sites in the harbour area, for distribution within the permitted Durban delivery area. Outside the bulk delivery area a certain amount of product is sold in drums, mainly in northern and southern Natal. The drums are manufactured by an independent contractor in Durban, as are various other containers for oils and greases - this being a further locational advantage in the siting of the Wentworth refinery.

The above general review of factors affecting the location of a coastal refinery should be compared to the problems facing Sasol, as outlined in Part 3 of this Chapter. Sasol was built adjacent to its source of raw material - the Sigma coal mine. The Stanvac refinery was constructed close to the import source of crude oil - Durban harbour. In both cases it was deemed more profitable to locate as near as possible to the raw materials and to transport the finished products to the consumer. In other words, PROCUREMENT COSTS - the costs of bringing raw materials to the chosen site of processing - were kept to a minimum.

In order to transform the raw coal into refined products Sasol takes 8 million gallons of water a day from the Vaal River (which is one of the few sources able to provide such a large quantity) and has built its own steam and power generating plant. Because of its isolated position Sasol has also found it necessary to develop a new township - Sasolburg - for its employees. Stanvac on the other hand draws power and water from the nearby city of Durban and most of its employees find their own accommodation in Durban or other nearby towns. Published figures of capital costs

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ϕ See discussion in Parts 3 and 5 of this Chapter. The inland distribution of the refinery's products is handled by two associated companies, Vacuum Oil Company of South Africa (Pty.) Limited, and Standard Oil Company of South Africa (Pty.) Limited.

∠ Delivery areas are discussed in Part 5.

x See Ref.63 Pp. 7 - 9

show that Sasol has already cost over £40 million, whist the Stanvac refinery cost about £7 million and is being expanded at a cost of a further £4 million. It must be accepted that each company is endeavouring to keep PROCESSING COSTS - costs of transforming the raw materials into refined products - as low as possible, but in the light of the above comparisons, it would seem that Stanvac has a distinct advantage over Sasol where amortisation of capital is concerned, particularly if relative output figures are taken into consideration.

When considering the question of DISTRIBUTION COSTS - costs of selling and delivering the products - it has already been shown that Sasol is at a disadvantage as compared to Stanvac's associated distributing companies Vacuum Oil Company of South Africa (Pty.) Limited and Standard Oil Company of South Africa (Pty.) Limited. These latter companies can recover their inland distribution costs, as the established price structure is based on coast prices plus rail/road transfer costs. The disadvantages of Sasol in this respect were discussed in Part Three of this Chapter, and in Part Five all aspects of the distribution of imported petroleum products in the Union will be covered in some detail. Inasmuch as the distribution system for Stanvac products is similar to that of the other importing oil companies, further consideration of the issues involved will be deferred for discussion in the following portion of this Chapter.

The refinery erected at Wentworth is of modern design in that it integrates the three basic processes of distillation, catalytic cracking, and thermal reforming in a single "combination unit". Distillation of crude oil in a fractionating tower will normally give up to only 30% petrol, plus kerosenes and diesel oils. However by catalytic cracking it is possible to break down some of the larger molecules of diesel oil into smaller molecules of petrol, thus improving the yield of petrol to about 40%. It is possible within certain limits to vary the output of heavier fractions (diesel oils and fuel oils) as compared to the lighter fractions (gasoline and kerosenes) but, in the case of a refinery constructed to serve a specific market area, the output of products will, as far as possible, be adjusted to suit the demand pattern of the area. The Stanvac management, whilst not able to provide anticipated production figures for long-term future output, has given the following rough approximation of 1958 production:-

Stanvac 1958 Production

Gasoline	350,000	long tons
Kerosenes	47,000	" "
Diesel Oils ≋	281,000	" "
Bunker Fuel) Asphalt, L.P.G.)	328,000	" "
Total Products	1,006,000	" "
Refinery Fuel and Loss	36,000	" "
Total Crude Run	1,042,000	" "

(≋ includes Marine Diesel Oil)
(L.P.G. = Liquified Petroleum Gas)

Of the sum of £40 million, about £2 million was spent on Sigma mine, about £3 million on housing and about £1 million on marketing facilities, leaving some £34 million as refinery costs. See Ref. 35, Page 2.

See Ref.63, Pp.7 - 9

Anticipated 1958 production of petroleum fuels:
Sasol 34,000,000 gallons, Stanvac 270,000,000 gallons

See Ref. 63 Pp 7 - 9

"Durban Standard-Vacuum Refinery" - a booklet issued by Stanvac to describe the construction of the refinery. See also "Harnessing Oil" a Stanvac pamphlet on refinery operation.

Private correspondence, Code 4320, dated 2.4.58.

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The above figures show that gasoline at present accounts for a little over one-third of total product output. The middle distillates (kerosene and diesel Oils) account for roughly another one-third. The balance of production is mainly marine bunker fuel, as asphalt accounts for only about 5 per cent of output. A £4,000,000 expansion programme now under way at the refinery is designed, inter alia, to increase production of the middle distillates and this will automatically involve a reduction in the output of bunker fuel. The following Table of percentage production shows clearly how the production pattern will change over the next three years as the new equipment is brought into operation:-

6

Stanvac Production Schedule 1958 - 1960.
(In Liquid %)

		1958	1959	1960
1.	Gasoline	37.0	38.0	36.0
2.	Kerosenes	5.0	10.0	13.0
3.	Automotive Diesel Fuel	18.0	22.0	24.0
4.	Marine Bunker Fuels	30.0	16.0	14.0
5.	Asphalt	5.0	5.0	5.0
6.	Liquified Petroleum Gas	0.5	0.6	0.7
7.	Refinery Fuel and Loss	4.5	8.4	7.3
8.	Crude run (long tons, 1,000's)	1042	1180	1181

Notes:

a) The division of item (2) into power kerosene and illuminating kerosene is not available, but the totals include about 1.5% aviation jet fuel per annum.

b) Item (3) includes about 1% of marine diesel fuel for local consumption - mainly for fishing fleets.

c) Item (4) includes fuel oil and diesel fuel used for ships bunkers.

d) The above arrangement of products is not directly comparable with that given earlier for 1958 production on a tonnage basis.

It should be remembered that the output from the refinery is marketed in the Union and in the Federation and in Portuguese East Africa. In addition bunker fuels are provided for the various ports in these areas. The above production schedule is therefore based on area needs rather than the specific requirements of any one country. It is understood however that the present output of marine bunkers is in excess of the company's local requirements and that the future increase in middle distillate production will bring the refinery output more into line with the growing demand for these products in the Union market. The implications of this changing demand pattern will be more fully discussed in Chapter 4 but in general it springs from the increasing

6 Private correspondence, Code 4320 dated 16.5.58.

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TABLE 28

UNION OF SOUTH AFRICA

≅ NETT IMPORTS OF PETROLEUM FUELS, 1946 - 1955

(Thousands of Gallons)

YEAR	ILLUMINATING PARAFFIN (1)	POWER KEROSENE (2)	DIESEL OIL (3)	MOTOR GASOLINE (4)	TOTAL (5)
1946	27,636	31,812	19,915	207,703	287,066
1947	30,882	30,044	35,054	228,255	324,235
1948	29,755	40,505	52,429	275,957	398,646
1949	36,718	51,266	47,077	306,403	441,464
1950	35,186	58,714	77,606	310,822	482,328
1951	40,687	70,544	74,100	323,462	508,793
1952	41,866	73,341	75,937	341,539	532,683
1953	40,806	84,511	69,813	360,508	555,638
1954 /-	41,953	95,181	65,622	296,279	499,035
1955	40,493	89,936	86,788	312,025	529,242
1955 Percentages	7.7%	16.9%	16.4%	59.0%	100%
Annual Average Rate of Increase					
1946 - 1953	5.73%	14.98%	19.64%	8.20%	9.89%
1946 - 1955	4.34%	12.24%	17.77%	4.63%	7.03%

(/- In this year the Stanvac Refinery at Durban commenced operations, - hence the reduction in imports for 1954 and/or 1955).

(Ref.64 Tables 1 & 10) (≅ Total Imports less Re-Exports)

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use of diesel engines for road and rail transport, plus the continued mechanisation of agriculture with diesel and/or kerosene powered tractors. The growing use of illuminating kerosene by the native population is another factor contributing to the increased demand for middle distillate fuels.

The anticipated 1958 crude requirement of 1,042,000 long tons represents an output of refined products equivalent to nearly 300,000,000 gallons, of which about 90% will be petroleum fuels. If the current output of marine bunker fuels is deducted, the balance remaining is about 180,000,000 gallons of other fuels for internal distribution in the Union, the Federation, and Mocambique by Stanvac's associated marketing companies. The methods adopted and the problems entailed in distribution in the Union of South Africa will be considered in the following pages.

5. THE DISTRIBUTION OF IMPORTED PETROLEUM

Tables 28 and 29 give latest available statistics of the importation of refined petroleum fuels into the Union and South West Africa. It should be emphasised that these are official figures of imports, which do not necessarily coincide with annual consumption figures because of variations in the quantity of stocks on hand in any particular year. However these Tables give sufficient indication of the annual volume of refined products to be handled by the importing oil companies and also of the average annual rate of growth in imports of each product. It is of particular interest to note from Table 28 that the drop in total volumes imported during 1954, when Stanvac refinery at Durban first came "on stream" was about 56,500,000 gallons when compared with the previous year. However the annual increase in demand was such that by the following year (1955) 50% of the drop in imports had been recouped, and it is highly probable (although figures are not yet available) that the 1957 import figures show a continuation of the upward trend which was interrupted in 1954. It is however clearly evident that over and above the output of refined petroleum products from Sasol, Satmar, and Stanvac, the current Union demand for imported petroleum fuels is well in excess of 500 million gallons per annum.

Table 28 gives annual average rates of increase in the importation of various petroleum fuels during the post-war years, and shows how the trend was interrupted in 1954. Prior to that year almost all the country's liquid fuel needs had been imported in refined state and it will be seen that the demand for petrol was rising at over 8% per annum, diesel fuel at nearly 20% per annum, and power kerosene at nearly 15% per annum. Together these three fuels accounted for over 90% of total petroleum fuel imports in any one year. The 1955 breakdown of imports on a percentage basis shows an interesting position in that petrol accounted for nearly 60% of petroleum fuel imports, with diesel oil and power kerosene roughly equal at about 16 - 17% each. In the next chapter, when dealing with inland consumption of petroleum fuels, it will be shown that the demand for automotive diesel fuel is in fact rising rapidly, whilst that for power kerosene is tending to decrease slightly.

The following four oil companies are engaged in importing and distributing refined petroleum products:-

Atlantic Refining Company of Africa (Pty.) Ltd.
Caltex (Africa) Limited,
The Shell Company of South Africa Limited,
Total Oil Products (Pty.) Limited.

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TABLE 29

SOUTH WEST AFRICA.

IMPORTS OF PETROLEUM FUELS 1946 - 1955

(Thousands of Gallons)

YEAR	ILLUMINATING PARAFFIN	POWER KEROSENE	DIESEL OIL	MOTOR GASOLINE	TOTAL
1946	336	521	1,031	3,878	5,766
1947	563	410	2,331	4,890	8,194
1948	650	393	3,847	5,272	10,162
1949	757	674	3,247	5,334	10,012
1950	707	646	5,222	5,757	12,332
1951	1,004	639	5,312	6,618	13,573
1952	1,345	634	5,934	5,850	13,763
1953	951	804	7,761	8,448	17,964
1954	1,052	733	9,201	8,726	19,712
1955		N O T	A V A I L A B L E		

(Ref.64 Tables 23 and 24)

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The first three of these companies have been operating in the Union for many years but Total commenced activities in this market only in 1956. Prior to the opening of the Stanvac refinery at Durban in 1954 the Vacuum Oil Company of South Africa (Pty.) Limited was also distributing imported refined petroleum products but this company now draws its requirements from local production at Durban.

In addition to the above major companies there are others operating marine bunkering and aviation fuelling facilities, or dealing in lubricants and chemicals. The main distributors of petroleum fuels however are Atlantic, Caltex, Sasol, Shell, Total and Vacuum.

The general pattern of distribution of imported petroleum fuels is to receive such fuels in bulk by ocean tanker at the various Union harbours, and from there to rail the products in bulk tank wagons to a series of inland depots for final delivery to the customer. Delivery is effected either by bulk road tanker or in drums of 44 gallons capacity and, for the latter purpose, certain selected bulk depots have been equipped with facilities for cleaning and filling drums of various products (See Table 30). Illuminating kerosene is also supplied in 4 gallon containers for domestic use.

Figure 13 shows the Union harbours at which Ocean Installations have been constructed for the reception and storage of products delivered there by tanker. Lourenco Marques has been included as, although this is not a Union harbour, it still ranks as a port of entry for petroleum products consigned to the Reef and the Northern Transvaal areas. It will be noticed that Installations exist at every port, the main reasons for this being as follows:-

a) It is much cheaper for products to be brought by sea to the various ports than to ship to say Durban, for rail distribution over the entire country. If any one company attempted to cover the whole Union from one port, it would have to incur extra transfer costs, in order to compete on a price basis in certain areas with product imported by a competitor through another port. The economic areas of delivery from the various ports are shown in Figure 13, which illustrates diagramatically the lines of supply for rail tankcars to different inland depots. The pattern of such deliveries is determined by comparative rail charges to inland destinations from competitive harbours, and an outline of the main line network serving these inland areas is shown in Figure 14.

b) The Union's rail network could not, in any case, handle the enormous volume of products that would flow inland if there was only one port of entry for petroleum fuels. To ease the strain on internal transportation resources it is essential to use all harbours. There is also a strategic reason, in the national interest, for having a number of ports capable of handling petroleum products.

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TABLE 30

DEPOTS ESTABLISHED BY THE OIL INDUSTRY FOR THE INTERNAL DISTRIBUTION OF PETROLEUM PRODUCTS

* GROUP 1.

Cape Town, Durban, East London, Lourenco Marques, Port Elizabeth, Walvis Bay.

* GROUP 2.

Bethlehem, Benoni, Bloemfontein, Johannesburg, Kimberley, Kroonstad, Ladysmith, Mossel Bay, Pietermaritzburg, Pretoria, Queenstown, Rosmead, Worcester.

GROUP 3.

Aliwal North, Bethal, Bloemhof, Caledon, Clocolan, Delareyville, Frankfort, Grahamstown, Krugers, Klerksdorp, Lichtenburg, Louis Trichardt, Luderitz, Middelburg, Moorreesburg, Nelspruit, Newcastle, Nylstroom, Ottosdal, Pietersburg, Port Nolloth, Potgietersrust, Rustenburg, Senekal, Standerton, * Tzaneen, Upington, Vredenburg, * Vryburg, Vryheid, Warmbad, Welkom, Windhoek.

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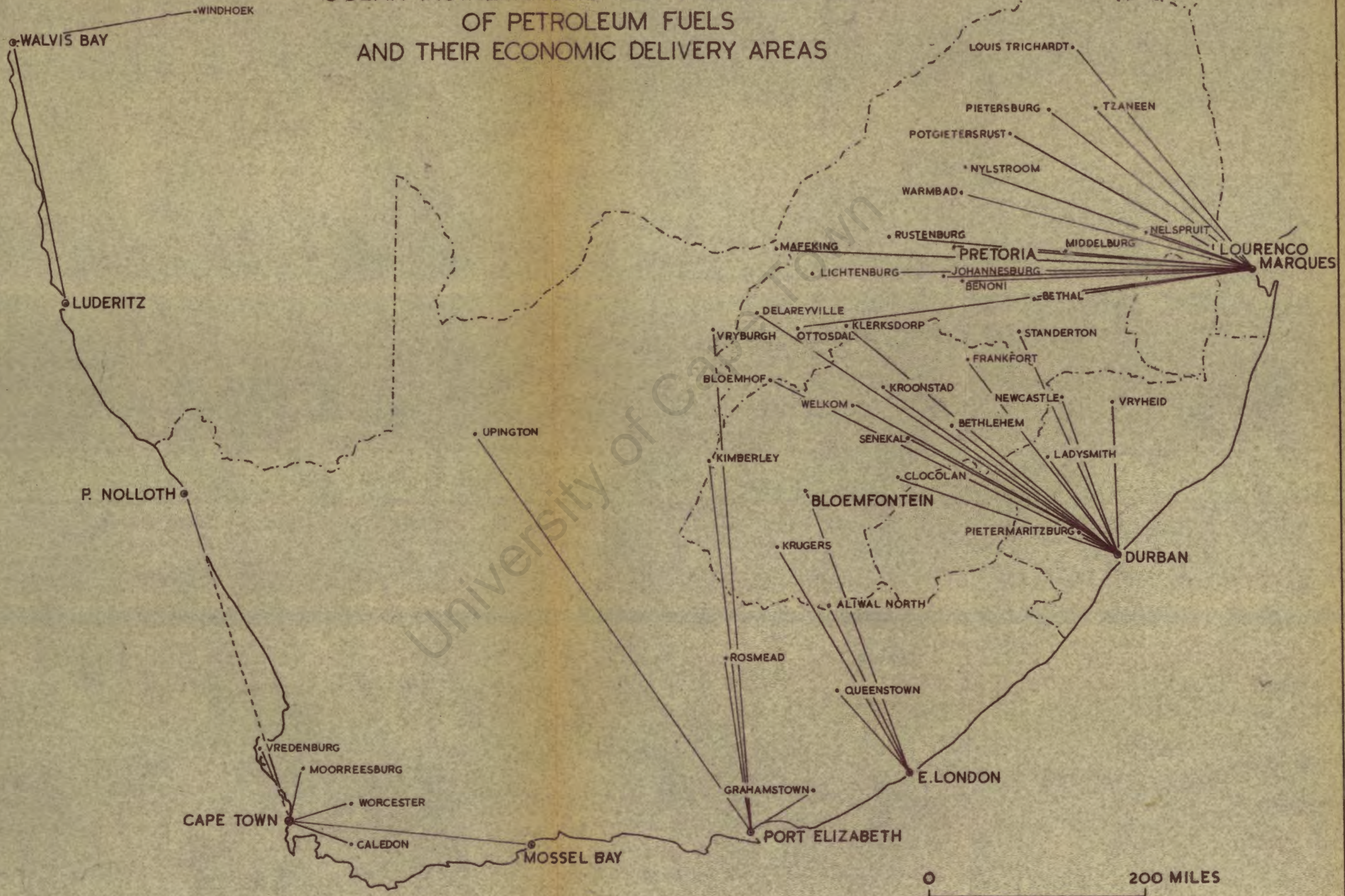
(* These depots are equipped with drum filling facilities.)

Source: Atlantic Refining Company of Africa (Pty.) Limited.

FIG. 13.

OCEAN INSTALLATIONS FOR THE RECEPTION OF PETROLEUM FUELS AND THEIR ECONOMIC DELIVERY AREAS



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In South Africa an Ocean Installation is essentially a facility for the reception in bulk, the storage of and the inland dispatch of petroleum products brought from overseas refineries. The products are stored in tanks which have to be of sufficient capacity to take the contents of a tanker, although sometimes if the vessel is a large one the contents may be divided between two ports. Two port discharge arrangements are however generally not desirable as the vessel incurs delay and extra costs by having to call at a second Union port. The Installation contains facilities for loading products into rail tank-cars for distribution to inland bulk depots. The tankcars are nominally of 8,000 gallons capacity and it will therefore be appreciated that over 600 tankcars are required to transfer inland the approximate quantity of 5,000,000 gallons of product that can be carried in a tanker of 16,500 tons capacity. Such movement can only be effected over a period of time and this emphasises the need for adequate petroleum storage capacity at the coast.

Ocean Installations in the Union are generally situated adjacent to the docks, on ground leased from the S.A.R.&H. Administration. This arrangement dates back to the days when petroleum products were first imported in bulk and, at that time, land was relatively plentiful in the harbour areas. The facility to erect large bulk storage tanks near to the tanker discharge berths made it easier and cheaper to conduct operations, there being only relatively short distances for the product to be pumped from the wharf to the storage tanks. Another advantage was that the oil sites could usually be easily served with railway sidings taken off the harbour service lines.

The situation today however is that land for oil sites in most of the Union harbours is very scarce and, although present facilities are adequate, the continually growing demand for petroleum fuels is posing a serious problem of future capacity. The storage of oil brings its own peculiar difficulties, and the flammable nature of the product plus the relatively large storage area required at each port makes it a difficult matter to obtain alternative sites. The issue is further complicated by the need to remain within reasonable distance of the tanker berths, as serious fire hazards and right-of-way complications are often involved when laying oil pipelines through an urban area. It seems likely that the demand for petroleum fuels may double during the next ten years and, although the need for additional storage capacity at Ocean Installations could be eased by more frequent arrival of tankers, this would necessitate extra berthing facilities for such vessels at harbours which by then will be operating at full pressure. Furthermore it has already been shown that some 600 rail tankcars are required to convey the contents of one 16,500 ton tanker and, if extra storage space is not available at the coast, additional rail tankcars must be provided to carry the increased volume of product to inland storage tanks. One way out of the difficulty would be to transfer petroleum fuels from the coast to the interior by pipeline, and such a project is at present being considered for the Durban-Reef route. In addition to eliminating the need for additional bulk storage tanks in Durban, this project would also give much relief to the railways in transporting products by tankcar from the coast to Reef areas. Consumers should also benefit through lower distribution costs, as the following authoritative comment clearly shows:-

ϕ A Government Commission of Enquiry has now recommended that further consideration of the pipeline project be deferred until 1968 (U.G. 60/1958)

ϕ "The cost of inland distribution is tied up with the question of rail preference, and the powerful influence wielded by the South African Railways. A commission has been studying the proposal to build a product pipeline of over 300 miles from Durban to the Rand which for a capital cost of £11 - 12 million would, it is estimated, be able to transport petroleum products to Johannesburg for 1d per gallon, compared with rail freight charges of 6.89d per gallon by the present route from the port of Lourenco Marques. Apart from the obvious advantage to the economy of the cheapest form of transport for petroleum products, the railways will find it increasingly difficult to deal with the ever larger quantities of petroleum products which will be needed in the future. The Commission has not yet given its recommendation on the pipeline proposal but its report is expected shortly".

Figure 14 shows the various inland depots which have been established by the oil industry for distribution to customers. It will be noticed that the Union's coastal harbours are also shown, the reason being that at each port a depot for local distribution is usually operated in conjunction with the Ocean Installation. The remarks which follow in regard to inland distribution are applicable to all oil companies, whether they import refined products or market the output of local refineries. In the cases of Atlantic, Caltex, Shell, Total and Vacuum, the distribution network operates from the coast towards the interior. The special position of Sasol Marketing Company, operating from an inland refinery, has been discussed in Part 3 insofar as it affects their ability to compete with other companies on a price basis. However the position of Sasol relative to depot operations and road delivery restrictions is exactly the same as the other companies.

It will be noticed from Figure 14 that the network of inland depots covers most of the more developed areas of South Africa. It will also be noticed that the layout tends to follow the main railway lines. In developed areas the depots are generally spaced from thirty to sixty miles apart, depending on the proximity of sales outlets and the location of suitable land, power, water, sidings and housing facilities in nearby towns. This pattern of inland distribution is forced upon the oil industry by the terms of The Motor Carrier Transportation Act of 1930 which, inter alia:

/ i) makes it an offence to carry on any motor transportation without a certificate or an exemption issued in terms of the Act, and

x ii) restricts the right of an oil company to carry its own products in bulk or in drums to a radius of 30 miles from an oil company depot.

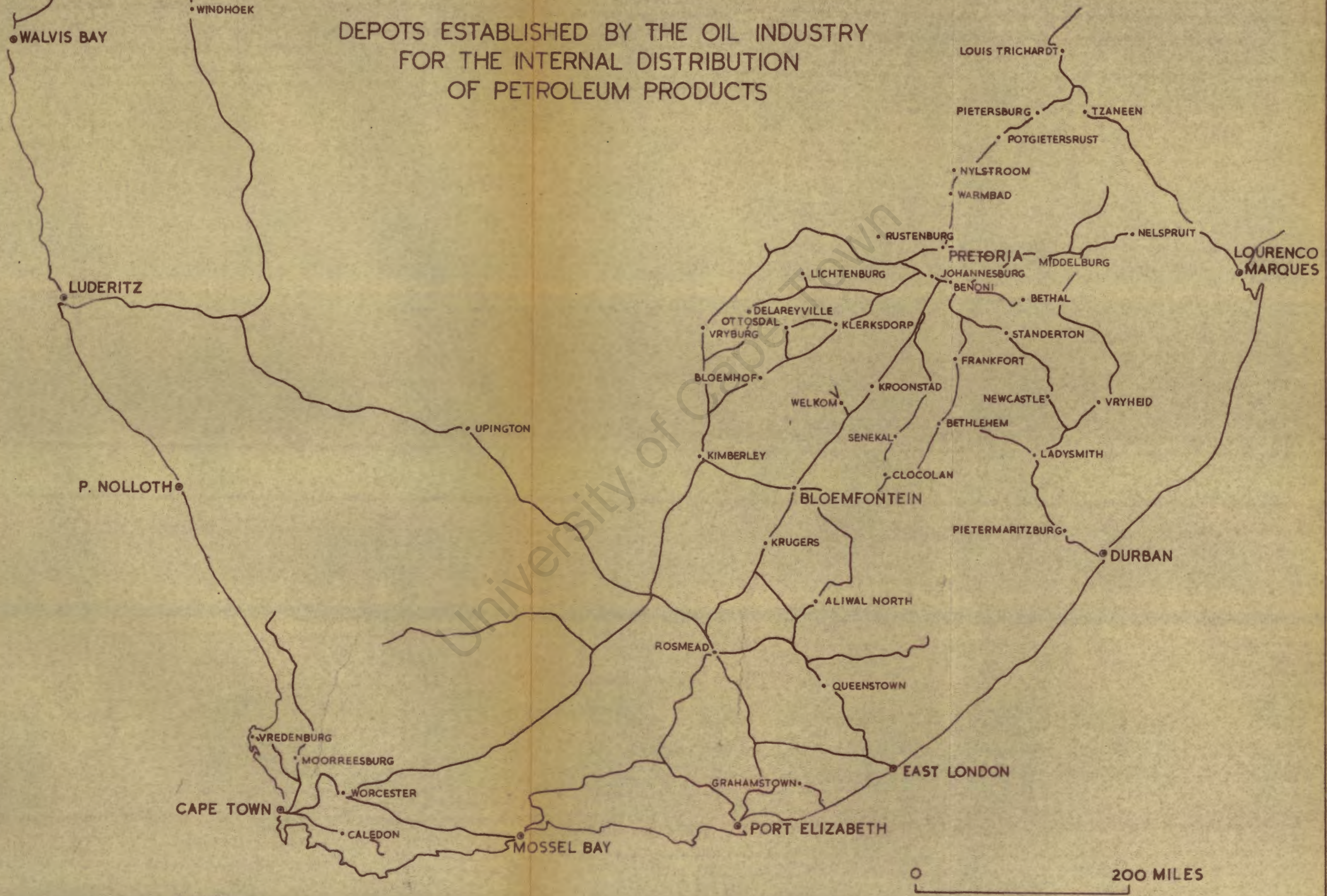
ϕ "Unusual South Africa" - an article in Petroleum Press Service for February 1957. The rail freight charge of 6.89d per gallon refers to petrol, and does not necessarily bear any relationship to the true cost of conveying this product in bulk by rail.

/ Ref. 65 Page 20 (Para 9 (1) of Act 39/1930)

x Ref.65 Page 64 (Regulations 51 (e) and (f) issued in terms of the Act).

FIG. 14.

DEPOTS ESTABLISHED BY THE OIL INDUSTRY FOR THE INTERNAL DISTRIBUTION OF PETROLEUM PRODUCTS



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This restrictive legislation refers to road transportation only, the nett effect being to protect the monopoly position of the South African Railways in regard to the transfer of petroleum products. The Act does in fact restrict all forms of commercial road transport to a greater or lesser degree, but we are here concerned only with its effect on the distribution of petroleum fuels which can be summarised as follows:

a) As the oil companies are not normally allowed to carry their own products beyond a thirty mile radius from a depot, the transportation of petroleum fuels from the coast to inland depots has been reserved for the railways. This has restricted the development of an inland depot network to towns which are served by the railways and where sidings facilities could be obtained, irrespective of whether such towns were in fact the best local centres for depot location from a sales point of view.

b) Because of the 30 mile radius road delivery limitation it was necessary to endeavour to space depots not less than 60 miles apart in order to obtain maximum territorial coverage from each depot without overlapping of areas. However, on the one hand the need for railway sidings restricted the choice of sites to towns on the rail route and, on the other hand, the rail routes were not conveniently spaced at 60 mile distances - hance in many instances it had to be accepted that the delivery area of new depots might overlap the delivery area of existing depots. This was wasteful in terms of capital expenditure and expensive in terms of operating costs, not only because the overlap area could be served from two depots, but also because distribution costs in the area might have to be absorbed by one depot to meet the delivered price of product from the other depot.

Commenting on this state of affairs, Petroleum Press Service has stated:-

"A very serious brake on economy and flexibility in the distribution of petroleum products is the limitation imposed by the National Transport Commission on delivery by road beyond a radius of 30 miles. By extending the limit to 50 miles, it is estimated that the railways would lose less than £250,000 of revenue from their oil company customers, out of the £10 million a year which these at present pay to the state rail and harbour authorities. The Joint Committee set up to examine the question is now investigating individual suggestions by the industry for specific points outside the 30 mile radius, where road bulk delivery is urgently needed.

In terms of the Regulations to the Act and under certain stringent conditions, it is sometimes possible to obtain exemption to deliver by road to places beyond a 30 mile radius. e.g. Cape Town to Paarl.

See Ref.63, Page 54 ff.

"Unusual South Africa" an article in Petroleum Press Service for February 1957. ("Petroleum Press Service" is a publication having much the same standing with the Oil Industry as "The Economist" possesses in the business world)

Within the present limitations, the companies are expanding bulk distribution as much as possible and some 35 new bulk depots were constructed in 1956. If the 30-mile restriction is retained it has been calculated that it will be necessary to construct 225 new depots in the next 14 years but, if the 50-mile radius were adopted, increased flexibility would permit the same distribution of supplies to be maintained with only 77 new depots. Extended road transport would also hasten the reduction in distribution by returnable drums - an expensive and obsolete method leading to shortages during the height of seasonal demand by farmers.

The reluctance of the state-owned railways to lose any oil traffic is rooted in the financial problems which arise partly from their public-utility character. Compared with a surplus of £10½ million in the year ended May 1956, losses on railway operations were more than £2.5 million in the first half of the current financial year and the deficit was expected to be larger over the 12 months. This too, at a time when the country is advancing economically. Yet, paradoxically, the railways have to forgo revenue owing to their inability to cope with all the traffic offering. In the year ended March 31st 1956, it was estimated that 5 million tons of potential revenue earning traffic - mainly ores and coal - had to be foregone compared with the 65 million tons handled."

The Joint Committee mentioned above has reached agreement in regard to bulk deliveries to a small number of places lying outside the 30 mile radius of existing depots, but there does not seem to be any likelihood of a general relaxation of restrictions governing petroleum delivery by road. The situation is somewhat Gilbertian, in that every time a new bulk depot is opened the railways automatically lose most of the drum freight revenue to that area, but they are apparently still determined to oppose any major relaxation in road transportation restrictions for the oil companies, thus forcing them to spend money on more and more bulk depots in order to keep pace with increasing demand. As shown above, an increase in the permitted delivery radius from 30 to 50 miles would reduce the number of new depots required by about two-thirds, with a commensurate saving in capital expenditure.

The history of bulk depot operation in the Union goes back to 1923 when the first "Bowser" petrol pump was introduced and from then onwards the oil companies gradually discontinued the importation of ready-packed petroleum products and erected large storage tanks at the principal ports into which such products could be discharged from ocean-going tankers. These "Ocean Installations" had by 1939 been established at all the major harbours (Group 1 in Table 30). In addition a small number of inland depots had been built, served with product in bulk by rail tankcars from the coast. These inland depots are shown in Group 2 of Table 30 and, in addition to making bulk road deliveries of petrol in local areas, they were also equipped with facilities for filling drums with various products for

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onward delivery by rail or road motor service to other areas. The Second World War interrupted this pattern of development but, as the post-war demand for petroleum fuels continued to rise, it became obvious that further depot construction would be necessary and during the period from 1950 onwards the depots shown in Group 3 of Table 30 were constructed. The main factors influencing this post-war trend towards the establishment of a large network of inland small bulk depots were as follows:-

i) The rail transportation crisis of 1950 - 54 caused serious difficulties in the internal distribution of petroleum fuels - both bulk transfers to established depots and the very large drummed trade to other customers being affected.

ii) The farming community in the post-war years had spent hundreds of thousands of pounds in the purchase of tractors and other items of machinery for farm use. The demand of this section of the national economy for petroleum fuels had two peak periods, one at ploughing time and the other at harvesting. Deliveries in drums were often unduly delayed due to shortages of railway trucks and handling facilities and, in any case, because of difficulties in the return of these containers the peak period demands were throwing an ever growing strain on the oil companies drum resources.

iii) The petrol needs of many larger towns had outgrown the capacity of the oil industry and the railways to maintain constant drum supplies. Furthermore the drums were an unwieldy and outmoded system of petrol delivery. They were frequently damaged in transit and the contents suffered leakage and evaporation loss. Extra labour had to be maintained to decant the drums into underground tanks, and there was also the ever present risk of fire when decanting.

Most of the depots shown in Group 3 of Table 30 were constructed to bring bulk petroleum fuels to the farmers and/or to the towns. The original programme envisaged that petrol would be delivered by bulk lorry to garages situated within the permitted delivery radius, whilst farmers would bring their empty drums to the depots for refilling with power kerosene or diesel fuel. The different treatment of these categories of consumer was based mainly on the economics of delivery. Garages normally required large quantities at frequent intervals and were situated on relatively good roads along which bulk trucks could travel in safety. Farmers on the other hand required smaller quantities, mainly at two distinct times of the year, and were often served by roads which would be impassable to a heavily laden bulk road tanker. Furthermore the garage owner dispensed his petrol in bulk to motorists calling at the garage for that purpose, whilst the farmer required to be able to carry his tractor fuel in drums to remote corners of his lands to avoid waste of time in refuelling.

In order to reduce the number of drums required to service the farmer trade and to encourage the use of the newly established depots, a small price incentive was offered to the farmer to bring

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drums for refilling to his local agricultural depot rather than to continue ordering fresh drums of product from the nearest drumming depot (See Table 30). This system was designed to reduce the number of drums in transit to and from individual farmers, which would relieve the strain on the oil companies drum resources. At the same time it was hoped to ease the product supply position for the farmer by eliminating railage delays and losses due to drum leakage. In due course it is probable that bulk deliveries by road tanker will be undertaken to selected large farming consumers, where road conditions permit. Such consumers will then be able to fill their own vehicles and/or drums from their own stocks of fuel.

The network of bulk distribution facilities from the depots shown in Figure 14 will be expanded in course of time, as local areas of demand develop to the stage where bulk deliveries are desirable. The main incentive to the oil companies in this respect is the elimination of the expensive and outmoded system of drum delivery. ƀ It has been estimated that at the end of 1957 some 3,000,000 returnable drums were in service in South Africa. These drums cost about 60/- each and remain the property of the oil company. However each year tens of thousands are "lost" and not returned for refilling. Most of the remainder come back so slowly that they can be used only twice in twelve months. It can readily be seen that millions of pounds are thus tied up unproductively in providing these containers. At one stage a deposit system was in force for returnable drums but it broke down through the impossibility of accounting for empty drums from individual customers when these were frequently dumped at unattended railway sidings or R.M.T. halts without separate consignment notes, or else sent to a different depot from that which originally supplied the fuel. Many alternative schemes have been mooted but the problem is fraught with administrative and technical difficulties on a large scale, chiefly on account of the fact that the oil companies have no control over the drums once they have been handed over to the railways for delivery.

To close this section on inland distribution, it is worth while quoting the remarks of Mr. S.L. Lloyd, former General Manager of the Shell Company of South Africa Limited. In dealing with the problems affecting petroleum deliveries, Mr. Lloyd had this to say:-

> x "This whole question of extending the areas in which we are permitted to deliver by bulk lorries instead of in returnable drums continues to be one of our major distribution problems.
>
> For years the oil companies have been asking for permission to deliver over a radius of 50 miles from each bulk depot, instead of the 30 miles allowed since the relevant Act was passed in 1930. For years the Railways have opposed our applications. In an endeavour to reach agreement the oil companies accepted a suggestion by the General Manager of the Railways that a joint committee should be formed to go into the whole matter, and at the same time to consider individual proposals for new bulk depots and for extended bulk delivery.
>
> Some measure of agreement on individual applications has been reached, and in the last two years twenty applications for exemption from the 30-mile

ƀ Ref.66, Page 13
x Ibid Pp 12 - 13

radius rule have been granted, but the major issue at stake has not been settled. The Railways apparently can only see the problem from the one point of view - "how does it affect our revenues?" - instead of asking the question "are we working in the best interest of South Africa by insisting on petroleum being carried in drums (an obsolescent method of transportation) when it can be carried more efficiently and more cheaply in bulk lorries?"

I am the first to agree that the Railways must consider their own economics, but it should not be overlooked that both they and the oil industry have a responsibility of service to the public, and my contention is that wherever it is practicable to do so the oil companies should be permitted by the Road Transportation Board to deliver petroleum products in bulk within a radius of 50 miles from each of their bulk depots and coastal installations. The Railways would still carry petroleum rail tank cars in bulk to inland depots, and would still carry drums by their road motor services to places outside the bulk delivery areas.

There are three main reasons for my contention. Bulk delivery is cheaper, is quicker, and is safer than delivering in drums, and I feel that efficient service to the public is more important than a comparatively small drop in Railway gross revenue which may well turn out to be a net profit to them and a gain to the country when the cost of distribution is worked out.....

Our intention is to build new bulk depots at a number of different points. The location of these new depots is, of course, decided only after close investigation into the economics of each individual project. But as long as the 30-mile radius restriction remains it will obviously be necessary for us to contemplate the establishment of many more bulk depots than would be the case were we permitted to deliver over the wider radius of 50 miles. As even small new depots cost about £15,000, this official restriction is costing us, the other oil companies, and in the long run the South African consumer, a lot of money".

6. COST AND SUPPLY ASPECTS

The foregoing sections of this Chapter have dealt mainly with the production and distribution of petroleum products in the Union of South Africa. To complete the picture it would be of considerable interest and advantage if matters affecting the supply of such products could be discussed, with particular reference to the comparative costs of the different fuels as between inland refineries, coastal refineries and imported refined spirit. To this could be added a comparative analysis of the costs of distributing petroleum fuels by coastal tanker, by rail tank waggon, by bulk road lorry and by drums. The study could then be taken

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a stage further to compare the overall economics of supply and distribution between:-

a) coastal refineries using imported crude (Stanvac).

b) inland refineries producing oil-from-coal (Sasol).

c) marketing companies selling imported refined products (Atlantic, Caltex, Shell, Total, Vacuum).

Such a study however, depends entirely on the availability of data concerning the supply and distribution of petroleum products and such data is unfortunately not readily available.

In an effort to ascertain whether the major Oil Companies would be prepared to assist in a survey of supply and cost aspects relevant to the production and/or distribution of petroleum fuels, a letter was addressed to each one of them asking for information. The following is the gist of their replies:-

ϕ a) ATLANTIC: ".... we regret that we are unable to provide any information relevant to our costs of supply and distribution of imported petroleum products".

/ b) CALTEX: "Present source of supply for our Petroleum imports to South Africa is the Persian Gulf - Saudi Arabia and Bahrein. Some shipments are made from Persia. Also possible sources of supply at present are Indonesia and the American Caribbean. The f.o.b. costs of the various products are the posted prices according to Platts Oilgram and the freight rates are the Afra rates. .... I am not disposed to give you the distribution costs".

// c) SASOL REFINERY: "I feel sure you realise that this kind of information is regarded as confidential by most Refineries and we at Sasol do not differ in this regard. .... I regretfully have to advise you that we cannot supply any information of the kind you request".

x d) SASOL MARKETING COMPANY: "In reply to your letter of the 5th instant, I very much regret that we cannot, for policy and other reasons, give you the information you require".

ϗ e) SHELL: ".... We should, of course, be only too pleased to help you in any way we could, but unfortunately the information for which you specifically ask..... is of a strictly confidential nature and could not be made public without risk of prejudice to the Company's interests".

ϕ Private correspondence dated 24th April 1959
/ Private correspondence dated 22nd April 1959
// Private correspondence dated 13th May 1959
x Private correspondence dated 20th May 1959
ϗ Private correspondence dated 22nd April 1959

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ж f) STANVAC REFINERY: ".... we regret we are unable to provide you with the information which you have requested. We would naturally like to assist you with subject matter for your thesis but, as you yourself mention, the information requested is of a highly confidential nature".

/ g) TOTAL: "With reference to your letter of even date requesting information with regard to the cost of petroleum fuels, distribution costs, etc., we very much regret that we are unable to accede to your request as this information is of a confidential nature".

x h) VACUUM: "Your efforts in desiring to write a comprehensive thesis dealing with the Commercial Energy Requirements of the Union are to be commended. However, the information you have called for is of such a confidential nature that - despite the greatest desire to help you - we are not in a position to do so".

It will be obvious from the foregoing that none of the major Oil Companies is willing to provide any data which would make it possible to compare the economics of supply from coastal refineries, inland refineries and imported refined products. Furthermore, none of the Companies is prepared to make available any cost data which would make it possible to study comparative distribution costs. There is sufficient published information to give an adequate picture of the demand for petroleum products and this will be discussed in the next Chapter. Unfortunately there is not sufficient data available in regard to supply aspects and production or distribution costs, to add materially to the information already contained in the previous portions of this Chapter. The following notes, will however help to clarify the supply position:-

1) The supply position of Stanvac cannot be analysed because this refinery serves other areas in Africa and figures for the Union share of estimated output are not available.

2) Sasol/Satmar, when working to capacity, will supply about 5½% of the total inland demand for petroleum fuels (1961 basis).

3) Natal Cane supply only two million gallons per annum (about ¼% of current demand) half of which is from blend stock of imported petrol.

4) In the absence of any domestic sources of crude oil about 95% of the Union's petroleum needs have to be imported, either as crude for refining locally or as refined spirit for direct marketing.

5) Imports come mainly from Middle East Sources but, in an emergency, supplies could be obtained from almost anywhere in the world, on the assumption that tankers were available to carry the product.

ж Private correspondence dated 27th May 1959
/ Private correspondence dated 20th May 1959
x Private correspondence dated 5th May 1959

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Prospecting for oil is being carried out in certain areas of South West Africa and other oil refineries are being planned to serve the South African market. These, however, are long term ventures about which very little knowledge is currently available. The discovery of economic quantities of crude oil within the territorial boundaries of the Union would, of course, completely change the present supply picture; but the pattern of consumption, discussed in the following Chapter is not likely to change materially during the next decade. That is a further reason for concentrating on consumption in this Thesis, although much more attention would certainly have been given to matters of supply and relative costs, if only appropriate data had been available.

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CHAPTER FOUR

THE CONSUMPTION OF PETROLEUM FUELS

1. Total Union demand for Petroleum fuels.
2. Ocean Bunkers.
3. Industrial Diesel Oil and Furnace Oil.
4. Automotive Diesel Oil.
5. Aviation Gasoline and Turbine Fuels.
6. Power Kerosene.
7. Illuminating Kerosene.
8. Motor Gasoline.
9. Summary and ten year forecast.

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CHAPTER FOUR

THE CONSUMPTION OF PETROLEUM FUELS

1. TOTAL UNION DEMAND FOR PETROLEUM FUELS

The only official figures for the inland consumption of petroleum fuels are contained in the schedule of sales of petrol companies published in the Monthly Bulletins of Statistics issued by the Bureau of Census and Statistics in Pretoria. These records go back to 1950 in the case of Union total figures, but give no indication of the breakdown of sales amongst the various sectors of the national economy. The only other official data having any bearing on the total demand for petroleum fuels are the Import figures published in the Annual Statements of Trade and Shipping and summarised for the years 1946 - 1955 in Tables 28 and 29 (Pages 129 and 131). The import statistics are not however a reliable guide to actual sales, as they do not reflect stocks on hand in any one year.

Having regard to the lack of detail in official statistics upon which to base an analysis of consumer demand, the problem arises of "where" and "how" to obtain such detailed information. The position is complicated by the fact that the greater part of oil company sales are made in small quantities at a time to garages, to farmers, to transport operators, to factories, to fishing boats, to municipalities, to storekeepers and to many other individual consumers. There are of course other sales in larger volumes to the Railways, to large mines, to construction projects of various sorts and to a few large industrial customers; but in general it is the aggregate of small sales to many customers that constitutes the major portion of the oil companies' business. Under these conditions it is hardly possible to obtain more than a minimum of data relevant to consumer demand without the aid of a complete market survey of petroleum sales throughout the Union. This is beyond the scope of the individual investigator, but is a somewhat less difficult task to those actually engaged in the distribution of petroleum products.

In order to build up a more comprehensive survey of the consumption of petroleum fuels it has accordingly been necessary to draw upon information furnished by the major oil companies. Each of these companies keeps accurate records of its own sales of products, although this information seems to be maintained mostly on an "area" and "product" basis. There is very little detailed information by categories of "end user", but in any case none of the major oil companies is prepared to make available any data relating to its own sales. However each company makes its own estimates of total market demand for various products, and as this information does not give away any details of the sales of individual companies, it has been possible to obtain considerable assistance from the leading companies on this basis. It should be emphasised

δ For the purposes of this Chapter South West Africa will be regarded as part of the Union, although relevant statistics will often be shown and discussed separately.

that the companies' own estimates of sales of different products do not necessarily coincide with the official figures published by the Bureau of Census and Statistics, nor do the estimates of any one company necessarily coincide with estimates made by another. There are several reasons for this:-

a) The Oil Companies require continuously up-to-date statistics, and from their own sales figures and Branch reports they can estimate total market demand month by month. The Bureau of Census and Statistics figures are compiled from returns and estimates made by the Companies, but are six months in arrears when published.

b) The Companies include the Protectorates and South West Africa in their own estimates. The Bureau has tabulated South West Africa's petrol consumption (separately) only since 1954, and does not yet show sales of other petroleum products in South West Africa, or sales in the Protectorates.

c) Each company prepares an analysis of market demand in its own way. Some companies use a grouping based on trade relationships and sectors of the economy, e.g. mining, fishing, government, agriculture, etc. Other companies adopt an "end use" analysis which cuts right across trade or sector groupings, e.g. automotive engines, stationary engines, marine engines, etc. Sometimes a mixture of both systems is used and, in any case, there is often considerable divergence of views in regard to classifications. For example, one company might show only tractor consumption under 'agriculture', whilst another company might include all forms of consumption by the agricultural industry under the same heading. This makes it difficult to compare the figures provided by different companies and it will not always prove possible to reconcile these figures in detail, although they may present a similar overall picture.

d) The fourth major point of variance is in the specific gravity figures applied to the various products when converting tons into gallons. Not only do specific gravities vary from product to product, but they also vary from shipment to shipment and from company to company. When thousands of tons are converted to gallons a fractional difference in specific gravity figures can make a big difference to the answer, and it frequently happens that each company's calculations are based on a specific gravity different from the others. The following list gives typical 1957 conversion factors calculated by one company on an average basis from various shipments:-

/

IMPERIAL GALLONS PER TON OF 2,240 lbs

Petrol - Regular	about	312
Petrol - Premium	"	306
Illuminating Kerosene	"	285
Power Kerosene	"	275
Automotive Diesel Oil	"	267
Industrial Diesel Oil	"	262
Furnace Oil	"	260

/ Information supplied by Atlantic Refining Company of Africa (Pty.) Ltd. As an example of the differences that may arise it can be mentioned that in 1951 the conversion factor for petrol was about 315 gallons to the ton.

Estimated consumption figures for the main petroleum fuels in the Union and South West Africa respectively for the years 1947 to 1956 are shown in Tables 31 and 32. South West Africa has been shown separately in this instance to illustrate the relative ratios of demand between that territory and the Union. It will be noticed that South West Africa in 1956 consumed a total of some 20 million gallons of all fuels (Table 32) but this represents only about 3% of the Union total of 690 million gallons consumed during the same year (Table 31). Several interesting comparisons may be made from a study of the two Tables:-

a) The total consumption of petroleum fuels in the post-war decade has increased at an average rate of 8.33% per annum in the Union. However the five year period 1951 - 1956 probably presents a more accurate picture of the present rate of increase, as this eliminates the pent-up demand of the immediate post-war years which tends to distort the ten-year figure. Taking only the period 1951 - 1956 into account, the average rate of increase in total Union demand for petroleum products was 6.34% per annum.

b) Similar figures for South West Africa show an average rate of increase in total consumption during the post-war decade of 11.74% per annum, and an average rate of 12.13% per annum during the years 1951 - 1956. This indicates that as far as the consumption of petroleum energy is concerned, the South West Africa demand, though relatively very small, is increasing at nearly double the average rate per annum of the Union demand. This is largely due to the continued economic prosperity of South West Africa coupled with the absence of natural fuel resources in the territory. The high cost of coal railed from the Transvaal and the problem of maintaining adequate supplies makes it possible for petroleum imported via Walvis Bay to compete for nearly all types of local energy requirements. Even the Railways have announced their intention of changing from coal to diesel locomotives in South West Africa, although in their case the difficulty of obtaining adequate supplies of water for steam engines is also an influencing factor.

c) Motor Gasoline and Automotive Diesel Oil are the main two fuels, but whereas in the Union Automotive Diesel Oil accounted for only 16.9% of 1956 total consumption, in South West Africa consumption of this product represented 37.95% of total demand in the same year. This was due partly to the activities of the fishing industry in South West Africa and partly to the needs of mining, transport and electrical generation. When the Railways change over to diesel locomotives the demand for automotive diesel oil will increase still further and by 1960 the total consumption of this product may even exceed that for motor gasoline in the territory.

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T A B L E 31 - UNION OF SOUTH AFRICA

INLAND CONSUMPTION OF PETROLEUM FUELS 1947 - 1956
(Thousands of Gallons)

YEAR	MOTOR GASOLINE 1.	AVIATION GASOLINE 2.	ILLUMINATING KEROSENE 3.	POWER KEROSENE 4.	AVIATION TURBINE FUEL 5.	AUTOMOTIVE DIESEL OIL 6.	INDUSTRIAL DIESEL OIL 7.	FURNACE OIL 8.	TOTAL 9.
1947	234,942	4,645	28,751	32,414	-	19,020	10,500	5,272	335,544
1948	276,304	5,800	32,709	38,568	-	24,631	11,441	5,976	395,429
1949	307,256	6,540	35,340	49,052	-	33,074	11,628	6,551	449,441
1950	304,451	7,046	36,044	55,627	-	40,057	8,913	5,716	457,854
1951	329,857	6,700	37,880	70,080	-	47,660	8,483	6,473	507,133
1952	341,112	6,983	38,803	74,191	571	54,621	6,788	6,838	529,907
1953	353,835	7,362	41,466	84,000	1,051	63,434	5,888	6,890	563,926
1954	366,492	8,026	44,756	90,627	729	77,648	5,448	8,143	601,869
1955	389,894	8,247	47,336	89,440	879	95,591	4,681	8,483	644,551
1956	408,691	9,385	49,889	90,687	1,344	116,324	3,768	9,527	689,615
1956 Percentages:	59.3%	1.4%	7.2%	13.1%	0.2%	16.9%	0.5%	1.4%	100%
Annual Average Rate of Increase:									
1947 - 1956	6.34%	8.13%	6.32%	12.11%	-	22.29%	(10.78%)	8.04%	8.33%
1951 - 1956	4.38%	6.97%	5.66%	5.29%	-	19.54%	(14.98%)	6.80%	6.34%

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd., and the Shell Company of South Africa Ltd.)

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T A B L E 32 - SOUTH WEST AFRICA:

INLAND CONSUMPTION OF PETROLEUM FUELS 1947 - 1956

(Thousands of Gallons)

YEAR	MOTOR GASOLINE 1.	ILLUMINATING KEROSENE 2.	POWER KEROSENE 3.	AUTOMOTIVE DIESEL OIL 4.	INDUSTRIAL DIESEL OIL 5.	TOTAL 6.
1947	4,060	544	438	800	1,550	7,392
1948	4,586	621	419	1,020	2,005	8,651
1949	5,018	751	428	1,394	2,366	9,957
1950	5,165	793	417	1,914	3,049	11,338
1951	5,996	810	501	2,789	1,229	11,325
1952	6,363	856	636	3,133	2,610	13,598
1953	7,001	916	607	4,192	1,859	14,575
1954	7,479	1,018	638	5,098	2,500	16,733
1955	8,255	1,064	722	6,707	1,915	18,633
1956	9,268	1,163	764	7,618	1,260	20,073
1956 Percentages:	46.17%	5.79%	3.81%	37.95%	6.28%	100%
Annual Average Rate of Increase:						
1947-1956	9.60%	8.81%	6.36%	28.46%	-	11.74%
1951-1956	9.10%	7.50%	8.81%	22.26%	-	12.13%

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd.)

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d) The demand for Power Kerosene (mainly for tractor operation) was still rising in South West Africa in 1956 whereas in the Union the figures for 1954, 1955 and 1956 show a definite levelling off in annual consumption of this product. Detailed discussion on this, and on other specific petroleum fuels will be reserved for subsequent parts of this Chapter.

The total consumption of petroleum products by the Union and South West Africa during the period 1947 - 1956 is summarised in Table 33. The figures are given in tons because this is the accepted oil industry method of calculating and comparing demand figures, and also because it will facilitate comparison with tons of coal when energy consumption in South Africa is discussed in Chapter Five. It can be accepted that Table 33 is an approximate summary in tons of the gallonage figures shown in Tables 31 and 32. The Table includes all inland sales of petroleum fuels and also the supply of bunker fuels to ocean going vessels. Fuels supplied to coasters and to fishing vessels is entered under Inland Sales. It will be recalled that in Chapter 1, Part 7, when discussing coal sales, it was found that the inclusion of fluctuating export and bunker figures gravely distorted the trend pattern of inland demand for coal. A study of Table 33 will show that the ocean bunkering figures for petroleum are similarly erratic. The 1949-56 figures, for example, were inflated by movements of shipping during the Korean War. Similarly the 1956 figures reflect bunkers supplied to some of the ships diverted around the Cape at the time of the Suez Crisis.

The erratic demand for bunker fuels is further emphasised in Table 34, where column (3) represents mainly the consumption of fuel oil by shipping. The peaks of war-time demand during 1940-43 can clearly be seen, when much shipping was using the Cape Route. By 1944 the centre of activity had moved to Europe, the Suez Canal was again open to ships of the allied nations, and the consumption of South African bunker fuel had fallen.

When determining energy consumption trends it is proposed to follow the method previously adopted in regard to coal, by considering only inland requirements of petroleum in order to establish a trend pattern. The exceptional fluctuations in demand for bunker fuels will thus be unable to influence the trend of inland consumption. Estimates of bunker fuel requirements will be added afterwards to complete the overall picture of expected total consumption.

Table 34 presents an interesting picture of past demand for gasoline and it will be noticed that over the period 1930 - 1939 the annual rate of increase averaged 13.28% per annum. During the war years, under the combined effects of vehicle shortages and petrol rationing, consumption was drastically reduced. Petrol rationing, which began in February 1942, mainly affected private and commercial motoring and, as Table 34 shows, the 1943 consumption was only about 75% of that in 1939. However in March 1946 rationing ended and consumption rose again rapidly thereafter. If the twenty year period 1930 - 1949 is taken as a whole, it will be seen that consumption increased nearly 500% during the twenty year period - from about 65 million gallons in 1930 to 315 million gallons in 1949 -

/ See Ref. 70 Pp.830-832

TABLE 33 - TOTAL CONSUMPTION OF PETROLEUM FUELS 1947-1956 ※

(Thousands of Long Tons)

		1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	Average Annual Rate of Increase 1947 - 1956	Average Annual Rate of Increase 1951 - 1956
1.	Motor Gasoline	765.1	898.4	998.9	982.9	1066.2	1103.1	1145.5	1197.1	1286.1	1342.2	6.44%	4.71%
2.	Aviation Gasoline	14.7	18.4	20.7	22.3	21.2	22.1	23.3	25.4	26.1	29.7	8.13%	6.98%
3.	Illuminating Kerosene	102.8	116.9	126.6	129.3	135.8	139.2	148.7	161.9	171.2	179.5	6.39%	5.74%
4.	Power Kerosene	119.5	141.8	179.9	203.8	256.7	272.1	307.7	330.7	329.1	332.3	12.03%	5.30%
5.	Aviation Turbine Fuel	-	-	-	0.7	0.5	2.0	3.8	2.6	3.1	4.7	-	56.54%
6.	Automotive Diesel Oil	74.7	96.4	129.6	157.8	189.7	217.1	254.2	310.7	384.1	464.9	22.53%	19.64%
7.	Industrial Diesel Oil	46.4	51.7	53.8	46.0	37.4	36.1	29.8	30.9	25.7	19.6	(9.13%)	(12.12%)
8.	Furnace Oil	20.2	22.9	25.1	21.9	24.8	26.2	26.4	31.2	32.5	36.5	6.79%	8.04%
9.	INLAND SALES	1143.4	1346.5	1534.6	1564.7	1732.3	1817.9	1939.4	2090.5	2257.9	2409.4	8.63%	6.82%
10.	Ocean Bunkers												
	Marine Diesel Oil	78.9	109.8	127.9	178.5	157.1	96.1	118.9	112.8	103.7	162.6	-	-
	Fuel Oil	205.9	318.0	364.0	384.1	429.5	298.8	266.2	296.8	322.2	531.3	-	-
11.	TOTAL SALES	1428.2	1774.3	2026.5	2127.3	2318.9	2212.8	2324.5	2500.1	2683.8	3103.3	-	-

(※ Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Limited, and The Shell Company of South Africa Ltd.)

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TABLE 34

ANNUAL FUEL CONSUMPTION OF SOUTH AFRICA : 1930-1949

(Millions of Gallons)

YEAR	GASOLINE (1)	KEROSENES (2)	BUNKER FUELS & DIESEL OILS (3)
1930	65.79	16.87	16.93
1931	67.58	12.57	15.62
1932	68.94	14.79	14.47
1933	76.27	15.55	20.28
1934	94.75	22.95	19.83
1935	101.79	21.79	37.86
1936	125.55	24.13	60.72
1937	153.08	20.80	91.71
1938	171.65	20.37	108.93
1939	202.10	34.32	137.47
1940	182.52	28.37	321.02
1941	176.73	25.11	288.42
1942	173.22	34.71	374.48
1943	150.24	38.65	221.61
1944	154.92	42.98	55.70
1945	162.33	43.48	79.71
1946	233.48	60.02	105.23
1947	237.58	61.50	104.26
1948	275.14	70.77	171.89
1949	315.24	88.67	166.68
ANNUAL AVERAGE RATE OF INCREASE:			
1930 - 1939	13.28%	8.21%	26.20%
1930 - 1949	8.60%	9.13%	12.79%

NOTES:

(1) The above figures include South West Africa and small quantities exported to Rhodesia.

(2) Kerosene figures include power and illuminating kerosene.

(3) Gasoline figures include local production.

(Ref.31 - Page 151)

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and would doubtless have increased even more had it not been for wartime restrictions. This is a measure of the tremendous growth of automotive transportation during the same period, which is also reflected in the increase in number of vehicles licensed, as shown in Table 35. This latter Table gives interesting details of past trends in the numerical growth of motor vehicles licensed in the Union. The 1941 and 1946 figures were of course affected by the Second World War but it is worthy of note that the total number of vehicles licensed has increased about 7½ times during the 30 year period. The 1946 total of vehicles licensed (column 5) had more than doubled by 1956 and, should this rate of increase be maintained, one must anticipate some 1,700,000 vehicles licensed in 1966. However, whatever the future number of motor vehicles may be, road transport represents by far the largest outlet for petroleum products in the Union and the oil industry's estimates of future consumption are intimately linked with estimates of the number of motor vehicles (including tractors) in use in the Union.

In the opening paragraphs of this Chapter it was mentioned that much reliance would have to be placed on estimates of consumption by the oil companies, as these are the only organisations with sufficient statistical material on which to base such calculations. Tables 31 to 33 have been compiled from figures supplied by two of the major companies and in the absence of any other complete data these are being accepted as "master" Tables insofar as the consumption of petroleum fuels during the years 1947 - 1956 is concerned. During subsequent discussion on individual products it is hoped to show adequate correspondence between these estimates and official figures published by the Bureau of Census and Statistics. Estimates of consumption provided by other oil companies will also be introduced wherever possible.

Each oil company maintains large statistical and research staffs charged with the duty of recording past sales, computing present demand, and predicting forward trends. Many thousands of pounds annually are spent on this task and, although the amount of detail available is not as large as might be expected, the data which will be given in the various Tables of this Chapter represent the end result of much painstaking research and analysis. There could be no better starting point for an examination of consumer demand than the considered estimates of the experts and the co-operation of the companies concerned in providing this information is gratefully acknowledged.

2. OCEAN BUNKERS

From the point of view of the oil industry ocean bunkers fall into two main categories: diesel oil for motor driven vessels, and fuel oil for burning under the boilers of ships driven by steam turbines. Normally these two categories are separate and distinct but recent research has shown that it is possible for a motor vessel to use fuel oil in its diesel engines, provided that suitable modifications to the fuel system have been made. These modifications include the provision of heating coils in the fuel tanks to reduce the viscosity of fuel and a double centrifuge filtering system to

T A B L E 35 - UNION OF SOUTH AFRICA

NUMBER AND DESCRIPTION OF MOTOR VEHICLES LICENSED: 1926-1956

	MOTOR CARS. (1)	%	PASSENGER BUSES (2)	%	COMMERCIAL VEHICLES (3)	%	MOTOR CYCLES (4)	%	TOTAL (100%) (5)	TRACTORS (6)
1926	80,347	70.4	656	0.6	5,436	4.8	27,656	24.2	114,095	-
1931	138,072	73.4	1,312	0.7	16,864	9.0	31,879	16.9	188,127	-
1936	246,724	79.3	1,315	0.4	33,792	10.8	29,657	9.5	311,488	-
1941	321,885	81.8	2,017	0.5	51,977	13.2	17,858	4.5	393,737	2,950
1946	305,639	74.6	2,818	0.7	79,937	19.2	22,725	5.5	410,119	9,973
1951	491,187	75.7	4,481	0.7	129,534	19.9	24,264	3.7	649,466	42,750
1956	626,906	73.9	5,713	0.7	177,314	20.9	38,915	4.5	848,848	105,241
Average annual rates of increase:										
1926-1956	7.09%		7.48%		12.32%		1.15%		6.92%	-
1936-1956	4.77%		7.62%		8.64%		1.17%		5.14%	-
1946-1956	7.45%		7.32%		8.43%		5.53%		7.55%	26.57%

(Source: Bureau of Census and Statistics - Annual Special Reports on Motor Vehicle Statistics).

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eliminate impurities which might clog the fuel injector nozzles. Although it is an expensive undertaking to convert a motor ship for fuel oil consumption, the lower cost of this fuel in comparison with diesel oil is sufficient inducement to influence an increasing number of owners to provide the necessary equipment. There are, however, certain problems of maintenance connected with the operation of diesel engines on fuel oil and as yet the number of diesel engined vessels using this product is not large. When considering shipping statistics it can therefore be assumed that most of the world's motor driven vessels still use diesel oil. A breakdown of world shipping by type of fuel used is given in Table 36 and an analysis of the statistical data reveals the following:-

a) At the outbreak of World War I, in 1914, nearly 97% of all shipping was coal fired. By 1939, when World War II commenced, the proportion of coal fired shipping had dropped to 45%, with 30% using fuel oil for steam raising purposes and about 25% using diesel propulsion.

b) Since 1948 the proportion of tonnage using fuel oil has remained fairly steady at about 55% of all shipping. Coal fired shipping has however dropped from over 22.5% in 1948 to 7.7% in 1957, whilst motor driven tonnage has increased from 21.4% to 37.2% during the same period.

c) Over 92% of world shipping is today fired by oil and very nearly two-fifths of the total tonnage is motor driven.

The continuing rise in the percentage of motor driven tonnage is an important and interesting phenomenon. From the point of view of the shipowner the main attraction is the saving in fuel costs, as witnessed by the fact that a turbine vessel consumes roughly two-thirds more fuel than a motor-ship of similar size and speed. For example, a 32,000 ton turbine-driven tanker doing 15 knots will consume about 80 tons of fuel a day, whilst a motor ship of similar size and speed will only use about 45 tons a day. If current Aden spot prices for bunker fuels are taken (for purposes of illustration) comparative fuel costs would be as follows:-

i) Marine fuel oil at 148/6 per ton - 80 tons = £594.

ii) Marine diesel oil at 226/6 per ton - 45 tons = £510.

The shipowner would thus have a substantial saving in daily fuel costs to set against the higher capital and maintenance charges of a diesel engined vessel. (If the vessel was equipped to burn fuel oil in its diesel engines the saving would be even greater).

The percentage figures given against column (2) of Table 36 would seem to indicate that the proportion of world shipping using fuel oil for steam raising may decline slightly during the next few years, whilst the proportion of motor driven shipping may

ϕ Comparative costs are discussed in following paragraphs.
ϕ Ref. 68 Page 174

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TABLE 36 : WORLD SHIPPING TONNAGE SHOWING TYPE OF FUEL USED

(Million Gross Tons)

YEAR	COAL FIRED (1)	%	OIL FIRED. STEAM (2)	%	OIL FIRED MOTOR (3)	%	TOTAL ALL SHIPS (100%)
1914	43.9	96.7	1.3	2.9	0.2	0.4	45.4
1939	31.0	45.2	20.6	30.1	16.9	24.7	68.5
1948	18.1	22.5	45.0	56.0	17.2	21.4	80.3
1949	17.4	21.1	45.8	55.4	19.4	23.5	82.6
1950	16.2	19.2	47.3	56.0	21.0	24.8	84.5
1951	14.7	16.8	49.2	56.4	23.4	26.8	87.3
1952	13.6	15.1	50.5	55.9	26.2	29.0	90.3
1953	12.1	13.0	52.1	55.8	29.1	31.2	93.3
1954	11.1	11.4	54.4	55.9	31.9	32.7	97.4
1955	9.8	9.8	56.2	55.9	34.5	34.3	100.5
1956	9.1	8.7	58.4	55.5	37.7	35.8	105.2
1957	8.5	7.7	60.8	55.1	41.0	37.2	110.3

(Source: Lloyds Register of Shipping, quoted in Ref. 68, Page 174)

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continue to rise. On the face of things and assuming no drastic changes in relative fuel prices, this would indicate a more rapidly rising rate of increase in demand for marine diesel oil than marine fuel oil as evidenced by the following figures of bunker sales over the past decade:-

[4] ESTIMATED FREE WORLD BUNKER SALES
(Million Metric Tons)

	DIESEL OIL	FUEL OIL	TOTAL
1947	7	36	43
1948	8	36	44
1949	9	38	47
1950	10	41	51
1951	11	46	57
1952	12	47	59
1953	12	48	60
1954	12	49	61
1955	13	53	66
1956	15	57	72

It will be noticed that fuel oil sales in the free world have risen by about 60% during the period 1947 - 56, while sales of diesel oils have increased by 114%. Yet in absolute amounts the consumption of fuel oil has increased by 21 million metric tons as against 8 million metric tons for diesel oil. An approximate geographical analysis of total 1956 bunker sales shows the following pattern:-

[5]

United States of America	30%
Western Europe	16%
Caribbean Area	12%
Middle East	12%
Mediterranean	7%
South East Asia	7%
Other Areas	16%

Details of South African bunker sales during the period 1947 - 56 are given in Table 37, and it will be seen that the 1956 total sales of about 693,900 long tons is very roughly equivalent to about 1% of the free world total of 72,000,000 metric tons given above. The South African figure for 1956 was however swollen to some extent by the demands of shipping diverted via the Cape during the Suez Crisis. A first glance at Table 37 would seem to indicate that there is no coherent pattern in the sales of bunker fuels at South African ports, as the annual demand fluctuates considerably. However a closer study does reveal some positive findings:-

a) If 1947 figures are disregarded as being still subject to wartime influences and shipping control, the total annual demand for bunkers during the years 1948-1956 has dropped to only a little below 400,000

[4] Ibid. Page 173
[5] Ibid. Page 173

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T A B L E 37 : OIL BUNKERS SUPPLIED FROM SOUTH AFRICAN PORTS ¤

(Thousands of Long Tons)

YEAR	FUEL OIL	%	MARINE DIESEL OIL	%	TOTAL BUNKERS
1947	205.9	72.3	78.9	27.7	284.8
1948	318.0	74.3	109.8	25.7	427.8
1949	364.0	74.0	127.9	26.0	491.9
1950	384.1	68.3	178.5	31.7	562.6
1951	429.5	73.2	157.1	26.8	586.6
1952	298.8	75.7	96.1	24.3	394.9
1953	266.2	69.1	118.9	30.9	385.1
1954	296.8	72.5	112.8	27.5	409.6
1955	322.2	75.7	103.7	24.3	425.9
1956	531.3	76.6	162.6	23.4	693.9

(¤ Overseas shipping only - coastwise vessels not included)

(Compiled from information supplied by The Shell Company of South Africa Limited)

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tons per annum on two occasions (1952 and 1953). It could therefore be reasonably held that 400,000 tons represents an approximate minimum figure for bunkers supplied from South African ports during the period.

b) An examination of the years in which the sale of bunker fuels substantially exceeded the minimum of 400,000 tons shows 1949, 1950, 1951 and 1956 as the main periods. The increased sales in 1949, 1950 and 1951 can mainly be attributed to increased shipping movements during the Korean War period. Similarly increased sales of bunker fuels in 1956 (and in 1957 - see Table 34) can mainly be attributed to shipping diverted via the Cape during the Suez crisis.

c) The ratio of demand for oil bunkers at Union ports would seem to be roughly 75% fuel oil and 25% marine diesel oil.

The problem is to determine whether there are any statistical data which can be used as indicators of the probable "normal" demand for bunkers at South African ports, in the absence of such complicating factors as wars and shipping diversions via the Cape. The problem is complicated by the absence of statistical information of bunker fuels supplied to ships trading with the Union as compared to those merely calling for bunkers whilst in transit. A further complication is that the price of bunkers at South African ports (although stored "in bond" and thus not subject to customs duty) is relatively high when compared to other parts of the world. Most vessels - even those trading with the Union - normally do no more than "top-up" with sufficient fuel for stability purposes or to enable them to reach a cheaper supply point. Most ships coming to the Cape via the West coast bunker at Las Palmas (or Dakar) and most ships coming via the Red Sea route bunker at Aden. The following relative bunker oil spot prices as at April 1958 are self-explanatory in this regard.

[6]

BUNKER OIL SPOT PRICES, APRIL 1958

(Shillings and Pence per long ton)

	MARINE FUEL OIL	MARINE DIESEL OIL
Freemantle	182.6	259.6
Durban/Cape Town	172.0	250.0
U.K./Western Europe ...	167.6	235.0
Las Palmas	155.6	222.6
Singapore	152.0	234.0
Aden	148.6	226.6

[6] Ref.68, Page 173

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The Bureau of Census and Statistics quotes certain figures of cargo handled at Union ports which illustrate the quantities of goods shipped to and from the Union. Unfortunately the value of recent statistics of cargo landed, as a basis for determining any possible future increase in the volume of shipping at Union harbours, is limited by the fact that Import Control was in force from 1949 to 1956 and this limited the volume of goods imported. Similarly the statistics of cargo shipped during the years 1950 - 1953 were probably affected by the temporary inability of the railways to carry all the export traffic offering. Insofar as coal and base mineral ores are concerned the railways are still unable to meet the demand for export railings. However the tonnage figures given in Table 38 show that both cargo landed and cargo shipped is increasing in volume, and this is particularly evident during recent years. With the relaxation of import control and the gradually improving transport position of the S.A.R., it is to be expected that there should be an increase in the volume of imports and exports, and consequently in the volume of cargo landed and the volume of cargo shipped. This should also lead to some increase in the demand for bunker fuels, notwithstanding the higher prices prevailing at Union ports. Unfortunately it is not possible to obtain any statistical data to show the relative proportions of bunkers purchased in Union harbours by ships trading with the Union, as compared with the quantities purchased elsewhere by the same vessels. The oil companies engaged in supplying bunker fuels at Union ports state that most of the bunker business is arranged on a contract basis between the shipping companies and the British or American Head Offices of the oil companies. Forward demand for bunker fuels is generally not estimated for periods in excess of twelve months at a time but even so, international incidents or political considerations could materially change the demand pattern at short notice. For this reason generous storage capacity for bunker fuels is maintained at most Union harbours.

From the above discussion there would seem to be three main factors affecting the normal supply of bunker fuels at South African ports:-

a) Price - It has been shown that bunkers are considerably more expensive in the Union than at other overseas centres and that, in general, ships purchase only their minimum fuel requirements here.

b) Tonnage of goods traded - It has been shown that the physical volume of cargo landed and shipped at Union ports is increasing steadily. (Table 38).

c) Shipping capacity - There is no evidence to show whether or not vessels plying regularly on the South African route are operating to maximum cargo carrying capacity. However as there seems to be little demand for tramp shipping in South African waters it may be assumed that the regular cargo operators are able to handle all the traffic offering, and will probably continue to do so in the future. Little is known in regard to the spare capacity which might be available for cargo in ships which trade regularly with the Union. If excess capacity exists it may not be necessary to put additional vessels into service for some time. This

Ref.67, (July 1953, Nov. 1956, May 1958).

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T A B L E 38

TONNAGE OF OCEAN CARGO HANDLED AT UNION PORTS.

(EXCLUDING COASTWISE TRAFFIC)

(1000 Tons)

YEAR	LANDED	SHIPPED	HANDLED
1935	3736	3027	6763
1936	4492	2373	6865
1937	5074	3665	8739
1938	4822	2756	7578
1939	4838	3340	8178
1940	5247	3029	8276
1941	4635	2412	7047
1942	4738	2498	7236
1943	3632	2438	6070
1944	2883	3095	5978
1945	3155	3043	6198
1946	5369	3307	8676
1947	5704	3157	8861
1948	7029	3486	10515
1949	7015	3433	10448
1950	6271	3611	9882
1951	7154	3466	10620
1952	6858	3084	9942
1953	6501	3376	9877
1954	7239	3902	11141
1955 x	8492	4520	13012
1956 x	8717	4875	13592
1957 x	9800	5208	15008

(x Provisional figures).

(Ref.67, July 1953, Nov. 1954, May 1958)

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could mean that, for a short period, any projected increase in bunker fuel requirements based on increased volumes of cargo handled, might not materialise, as no additional ships would be required until the excess capacity had been utilised.

In the light of all the foregoing discussion it would seem that there is insufficient data on which to base any definite conclusions regarding possible future demand for bunker fuels at South African ports. However, bearing in mind the fact that over the next ten years the Union's expanding economy will both export and import more goods than at present, and after making due allowance for the fact that some shipowners will continue to purchase their major requirements of bunker fuels at Las Palmas or Aden, it seems that allowance should be made for at least a slight annual increase in the normal demand for bunker fuels at Union harbours. There is also the knowledge that a number of larger vessels (including super-tankers) will be using the Cape route in future years and it is reasonable to expect that this traffic will have some increased effect on demand for Union bunker fuels, even if only when calling for servicing or for dry-docking.

In the absence of any other indicators of future demand, the figures shown in Table 39 have been compiled as the "best estimates" for the years 1957 - 66. The 1957 figure has been based on actual sales and is of course very much inflated by the needs of shipping diverted via the Cape during the Suez crisis. The 1958 and 1959 figures were prepared with help from the Shell Company and are derived from a certain amount of short-term knowledge of the market. They probably represent a new post-Suez minimum level of demand for bunkers at Union ports - especially having regard to the increased quantities of cargo now being handled (Table 38.) In the absence of any major international crisis it would not seem unreasonable to expect the normal level of total demand to reach some 525,000 tons by 1961 and about 600,000 tons by 1966. However, the patterns of demand for fuel oil and marine diesel are expected to reveal different tendencies during this period, as the following discussion will show.

Actual bunker sales for the past ten years and estimates for the next decade have been plotted in the form of a semi-logarithmic trend chart in Figure 15. There are several interesting features about this chart:

a) The abnormal increases in demand during the years 1948 to 1951 are due to the release of war-time shipping for peaceful trade, followed closely by the diversion of many vessels around the Cape during the period of the Korean War.

b) The years 1952 to 1955 represent a more or less "normal" period in the supply of bunkers from South African ports.

c) 1956 and 1957 again show abnormal increases due to the demands of shipping diverted via the Cape during the Suez crisis.

d) The estimates for 1958 and 1959 are based on reasonable knowledge of the market as indicated by short term contract arrangements with leading Oil Companies.

TABLE 39

ESTIMATED CONSUMPTION OF BUNKER FUELS AT UNION PORTS 1957-1966

(Thousands of Long Tons)

YEAR	MARINE DIESEL	FUEL OIL.	TOTAL
1957	224.4	1014.5	1238.9 ≈
1958	117.1	379.1	496.2
1959	119.0	370.0	489.0
1960	122.0	385.0	507.0
1961	125.0	400.0	525.0
1962	128.0	414.0	542.0
1963	131.0	427.0	558.0
1964	134.0	439.0	573.0
1965	137.0	450.0	587.0
1966	140.0	460.0	600.0

(≈ 1957 figures inflated due to Suez crisis)

N.B. Owing to the erratic nature of total demand for bunker fuels the above figures should be taken as illustrative of an expected trend rather than as actual estimates for specific years, (See text).

(Compiled by the author with assistance from the Shell Company of South Africa Limited)

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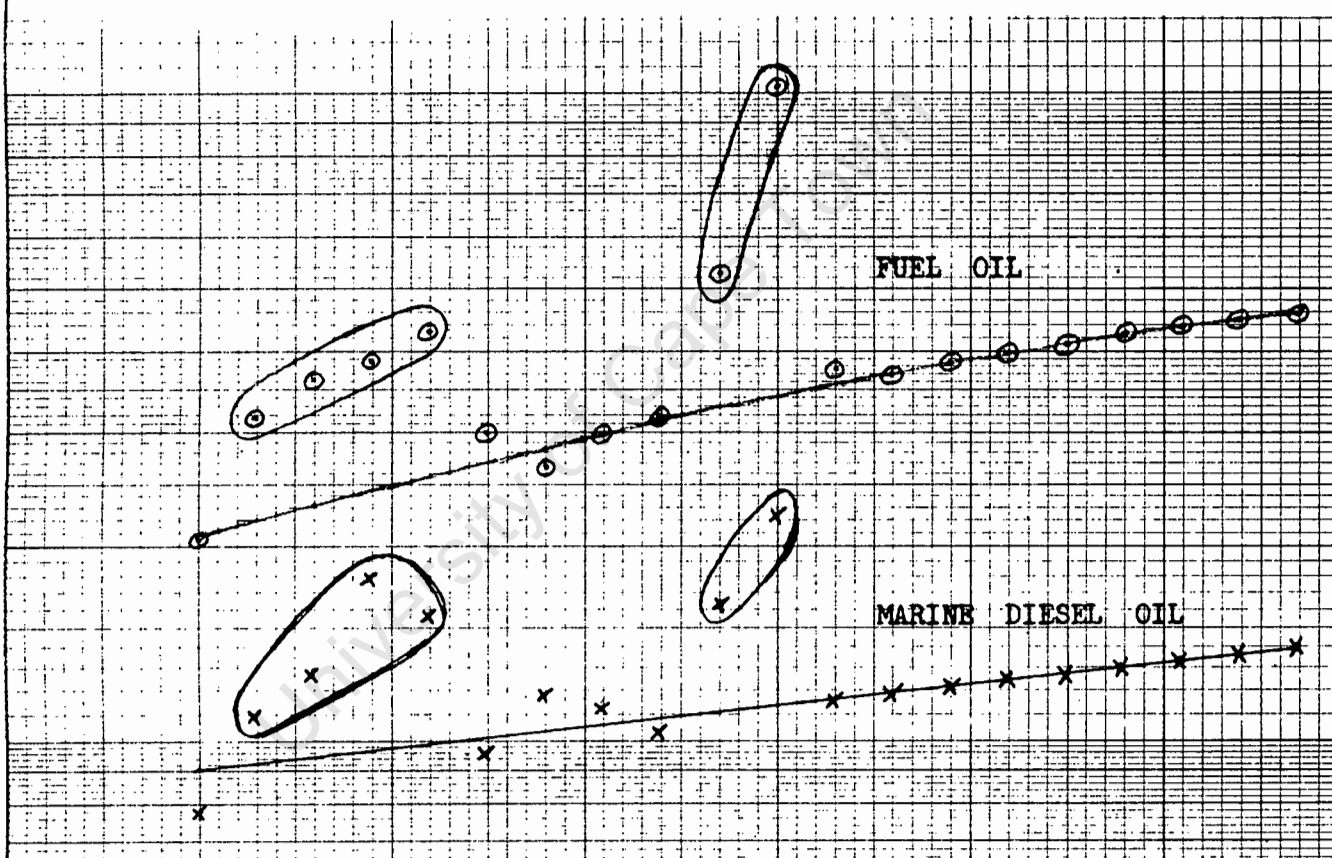
FIG. 15 OCEAN BUNKERS

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)	Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1947	205.9	-	-	1957	1014.5	483.2	90.9
1948	318.0	112.1	54.4	1958	379.1	-635.4	-62.6
1949	364.0	46.0	14.5	1959	370.0	- 9.1	- 2.4
1950	384.1	20.1	5.5	1960	385.0	15.0	4.1
1951	429.5	45.4	11.8	1961	400.0	15.0	3.9
1952	298.8	-130.7	-30.4	1962	414.0	14.0	3.5
1953	266.2	- 32.6	-10.9	1963	427.0	13.0	3.1
1954	296.8	30.6	11.5	1964	439.0	12.0	2.8
1955	322.2	25.4	8.6	1965	450.0	11.0	2.5
1956	531.3	209.1	64.9	1966	460.0	10.0	2.2



Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)	Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1947	78.9	-	-	1957	224.4	61.8	38.0
1948	109.8	30.9	39.2	1958	117.1	-107.3	-47.8
1949	127.9	18.1	16.5	1959	119.0	1.9	1.6
1950	178.5	50.6	39.6	1960	122.0	3.0	2.5
1951	157.1	-21.4	-12.0	1961	125.0	3.0	2.5
1952	96.1	-61.0	-38.8	1962	128.0	3.0	2.4
1953	118.9	22.8	23.7	1963	131.0	3.0	2.3
1954	112.8	- 6.1	- 5.1	1964	134.0	3.0	2.3
1955	103.7	- 9.1	- 8.1	1965	137.0	3.0	2.2
1956	162.6	58.9	56.8	1966	140.0	3.0	2.2

e) Estimates for the years 1960 to 1966 have been based on assumed volumetric increments as indicated in Figure 15. These figures, of course, are arbitrary but they are intended only to illustrate the expected trend. They are average estimates, not specific annual totals.

It will be noticed from Figure 15 that the trend of marine diesel consumption is expected to be steadily and progressively upwards, whilst the annual increase in demand for fuel oil is expected to tail-off a little during the last decade. The former trend is based on the growing popularity of marine diesel engines in new shipping which can be expected to oust some of the older fuel oil vessels. This will have a long term effect on the estimates of future fuel oil consumption and for that reason the forecasts for this fuel have been compiled to show a slightly declining rate of annual increment up to 1966. The reason why the marine diesel trend line does not curve upwards during the same period is that (as mentioned earlier) a diesel engined vessel consumes only about 60% of the tonnage of oil required by an equivalent fuel oil burning vessel per day. A substitution of diesel engined vessels for fuel oil burning vessels would therefore cause an absolute decline in the quantity of fuel oil needed, without a commensurate increase in the demand for diesel oil.

3. INDUSTRIAL DIESEL OIL AND FURNACE OIL

These two products are discussed together because they are sometimes both used as Furnace Fuels and because official Government statistics do not differentiate between them when recording consumption figures. The Oil Companies keep separate statistics of demand for each product but considerable confusion of nomenclature is encountered when discussing the products with different companies, owing to the various brand names and descriptions adopted by the industry. For instance, Furnace Oil is sometimes described as "Industrial Furnace Oil", "Fuel Oil", "Light Furnace Oil" or, in its coastal application, "Marine Diesel Fuel". Similarly Industrial Diesel Oil is sometimes referred to as "Industrial Gas Oil" or "Heavy Diesel" to distinguish it from Automotive Diesel Oil. Confusion of description seems to be particularly rife at this lower end of the distillation scale where a number of "different" fuels can be obtained for industrial and/or heating purposes by blending appropriate quantities of the heavier fractions and the middle distillates. Fortunately in discussion with the four main marketing companies it was possible to reconcile differences in product description, although it would seem that these may, in the past, have given rise to occasional statistical discrepancies in internal records.

The official Bureau of Census and Statistics figures for the consumption of Industrial Diesel Oil and Furance Oil, broken down on a Provincial basis but without indicating the actual quantities of each product, are given in Table 40. This method of keeping consumption records is of very dubious usefulness, because the official statistics hide completely the fact that consumption of Industrial Diesel Oil is dwindling yearly, whilst consumption of Furnace Oil is increasing rapidly. The percentage analysis

T A B L E 40 - UNION OF SOUTH AFRICA

INDUSTRIAL DIESEL OIL AND FURNACE OIL CONSUMPTION BY PROVINCES

(1,000's of Imperial Gallons)

	CAPE	%	NATAL	%	O.F.S.	%	TVL.	%	UNION TOTAL	(a) INDUSTRIAL DIESEL OIL %	(a) FURNACE OIL %
1950									14,224	61	39
1951	(Provincial figures not available)								14,610	57	43
1952									16,709	50	50
1953	4,728	39.44	1,454	12.13	1,295	10.80	4,512	37.63	11,989	46	54
1954	5,271	40.93	1,637	12.71	1,137	8.83	4,833	37.53	12,879	40	60
1955	5,159	40.53	1,892	14.86	1,070	8.41	4,608	36.20	12,729	36	64
1956	4,743	36.82	1,994	15.48	1,112	8.63	5,033	39.07	12,883	28	72

(Ref.67 Table H.1)

(a) The percentage breakdown shown in these columns is based on the respective gallonage ratios between the products shown in columns 7, and 8 of Table 31)

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between these two products shown on the right of Table 40, has been calculated in accordance with the gallonage ratios shown in columns 7 and 8 of Table 31 (Page 150) where the decline in demand for one product and the rise in demand for the other can be clearly seen. If the demand for Industrial Diesel Oil continues to fall it would seem that the Bureau of Census and Statistics might do well to drop this product from their Tables altogether and to maintain separate figures for the consumption of Furnace Oil.

Industrial Diesel Oil, as the name implies, is a type of diesel fuel which can be satisfactorily used for certain industrial purposes. In general, as the almost black colour would indicate, it is a slightly less "pure" fuel than automotive diesel oil and the sulphur content is usually higher. It is a product which, as a Diesel engine fuel, is suitable only for the older, heavier, slower-running type of stationary diesel engines with speeds below 700 r.p.m. As these are replaced by more modern, compact and faster-running engines, so the demand for industrial diesel oil will gradually drop. At present (May 1958) industrial diesel oil sells for ½d. per gallon less than automotive diesel oil, so that there is some incentive for major consumers to continue using the product if satisfactory results can be obtained in old engines of the type described above.

Tables 31 and 32 (Pages 150 and 151) show the relative trend in consumption in the Union and South West Africa. In the former case there has been an annual average decrease in demand of 10.78% between 1947 and 1956 whilst, if the last five years of this period are considered separately, the rate of decrease has accelerated to 14.98% per annum. Tonnage figures by product for the area are given in Table 33 (Page 153) and it will be noticed that after allowing for the small South West African consumption the average rate of decrease in demand for industrial diesel oil is still 12.12% over the period. This is the only product showing an actual net decrease per annum. Considerable difficulty was experienced in obtaining any analysis of consumer demand for industrial diesel oil by categories of "end-user". There are apparently one or two larger customers whose purchases could be identified, but in general the total demand for this product - as indeed for all petroleum products - consists of the aggregate of demand from many small consumers. The only positive statistical contribution that could be obtained was compiled from certain estimates made by the Shell Company, and these are shown in Table 41. The years 1951 and 1957 are shown as being respectively the earliest and the latest years for which information is available. The following comments are relevant:-

1) The quantity of industrial diesel oil consumed by Agriculture is mainly used for stationary pumping engines (irrigation), for a limited amount of farm machinery (including power plants) and for certain types of heavy tractors and earth-moving equipment on large estates. Consumption has dropped by about one-third during the past six years, due to the gradual change-over to automotive diesel fuel.

2) The consumption shown for "Fishing and Marine" is almost all for the fishing industry. In 1951 the demand was shared more or less evenly between

T A B L E 41

INDUSTRIAL DIESEL OIL - APPROXIMATE CONSUMER ANALYSIS ≡

(Gallons)

		1951	%	1957	%
1.	Agriculture	997,000	10.28	620,000	18.24
2.	Fishing and Marine	215,000	2.22	280,000	8.24
3.	Government				
	Central	505,000	5.21	65,000	1.91
	Local	302,000	3.11	205,000	6.03
4.	Railways	428,000	4.41	114,000	3.35
5.	Mining	3,674,000	37.87	585,000	17.20
6.	Unspecified	3,579,000	36.90	1,531,000	45.03
7.	T O T A L:	9,700,000	100%	3,400,000	100%

(≡ Union and South West Africa)

(Compiled from estimates made by the Shell Company of South Africa Limited)

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the Union and South West Africa, but in 1957 over three-quarters of the total of 280,000 gallons was required for South West Africa. The fuel is used to drive machinery associated with the fish canning and fish meal production processes and during 1957 a large part of this activity was concentrated in South West Africa. Industrial diesel oil can also be used for burning in furnaces at factories and there is no doubt that part of the consumption by the West coast fishing industry (which is remote from other sources of energy) was diverted to this use. As a furnace fuel, industrial diesel oil possesses less impurities than furnace oil and this helps towards easier maintenance of boiler plants in out-of-the-way areas.

3) Central and Local Government used quantities of industrial diesel oil in 1951 for various types of stationary engines (including small power stations) and probably also for heavy equipment of the Public Works Department. By 1957 most of the latter were using automotive diesel oil, but local authorities continued to use a certain amount of industrial diesel oil in slow-speed generating units at small power stations. ♭

4) Railway consumption was mainly for stationary engines and heavy construction equipment. Once again there is evidence of a change-over to automotive diesel oil in the 1957 figures.

5) Heavy consumption by the mining industry is concentrated mainly in Namaqualand and South West Africa where other energy fuels are not readily available. In 1951 the heavy demand for industrial diesel oil was for the dual purpose of operating stationary diesel engines and for use in smelting and reduction processes, particularly in the copper industry. In that year it will be remembered that the railways faced an internal transportation crisis which affected their ability to maintain adequate supplies of coal and oil for mining purposes. By 1957 the transport position had been greatly improved but, even so, the post-war decade has seen a steady fall in the demand for coal for mining purposes (Table 23) and a steady rise in the demand for oil fuels (Table 51). It is also true that the pattern of demand for oil fuels in the mining industry has changed, industrial diesel oil being replaced by automotive diesel oil for road transport purposes and furnace oil (which is ½d. per gallon cheaper than industrial diesel oil) for smelting and steam-raising, although there still remains a small demand for the latter product, as the 1957 figures show.

♭ Incomplete statistics given in the Electric Light and Power section of the South African Municipal Year Book for 1956-57 indicate that about 50% of South African Municipalities still operate oil driven generating units, many of which are of the heavy, slow-speed type, probably using industrial diesel oil.

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6) The above comments cover known major consumers accounting for about 60% of the demand for industrial diesel oil. There remains a large number of small consumers whose needs and preferences have not been recorded. However, inasmuch as the consumption of this group has dropped from about 3½ million gallons in 1951 to about 1½ million gallons in 1957, it seems obvious that these consumers are also gradually changing to automotive diesel oil and/or furnace oil.

The above comments pose the questions as to why these consumers should change their fuel preferences and, in particular, as to why they should change from industrial diesel to automotive diesel oil when the former is normally one half-penny per gallon cheaper than the latter. The answer is to be found in the fact that modern diesel engines have a higher compression ratio, a more intricate fuel injection system, and usually operate at higher r.p.m. than older models. In much the same way that improvements in petrol engines have brought about the need for higher octane petrol, so improvements in diesel engine design have made it necessary to use a clean, filtered diesel fuel containing a minimum of impurities. Automotive diesel oil, even at a slightly higher cost, is to be preferred on this account as it contains less impurities than industrial diesel oil, has a higher cetane number (automotive diesel about 56, industrial diesel about 53) and is generally speaking a more efficient fuel.

The swing from industrial diesel oil towards furnace oil is largely due to the price factor - the latter product being ½d. per gallon cheaper than the former. Admittedly furnace oil contains a greater proportion of impurities but, in general, price is the dominant consideration. There is thus a two-fold move away from industrial diesel oil - on the one hand towards a more expensive and more efficient product for high speed diesel engines, and on the other hand, towards a cheaper fuel for burning in furnaces. This being the case the demand for industrial diesel oil can be expected to decline still further during the next few years.

The demand pattern for industrial diesel oil during the post-war decade is shown in Table 33 (Page 153) and it will be noticed that from 1950 onwards there was a steady decline in consumption. This decline continued in 1957 and Table 44 shows that it is expected to continue into 1958 and indeed on to about 1961/62. Thereafter the oil companies are a little uncertain as to the future demand for industrial diesel oil. Some hold the view that there will remain a small but steady demand, while others feel that it will continue to decline until it reaches a level at which it is no longer worth while for the oil industry to carry supplies. The trend of consumption during the period 1947-66 is shown in Figure 16 using data taken from Tables 33 and 44. It will be noticed that the usual post-war increase in demand reached a peak in 1950 and then fell off rapidly. The trend determined for the first ten year period has been continued by the estimates for the second decade but, instead of falling away altogether (as indicated by the broken line) the estimates anticipate a constant demand of just under 6,000 tons per annum for the period 1961-66. This is

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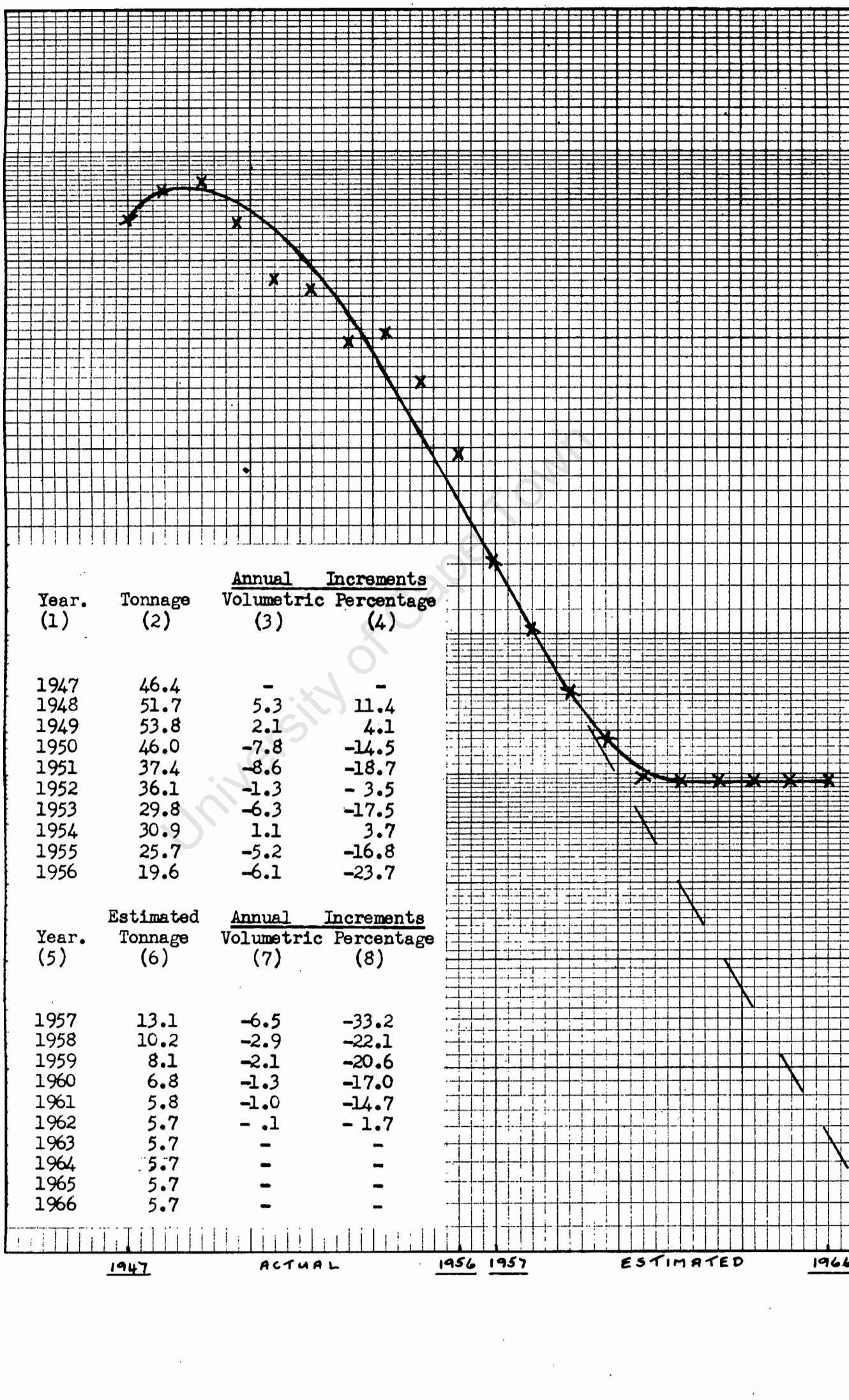
FIG. 16 INDUSTRIAL DIESEL OIL CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).



Year. (1)	Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	46.4	-	-
1948	51.7	5.3	11.4
1949	53.8	2.1	4.1
1950	46.0	-7.8	-14.5
1951	37.4	-8.6	-18.7
1952	36.1	-1.3	- 3.5
1953	29.8	-6.3	-17.5
1954	30.9	1.1	3.7
1955	25.7	-5.2	-16.8
1956	19.6	-6.1	-23.7

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	13.1	-6.5	-33.2
1958	10.2	-2.9	-22.1
1959	8.1	-2.1	-20.6
1960	6.8	-1.3	-17.0
1961	5.8	-1.0	-14.7
1962	5.7	- .1	- 1.7
1963	5.7	-	-
1964	5.7	-	-
1965	5.7	-	-
1966	5.7	-	-

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TABLE 42

FURNACE OIL - APPROXIMATE CONSUMER ANALYSIS *

(Gallons)

		1951	%	1957	%
1.	Agriculture	33,000	.52	2,000	.02
2.	Fishing and Marine	1,000	.02	1,060,000	10.50
3.	Government				
	Central	205,000	3.20	187,000	1.85
	Local	18,000	.28	140,000	1.39
4.	Railways	1,934,000	30.22	2,263,000	22.40
5.	Mining	320,000	5.00	1,100,000	10.89
6.	Unspecified	3,889,000	60.76	5,348,000	52.95
7.	T O T A L S:	6,400,000	100%	10,100,000	100%

(* Union and South West Africa)

(Compiled from estimates made by the Shell Company of South Africa Limited)

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not an arbitrary figure but one calculated from oil company records of consumption by slow speed diesel engines in service (particularly for power generation in rural areas) for which the ½d. per gallon saving, when compared to the price of automotive diesel oil, is a paramount consideration. The figure of about 5,700 tons per annum will cover the needs of such engines up to 1966 but it is the general opinion of the oil companies that, in the long run, the demand for industrial diesel oil as a separate product will almost certainly disappear.

Furnace oil is also a somewhat complicated product to discuss. In essence it is what the name suggests - an oil for burning in furnaces - and as such it cannot (without further processing) be used as a fuel for diesel engines. However there are various types of fuel sold for inland consumption which are classified as "furnace oils" for statistical purposes and this category includes "light furnace oils" and "marine diesel oil". The latter is really a type of ocean bunker fuel but, when sold for inland use, it falls under the generic title of "Furnace Oil". On occasions the residual fuel oil left over from refining processes is also sold as a furnace oil to those customers who are equipped to use it. The heavier grades of such oils normally require preheating to handle, but the lighter grades do not.

An approximate analysis of consumer demand for furnace oil is given in Table 42 for the years 1951 and 1957, on the same basis as that already discussed for industrial diesel oil. It will be noticed that here again an analysis is only possible in regard to known major consumers, totalling between 40% and 50% of demand. In other words, the pattern of consumer demand can be sketchily portrayed for about 50% of the market, whilst nothing at all is known about the other 50% except that the total requirement increases each year. Table 33 indicates that the post-war demand for furnace oil is showing a gradual annual increase and, in fact, if aviation turbine fuel is disregarded, the annual average rate of increase in consumption of furnace oil during 1951-1956 (8.04%) was second only to automotive diesel oil (19.64%). However the total demand in tons was only about 1½% of all inland sales (1956).

1) The agricultural consumption of Furnace Oil shown in Table 42 is mainly for such purposes as milling and the drying of tobacco. The quantities used by this sector of the economy are negligible in relation to total demand and can be ignored.

2) The category of Fishing and Marine is intended to record furnace oil consumption by the fishing industry and by coastal shipping. In its latter usage the product is often referred to as "marine diesel" or "marine fuel oil" but, since supplies to coasters are counted as part of the inland consumption total, the figures are shown here rather than with ocean bunkers. According to information furnished by the Shell Company, at least 440,000 gallons out of the estimated total of 1,060,000 gallons sold to "Fishing and Marine" during 1957 was in the form of bunkers for coastal

TABLE 43

COASTWISE CARGO HANDLED AT UNION PORTS.

(EXCLUDING OCEAN TRAFFIC)

(1000 Tons)

YEAR	LANDED	SHIPPED	HANDLED
1935	196.3	209.6	405.8
1936	250.7	285.2	535.8
1937	415.5	337.7	753.3
1938	427.5	329.4	756.9
1939	325.3	314.0	639.3
1940	262.1	297.4	559.5
1941	249.7	247.9	497.6
1942	225.5	197.9	423.4
1943	203.1	213.7	416.8
1944	262.8	325.2	588.0
1945	269.7	282.4	552.1
1946	273.2	268.1	541.3
1947	303.6	298.2	601.8
1948	339.4	410.7	705.1
1949	599.0	610.5	1,209.5
1950	331.0	351.3	682.3
1951	405.8	426.1	831.9
1952	368.2	393.6	761.8
1953	430.2	412.8	843.0
1954	590.5	611.8	1,202.3
1955 ≈	1,034.7	983.9	2,018.5
1956 ≈	1,061.8	1,061.6	2,123.4
1957 ≈	1,020.7	1,125.8	2,146.5

(≈ Provisional figures).

(Ref. 67, July 1953, Nov. 1954, May 1958).

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shipping. It is considered likely that category 6 of Table 42 may also contain other (unknown) quantities of furnace oil supplied for this purpose. A study of Table 43 would seem to confirm this opinion, in view of the considerable increase in coastwise cargo handled during the past few years. Unfortunately an adequate statistical breakdown of furnace oil demand in the form of coastal bunkers is not available, as both supplying and consuming companies are reluctant to disclose details.

The demand pattern of the fishing industry for furnace oil fluctuates according to the level of fishing activity, but in general is showing a slight upward trend. This will probably continue to be the case in the future unless quota restrictions on the annual catch of pilchards are drastically tightened. Latest statistics show that in 1956 West coast fishermen landed over 1,000,000 metric tons of fish. This catch was three times the size of the 1948 one and nearly ten times the size of the 1938 catch. As a matter of interest the fisheries of the Union and South West Africa produced about 2% of the world total in 1956, compared with less than 1% in 1938. The furnace oil used by the fishing industry is mainly for heating in canning factories and in the production of fish meal and oil. However statistics are incomplete and complicated to some extent by the use of industrial diesel oil for furnace burning, as mentioned earlier in the case of South West Africa.

3) All that need be said about the furnace oil consumed by central and local government is that it was mainly used for heating. Some went to forges and workshops in the Defence Department and the Public Works Department, and some to central heating of offices, hospitals, barracks etc. A portion of the local Government consumption for 1957 was used by Municipal Gas undertakings for the enrichment of Towns' Gas (See Chapter 2 part 4).

4) The railways use large quantities of furnace oil in their various workshops and it would appear that the Administration is the largest single consumer of Furnace Oil in the Union. It is understood that the figures given in item (4) of Table 42 do not include any bunker fuels supplied to shipping, harbour tugs etc., operated by the Administration.

5) Mining figures reflect the change in demand mentioned earlier from industrial diesel oil in 1951, to furnace oil and/or automotive diesel oil in 1957. Increased demand for furnace oil is shown in Table 42, and statistics of the increased demand for automotive diesel oil will be given in Part 4 of this

6 See article by L.P.D. Gertenbach of the F.A.O. on Page 46 of "The South African Shipping News and Fishing Industry Review" - May 1958.

TABLE 44

ESTIMATED CONSUMPTION OF INDUSTRIAL DIESEL OIL AND FURNACE OIL 1957-1966¤

(Thousands of Long Tons)

YEAR	INDUSTRIAL DIESEL OIL	FURNACE OIL
1957	13.1	38.9
1958	10.2	45.8
1959	8.1	49.4
1960	6.8	51.5
1961	5.8	53.6
1962	5.7	55.9
1963	5.7	58.2
1964	5.7	61.0
1965	5.7	63.7
1966	5.7	66.4
Average Annual Rate of Decrease/Increase	(8.83%)	6.12%

(¤ Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd., and the Shell Company of South Africa Ltd.)

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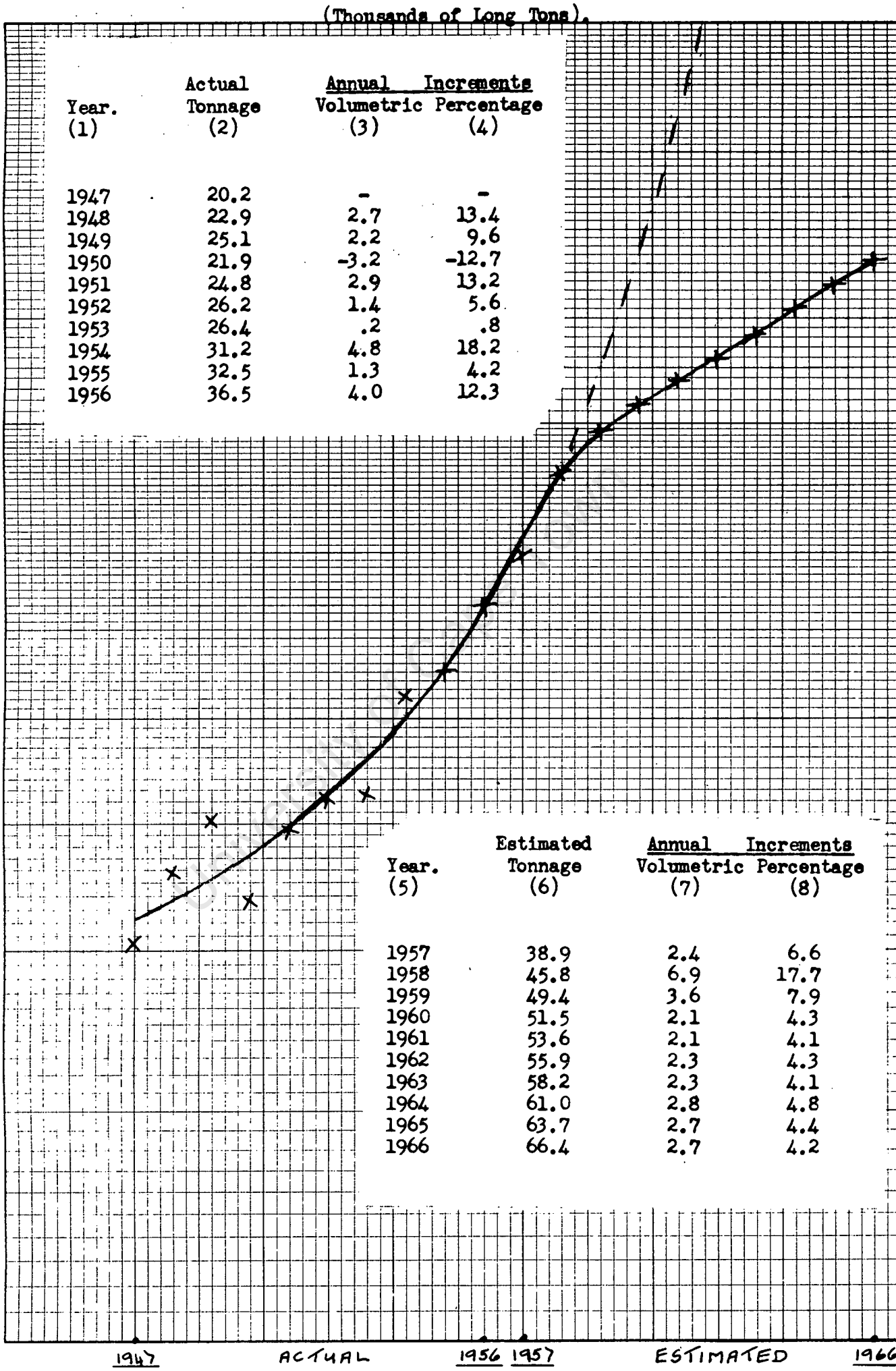
FIG. 17 FURNACE OIL

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	20.2	-	-
1948	22.9	2.7	13.4
1949	25.1	2.2	9.6
1950	21.9	-3.2	-12.7
1951	24.8	2.9	13.2
1952	26.2	1.4	5.6
1953	26.4	.2	.8
1954	31.2	4.8	18.2
1955	32.5	1.3	4.2
1956	36.5	4.0	12.3



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	38.9	2.4	6.6
1958	45.8	6.9	17.7
1959	49.4	3.6	7.9
1960	51.5	2.1	4.3
1961	53.6	2.1	4.1
1962	55.9	2.3	4.3
1963	58.2	2.3	4.1
1964	61.0	2.8	4.8
1965	63.7	2.7	4.4
1966	66.4	2.7	4.2

Chapter. Column 1 of Table 51 gives a composite demand figure for fuel and power oils for all types, as supplied for mining purposes. It will be seen that, with minor fluctuations, the trend in demand is continually upwards but unfortunately there are no detailed statistics for the fuels that are included in this category.

6) Nothing is known of the requirements of other consumers of furnace oil, totalling between 50% and 60% of the inland market for this product. The major oil companies are aware of the confusion that exists in regard to the number of products classified as "Furnace Oil" for statistical purposes and also in regard to the shortage of data on "end-users". However it is hoped that over a period of time it may be possible to obtain a more detailed analysis.

Estimated figures for the consumption of Furnace Oil in the years 1957 to 1966 are given in Table 44, based on the expectation that demand will tend towards a lower annual rate of increase than in the past five years (Table 33) once the role of industrial diesel oil has become stabilized. The tendency of most consumers using industrial diesel for heating purposes is to change to furnace oil and by 1959/60 this change, as forecast in Figure 16, should be fully effective. Thereafter the demand for furnace oil is expected to rise less steeply, in increments of between two and three thousand tons per annum, to an estimated 66,400 tons by 1966. It should be remembered that in many industrial applications Furnace Oil is in competition with coal for heating purposes. It follows that, in the absence of any special considerations requiring one fuel in preference to the other, the main criterion deciding which fuel to be used will be the comparative delivered price per unit of useful heat obtained. However the relative cleanliness and lower operating costs (labour and maintenance) of an oil fired furnace often influence consumers' choices, even when comparative direct costs favour coal as a fuel.

The overall trend pattern for furnace oil consumption during the period 1947-66 is shown in Figure 17. The diagram has been based on the known consumption figures for the first ten year period as given in Table 33 (Page 153) and the estimates for the second decade discussed above. The anticipated easing in the demand position from 1959 onwards is founded on the knowledge that the swing from industrial diesel oil to furnace oil is nearly completed. Thus the steep trend curve of the past few years cannot be continued (dotted line) and the consumption trend must therefore show a more moderate annual rate of growth. The estimates formulated for 1960-66 have been calculated on the assumption that the annual rise in demand will tend to grow slowly from about two thousand tons in 1960 to about 2.7 thousand tons by 1966. These figures are not just arbitrary assessments as they have been compiled from oil industry expectations of the trend but, in any particular year, the actual consumption of furnace oil may be above or below the trend line, as in the previous decade.

T A B L E 45 - UNION OF SOUTH AFRICA

AUTOMOTIVE DIESEL OIL CONSUMPTION BY PROVINCES

(Thousands of Gallons)

	CAPE (1)	%	NATAL (2)	%	O.F.S. (3)	%	TVL. (4)	%	UNION TOTAL (5)	ROAD VEHICLES (6)	%	OTHER USERS (7)	%
1950									39,811	19,668	49.40	20,144	50.60
1951	(Provincial Figures not Available)								47,540	25,088	52.77	22,452	47.23
1952									54,707	30,286	55.36	24,421	44.64
1953	21,177	33.43	8,747	13.81	8,654	13.66	24,770	39.10	63,348	34,874	55.05	28,474	44.95
1954	25,050	32.40	10,058	13.01	11,614	15.02	30,600	39.57	77,323	45,956	59.43	31,367	40.57
1955	29,142	30.58	12,427	13.04	14,283	14.98	39,455	41.40	95,306	57,629	60.47	37,677	39.53
1956	33,760	29.27	15,222	13.19	17,230	14.94	49,143	42.60	115,355	71,745	62.19	43,610	37.81
Average Annual Rate of Increase: 1950-1956									19.35%	24.07%		13.74%	

(Ref.67 - Table H.1)

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4. AUTOMOTIVE DIESEL OIL

This product is variously known as "Light Diesel Fuel", "Diesel Gas Oil", "C.I. Fuel", "Dieselene", or just "Gas Oil. It is a fuel for compression ignition engines of the type first successfully developed by Rudolf Diesel at the end of the last century. Diesel engines have a much higher thermal efficiency than petrol engines and can be operated on middle distillate fuel, which costs considerably less than gasoline. The main users of diesel engines and consequently the main consumers of automotive diesel oil, are as follows:-

a) Road Transport - operators of commercial vehicles of all descriptions including buses, lorries and vans. There is also a small number of diesel engined cars in South Africa, but their fuel consumption can be regarded as negligible in relation to the total demand.

b) Agriculture - many farmers operate diesel tractors and farming equipment. Water boring, pumping and irrigating machinery is frequently diesel driven. Farmers and/or Co-operative Societies often run their own diesel trucks to carry produce to market.

c) The Fishing Industry - uses large quantities of automotive diesel fuel in the engines of fishing boats and in trucks conveying products to railheads or to market.

d) Government and Local Authorities - use large quantities of automotive diesel oil in road transport, in roadmaking and constructional machinery, and in stationary engines of various types, including some used for the generation of electricity.

e) The Railways Administration - uses diesel fuel in road transport, in harbour vessels, and in constructional machinery. Prior to 1958 the Administration had no diesel locomotives in service but many have now been ordered, and their future needs will have a marked effect on the total demand for automotive diesel oil.

f) Mining - calls for large quantities of diesel oil for pumping, for ventilating and winding machinery; for underground and surface transport; and sometimes for electrical generation on remote mines.

g) Industry - in general is using increasing quantities of light diesel fuel for power driven machinery, for private locomotives, for transport purposes and in the manufacture of such products as agricultural insecticides etc.

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T A B L E 46 - UNION OF SOUTH AFRICA

MOTOR VEHICLES LICENSED AND GOVERNMENT VEHICLES EXEMPT FROM LICENCE 1947 - 1956

	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	ANNUAL AVERAGE RATES OF INCREASE 1947-1956	ANNUAL AVERAGE RATES OF INCREASE 1951-1956
1. MOTOR CARS	354,201	417,015	454,688	474,413	494,230	513,065	542,740	561,078	596,367	632,596	6.66%	5.06%
2. BUSES	3,843	4,310	4,439	4,740	4,806	4,915	5,022	5,324	5,624	6,269	5.59%	5.46%
3. LORRIES, TRUCKS, VANS	97,063	119,146	128,748	133,120	138,333	145,367	152,399	161,130	176,724	192,023	7.88%	6.78%
4. MOTOR CYCLES	22,747	23,684	23,786	24,019	24,443	25,397	27,189	28,227	30,681	39,362	6.28%	10.00%
5. TRACTORS ♁	12,740	19,359	28,742	33,925	44,014	50,176	58,398	66,606	87,000※	107,126	26.69%	19.47%
6. TOTAL VEHICLES	490,594	583,514	640,403	670,217	705,826	738,920	785,748	822,365	896,396	977,376	7.96%	6.73%

(♁ Incomplete, does not include all tractors on farms) (※ Estimated)

(Source: Bureau of Census and Statistics - Annual Motor Vehicle Statistics Special Reports)

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Annual consumption figures for automotive diesel oil for the Union of South Africa, as estimated by the statisticians of two oil companies, are set out in Table 31 (Page 150). The available official statistics provided by the Bureau of Census and Statistics are shown in Table 45 and it will be noticed that insofar as the annual totals are concerned there is close agreement between the two sets of figures. Both Tables agree that the average rate of increase in demand for automotive diesel oil during the last five or six years has been almost 20% per annum. This is an extraordinary rapid rate of growth which will be examined in some detail in the following paragraphs. Table 32 incidentally, shows that in South West Africa the rate of increase has been even greater than in the Union, averaging 22.26% per annum for the same period.

The provincial breakdown of consumption given in Table 45 is of interest but, as the statistics have been recorded only since 1953, there is insufficient data to determine definite trends. From the available information it would seem that the percentage share of total consumption attributable to Natal and O.F.S. is fairly steady, but that demand in the Transvaal is increasing much more rapidly than in the Cape. One of the reasons for this rapid increase in demand in the Transvaal is to be found in the greatly increased consumption by diesel road vehicles, of which the Transvaal has the major share. The relative official provincial figures for 1956 were as follows:-

	Buses	Commercial Vehicles.	Total
Cape	700	2,383	3,083
Natal	634	1,801	2,435
O.F.S.	92	600	692
Transvaal	1,088	5,169	6,257

The demand for automotive diesel oil for road transport has increased at an average rate of over 24% per annum and in 1955/56 over 60% of total consumption was for this purpose (Column (6) of Table 45). It is believed however that these figures, officially shown as consumption by "Road Vehicles", also include diesel fuel consumed by tractors on farms. If this is so there is rough corroboration of the 1956 figure of 71.7 million gallons to be found in items 1-6 of Table 53. These latter items show a total of 79.1 million gallons consumed by road transport and by agriculture in the Union and South West Africa during 1956. After making due allowance for the consumption of South West Africa and for non-tractor uses in the Union (say about 7 million gallons in all) it can be seen that there is sufficient agreement between the two Tables. In similar manner the 1955 figures for Union transport and tractor consumption given in items 1-4 of Table 54 show fair agreement with the official 1955 figure given in column 6 of Table 45 (58.7 million and 57.6 million gallons respectively).

The relationship between the number of diesel engined road vehicles and the number of petrol engined road vehicles is shown in Table 47 which incorporates all available published information covering the years 1949-56. This Table shows that the percentage of diesel buses licensed annually is steadily increasing, and Table 48 shows quite clearly that most of the major urban centres

[4] Part of the increase in consumption during the last few years is due to the carriage of coal in heavy duty road transporters from the Witbank area to Reef towns.

[6] Ref.69, Page 10.

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TABLE 47 - UNION OF SOUTH AFRICA

BUSES AND COMMERCIAL VEHICLES LICENSED 1949-1956, SHOWING TYPE OF FUEL USED

	PASSENGER BUSES					COMMERCIAL VEHICLES				
	PETROL	%	DIESEL	%	TOTAL	PETROL	%	DIESEL	%	TOTAL
1949	2,847	68.9	1,284	31.1	4,131	118,507	99.2	907	0.8	119,414
1950	3,145	70.9	1,288	29.1	4,433	122,430	99.1	1,111	0.9	123,541
1951	2,980	66.5	1,501	33.5	4,481	127,884	98.7	1,650	1.3	129,534
1952	2,828	65.1	1,516	34.9	4,344	131,473	98.3	2,215	1.7	133,688
1953	2,919	65.4	1,542	34.6	4,461	137,346	98.0	2,797	2.0	140,143
1954	2,888	62.2	1,753	37.8	4,641	143,930	97.4	3,914	2.6	147,844
1955 ≈	3,000	60.0	2,000	40.0	5,000	158,500	96.1	6,500	3.9	165,000
1956	3,199	56.0	2,514	44.0	5,713	167,361	94.4	9,953	5.6	177,314

(Source: Bureau of Census and Statistics - Annual Special Report on Motor Vehicle Statistics).

N.B. Does not include Government vehicles exempt from license.

(≈ Estimated).

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T A B L E 48

FUEL CONSUMED BY PRINCIPAL URBAN PASSENGER MOTOR BUS SERVICES - FINANCIAL YEAR 1955/56

SERVICE	NUMBER OF MOTOR BUSES	PETROL CONSUMED (Galls.)	AUTOMOTIVE DIESEL OIL CONSUMED (Galls.)
East London	60		186,000
Springs	60		138,000
Bloemfontein	52		129,000
Pietermaritzburg	61		220,000
Welkom	16	7,000	22,000
Durban	220		748,000
Benoni	46		113,000
Boksburg	31	1,000	81,000
Brakpan	34		88,000
Germiston	53	4,000	182,000
Johannesburg	185		516,000
Nigel	17		33,000
Pretoria	108	59,000	257,000
Putco (Reef)	313		1,467,000
Cape Town	206		1,087,000
Port Elizabeth	131		503,000
T O T A L S	1,593	71,000	5,770,000

(Ref.69, Page 60).

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apparently prefer diesel-engined motor buses to the petrol driven variety. A further examination of Table 48 shows that about 50% of the total consumption of automotive diesel oil was by Transvaal bus services. The number of diesel-engined commercial vehicles is also showing a steady annual increase, although, as Table 47 shows, most commercial vehicles are still petrol driven. There are however some grounds for believing that the official statistics
/ of diesel-engined vehicles licensed do not accurately reflect the number of such vehicles in service and this point will be further discussed in later paragraphs.

An analysis of tractors licensed in each of the years 1949 to 1956 showing the type of fuel consumed, is given in Table 49. These figures are not a complete record of all tractors in use, as
ƅ those used exclusively on farms in the Cape were not liable for licence prior to 1956. Crawler type tractors on farms are still not subject to license in the Cape and Orange Free State. The difference between number of tractors licensed and number of tractors actually in use can be gauged from a comparison of Tables 49 and 50, the latter giving figures taken from the Agricultural Census of tractors actually in use on farms in the years 1950 and 1953.

Several interesting observations can be made in regard to Table 49. In the first place it should be noted that from 1949 onwards the percentage of petrol driven tractors has shown a steady decline. Secondly, the percentage of kerosene driven tractors reached a peak in 1952/53 and is now declining. Thirdly, the percentage of diesel driven tractors has risen sharply since 1954. This latter movement is part of a noticeable world-wide swing towards the greater use of diesel engines in heavy transport and tractor operations. The sharp increase in the number of diesel tractors in
x use in the Union continued in 1957, when according to the Shell "Report" for the year it was estimated that 80% of the tractors imported into the Union were diesel-engined.

Table 49 shows also that 9,298 petrol driven tractors were licensed in 1953 but most of these must have been engaged in road transportation as, according to Table 50, only 2,828 petrol driven tractors were actually used on farms in that year. This can be substantiated by a rough reconciliation of the figures given in Tables 49 and 50. Assuming that all tractors on farms in the Cape Province were unlicensed (as mentioned earlier) the respective totals of Cape tractors shown in Table 50 by type of fuel used, can be added to the appropriate number licensed as given in Table 49. It will be noticed that there is then reasonably close agreement, insofar as Power Kerosene and Diesel tractors are concerned, with the Union totals of tractors on farms (Table 50). The number of petrol-engined tractors cannot, however, be reconciled in this manner, the difference being accounted for by tractors licensed for road use only and not used on farms.

Tables 49 and 50 show very clearly that power kerosene is still the main fuel for farm tractors, albeit with a growing demand for diesel oil. It is to be regretted that comparative 1956 figures for the number of tractors on farms (Table 50) are not yet available,

/ In Ref.69, Page (iv) it is stated "It should be noted that the Bureau (of Census and Statistics) is entirely dependent upon details as supplied by licensing authorities and cannot always ensure the accuracy of the data supplied".
ƅ Ref.69, Page (vii)
x Ref.66, Page 5

TABLE 49

UNION OF SOUTH AFRICA

TRACTORS LICENSED 1949 - 1956 SHOWING TYPE OF FUEL CONSUMED δ

	PETROL		POWER KEROSENE.		DIESEL FUEL.		TOTAL.
	No.	%	No.	%	No.	%	
1949	7,173	25.9	18,645	67.4	1,860	6.7	27,678
1950	8,021	24.2	23,349	70.3	1,818	5.5	33,188
1951	8,425	19.7	31,742	74.3	2,566	6.0	42,733
1952	8,514	17.6	36,920	76.4	2,905	6.0	48,339
1953	9,298	16.4	43,191	76.4	4,057	7.2	56,546
1954	10,463	16.2	48,695	75.3	5,474	8.5	64,632
1955 ж	10,000	11.8	63,000	74.1	12,000	14.1	85,000
1956	8,395	8.0	76,238	72.4	20,608	19.6	105,241

(ж Estimated)

(δ Excluding Government tractors exempt from license).

(Source: Bureau of Census and Statistics - Annual Special Reports on Motor Vehicle Statistics)

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TABLE 50 - NUMBER OF TRACTORS ON FARMS 1950 AND 1953 SHOWING TYPE OF FUEL USED

		TOTAL		PETROL		POWER KEROSENE		AUTOMOTIVE DIESEL OIL	
		No.	%	No.	%	No.	%	No.	%
1950	Cape	16,126	100	2,066	12.8	12,742	79.0	1,318	8.2
	Natal	4,170	100	1,000	24.0	2,757	66.1	413	9.9
	Transvaal	14,341	100	1,768	12.3	11,812	82.4	761	5.3
	O.F.S.	13,785	100	995	7.2	12,316	89.4	474	3.4
	UNION TOTAL	48,422	100	5,829	12.0	39,627	81.9	2,966	6.1
1953	Cape	23,863	100	1,359	5.7	19,979	83.7	2,525	10.6
	Natal	5,652	100	394	7.0	4,554	80.6	704	12.4
	Transvaal	23,877	100	685	2.9	21,194	88.7	1,998	8.4
	O.F.S.	21,218	100	390	1.8	19,224	90.6	1,604	7.6
	UNION TOTAL	74,610	100	2,828	3.8	64,951	87.1	6,831	9.1

(Source: Union Year Book No. 28, Page 536) (Statistics for 1956 not yet available).

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as these would probably show the same rapid increase in diesel tractors in use, as Table 49 shows for diesel tractors licensed. One of the leading oil companies has estimated that about 28,000 diesel tractors were in use on farms in 1956 (see Table 53) as compared to the 20,608 for which licenses were issued (Table 49). This does not seem to be an unreasonable estimate in view of the differing Provincial regulations regarding the licensing and/or exemption of tractors actually in use on farms.

[a] The statistical data given in column (1) of Table 51 reflects the official figures of demand for fuel and power oil by the larger mines of the mining industry in the Union. No breakdown of these figures is available to show the actual quantity of automotive diesel oil consumed each year and, in any case, there is some doubt as to whether the official returns include diesel fuel used for road transportation by the mines. The oil companies' own estimates for various years, shown in Tables 52 and 53, reflect a much higher consumption of automotive diesel oil by the mining industry, but these Tables cover all mines in the Union and in the Protectorates and South West Africa. In these latter territories alternative forms of energy such as coal and electricity are not readily available and large quantities of automotive diesel fuel are used in the transportation of stores and ores - which for mines situated in remote areas may often comprise the major portion of their automotive diesel oil requirements. It is not without significance that, even on the basis of official statistics, 71% of the total 1955 consumption of petroleum fuels by the mining industry in the Union was in the form [b] of furnace oils and diesel fuels, and automotive diesel oil probably accounted for the lion's share. This product could be used in a variety of ways, such as for example in diesel engines driving air compressors, pumps, generators, hauling and winding gear etc.

In an attempt to obtain a more complete analysis of consumer demand than could be provided by the official statistics so far consulted, the four major oil companies were invited to submit as much detailed information as they could in regard to the ultimate use of the total annual sales of automotive diesel oil. Tables 52 to 55 reflect the estimates provided by the companies and these will now be examined separately.

An analysis of demand based on estimates of sales made to the main consumer groups has been compiled from information supplied by the Shell Company and is presented in Table 52. This type of demand schedule is helpful from a sales point of view as it indicates the major outlets for the product, but its usefulness is in direct proportion to its completeness and item 7 shows that no information was available in regard to about one-third of the annual sales of automotive diesel oil. This lack of knowledge of consumer demand for petroleum products has been mentioned before, and it is a problem that is receiving the constant attention of all oil companies. Table 52 however does highlight the fact that some of the major statistical problems insofar as automotive diesel oil is concerned lie in the fields of transport

[a] See Ref.28, Table 9 (and for earlier years). The official figures are quoted as being for "large mines" only.

[b] See Tables 41 and 42 for 1957 estimates of industrial diesel oil and furnace oil consumption by the mining industry in the Union and South West Africa.

T A B L E 51 - UNION OF SOUTH AFRICA

PETROLEUM FUELS CONSUMED BY THE MINING INDUSTRY 1946-1955

(Gallons)

	FUEL AND POWER OIL /ϕ (1)	ILLUMINATING PARAFFIN (2)	MOTOR GASOLINE (3)	TOTAL PETROLEUM FUELS (4)
1946	3,136,406	216,590	835,238	4,188,234
1947	4,081,567	227,364	1,111,046	5,419,977
1948	4,343,768	278,529	1,402,758	6,025,055
1949	5,326,586	324,286	1,509,318	7,160,190
1950	5,769,538	341,932	1,692,392	7,803,862
1951	5,510,758	389,646	1,928,376	7,828,780
1952	4,880,427	472,138	2,035,102	7,387,667
1953	5,662,288	464,358	2,149,017	8,275,663
1954	5,421,935	509,468	1,969,985	7,901,438
1955	5,877,684	457,146	1,915,720	8,250,550
1955 Percentages	71%	6%	23%	100%

(ϕ includes Furnace Oils and Diesel Fuels).

(Dept. of Mines - Annual Reports, Table No. 9 - Office statistics for "large mines" only).

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and industry. Table 48 for example, shows that the principal urban passenger bus services must have consumed about 6,000,000 gallons of automotive diesel oil in 1957, but the category of "Public Transport" is not shown separately in Table 52 and is presumably included in Local Government (item 4) insofar as municipal services are concerned, or else contained in the "unspecified" figure (item 7).

In regard to industrial consumption it is understandable that statistics of fuel demand are not easy to obtain. The same problem arose in statistics of coal consumption, where the lack of market knowledge was clearly evident, and it was shown that no means had yet been found for recording the multitude of small sales which together comprised the aggregate demand of industry. There will inevitably be a proportion of annual sales figures for automotive diesel oil which for want of a better term should probably be classed as"Industry and General", but there would appear to be insufficient information in regard to industrial consumers to warrant an attempt at defining the demand pattern of this group at the present time.

In Table 52 Shell shows that no automotive diesel fuel was sold through resellers in 1951, but that in 1957 over 5.6 million gallons were distributed in this manner. This in itself is a result of the extraordinary rise in demand during the past few years and is evidence of the longer journeys now being undertaken by diesel vehicles, which in turn have created a demand for refuelling points at garages. It also reflects a small but growing demand from owners of diesel engined motor cars - types which were not available in the Union in 1951.

The remaining items of Table 52 are self explanatory. The growing demands of agriculture are clearly evident, and this sector of the economy is now the largest consuming group for automotive diesel oil. The mining industry would appear to be the next largest consumer at the present time, and once again it should be mentioned that the figures shown against item 6 of Table 52 include sales in South West Africa and the Protectorates, where alternative forms of energy are not readily available for mining purposes, and where diesel powered transport is a vital factor. The final interesting feature of this Table is the 180% growth in total demand for automotive diesel oil between 1951 and 1957.

Table 53, based on information supplied by Atlantic Refining Company, sets out to tackle the problem of road transport requirements using the techniques and assumptions detailed hereunder:-

a) The Bureau of Census and Statistics estimated the 1956 consumption of automotive diesel oil by all road vehicles to be 71,745,000 gallons, being some 62% of the total sales (Table 45). However Atlantic felt that this figure was too high for road vehicles only, as their own past experience and the observations of Branches in the field tended to show that road transport consumed less than 50% of the annual sales total.

Chapter 2 Part 8

Table 53 was compiled in ton units which were converted to gallons at approximately 267 gallons to the ton;

TABLE 52

AUTOMOTIVE DIESEL OIL - COMPARATIVE CONSUMER ANALYSIS 1951 AND 1957 ¤

(1,000 Gallons)

		1951	%	1957	%
1.	Resellers	-	-	5,627	4.01
2.	Agriculture	9,503	18.84	40,378	28.75
3.	Fishing	2,630	5.21	5,230	3.72
4.	Government				
	Central	4,707	9.33	9,354	6.66
	Local	5,456	10.81	10,736	7.65
5.	Railways	1,264	2.51	5,107	3.64
6.	Mining	8,629	17.10	17,554	12.50
7.	Unspecified	18,260	36.20	46,432	33.07
8.	TOTALS:	50,449	100%	140,418	100%

(¤ Union and South West Africa)

(Compiled from estimates made by the Shell Company of South Africa Limited)

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TABLE 53 - AUTOMOTIVE DIESEL OIL - ESTIMATES OF CONSUMPTION BY USER CATEGORIES 1956, 1961, 1966 ※

(Thousands of Gallons and Tons of 2,240 lbs.)

		1956:				1961:				1966:			
		No.	Galls.	Tons	%	No.	Galls.	Tons	%	No.	Galls.	Tons	%
1.	S.A.R. Vehicles	2,140	4,854	18,180	3.9	3,200	7,262	27,200	2.9	3,900	8,851	33,150	2.4
2.	Government Vehicles	1,370	3,111	11,650	2.5	1,900	4,312	16,150	1.7	2,200	4,993	18,700	1.3
3.	Private Buses	2,519	8,069	30,220	6.5	3,415	10,942	40,980	4.3	3,828	12,263	45,930	3.3
4.	Private Comm. Vehicles	16,458	32,958	123,440	26.6	39,100	78,298	293,250	31.1	55,800	111,740	418,500	29.8
5.	Total Road Transport	22,487	48,992	183,490	39.5	47,615	100,814	377,580	40.0	65,728	137,847	516,280	36.8
6.	Agricultural Purposes	28,300	30,144	112,900	24.3	58,500	62,345	233,500	24.7	76,800	81,809	306,400	21.8
7.	Diesel Locomotives												
	Private	-	2,670	10,000	2.2	-	3,204	12,000	1.3	-	4,005	15,000	1.1
	S.A.R.	-	-	-	-	220	26,046	97,550	10.3	600	72,090	270,000	19.2
8.	Government Projects	-	6,234	23,350	5.0	-	8,277	31,000	3.3	-	10,680	40,000	2.8
9.	Coastal and Fishing Vessels	-	4,606	17,250	3.7	-	5,607	21,000	2.2	-	6,354	23,800	1.7
10.	Electrical Generation	-	9,372	35,100	7.5	-	11,748	44,000	4.7	-	14,151	53,000	3.8
11.	Central and Domestic Heating	-	801	3,000	0.6	-	1,068	4,000	0.4	-	1,335	5,000	0.4
12.	Mining and Industrial	-	20,719	77,600	16.7	-	32,093	120,200	12.7	-	45,390	170,000	12.1
13.	Miscellaneous	-	598	2,240	0.5	-	953	3,570	0.4	-	1,148	4,300	0.3
14.	TOTAL, ALL PURPOSES	-	124,136	464,930	100%	-	252,155	944,400	100%	-	374,809	1,403,780	100%
	Percentage increase on 1956 figures			-				103.1				201.9	

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Limited.)

(※ Union and South West Africa)

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The position was complicated by an examination of official figures for diesel commercial vehicles licensed during 1956 (Table 47) which showed only 9,953 such vehicles in the Union. This figure was felt to be too low and after an examination of the numbers of commercial vehicles licensed by make of vehicle, the following pattern emerged:-

ESTIMATED NUMBER OF DIESEL ENGINED COMMERCIAL VEHICLES IN USE - 1956

MAKE	Total Commercial Vehicles Licensed	Estimated Number Having Diesel Engines	
A.E.C.	314	314	
Albion	2,652	2,652	
Atkinson	182	182	
Austin	9,539	475	(5%)
Bedford	8,718	870	(10%)
Borgward	318	318	
Bussing	333	333	
Diamond T	663	663	
E.R.F.	418	418	
Foden	347	347	
Ford	38,609	770	(2%)
Guy	215	215	
Hanomag	332	332	
Henschel	411	411	
International	13,835	414	(3%)
Leyland	2,549	2,549	
Mack	134	134	
Magirus Deutz	361	361	
Mercedes-Benz	733	700	(95%)
Morris, Morris Commercial	2,991	600	(20%)
Seddon	650	650	
Thames	3,172	2,540	(80%)
Thornycroft	359	359	
Volvo	166	166	
Total		16,773	
Allowance for errors		773	
Final Total Estimate, say		16,000	

The above estimates were made after personal contact with the assemblers, main distributors, agents or factory representatives for each make of commercial vehicle mentioned. The allowance for possible error at the foot of the Table is a measure of prudence to ensure that the final total was not an over-estimate. A significant thing about this estimate of diesel engined commercial vehicles in use is that it is taken from the same Government publication that shows a total of only 9,953 such vehicles licensed in the same year. The publication is the Bureau of Census and Statistics Special Report No.216 on Motor Vehicle Statistics for the year 1956.

Ref.69, Page 10
Ibid, Pages 38 - 41
Ref.69

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On page 10 Table 9 of the Report gives a total of 9,953 diesel engined commercial vehicles licensed in the Union; whilst the above schedule, extracted from pages 38-41 (Table 10) of the same Report, reaches a very different conclusion.

In regard to South West Africa it was not possible to contact the various agents in the territory but, on preparing a Table similar to the above and applying the same percentage allowances, a total of 500 diesel-engined commercial vehicles (by make) was estimated for 1956. When allowance is made for possible error the resulting total is near enough to the official figure of 458 such vehicles (licensed) to allow this figure to be accepted unchanged. Atlantic therefore based their analysis of diesel oil consumption by private commercial vehicles in 1956 on a total of 16,000 such vehicles in the Union and 458 in South West Africa (Line 4 of Table 53). The average consumption of each vehicle was estimated at 2,000 gallons of automotive diesel oil per annum (i.e. 7½ tons) giving a total of nearly 33 million gallons for this category for the year (Table 53, item 4).

b) In regard to private buses, the official figure of 2,519 for the Union and South West Africa was accepted as correct. An average consumption of automotive diesel oil of about 3,200 gallons (12 tons) per bus per annum was calculated from data given on page 367 of Union Year Book No.28. This might seem a little low, as a rough calculation based on Table 48 gives an average of about 3,600 gallons (13½ tons) per bus per annum. However as buses in the principal urban areas are undoubtedly subjected to more intensive use than those operated in peri-urban and rural areas, an average of 3,200 gallons per bus per annum can be accepted as a reasonable overall estimate (Table 53, item 3)

c) Consumption of automotive diesel oil by Government Departments was estimated from Tender requirements published during the year at about 9.3 million gallons (35,000 tons) in all (Items 2 and 8 in Table 53). One third of this total - possibly a liberal estimate - was assumed to be required for diesel road vehicles of various types at an average of 2,270 gallons (8½ tons) per vehicle per annum, and is shown in item (2). The balance was allocated to construction projects, irrigation and pumping, and the sundry needs of Central and Local Government throughout the area (item 8)

d) The total automotive diesel oil consumption of the South African Railways was credited to Road Motor Services. This may be a generous estimate

6 Vehicle figures again taken from Ref.69, Pp 38-41
4 Ref.69, Page 10.
x Ibid Page 10.

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but the assumption is not unrealistic as this Branch of the Administration is by far the largest consumer of diesel fuel. The figure of 4,854,000 gallons (18,180 tons) shown by Atlantic for 1956 in Table 53 can be compared to the estimate of 5,107,000 gallons given by Shell for 1957 in Table 52 - a seemingly reasonable degree of correspondence being evident.

e) In summary therefore Atlantic's total estimate of automotive diesel oil consumed by road transport during 1956 amounts to 48,992,000 gallons (183,490 tons), being 39.5% of total sales (item 5 of Table 53). This is much lower than the official figures of 71,745,000 gallons and 62.19% given in Table 45 under the heading of "Road Vehicles" but, as mentioned earlier, this title is misleading as it almost certainly includes diesel tractors.

On the prima facie evidence of Atlantic's methods of calculation it would also seem that official statistics of diesel vehicles licensed are not a good guide to the numbers actually in service, (insofar as tractors are concerned, Tables 49 and 50 substantiate this point very clearly).

Atlantic has given some interesting forward estimates in Table 53 for the years 1961 and 1966. These are based on anticipated increases in demand by each category of consumer, and according to the estimates, the total consumption of automotive diesel oil by road transport will continue at a rate not exceeding 40% of the annual total.

The introduction of diesel locomotives by the South African Railways will have an important bearing on future requirements of automotive diesel oil. Each diesel locomotive has been estimated to consume 450 tons per annum and the number in service is expected to reach 600 by 1966. (Item 7 of Table 53).

Each diesel tractor in service is estimated to consume about 1,000 gallons (3.8 tons) of automotive diesel fuel per annum and the total consumption figure for agricultural purposes, given in item 6, makes a small allowance for stationary diesel engines used in agriculture.

Notwithstanding the expanding Escom power network, item 10 of Table 53 assumes that within the next ten years there will still be a small annual rise in the amount of automotive diesel oil required for electrical generation by local authorities in rural areas and for stand-by units in urban areas. This is a reasonable assumption as the Escom expansion programme is of necessity long-term in its nature and in any case is restricted by the shortage of

See Ref. 38, Pages 131 and 135, for details of R.T.S. and Cartage vehicles in service with the S.A.R.

TABLE 54

AUTOMOTIVE DIESEL OIL - END USE ESTIMATES 1955

(1,000 Gallons)

USE.	UNION ONLY.	%	UNION AND S.W.A.
1) Trucks and Vans	21,596	22.66	23,181
2) Passenger Buses	10,655	11.18	11,437
3) All Road Transport	32,251	33.84	34,618
4) Agricultural Tractors	26,533	27.84	28,480
5) Agricultural Machinery	572	0.60	614
6) Earth moving equipment	8,015	8.41	8,603
7) Locomotives (not S.A.R.)	2,097	2.20	2,251
8) Marine Engines (Coastal)	5,413	5.68	5,811
9) Electrical Generation	10,780	11.31	11,570
10) Stationary Engines	6,614	6.94	7,100
11) Industrial Furnaces	2,001	2.10	2,148
12) Miscellaneous	1,030	1.08	1,105
TOTAL, ALL USES:	95,306	100%	102,300

(Compiled from percentage estimates made by Caltex (Africa) Ltd.)

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adequate water supplies for power station use.

The overall demand figure (item 14) is expected to show about 200% increase by 1966 over the actual 1956 demand. This remarkably rapid rise will be brought about in part by the large scale replenishment of existing petrol and power kerosene engined commercial vehicles by diesel vehicles, as and when the former have reached the end of their economic life. The demand for additional commercial vehicles to fill the needs of the expanding economy of the Union and South West Africa will be met to a greater degree than heretofore by diesel-engined types, whilst the dieselization programme of the S.A.R. will also help to swell demand for automotive diesel oil during the next decade.

An indication of the actual end uses of the automotive diesel oil sold during 1955 is given in Table 54. The information contained in this Table is based on a detailed market survey carried out by Caltex (Africa) Limited two years ago in which, as the purpose of the survey was to determine "end uses", consumer groupings by economic sector were largely ignored. For example, in an analysis by consumer groups some of the consumption shown for earth moving equipment would be classed as "Government", most of the consumption shown for electrical generation would be classed under "Local Authorities", but some would be "Mining", as would part of the consumption shown for stationary engines. It is therefore not possible to compare Table 54 directly with information given in other Tables under consumer groupings, except insofar as transport and tractor consumption figures are concerned, where the correspondence between the total of items 3 and 4, and the 1955 figures given in column 6 of Table 45, has already been noted. Nevertheless Table 54 does give a possible alternative approach to the problem of estimating future demand, based on the number of diesel engines in service for specific purposes rather than on consumer groupings by sectors of the national economy. However the difficulties inherent in maintaining statistics of diesel engines in service for specific purposes would probably militate against a permanent analysis of this sort, it being easier to group by economic sector.

It is interesting to note from the Caltex survey that in 1955, apart from road transport and tractors the next largest consumer use of automotive diesel oil was in the generation of electricity through diesel power plants. However, 11,570,000 gallons is equivalent to only about 65,000 tons of coal, which is negligible in relation to the quantities of this latter fuel converted into electricity each year (See Table 23, Page 95).

An analysis of 1957 automotive diesel oil consumption, based upon information provided by Vacuum Oil Company, is shown in Table 55. It will be noticed that their analysis is similar to that of Caltex (i.e. by actual end-use) as compared with the consumer group analysis favoured by Shell and Atlantic. The following comments are relevant:-

a) The correspondence between Shell's total for 1957 of 140,418,000 gallons (Table 52) and Vacuum's total for the same year of 139,587,000 gallons is self evident.

TABLE 55 - AUTOMOTIVE DIESEL OIL - END USE ESTIMATES 1957

(1,000 Gallons.)

	UNION OF SOUTH AFRICA	%	SOUTH WEST AFRICA	%	TOTAL	%
1. Buses, Trucks, Vans	49,050	37.6	1,151	12.6	50,201	36.0
2. Agricultural Tractors	41,092	31.5	3,362	36.8	44,454	31.9
3. Total All Vehicles	90,142	69.1	4,513	49.4	94,655	67.9
4. Stationary Engines	29,743	22.8	3,526	38.6	33,269	23.8
5. Marine Engines (Coastal)	3,392	2.6	950	10.4	4,342	3.1
6. Miscellaneous	7,175	5.5	146	1.6	7,321	5.2
7. TOTAL, ALL USES.	130,452	100%	9,135	100%	139,587	100%

(Compiled from information supplied by Vacuum Oil Company of South Africa (Pty.) Ltd.)

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b) The correspondence between the 1957 official Union total consumption for all vehicles of 82,430,000, and Vacuum's total of 90,142,000 is not as close as that previously discussed for 1955 and 1956 in Tables 53 and 54. However it may well be that there is an error in the official statistics, as generally speaking oil company vehicle estimates appear to be based on more accurate information.

c) There is a large measure of agreement between the Shell 1957 figure for Agriculture (Table 52) of 40,378,000 gallons and Vacuum's figure of 41,092,000 gallons.

d) If the total of 139,587,000 gallons shown in Table 55 for the Union and South West Africa is converted to tons (267 gallons/ton) it agrees with the 526,000 tons shown for automotive diesel oil (1957) in Table 56.

The foregoing discussion has drawn attention to several important matters in regard to statistics of consumer demand for automotive diesel oil. In the first place the oil companies do not seem to place much reliance on official statistics of diesel engined commercial vehicles. There seems to be a reasonable belief that figures of diesel vehicles licensed, and particularly diesel tractors, bear little resemblance to the numbers actually in use each year and, for this reason, the companies appear to prefer their own empirical observations and estimates. Secondly, each company has a certain amount of knowledge of the market but no company has a complete analysis of the total internal market for automotive diesel oil. Each company however keeps fairly detailed statistics of its own customers - which are naturally not available for publication. In order to obtain co-ordinated statistics of total demand by consumer categories it would be necessary for the companies to pool their sales data and, as each is marketing in competition with the others, there is little likelihood of such an arrangement ever coming about. However the very fact of being in competition means that no company can afford to ignore statistical trends and, for that reason, whilst each company may have its own ideas about the strength of demand from various consumer groups, it seems that total demand and the future trend of total demand is fairly well known to all.

Table 33 showed that the total consumption of automotive diesel oil increased at an average rate of about 22% per annum during the post-war decade. The rate of growth during the next ten years is expected to ease off somewhat to an average of about 11.5% per annum (See Table 56). It should be borne in mind that the anticipated rapid rise in the number of diesel vehicles and diesel engines for other purposes, is partly due to a change-over from petrol or power kerosene to diesel fuel. For example the 300% increase in total vehicles between 1956 and 1966 shown in Table 53 does not all represent a nett addition to stocks, but partly a change in consumers' preferences in favour of diesel-engined vehicles. This change in consumer's preferences cannot be measured for future years, but can be assessed only on the basis of past experience and present knowledge. In general

Ref. 67, May 1958, Table H.1

TABLE 56

ESTIMATED CONSUMPTION OF AUTOMOTIVE DIESEL OIL 1957-1966[1]

(Thousands of Long Tons)

YEAR	AMOUNT	ANNUAL INCREMENT
1957	526.0	-
1958	596.5	70.5
1959	707.1	110.6
1960	833.6	126.5
1961	944.4	110.8
1962	1033.4	89.0
1963	1123.5	90.1
1964	1215.5	92.0
1965	1309.0	93.5
1966	1403.7	94.7
Annual Average Rate of Increase:	11.5%	-

([1] Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd. - See Table 53)

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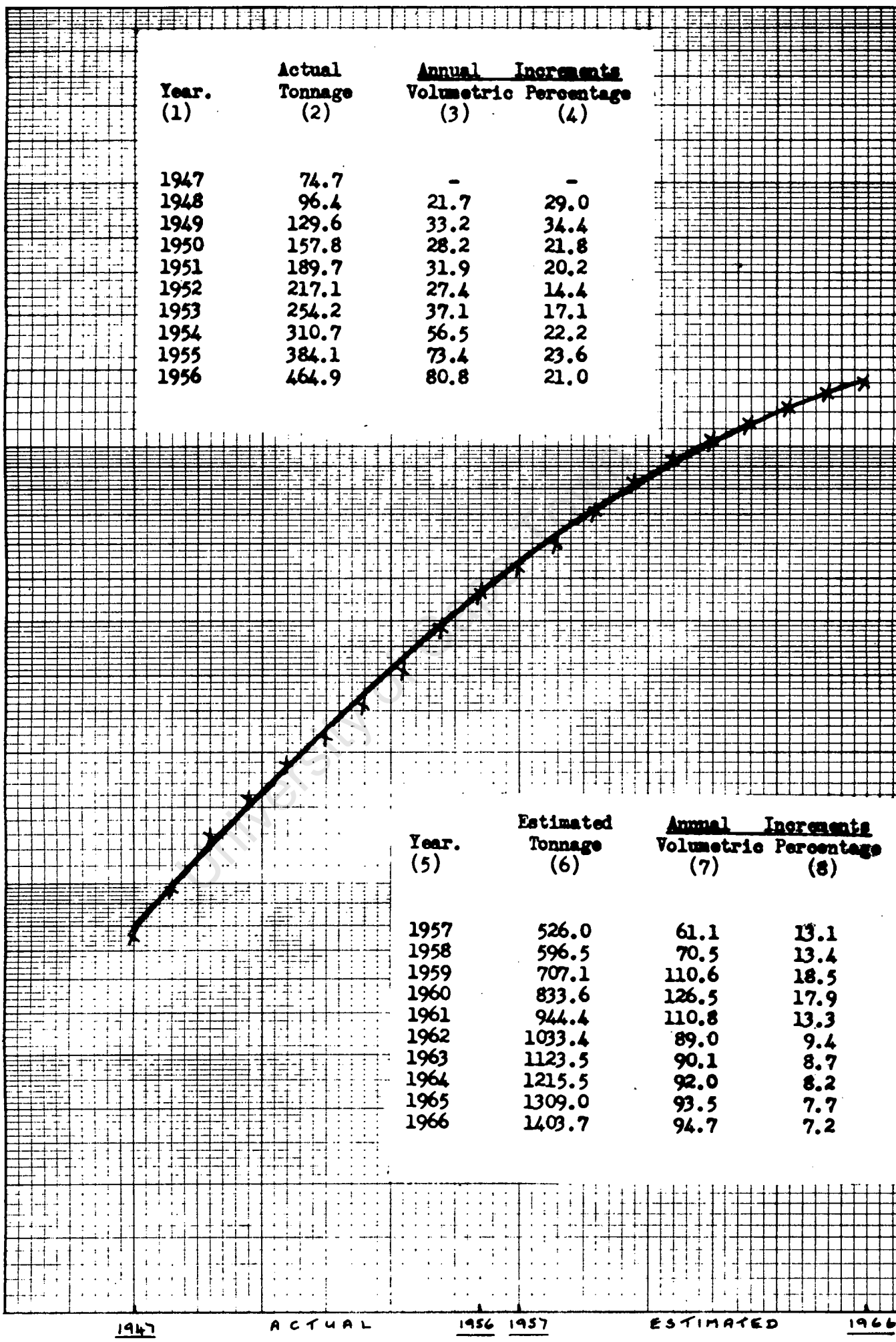
FIG. 18 AUTOMOTIVE DIESEL OIL
CONSUMPTION TREND 1947 - 1966
(Thousands of Long Tons).



Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	74.7	-	-
1948	96.4	21.7	29.0
1949	129.6	33.2	34.4
1950	157.8	28.2	21.8
1951	189.7	31.9	20.2
1952	217.1	27.4	14.4
1953	254.2	37.1	17.1
1954	310.7	56.5	22.2
1955	384.1	73.4	23.6
1956	464.9	80.8	21.0

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	526.0	61.1	13.1
1958	596.5	70.5	13.4
1959	707.1	110.6	18.5
1960	833.6	126.5	17.9
1961	944.4	110.8	13.3
1962	1033.4	89.0	9.4
1963	1123.5	90.1	8.7
1964	1215.5	92.0	8.2
1965	1309.0	93.5	7.7
1966	1403.7	94.7	7.2

therefore, the consumption figures for future years shown in Tables 53 and 56 have been conservatively estimated, taking into account all foreseeable happenings in the market for automotive diesel oil. The pronounced swing towards increased use of diesel engined commercial vehicles and tractors has been responsible for most of the increased demand for automotive diesel oil during recent years and, from 1959 onwards, the introduction of diesel locomotives will cause another heavy upsurge in demand. Table 56 clearly reflects this increase during the years 1959, 1960 and 1961. Thereafter it is expected that demand will continue to rise fairly rapidly, but somewhat more steadily, each year until 1966 at which date this survey ends.

A consumption trend curve is shown in Figure 18 covering the period 1947 - 1966. It will be noticed that the actual annual consumption figures for the first ten years are very close to the trend and that the same curve is projected forward for the first few years of the second decade. Thereafter however the annual rate of growth in demand for automotive diesel oil is expected to ease somewhat (Table 56) resulting in a distinct "flattening" effect to the trend curve for the last five years. This "easing" of demand is really only a return to "normal" rates of annual increase, following a period of extra heavy demand which, as mentioned earlier, is mainly due to the introduction of diesel engined locomotives by the S.A.R. and the change-over from petrol to diesel engines by commercial transport operators. These points were discussed in detail in previous pages during the analysis of Table 53. The future estimates plotted in Figure 18 are based on this earlier discussion of consumption patterns, and the calculations are the same as those made for Table 53 with the addition of figures for the intervening years. The trend diagram is the final illustrative summary of this discussion.

5. AVIATION GASOLINE AND TURBINE FUELS.

The normal demand for aviation fuels in the Union can be divided into four categories. In the first place there is the demand for gasoline and turbine fuel by the South African Air Force, details of which are not available for publication. It is however common knowledge that apart from training and communications aircraft the Air Force operates Avro Shackleton long-range reconnaissance planes (gasoline) and Vampire and Sabre jet aircraft (turbine fuel). Under peace-time conditions the strength of the South African Air Force is not large and the bulk of demand for aviation fuels normally comes from airline operators.

The South African Airways (category two) is the largest single consumer of petroleum fuels in the Union at the present time. As at the 31st March 1958 the aircraft fleet consisted of:-

ϕ Report of the General Manager of Railways and Harbours for the year ended 31st March 1958, Page 36.

i) In Service:

3 DC - 7B's	(Gasoline)
4 L749 Constellations	"
7 DC - 4 Skymasters	"
6 DC - 3 Dakotas	"

ii) On Order:

1 DC - 7B	(Gasoline)
7 Vickers Viscount 810D	(Turbine Fuel)
3 Boeing 707-320	(Turbine Fuel)

The DC - 7B aircraft are used on the Springbok route between Johannesburg and London and also on the route between Johannesburg and Australia. Their consumption of aviation gasoline from Union sources is therefore limited to the quantities carried when they leave Johannesburg on each trip. From 1961 onwards South African Airways expect to introduce Boeing 707 aircraft on the Springbok route. This will cause a change in demand from gasoline to turbine fuel on the external services, whilst it can be assumed that the DC - 7B's will be transferred to the internal and regional services.

Internal services between all the major towns are at present operated by Viscount, Skymaster and Dakota aircraft and these also provide regional links with the Federation and Lourenco Marques. All the fuel consumed by these planes is taken from Union stocks (except perhaps for 'topping-up' purposes prior to their return flights). The introduction of turbine-engined Vickers Viscount aircraft on the internal services during the last quarter of 1958 caused some transfer of demand from gasoline to turbine fuel in this and succeeding years. (See Table 58).

The Constellation aircraft, which are nearing the end of their economic life, are now mainly engaged on charter work and relief duties but could also be used for freight carriage should there be sufficient demand.

The present schedule of internal services linking the major cities of the Union calls for 124 flights each week between terminal centres. These are as follows:-

Johannesburg - Cape Town: ...	15 weekly in each direction
Johannesburg - Durban: ...	22 weekly in each direction
Johannesburg - Port Elizabeth:	7 weekly in each direction
Johannesburg - Windhoek: ...	4 weekly in each direction
Cape Town - Durban:	7 weekly in each direction
Cape Town - Port Elizabeth:	3 weekly in each direction
Cape Town - Windhoek:	4 weekly in each direction

Special non-scheduled flights are made between Johannesburg - Durban, and Johannesburg - Cape Town during holiday periods to cater for seasonal peaks in demand for air travel. In addition, "Skycoach" services at reduced fares are operated between Johannesburg and Cape Town, Durban and Port Elizabeth.

Ibid. The DC-7B and the Vickers Viscount aircraft on order have now been delivered and are in service).

The regional and trunk route services of South African Airways are set out hereunder:-

Frequency	Aircraft	Destination
1 fortnightly	DC-7B	Australia
5 weekly	DC-7B	London
4 "	Constellation	Salisbury
4 "	Skymaster	Bulawayo
2 "	Dakota	Lourenco Marques
1 "	Dakota	Salisbury

The third group of major consumers of aviation fuels consists of foreign aircraft flying into Johannesburg from many other countries. As far as can be ascertained the following is a complete summary of overseas airline connections with the Union:-

ϕ

	Airline	Frequency	Aircraft	Fuel
1.	B.O.A.C.	4 per week	Brittania	Turbine Fuel
2.	C.A.A.	8 " "	Viscount	" "
		3 " "	Viking	Gasoline
3.	K.L.M.	2 " "	DC - 7C	"
4.	P.A.A.	2 " "	DC - 7C	"
5.	SABENA	2 " "	DC-6A or B	"
		1 " "	Skymaster	"
6.	ALITALIA	2 " "	DC - 6B	"
7.	U.A.T.	2 " "	DC - 6B	"
8.	S.A.S.	1 " "	DC - 7C	"
9.	D.E.T.A.	2 " "	Dakota	"
10.	E.A.A.C.	1 " "	Dakota	"
		1 " "	Canadair 4	"
11.	QUANTAS	1 fortnightly	Constellation	"

It will be noticed that with the exception of B.O.A.C. and C.A.A. all the above airlines use petrol engined aircraft at the present time. From 1961 onwards however Boeing 707, Comet 4 and DC - 8 jet-engined aircraft will be introduced by the major airlines and this will cause a greatly increased demand for turbine fuel.

The fuel requirements of the large international airlines are ordered on a basis similar to that of ships bunkers. That is to say, their anticipated annual requirements for refuelling in the Union are notified to the overseas associates of South African oil companies who, in turn, arrange for supplies to be made available at Johannesburg. In much the same way that the requirements of tramp shipping and other unscheduled visitors may cause unexpected demand for bunker fuels at ocean ports, so the arrival of charter 'planes or freight aircraft might also cause some unexpected demand for aviation fuels. However Johannesburg is a terminal city at the end of the African international air route and, as such, there are normally few unscheduled foreign aircraft to be fuelled. This means that normal annual demand can be assessed with a reasonable degree of accuracy, having regard to the number of aircraft in operation, their tankage capacities, and the frequency of flights.

ϕ June 1958 - Data taken from published flight schedules.

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T A B L E 57 - SOUTH AFRICAN AIRWAYS PASSENGER TRAFFIC 1951-1956.

YEAR.	INTERNAL (1)	%	REGIONAL (2)	%	OVERSEAS (3)	%	TOTAL (4)
1951-52	133,935	79.8	18,630	11.1	15,301	9.1	167,866
1952-53	154,096	82.9	18,252	9.8	13,501	7.3	185,849
1953-54	170,630	80.9	20,602	9.8	19,644	9.3	210,876
1954-55	176,344	80.2	17,875	8.1	25,601	11.7	219,820
1955-56	201,390	81.7	18,433	7.5	26,533	10.8	246,356
Average Annual Rate of Increase	10.74%		-		14.75%		10.07%

(Ref.38, Page 30)

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The fourth category of consumers of aviation fuels consists of South African unscheduled airline operators (both passenger and freight) and a small but growing group of owners of private light aircraft. Amongst the unscheduled airlines are such companies as Trek Airways (Johannesburg) who operate four Skymasters. Many light aircraft are operated by mining companies, by farmers, by businessmen, by flying clubs and by private charter companies throughout the Union. Almost without exception the fuel used by aircraft in this fourth category is gasoline, but the total demand of this group is relatively small in relation to the large volumes of fuel consumed by scheduled airlines operating within, or to and from the Union.

The growth in demand for aviation fuels can to some extent be gauged from the growth in passenger traffic. Figures for all airlines are not available but Table 57, which reflects the position of South African Airways, provides a good illustration for the five year period 1951 - 1956. It will be noticed that about 80% of the total passenger traffic of South African Airways is carried on internal air routes, and that the number of such passengers is increasing by an average of 10.74% per annum. Overseas passenger traffic is increasing still more rapidly, at about 14.75% per annum. These are significant figures and if the same rate of increase is maintained during the next ten years it will require more than double the present number of flights to carry the extra traffic. Irrespective of whether this situation is met by more intensive use of the existing fleet or whether additional aircraft are purchased to provide extra seating accommodation, the end result insofar as the total demand for aviation fuels is concerned is an undoubted and substantial annual increase. However, as will be shown later, the expected rapid increase in demand for turbine fuels can mask periods during which the actual demand for aviation gasoline is showing an annual decrease.

Table 33 (Page 153) shows the pattern of demand for aviation gasoline and turbine fuels during the post-war decade and Figures 19 and 20 show the trend of such demand. It will be noticed that during this period the consumption of aviation gasoline showed a steady annual increase which averaged 8.13% per annum. However following the advent of jet and turbo-engined aircraft in the Union in the 1950's the increase in demand for aviation gasoline dropped to 6.98% per annum during the second half of the period. By 1956 consumption of turbine fuel had risen to about 14% of the total requirement of aviation fuels.

The estimated demand for aviation fuels during the period 1957-1965, based on present knowledge of the aircraft likely to be operating during that time, is reflected in Table 58. Consumption trend patterns for both fuels are shown in Figures 19 and 20, and the following comments on future estimates are generally applicable to the Table and the two diagrams:-

a) The anticipated decrease in demand for aviation gasoline from 1958 to 1961 (Figure 19) is due to the introduction of turbine engined Viscount aircraft by South African Airways on the internal services (late 1958). There is a related increase in demand for turbine fuel, shown in Figure 20, but it should be borne in mind that turbine

TABLE 58

ESTIMATED CONSUMPTION OF AVIATION GASOLINE AND TURBINE FUELS 1957-1966 x

(Thousands of Long Tons)

YEAR	AVIATION GASOLINE (1)	AVIATION TURBINE FUEL (2)	TOTAL AVIATION FUELS. (3)
1957	31.6	8.1	39.7
1958	30.2	12.0	42.2
1959	20.8	26.5	47.3
1960	20.4	27.9	48.3
1961	19.1	33.9	53.0
1962	19.8	35.6	55.4
1963	20.5	37.4	57.9
1964	21.3	39.4	60.7
1965	22.2	41.4	63.6
1966	23.0	43.4	66.4

(x Union and South West Africa)

(Compiled from information supplied by The Shell Company of South Africa Limited)

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TABLE 58

ESTIMATED CONSUMPTION OF AVIATION GASOLINE AND TURBINE FUELS 1957-1966 x

(Thousands of Long Tons)

YEAR	AVIATION GASOLINE (1)	AVIATION TURBINE FUEL (2)	TOTAL AVIATION FUELS. (3)
1957	31.6	8.1	39.7
1958	30.2	12.0	42.2
1959	20.8	26.5	47.3
1960	20.4	27.9	48.3
1961	19.1	33.9	53.0
1962	19.8	35.6	55.4
1963	20.5	37.4	57.9
1964	21.3	39.4	60.7
1965	22.2	41.4	63.6
1966	23.0	43.4	66.4

(x Union and South West Africa)

(Compiled from information supplied by The Shell Company of South Africa Limited)

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FIG. 19 AVIATION GASOLINE

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	14.7	-	-
1948	18.4	3.7	25.2
1949	20.7	2.3	12.5
1950	22.3	1.6	7.7
1951	21.2	-1.1	- 4.9
1952	22.1	.9	4.2
1953	23.3	1.2	5.4
1954	25.4	2.1	9.0
1955	26.1	.7	2.8
1956	29.7	3.6	13.8

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	31.6	1.9	6.4
1958	30.2	-1.4	- 4.4
1959	20.8	-9.4	-31.1
1960	20.4	- .4	- 2.0
1961	19.1	-1.3	- 6.4
1962	19.8	.7	3.7
1963	20.5	.7	3.5
1964	21.3	.8	3.9
1965	22.2	.9	4.2
1966	23.0	.8	3.6

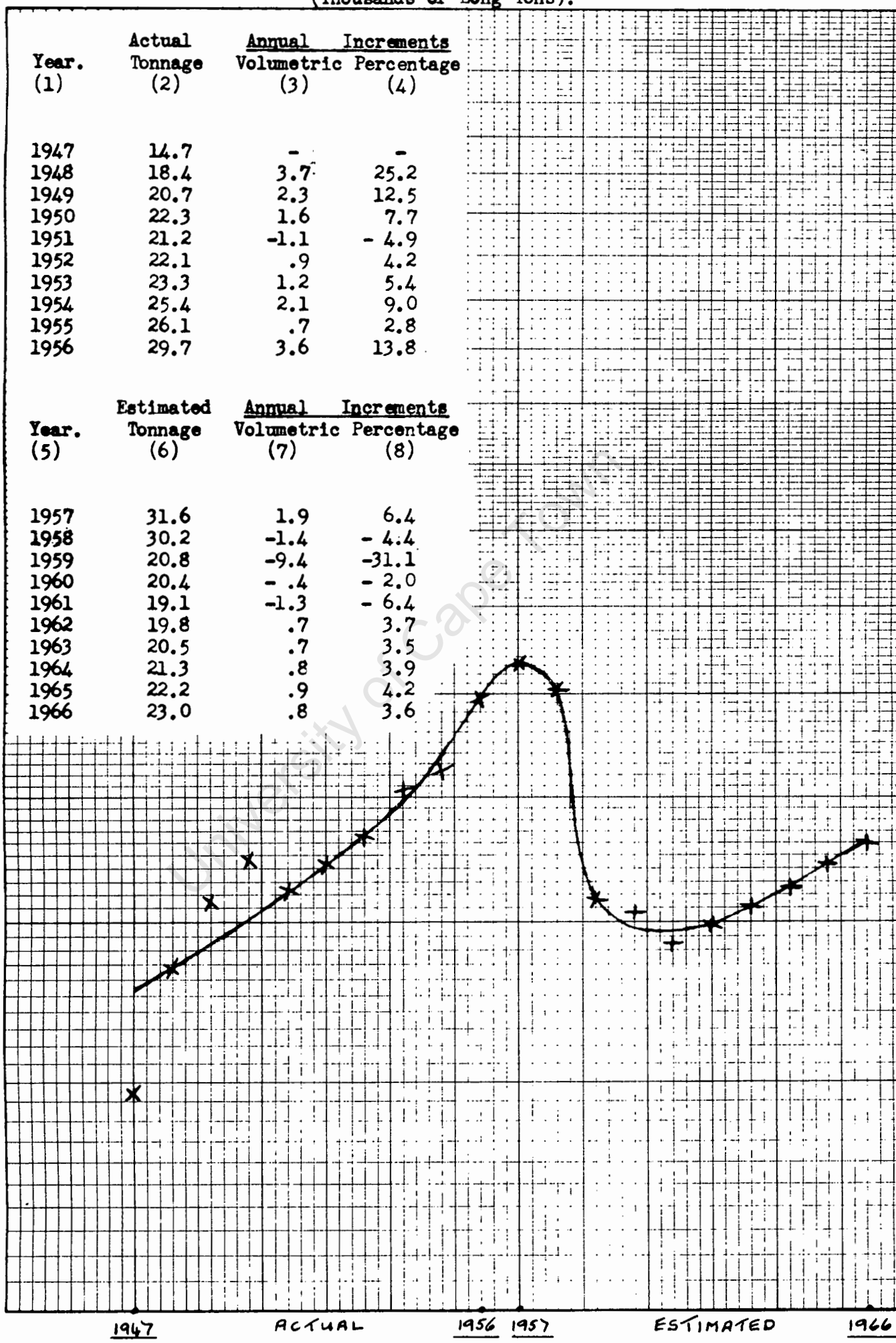

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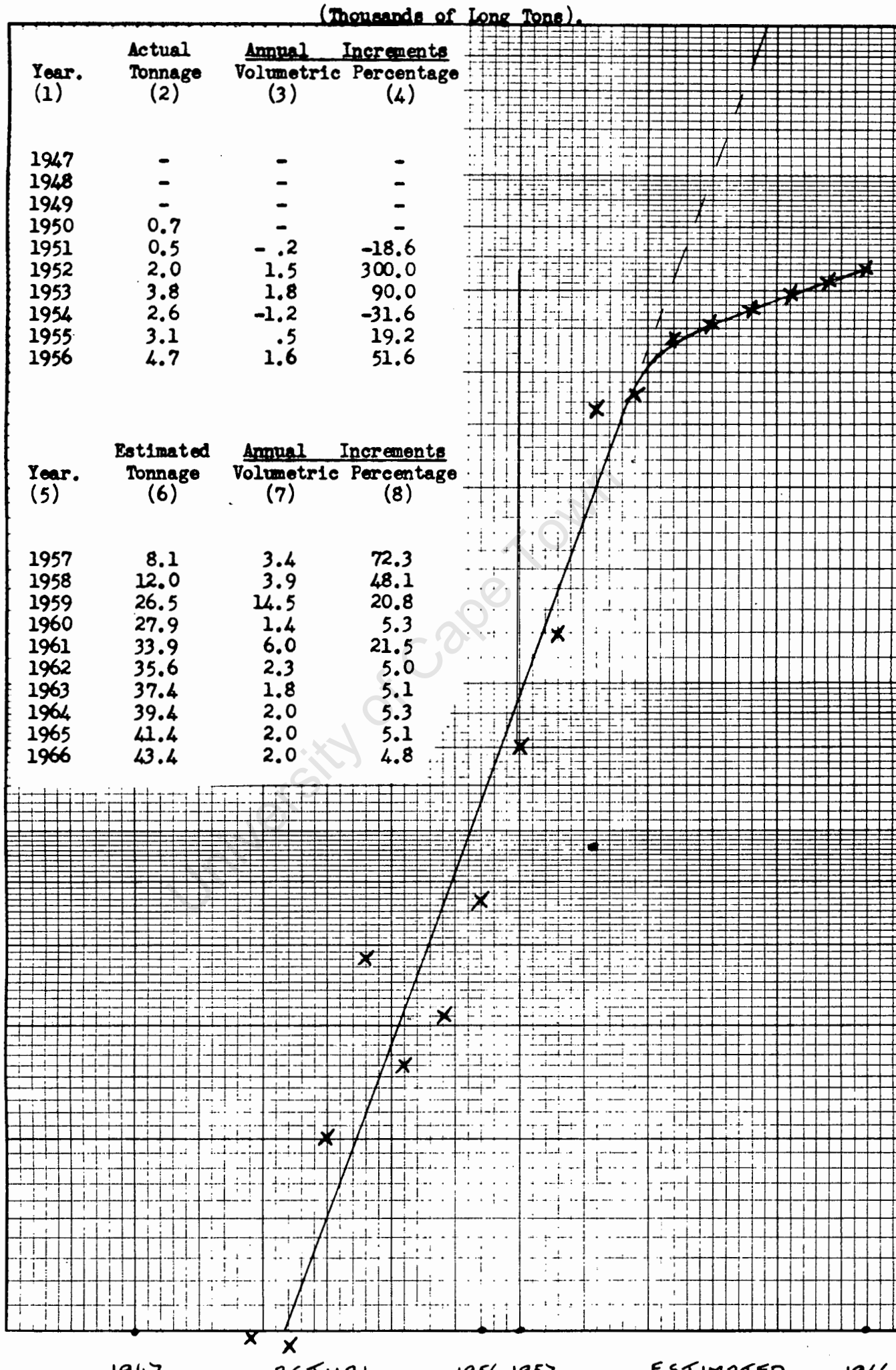
FIG. 20 AVIATION TURBINE FUEL

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	-	-	-
1948	-	-	-
1949	-	-	-
1950	0.7	-	-
1951	0.5	- .2	-18.6
1952	2.0	1.5	300.0
1953	3.8	1.8	90.0
1954	2.6	-1.2	-31.6
1955	3.1	.5	19.2
1956	4.7	1.6	51.6

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	8.1	3.4	72.3
1958	12.0	3.9	48.1
1959	26.5	14.5	20.8
1960	27.9	1.4	5.3
1961	33.9	6.0	21.5
1962	35.6	2.3	5.0
1963	37.4	1.8	5.1
1964	39.4	2.0	5.3
1965	41.4	2.0	5.1
1966	43.4	2.0	4.8



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engines consume roughly 3 gallons of fuel to every one gallon of gasoline previously required. The 1958 estimate for turbine fuel is further increased by the anticipated needs of an additional weekly Brittania service to London by B.O.A.C. (See Table 58).

b) The 1959 consumption figures for turbine fuel reflect considerable increased demand from South African Airways following the introduction of Viscount aircraft on their internal services, and also a planned extension of Viscount operations to Bulawayo. The demand for aviation gasoline in the same year is considerably reduced as it is expected that some of the older petrol-driven aircraft of S.A.A. will be removed from service, after the introduction of the Viscounts, and will probably be sold as soon as an opportunity occurs to dispose of them on favourable terms. Pending such disposal these aircraft may operate on charter, freight, or "tourist" flights.

c) Little change is expected in the demand pattern of overseas airlines until 1961, when a number of these, in common with South African Airways, will be introducing jet airliners on their service to Europe. The anticipated 1961 demand for turbine fuel reflects this change-over. (Figure 20). Thereafter the pattern of demand for turbine fuel should show a more gradual rate of increase of about 5% per annum, due to the more intensive use of existing aircraft rather than the introduction of further new models.

d) From 1961/62 onwards the demand for aviation gasoline should also begin to rise again on a gradual basis as the DC-7B's of South African Airways are transferred to internal and regional services, after being relieved on the overseas routes by Boeing 707 jet aircraft. The DC-7B's will then be taking nearly all their gasoline in the Union, instead of only the first tankfull as for present international flights. (Figure 19).

e) The estimates of future consumption shown in Table 58 and illustrated in Figures 19 and 20 have been based on short term contract information supplied by the Shell Company. These estimates cover the needs of the S.A.A.F. and commercial airlines up to and including 1961. The estimates for the period 1962 to 1966 have been based upon present expectations in regard to the composition of South African Airways fleet of aircraft and the announced intentions of other operators in regard to the introduction of jet aircraft. However any change in these expectations or alterations in flight frequencies

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could have an effect on the estimates. In general they are more likely to prove conservative than over-optimistic.

During the ten year period 1957-1966 therefore, the demand pattern for aviation fuels is expected to undergo a radical change. From a 1957 ratio of almost 4 to 1 in favour of gasoline, the pattern is expected to change to about 2 to 1 in favour of turbine fuel by 1966. In due course, when all the petrol engined aircraft have served their time and been replaced by more modern machines, it is probable that about 90% of demand will be for turbine fuels. This figure may even reach 100% if a suitable turbine engine is developed for light aircraft. However such speculation is of a long-term nature and, for present purposes, Table 58 gives the anticipated pattern of demand for aviation fuels in the Union during the next decade.

6. POWER KEROSENE

This product which is sometimes known as power paraffin or vaporising oil is essentially a fuel for tractors and, as such, it did not come into commercial prominence in South Africa until the growth of mechanised agriculture in the 1930's. Kerosene is a middle distillate fuel and power kerosene has an octane number of about 50, in comparison to the 80/90 rating of modern petrol. Power Kerosene costs less to produce than petrol and in South Africa it is not subject to Customs or Excise duty. This means that it can normally be sold at a much lower price than petrol.

x The earliest records of number of tractors licensed show that in 1937 there were 650 such vehicles. By 1941 the number had reached nearly 3,000 (Table 35, Page 156) but it was not until 1949 that records were available showing the number of tractors licensed by type of fuel used. Table 49 (Page 188) shows that in 1949, 67.4% of tractors licensed were fuelled by power kerosene. In 1952 and 1953 this type of tractor constituted 76.4% of all tractors licensed but, although the actual numbers have continued to increase in succeeding years, the percentage share of the tractor market enjoyed by power kerosene models has dropped in the face of increasing competition from diesels. In 1956 there were 76,238 power kerosene tractors licensed in the Union (Table 49) compared to about 29,000 petrol and diesel varieties. However, as mentioned in part 4 of this Chapter, there is a noticeable change in favour of diesel tractors taking place in consumers' preferences. Some of the underlying reasons for this change will be examined shortly when discussing the demand for power kerosene as a tractor fuel.

The demand for power kerosene in the Union of South Africa for the post-war decade is reflected in Table 31 (Page 150). It will be noticed that demand increased considerably each year until 1954, at which time it suddenly levelled-off and remained at about 90 million gallons for 1954, 1955 and 1956. The 1958 consumption figure of 89.2 million gallons continued this "plateau" in demand for power kerosene but, as the following figures show, the same four years also saw a rapid rise in the demand for automotive diesel oil.

x Bureau of Census and Statistics. Special Feature No. 2 of 1947.

[a] RELATIVE DEMAND STRENGTH FOR POWER KEROSENE AND AUTOMOTIVE DIESEL OIL

(Millions of Gallons)

	Power Kerosene	Annual Increase	Automotive Diesel Oil	Annual Increase
1947	32.4	-	19.0	-
1948	38.6	6.2	24.6	5.6
1949	49.0	10.4	33.1	8.5
1950	55.6	6.6	40.0	6.9
1951	70.1	14.5	47.7	7.7
1952	74.2	4.1	54.6	6.9
1953	84.0	9.8	63.4	8.8
1954	90.6	6.6	77.6	14.2
1955	89.4	-1.2	95.6	18.0
1956	90.7	1.3	116.3	20.7
1957	89.2	-1.5	130.5	14.2

It is interesting to note from the above tabulation and from Table 49 that during 1955/56, when the consumption of power kerosene had levelled-off at about 90 million gallons per annum, the number of power kerosene tractors licensed actually increased by some 28,000 (on 1954 figures). To some extent this increase [b] was due to changes in the licensing regulations which made it necessary to register farm tractors in the Cape (hitherto exempt) but it is considered that this also reflects a real decrease in the average number of gallons consumed per power kerosene tractor per annum.

Table 32 (Page 151) shows that demand in South West Africa, although small by Union standards, has continued to grow without reaching any "plateau". This is felt to be due to the lighter nature of farming operations in the territory (mostly "ranching") which do not call for intensive use of heavy duty tractors. The trend probably indicates a continuing future demand for lighter tractors of the power kerosene variety by South West African farmers. However, the total demand of the territory for power kerosene is relatively small and discussion on overall trends will be based mainly on Union consumption figures.

The official figures of annual nett imports are given in Table 59 and these correspond fairly closely with the official figures of total consumption given in Table 60. It is interesting to note from this latter Table that power kerosene consumption is showing a stationary trend in all four Provinces, thus indicating

[a] Taken from Table 31, with 1957 figures from Ref.67 (May 1958) Table H.1.
[b] Ref.69, Page vii.

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TABLE 59

UNION OF SOUTH AFRICA

POWER KEROSENE IMPORTS, 1946 - 1955.

(Thousands of Gallons)

YEAR	TOTAL IMPORTS	LESS RE-EXPORTS	NETT IMPORTS
1946	33,782	1,970	31,812
1947	32,291	2,247	30,044
1948	43,057	2,552	40,505
1949	55,134	3,868	51,266
1950	63,388	4,674	58,714
1951	72,439	1,895	70,544
1952	74,737	396	73,341
1953	84,582	71	84,511
1954	95,232	51	95,181
1955	89,951	15	89,936

(Ref. 64, Tables 1 and 10)

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T A B L E 60 POWER KEROSENE CONSUMPTION BY PROVINCES.

(1,000's of Imperial Gallons)

YEAR	CAPE	%	NATAL	%	O.F.S.	%	TVL.	%	UNION TOTAL
1950									55,979
1951			(Provincial figures not available)						70,528
1952									74,247
1953	18,660	22.32	6,520	7.80	26,301	31.45	32,136	38.43	83,617
1954	19,269	21.28	7,165	7.91	28,950	31.97	35,166	38.84	90,550
1955	19,169	21.46	7,017	7.86	28,921	32.37	34,227	38.31	89,334
1956	19,522	21.57	6,408	7.08	30,107	33.26	34,483	38.09	90,520

(Ref. 67, Table H.1)

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that the apparent swing towards diesel-engined tractors is a Union-wide phenomenon which is not confined to particular areas where, for example, there might be a strong local Dealer/Agent to influence sales.

An analysis of power kerosene consumption by various sectors of the economy is shown in Table 61. It will be noticed that in both 1951 and 1957 over 90% of demand was for agricultural purposes. The portion attributed to central and local Government was also mainly for use in tractors, whilst the small quantity given under item 4 was used for general industrial purposes and in such processes as the manufacture of insecticides.

In Table 62 an attempt has been made to project a possible pattern of future demand based on the number of power kerosene tractors in service in 1956, and the estimated numbers that will be in service in 1961 and 1966. The number of power kerosene tractors in service in the Union in 1956 was estimated to be 77,000, against the official figure of 76,178 such tractors licensed. For South West Africa however, the official figure of 17 was discounted entirely and an estimate of 1,100 was adopted, based on information from field representatives of the oil company concerned.

It will be noticed that insofar as Union consumption is concerned Table 62 postulates an average consumption of approximately 4 tons per tractor per annum in 1956 and succeeding years, but the total number of power kerosene tractors in service is expected to decline. On the other hand the evidence of Table 49 and Table 60 is that the number of power kerosene tractors is continuing to increase (albeit perhaps less rapidly than in earlier years) whilst sales of power kerosene fuel remain more or less constant. This indicates a declining average fuel consumption per tractor per annum. However, bearing in mind that about 80% of current tractor imports are diesel-engined models, it does seem probable that the number of power kerosene tractors in service may show a decline by 1961, but it is possible that Atlantic's estimates are a little severe and that 74,000 tractors in 1961 and 70,000 in 1966 might be more reasonable figures. There is no evidence that farmers are scrapping kerosene tractors in favour of diesel - on the contrary the available information indicates that diesel tractors purchased at the present time are mostly additional rather than replacement vehicles. Furthermore, the majority of post-war tractors are expected to have a useful life of about 15 years and, on this basis, replacement of large numbers is unlikely until about 1965 onwards.

In regard to South West Africa, Table 62 postulates a slow rise in the number of power kerosene tractors and an average fuel consumption of about 2.5 tons per tractor per annum. This is in accordance with the generally lighter duties carried out by agricultural tractors in that territory. The indications are that demand for power kerosene will continue to rise in South West Africa for a number of years, in contrast to the present static position in the Union. In the light of present knowledge

[6] Ref.69, Page 10
[7] Ref.66, Page 5

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TABLE 61

POWER KEROSENE - COMPARATIVE CONSUMER ANALYSIS

1951 and 1957.[x]

(1,000 Gallons)

		1951	%	1957	%
1.	Agriculture	64,629	91.6	81,626	90.3
2.	Government				
	Central	604	0.9	645	0.7
	Local	502	0.7	418	0.5
3.	Marine Use	165	0.2	61	-
4.	Miscellaneous	4,680	6.6	7,713	8.5
		70,580	100%	90,463	100%

(x Union and South West Africa)

(Compiled from estimates made by The Shell Company of South Africa Limited)

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TABLE 62 - ESTIMATES OF POWER KEROSENE CONSUMPTION 1956, 1961, 1966

(Thousands of Gallons and Tons of 2,240 lbs)

	1956			1961			1966		
	No.	Galls.	Tons	No.	Galls.	Tons	No.	Galls.	Tons
1. Union of South Africa:									
Tractors	77,000	88,000,000	319,800	71,800	79,200,000	287,900	64,700	71,330,000	259,400
Other Uses	-	2,680,000	9,750	-	2,700,000	9,800	-	2,700,000	9,800
	77,000	90,680,000	329,550	71,800	81,900,000	297,700	64,700	74,030,000	269,200
2. South West Africa:									
Tractors	1,100	745,000	2,700	1,400	965,000	3,510	1,700	1,178,000	4,280
Other Uses	-	15,000	50	-	25,000	90	-	32,000	120
	1,100	760,000	2,750	1,400	990,000	3,600	1,700	1,210,000	4,400
3. Union and South West Africa									
Tractors	78,100	88,745,000	322,500	73,200	80,165,000	291,410	66,400	72,508,000	263,680
Other Uses	-	2,695,000	9,800	-	2,725,000	9,890	-	2,732,000	9,920
	78,100	91,440,000	332,300	73,200	82,890,000	301,300	66,400	75,240,000	273,600
Percentage decrease on 1956 Figures			-			9.3			17.7

(Compiled from information supplied by Atlantic Refining Co. of Africa (Pty.) Ltd.)

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Atlantic's estimates do not seem unreasonable, particularly when it is remembered that in such relatively small volumes even a slight increase in tractor usage will have a correspondingly marked effect on product sales. Sooner or later however the South West African demand pattern for power kerosene should reach a "plateau" and follow the same future demand trend as in the Union.

To look further into the overall background of demand for power kerosene it is necessary to examine a number of facts and hypotheses dealing with the relationship between kerosene and diesel-powered tractors. Prior to the devaluation of sterling in 1949, most power kerosene and diesel tractors imported into the Union came from North America. In the popular ranges of 30/45 horse power tractors the diesel models were considerably more expensive than kerosene models, and this was one of the factors influencing farmers in their choice. Tables 49 and 50 (Pages 188 and 189) show clearly that up to 1953 the percentage of power kerosene tractors in the Union was increasing each year. These did not all come from North America, as after devaluation in 1949 British made tractors became relatively cheaper than American built models, but the emphasis was still on power kerosene as the main tractor fuel.

In 1954 certain American tractor companies began producing power kerosene and diesel-engined tractors in Britain. To meet this competition other British and Continental tractor manufacturers stepped-up production of their own models and, under the spur of intense competition, mass-production methods proved that a comparable diesel-engined tractor could be produced at only slightly higher cost than a kerosene model. Prior to 1954 diesel tractors had always cost considerably more than the equivalent kerosene models, but the new situation is reflected in the present relative South African costs of the popular 35/40 horse power models, as under:-

American diesel	about £1,800
American power kerosene.. ...	" £1,500
European diesel	" £1,200
European power kerosene.. ...	" £1,100

Bearing in mind that the main upsurge in demand for diesel tractors dates from about 1954 (See Table 49) one of the major factors influencing this sudden change must surely have been the changing relative prices of tractors. In other words, it is probable that if the price differential between European diesel and kerosene tractors was much larger (say £300) and the relative prices of diesel fuel and kerosene remained as at present, farmers would continue to buy kerosene tractors and would show no pronounced preference for diesel. This is admittedly hypothesis, but in the light of subsequent argument it may not seem unreasonable.

The present Union price structure for power kerosene and automotive diesel oil (which are the two main tractor fuels) shows a 6d. per gallon differential in favour of power kerosene when calculated on the coast price of a 44 gallon drum. On the same drum basis, the comparative prices of the two fuels at inland depots also show approximately 6d. per gallon differential in favour of power kerosene. This is not a true economic differential but one that exists because of Government control.

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Automotive diesel oil carries approximately 1.75 pence per gallon Customs/Excise duty and is free of price control. Power kerosene is free of all duties, but the selling price is controlled by the Government at such a low level as to make it hardly worth while for the oil companies to distribute the product. The position has been summarised by the General Manager of the Shell Company, in the following words:

> "During 1955 the Minister of Economic Affairs removed certain petroleum products from price control, as a result of which only petrol and power paraffin are still under Government price control. There is no justification for retaining this control as both products are in free supply and I am confident that inter-company competition would ensure that prices for all petroleum products found their proper level. In particular the pegging, under price control, of the power paraffin price becomes less reasonable every year with the development, which I referred to earlier, of gas oil as a tractor fuel in place of power paraffin. Naturally it is our desire to be permitted to market power paraffin at a realistic figure instead of continuing to lose approximately 2d. on every gallon we sell".

However, apart from the oil companies' pricing problems, the question that this issue brings to mind is why should a farmer buy a diesel tractor at a price higher than the equivalent kerosene model if, in addition, he has to pay some 6d. per gallon more for his diesel fuel. Furthermore, diesel engines have complicated fuel injection equipment whilst power kerosene tractor engines are similar in most respects to an ordinary car or truck engine. Hence farmers who live far away from garages and are accustomed to doing their own vehicle repairs usually find little trouble in maintaining a kerosene tractor. These facts pose questions which cannot easily be answered, but the following summary of other related matters helps to throw some light on the issue:-

a) Power Kerosene tractors have to be started on petrol and can only be switched to kerosene when thoroughly warm. A special type of carburettor is fitted in which engine heat is used to assist in vaporising the kerosene. There is no doubt that the need to have a certain amount of petrol available for starting purposes is a nuisance, particularly when the relative ease of starting a compression ignition engine is considered.

b) Diesel engines use precision-made fuel injection nozzles which can only be checked, cleaned and adjusted by trained mechanics using a special testing rig. However in practice, diesel-engined tractors give little trouble and mobile field service units have been established by distributors to ensure regular maintenance.

When used for farming purposes or for passenger transport.

"Report on 1955", (Page 12) issued by the Shell Company of South Africa Limited, Cape Town

c) Both types of tractor have a normal useful life of about 15 years. The diesel tractor, because of its better thermal efficiency, will give greater power at the drawbar and is probably more suitable for sustained heavy work. The kerosene tractor will perform lighter work more quickly and will probably cover a greater acreage per day than its diesel counterpart.

d) The extra cost of diesel fuel is offset to some extent by the better performance of diesel tractors in heavy duty operations, particularly where crawler-type tractors are concerned. In some farming operations a power kerosene tractor may consume up to double the quantity of fuel used by a comparable diesel tractor for the same amount of work.

The foregoing discussion on the respective merits of power kerosene and diesel tractors has been designed to illustrate one of the dilemmas facing present day fuel forecasters - what will be the future trend of demand for power kerosene? It has been shown that a diesel tractor can now be bought for very little more than an equivalent kerosene model - yet diesel fuel is more expensive than power kerosene. Even if the farmer provides his own tankage and receives diesel fuel in bulk, it will still cost him about 4½d. per gallon more than the controlled price of power kerosene. It has been shown that maintenance of a kerosene tractor is probably much easier and cheaper for the average farmer than maintenance of a diesel, yet in 1957 over 80% of tractors imported into the Union were diesel-engined. It has been shown that the number of power kerosene tractors continues to increase each year (Table 49) yet the consumption of power kerosene has been fairly constant at around 90 million gallons for the past four years. What deductions or assumptions can be made from this evidence, which would help to determine the future demand for power kerosene?

The problem of power kerosene demand has been studied very closely by oil company specialists, with particular reference to the distribution facilities needed for the product both now and in the future. Two schools of thought are evident, the one holding that there will be a rapid growth in demand for diesel tractors and a corresponding rapid fall in demand for power kerosene fuel. This pre-supposes that some of the existing kerosene tractors will be scrapped. The other school holds the view that the demand for power kerosene will remain fairly constant, or perhaps decline slightly over a number of years, whilst conceding that new tractors purchased will be mostly diesel-engined.

The second view-point is probably more accurate as, if the useful life of a kerosene tractor is taken to be 15 years, the majority of such tractors purchased in the post-war decade will not be scrapped until 1965-1970. Thus the numbers in service, plus the annual additions of such tractors, should maintain consumption of power kerosene at around the current 90 million gallons per annum figure for some years ahead. There is, however, one other trend in demand which may affect this supposition, and that concerns the previously noted tendency for the number of power

ϕ Ref. 66 Page 5.

TABLE 63

POWER KEROSENE - ESTIMATED CONSUMPTION 1957-1966[x]

(Thousands of Long Tons)

YEAR	AMOUNT	ANNUAL DECREASE
1957	328.3	-
1958	319.5	8.8
1959	313.3	6.2
1960	307.2	6.1
1961	301.3	5.9
1962	295.4	5.9
1963	289.8	5.6
1964	284.4	5.4
1965	279.0	5.4
1966	273.6	5.4

Annual Average Rate of Decrease: 2.0%

(x Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Limited.)

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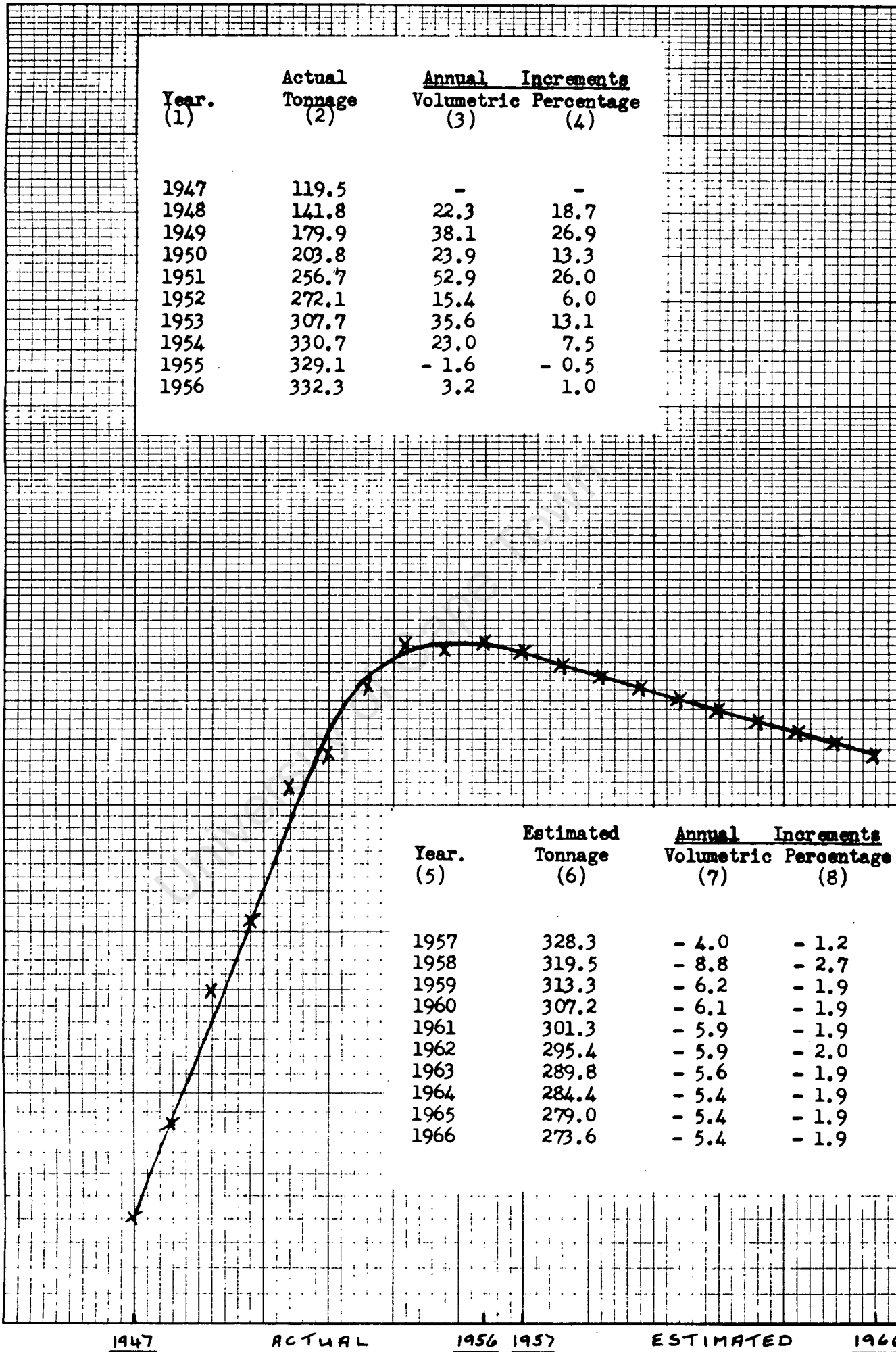
FIG. 21 POWER KEROSENE

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Annual Increments Percentage (4)
1947	119.5	-	-
1948	141.8	22.3	18.7
1949	179.9	38.1	26.9
1950	203.8	23.9	13.3
1951	256.7	52.9	26.0
1952	272.1	15.4	6.0
1953	307.7	35.6	13.1
1954	330.7	23.0	7.5
1955	329.1	- 1.6	- 0.5
1956	332.3	3.2	1.0



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Annual Increments Percentage (8)
1957	328.3	- 4.0	- 1.2
1958	319.5	- 8.8	- 2.7
1959	313.3	- 6.2	- 1.9
1960	307.2	- 6.1	- 1.9
1961	301.3	- 5.9	- 1.9
1962	295.4	- 5.9	- 2.0
1963	289.8	- 5.6	- 1.9
1964	284.4	- 5.4	- 1.9
1965	279.0	- 5.4	- 1.9
1966	273.6	- 5.4	- 1.9

kerosene tractors to increase each year, whilst the demand for fuel remains fairly static. This implies a decrease in average consumption per tractor per annum and it is possible that this trend indicates a tendency on the part of farmers to keep power kerosene tractors for lighter work, and to purchase diesel-engined tractors for heavy duties. The present relative prices of popular European models would most probably encourage such a move, particularly bearing in mind the admitted superiority of diesel tractors for sustained heavy duty operations, and the cheaper fuel costs of power kerosene tractors for normal run-of-the-farm work. There is also good reason to believe that a number of farmers keep their power kerosene tractors in reserve to expedite ploughing and planting after the rains, and to assist the heavier diesel tractors, when necessary, during cultivation and harvest. Field reports from oil company representatives indicate that this may be happening to some extent on the larger farms, but at the same time these reports emphasise that where a farmer has only one tractor, it is usually a power kerosene model.

In summary therefore, it seems unlikely that there will be any sudden diminution of demand for power kerosene in the near future, but there is likely to be a slight annual fall as power kerosene tractors are transferred to less intensive usage on farms where diesels take over the heavy work. With this in mind, Table 63 has been compiled showing an anticipated decrease in demand of about 2.0% per annum during the next ten years. Thereafter it is possible that demand may fall more steeply, as considerable numbers of power kerosene tractors will be due for replacement. The ultimate choice of replacement model is, however, largely a matter of cost and, if the price of diesel tractors should rise relative to kerosene models, or if the price of diesel fuel should be raised considerably (e.g. by taxation) there is always the possibility of farmers again turning to power kerosene as their main tractor fuel. Conversely, if price control is removed from power kerosene the free market price of this product would probably be more-or-less the same as automotive diesel oil and the issue would then hinge mainly on the relative prices of the different tractors, with the trend remaining in favour of diesel-engined models as long as the capital cost differential remained small.

The consumption trend for power kerosene during the period 1947-1966 is illustrated in Figure 21. It will be noticed that actual consumption figures during the first decade (taken from Table 33) lie close to the trend line. The sudden levelling-off in demand during 1955-56 can also clearly be seen. The estimates for the second decade are those of Table 63 which postulates a gradual decrease averaging about 2% per annum. The figure of two per cent was adopted after much discussion with oil company experts as to the probable rate of decline in power kerosene consumption and is in line with the views expressed in the foregoing pages regarding the future role of power kerosene tractors in agriculture.

7. ILLUMINATING KEROSENE

Illuminating Kerosene, more commonly known as "paraffin" is widely used as a domestic fuel throughout the Union and South West Africa. Table 31 (Page 150) shows that in 1956 nearly 50,000,000 gallons of this product were sold in the Union and Table 32 (Page 151)

shows over 1,000,000 gallons used in South West Africa during the same year. It will be noticed that in each territory demand has increased steadily during the post-war decade, there being an average annual rate of increase of about 6.0% in the Union and about 8.0% in South West Africa.

Paraffin imports for the years 1946 to 1955 are detailed in Table 64, while Table 65 gives the Bureau of Census and Statistics figures for consumption. A comparison of these two tables shows a fair degree of correspondence between imports and consumption for the years 1950-1953, but in 1954 the Wentworth Refinery came "on stream" and thereafter part of the total demand was satisfied from this source, resulting in a relative drop in import figures. It is significant that although consumption in the Union increased 25% during the period 1952-1956 (Table 65) imports did not vary to any great extent, the increased consumption being met from stocks on hand and by production from Wentworth. It is probable that from 1957 onwards the figures of illuminating kerosene imports will again resume an upward trend indicating that the Wentworth production has been fully absorbed by the rising market demand.

A comparison between published statistics of population and the provincial consumption figures shown in Table 65 does not reveal any noticeable direct relationship. The relevant population estimates for 1955, for example, are as follows:-

Cape	all races ...	4,727,000 (34%)
Natal	" " ...	2,571,000 (19%)
Transvaal ...	" " ...	5,242,000 (38%)
Orange Free State	" " ...	1,129,000 (9%)

These figures show that the Cape has 34% of the Union's population and the Transvaal 38% but, according to Table 65, the Cape consumed 40.73% of illuminating kerosene sold in 1955 and the Transvaal, with its greater population, only 31.31%. One of the possible reasons for this is that the Cape has a larger proportion of the population living in rural areas, as evidenced by the following figures taken from the 1951 Census:-

	Population	
	Urban	Rural
Cape	1,765,319	2,661,407
Transvaal	2,492,675	2,320,163
Natal	771,132	1,633,186
Orange Free State ...	367,132	649,052

On the other hand the difference in numbers between the rural populations of the Cape and Transvaal hardly seems, by itself, to be sufficient reason for the difference in consumption figures illustrated in Table 65. Furthermore Natal, which has more than double the rural population of the Orange Free State, did not consume double the quantity of paraffin. The Transvaal has a preponderance of both white and non-white population, with the Cape a close second,

Ref.24, Page 680
Ref.70, Page 717
Ref.24, Page 684

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TABLE 64

UNION OF SOUTH AFRICA.

ILLUMINATING KEROSENE IMPORTS. 1946 - 1955.

(Thousands of Gallons)

YEAR	TOTAL IMPORTS	LESS RE-EXPORTS	NETT IMPORTS
1946	27,883	247	27,636
1947	31,450	568	30,882
1948	30,355	600	29,755
1949	38,763	2,045	36,718
1950	36,502	1,316	35,186
1951	41,793	1,106	40,687
1952	43,991	2,125	41,866
1953	42,096	1,290	40,806
1954	43,320	1,367	41,953
1955	41,075	582	40,493

(Ref.64, Tables 1 and 10)

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TABLE 65 - ILLUMINATING KEROSENE CONSUMPTION BY PROVINCES

(1,000's of Imperial Gallons)

YEAR	CAPE	%	NATAL	%	O.F.S.	%	TVL.	%	UNION TOTAL
1950									36,478
1951			(Provincial figures not available)						38,315
1952									38,997
1953	17,150	41.52	6,757	16.36	4,220	10.22	13,177	31.90	41,304
1954	18,328	41.01	7,463	16.70	4,932	11.03	13,969	31.26	44,692
1955	19,405	40.73	7,947	16.68	5,376	11.28	14,915	31.31	47,643
1956	19,831	39.99	8,477	17.09	5,780	11.66	15,499	31.26	49,587

(Ref. 67, Table H.1)

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but Table 65 reflects a declining percentage of the illuminating kerosene market for these two provinces and a rising percentage for Natal and the Orange Free State, where the population is much smaller. It would seem from these figures that, whilst population must certainly have a bearing on the consumption of illuminating kerosene, there are other factors in the Union which play an important role in affecting consumers preferences.

One such influencing factor is the size of the potential domestic market for illuminating kerosene, which is by no means as large as the total population figure might imply. For example, a large portion of the Union's native population is still living in a primitive fashion and mainly dependent on wood or dried dung as domestic fuel. At the other extreme a smaller proportion of the population uses electricity, gas and coal as sources of domestic light and heat. Between these extremes there are many thousands of the poorer classes (mostly urban natives) who are beginning to use paraffin as a domestic fuel instead of wood, and those others with a greater purchasing power who are using partly paraffin and partly other forms of energy (such as electricity) for domestic purposes.

In general it can be said that the very poor and the well-to-do sections of the urban population are not consumers of illuminating kerosene - the former because they can ot afford it and the latter because they prefer the convenience of other forms of energy. The problem is to define the numerical and regional distribution of the groups that can afford paraffin and to study their pattern of demand but, unfortunately, there are no statistics of any kind which would facilitate such an investigation.

Oil company research specialists are aware of the fact that the gradual improvement of the standard of living of non-whites is an important factor in the growth of demand for paraffin. They point out that sales of the product to Coloured people in the Cape, to Indians in Natal and to natives in urban locations all over the Union are increasing rapidly, but again no facts and figures are available to determine the demand pattern for paraffin for these groups in these areas. There is general agreement with the view that the domestic use of illuminating kerosene marks an intermediate stage in the economic development of the people, between the primitive stage of burning wood or dung and the more advanced stage of using gas or electricity. This opinion is based upon economic considerations involving especially the real wages and standards of living of the peoples concerned. For example, natives living under tribal conditions have little money and a relatively low standard of living. Their principal domestic fuel consists of locally gathered brushwood. Natives living in urban locations probably have more money but their earnings are usually so meagre that after providing for food and shelter they have a minimum of cash to spend on lighting and heating. Their urban existance precludes large scale foraging for wood and they therefore have to choose between paraffin, coal and electricity as forms of domestic fuel.

It has been found in practice that native purchasing habits are usually limited to a maximum of sixpenny quantities
ϕ of fuel at a time. Sixpence will purchase 20 lbs of coal in

ϕ G.N. 1070 d.d. 25.7.58.

the Transvaal and Orange Free State areas, or 15 lbs. of coal in coastal districts. This could be burnt in the open or in a brazier for cooking and heating purposes, but coal is not much use as a source of illumination. Furthermore coal is wasteful in domestic usage as the rate of burning cannot be finely controlled. A bottle of paraffin costs between 3d. and 6d. in most areas of the Union and this fuel can be used for lighting, heating and cooking. Paraffin lamps can be purchased at prices ranging from about 2/6d. upwards. A small boiling stove with separate oven costs about £6, and a small room heater about £3. These items are portable and they allow for a fine degree of heat control with a minimum of fuel wastage. Sixpence will also purchase a small amount of electricity, the number of units varying considerably from one urban area to another. However before electricity can be used the house must be wired and connected to the main supply. This can cost anything from £50 (for an average two-roomed house) upwards, without taking into account such things as the cost of electric stoves and heaters.

The above review shows that coal is the cheapest form of energy available to the urban native but because of heat wastage in use the amount of useful energy derived from six-pennyworth of coal is probably less than that obtained from six-pennyworth of paraffin. The capital cost of lamps and stoves required for paraffin burning is, however, much lower than the capital cost of wiring and equipment needed to use electricity. Most urbanised natives therefore pass from a "wood economy" to a "paraffin economy" insofar as their domestic energy requirements are concerned, for the reason that the latter fuel gives them greater satisfaction. It can be purchased in small quantities at a cost which suits their purchasing habits, it is portable, the amount of heat can be finely controlled in lamps and stoves and, in general, it is efficient for both lighting and heating.

This theme can be developed further by an examination of the domestic energy requirements of the relatively better off Indians and Coloured people who proceed to use electricity for lighting purposes as soon as they can afford to rent a house which is provided with electric wiring, whilst still retaining paraffin for cooking and heating purposes. The final transition comes with the use of gas or electric cookers, water heaters, fires and other equipment, when the standard of living passes from the "paraffin economy" into the "electric economy" as the family income rises and standards of living improve.

If the above hypothesis is correct it would seem that the market for illuminating kerosene in South Africa is governed mainly by the level of economic activity and that the following factors require careful study:-

1. The rate of economic growth in the Union.

2. The growing purchasing power which this economic growth produces and its distribution amongst the various sectors of the population.

3. The effect of increasing purchasing power within different income groups and in different environments on the demand for kerosene for lighting, cooking and heating.

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TABLE 66

ILLUMINATING KEROSENE - END USE ESTIMATES 1955

(1,000 gallons)

	USE	UNION ONLY	%	UNION and S.W.A.
1.	Cooking	23,260	48.82	23,775
2.	Lighting	18,605	39.05	19,017
3.	Space Heating	1,167	2.45	1,193
4.	Refrigeration	2,325	4.88	2,377
5.	Incubators and Brooders	967	2.03	989
6.	Solvents and Diluents	500	1.05	511
7.	Insecticides	262	0.55	268
8.	Miscellaneous	557	1.17	570
	Total all Uses:	47,643	100%	48,700

(Compiled from percentage estimates made by Caltex (Africa) Ltd.)

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A detailed market survey carried out by Caltex (Africa) Limited shows that in 1955 over 90% of the total sales of illuminating kerosene were for lighting, cooking and heating purposes with the greater proportion for cooking. (Table 66). This has some relevance to provincial consumption as, in its domestic applications, the product is in competition with other fuels - notably electricity and coal. In the Transvaal about half of the population lives in urban areas well served by electricity. Furthermore coal is relatively cheap in that province as compared to other provinces. These facts are largely responsible for the lower average per-capita paraffin consumption figures in the Transvaal as compared to other provinces.

In the Cape the population distribution is about 3/5ths rural to 2/5ths urban. Coal is expensive as it has to be brought by rail from the Transvaal and, outside the major cities, electricity (where it is available) is also an expensive item. One reason for the Cape's greater consumption of illuminating kerosene is therefore to be found in the higher relative cost and/or non-availability of alternative fuels for cooking and lighting. Another factor to be considered is the personal preferences of different categories of consumers. Platteland farmers for example may be remote from electricity, but probably prefer kerosene to coal for domestic purposes because of the convenience and cleanliness of the former product. (Coal cannot in any case be used for lighting purposes).

The whole topic of kerosene consumption needs careful study on a regional basis because there are good grounds for believing that the slowly improving standard of living of the non-white population of South Africa is presenting a large potential market for the product, the size and scope of which is as yet undetermined. The potentialities of this market can become obscured if the domestic energy consumption of urban whites is not separated from the picture, because most of this latter group have attained a standard of living which lifts them out of the "paraffin economy" stage. On the other hand it would be useful to study the position of those persons still living in a "wood fuel economy" with a view to determining when they are likely to joint the ranks of the growing numbers in the "paraffin economy" stage and the effect that this may have on the pattern of future demand. However no facts and figures are available at present which would help to throw further light on the topic and a socio-economic research project of this magnitude would require the assistance of investigators all over the Union. The oil companies are hoping to improve their statistical knowledge of the illuminating kerosene market in the near future and this should help to throw some much needed light on the pattern of consumer demand for this product.

Tables 66 and 67 give all statistical information that is presently available regarding the end uses of illuminating kerosene. The first three items of Table 66 and some (unknown) portion of item four are probably all domestic consumption, the balance of the Table representing the industrial use of the product.

ϕ For this reason "per capita" consumption figures can very easily be misleading unless they are restricted to that part of the population which comprises the normal market for illuminating kerosene. To use the whole population would be as misleading as to calculate fertility rates on the basis of total number of females, including old women and young children.

TABLE 67

ILLUMINATING KEROSENE - COMPARATIVE CONSUMER ANALYSIS

1951 and 1957 [x]

(1,000 gallons)

		1951	%	1957	%
1.	Resellers	29,295	75.7	39,829	76.4
2.	Agriculture	3,617	9.4	4,656	8.9
3.	Mining	396	1.0	527	1.0
4.	Railways	663	1.7	807	1.6
5.	Government				
	Central	569	1.4	917	1.7
	Local	318	0.8	287	0.6
6.	Fishing and Marine	2	-	112	0.2
7.	Miscellaneous	3,830	10.0	5,002	9.6
		38,690	100%	52,137	100%

(x Union and South West Africa)

(Compiled from estimates made by The Shell Company of South Africa Limited)

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There is no present method of determining the share of domestic consumption that can be attributed to the relatively small number of white consumers in the Union or to the potentially large number of non-white consumers. The requirements of the former may be static or even declining each year, whilst the total demand of the latter group might be rising strongly. Illuminating kerosene may perhaps be the one petroleum fuel which is today in greater demand by the poorer section of the population than by the richer, but this surmise cannot be substantiated by facts and figures.

In Table 67 the 1951 and 1957 consumption is sub-divided between the main economic sectors. It will be noticed that over 75% of sales were made through retailers and it is believed (but again cannot be proved) that most of this business was to urban non-white consumers. The 9% (or thereabouts) sold to "agriculture" probably represents the bulk purchases of farmers living in outlying areas. It is perhaps significant that consumption under item (1) shows only a small percentage increase as between 1951 and 1957 and, if this is taken to mean that the potentially large non-white share of market demand for kerosene is increasing, the effect is certainly very gradual and would seem to indicate a slow long-term rate of growth rather than any sudden upward surge.

In calculating the likely pattern of demand for the next ten year period allowance was made for the facts and hypotheses discussed in the preceding paragraphs. A major problem was to assess the strength and direction of demand emanating from the growing numbers of urbanised natives, but it proved impossible to arrive at any factual conclusions. Oil company statisticians pointed out that the urbanisation process had been proceeding for a number of years but that the government was now attempting to halt the flow of natives to urban areas. It was therefore unlikely that the paraffin consuming section of the native population would show any upward surge but rather that the slow growth trend of the past years would continue for the next decade. The view was also expressed that the future consumption trend in total demand for illuminating kerosene was tending towards a "straight line" basis rather than a parabolic curve. This would indicate a move towards fairly constant average annual increments in sales rather than a fixed cumulative percentage increase. A study of past annual consumption figures made by Atlantic indicated that although year-by-year demand figures showed a slight deviation above and below the trend line, there was considerable evidence that the cyclical deviations were decreasing and that the trend was towards a reasonably constant annual increase in demand on a quantitative basis. Table 68 was accordingly constructed as an estimate of future demand based on the assumption that there will be little change in the average pattern of consumers preferences during the ten year period 1957 to 1966. The small variations in annual increment shown in this Table are caused by anticipated decreasing cyclical movements of demand above and below the trend line. These movements follow the previously established short-term patterns, the reasons for which have not yet been fully determined due to the lack of detailed knowledge of the illuminating kerosene market.

[4] It is a commonplace of economic analysis to find changes in demand occuring with rising incomes. Thus butter may be substituted for margarine or, to take the example of energy, paraffin may be preferred to wood fuel, and gas or electricity may be "more preferred than paraffin as income rises (See Ref.51, Page 71)

[5] Not available for publication. Atlantic's studies of market demand cover a 30 year period and show an earlier 8-10 year short term cycle within the general trend. The movement is however, of small amplitude and is decreasing.

TABLE 68

ESTIMATED CONSUMPTION OF ILLUMINATING KEROSENE

1957 - 1966 x

(Thousands of Long Tons)

YEAR	AMOUNT	ANNUAL INCREMENT
1957	183.0	-
1958	193.0	10.0
1959	201.4	8.4
1960	209.4	8.0
1961	217.7	8.3
1962	226.0	8.3
1963	234.7	8.7
1964	243.7	9.0
1965	253.2	9.5
1966	262.4	9.2
Percentage increase 1966 over 1957	43.4	

(x Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Limited)

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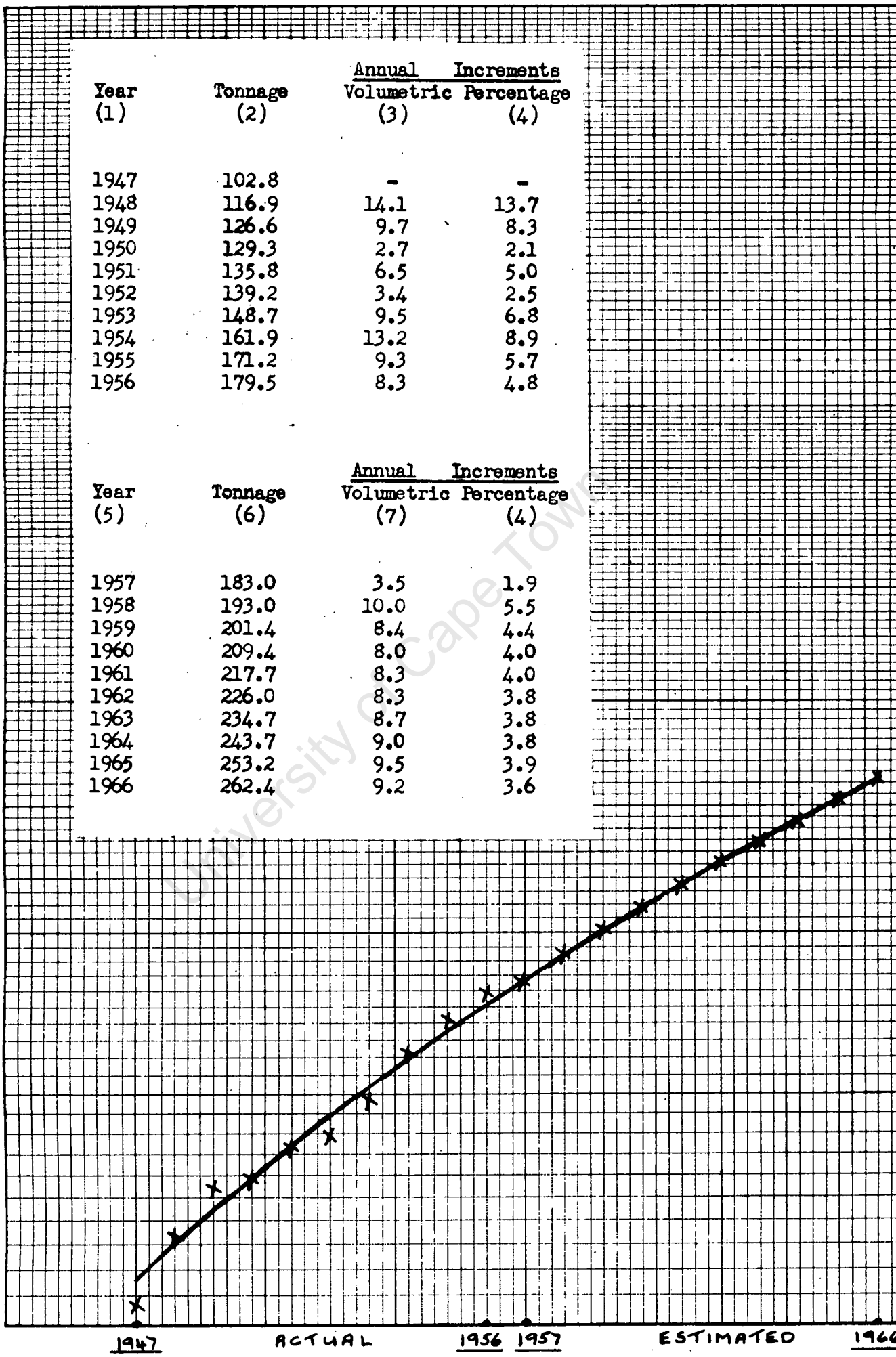
FIG. 22 ILLUMINATING KEROSENE CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year (1)	Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	102.8	-	-
1948	116.9	14.1	13.7
1949	126.6	9.7	8.3
1950	129.3	2.7	2.1
1951	135.8	6.5	5.0
1952	139.2	3.4	2.5
1953	148.7	9.5	6.8
1954	161.9	13.2	8.9
1955	171.2	9.3	5.7
1956	179.5	8.3	4.8

Year (5)	Tonnage (6)	Annual Increments Volumetric (7)	Percentage (4)
1957	183.0	3.5	1.9
1958	193.0	10.0	5.5
1959	201.4	8.4	4.4
1960	209.4	8.0	4.0
1961	217.7	8.3	4.0
1962	226.0	8.3	3.8
1963	234.7	8.7	3.8
1964	243.7	9.0	3.8
1965	253.2	9.5	3.9
1966	262.4	9.2	3.6



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The foregoing discussion is illustrated graphically, as a semi-logarithmic trend diagram, in Figure 22. The actual consumption figures for the ten year period 1947 - 1956 show how the cyclical variations are decreasing in severity. The slight movements anticipated during the second decade (Table 68) do not show up clearly in the diagram but it is noticeable that the trend curve of the second decade is much more shallow than that of the first ten year period. This bears out the expectation that the trend curve for illuminating kerosene is moving towards a straight line.

8. MOTOR GASOLINE

Motor Gasoline is the accepted industry term for petrol and is so called to distinguish it from aviation gasoline and similar high octane fuels. Petrol is the most important petroleum fuel sold in the Union, accounting for about 60% of the total volume of such products. Table 31 (Page 150) which gives this information also shows how demand has risen steadily during the post-war decade from 234.9 million gallons in 1947 to 408.7 million gallons in 1956. Corresponding figures for South West Africa (Table 32) indicate an increase in consumption of over 120% during the same ten-year period. The total petrol consumption of the two areas is shown in Table 33 (Page 153) where it will be seen that in any one year the demand for petrol on the inland market exceeded the combined total demand for all other petroleum fuels. This is a measure of its importance in meeting the growing demand for energy from petroleum.

Petrol is used almost exclusively as a fuel for road vehicles and Table 35 (Page 156) shows how the Union's vehicle numbers have grown between 1926 and 1956. Tables 34 and 31 together, show how the consumption of petrol has increased during the period 1930 - 1956. It will be seen from these Tables that during the twenty-five years from 1931 to 1956 the total number of vehicles in the Union increased by about 350%, whilst the consumption of gasoline rose by about 500%. These percentages show that the demand for gasoline increased at a faster rate than the average number of vehicles in service, and this implies an increasing consumption of petrol per vehicle during the period. A more detailed analysis of statistical data, taken from Tables 31 and 34 in relation to petrol consumption and from Tables 35 and 46 in relation to vehicle numbers, reveals the following details of average consumption per vehicle:-

YEAR	NUMBER OF ROAD VEHICLES≈	TOTAL PETROL SALES (Galls.)	AVERAGE CONSUMPTION PER VEHICLE (Galls.)
1931	188,127	67,580,000	359.2
1936	311,488	125,550,000	403.1
1941	393,737	176,730,000	448.8
1946	410,119	233,480,000	569.3
1947	477,854	234,942,000	491.7
1948	564,155	276,304,000	489.8
1949	611,661	307,256,000	502.3
1950	636,292	304,451,000	478.5
1951	661,812	329,857,000	498.4
1952	688,744	341,112,000	495.3
1953	727,350	353,835,000	486.5
1954	755,659	366,492,000	485.0
1955	809,396	389,894,000	481.7
1956	870,250	408,691,000	469.6

(≈ Excluding tractors)

TABLE 69

UNION OF SOUTH AFRICA

MOTOR GASOLINE IMPORTS, 1946 - 1955

(Thousands of Gallons)

YEAR	TOTAL IMPORTS	LESS RE-EXPORTS	NETT IMPORTS
1946	209,549	1,846	207,703
1947	231,891	3,636	228,255
1948	271,403	5,446	275,957
1949	315,431	9,028	306,403
1950	316,349	5,527	310,822
1951	327,737	4,275	323,462
1952	347,557	6,018	341,539
1953	363,942	3,434	360,508
1954 =	300,358	4,079	296,279
1955	316,614	4,589	312,025

(= Stanvac refinery at Durban came "on stream")

(Ref.64, Tables 1 and 10)

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The foregoing figures show clearly that up to 1946 the average petrol consumption per vehicle was increasing rapidly. During the immediate post-war years the influx of smaller European vehicles with their greater petrol economy caused a levelling-off in the average consumption figure and from about 1951 onwards there has been a gradual drop. The decline in average petrol consumption per vehicle has been accentuated by the fact that the main substitution of diesel for petrol engines has occurred in the field of commercial transport (including buses) where the heaviest milage and greatest fuel consumption is experienced. These phenomena will be discussed in more detail when dealing with estimates of gasoline consumption by types of vehicle, but for the present it is sufficient to place on record the fact that the increase in annual petrol consumption per average vehicle has apparently been halted and replaced by a downward trend.

Details of gasoline imports during the post-war decade are shown in Table 69. The 50% increase in imports during the period 1946 - 1949 was brought about by the release of pent-up demand in the years following the end of the war, but the introduction of import control in 1949 and the higher prices payable for American cars following devaluation of sterling caused a definite easing in the upward surge of demand. From 1950 to 1953 petrol import figures increased by only 50 million gallons compared with 100 million gallons in the previous four years. In 1954, the Stanvac refinery at Durban came "on stream" and the nett import of petrol dropped by 64 million gallons in that year. However in 1955 the figures began increasing again and it is probable that by 1960 the annual import of petrol will be near to 400 million gallons - even after making allowances for local production ex Stanvac, Sasol and Satmar.

The Bureau of Census and Statistics has published records of petrol consumption in the Union since 1950. These are shown in Table 70 and it is of interest to see how the figures of petrol consumption by Provinces correspond to the numbers of road vehicles in operation in each province. Relevant figures for 1956 are as follows:-

Province	Total Motor Vehicles	%	Petrol Consumption (million gallons)	%
Cape	282,199	32.4	119.47	29.4
Natal	104,912	12.1	54.92	13.5
O.F.S.	84,557	9.7	48.22	11.8
Transvaal	398,582	45.8	184.55	45.3
	870,250	100%	407.16	100%

These figures indicate that the average consumption per vehicle in the Cape is slightly less than in other provinces, but the significant fact from a marketing point of view is that the Transvaal accounts for 45.8% of the total number of motor vehicles and 45.3% of the total consumption of petrol - most of the latter being sold in the Reef area. It is hardly surprising therefore to find six oil companies engaged in active competition for petrol sales in this concentrated marketing area - Atlantic, Caltex, Sasol, Shell, Total and Vacuum.

See Tables 75 and 76.
Ref.69, Page 3 and Ref.67, Table H.1

TABLE 70 - PETROL CONSUMPTION BY PROVINCES
(1,000's Imperial Gallons)

YEAR	CAPE.	%	NATAL.	%	O.F.S.	%	TVL.	%	UNION TOTAL	ANNUAL PERCENTAGE INCREASE
1950	91,484	30.16	43,875	14.46	34,082	11.23	133,932	44.15	303,374	-
1951	99,391	30.23	46,177	14.04	39,555	12.03	143,693	43.70	328,815	8.39
1952	102,864	30.42	47,428	14.02	37,799	11.18	150,077	44.38	338,168	2.84
1953	109,386	31.09	48,291	13.72	38,567	10.96	155,632	44.23	351,877	4.05
1954	110,555	30.34	49,557	13.60	42,764	11.73	161,543	44.33	364,420	3.56
1955	115,421	29.66	52,274	13.43	46,291	11.90	175,131	45.01	389,117	6.78
1956	119,471	29.34	54,916	13.49	48,223	11.84	184,551	45.33	407,161	4.64
Annual Average rates of Increase: 1950 - 1956	4.55%		3.81%		5.96%		5.49%		5.03%	

(Ref. 67, Table H.1).

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TABLE 71 - ANALYSIS OF UNION PETROL CONSUMPTION

(1,000's Imperial Gallons)

YEAR	GENERAL TRADE	GOVT. DEPTS.	FARMERS & CO-OPS	UNION TOTAL
1950	262,112	22,715	18,547	303,374
(%)	86.40	7.49	6.11	100%
1951	283,456	24,292	21,067	328,815
(%)	86.20	7.39	6.41	100%
1952	295,430	24,556	18,182	338,168
(%)	87.36	7.26	5.38	100%
1953	311,679	22,589	17,609	351,877
(%)	88.58	6.42	5.00	100%
1954	324,900	21,677	17,842	364,420
(%)	89.15	5.95	4.90	100%
1955	347,628	24,256	17,232	389,117
(%)	89.34	6.23	4.43	100%
1956	366,406	22,929	17,826	407,161
(%)	89.99	5.63	4.38	100%

(Ref. 67, Table H.1)

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The system of wholesale distribution of petrol in the Union was described in the previous chapter but the actual sales outlets fall into several different categories. Table 71 gives an analysis of petrol consumption under three main headings, which can again be sub-divided along the following lines:-

1) General Trade - This covers many categories of consumer outlets, the chief ones being:-

   a) Retail outlets through service stations which may be company-owned, or "tied" by means of a sales agreement to sell only the one brand of petrol for a specified period of time. There is usually some form of inducement offered to the owner of a tied station in the form of a cash grant or a loan to improve his operating facilities, in return for the sole petrol selling rights. The owner gains capital to assist in developing his business and the oil company gains an assured vantage point for the sale of its products, secure in the knowledge that competitors cannot use the same site. Sasol is an exception to this procedure as, by agreement between the government and the oil companies, one Sasol pump is permitted on the forecourt of each service station. This leads to the peculiar anomaly that one of the other oil companies may find it has, in effect, purchased the sole petrol selling rights at a particular service station only to find that a large portion of the sales are made from the Sasol pump. However the fact remains that there is a certain amount of "brand consciousness" on the part of the motoring public, and each company is competing strongly with the others to hold and if possible to improve its share of the market.

   b) Another form of general petrol outlet is to be found in small towns where only one or two garages exist or where general dealer stores also sell petrol. At sites such as these it is common to find one pump from each of the companies, or at least from those companies wishing to be represented.

   c) General trade also covers sales in bulk or in drums to large commercial users, to mines, to industry, and to Local Authorities (excluding central and provincial government).

2) Government Departments - Sales under this heading are usually made by contract under rebate of duty to the South African Railways and Harbours Administration, the various Provincial Administrations and to all Government Departments including the Union Defence Force.

3) Farmers and Co-ops - this category covers sales made to bona-fide farmers and to agricultural co-operative societies.

It is interesting to note that the percentage of sales through general outlets is rising each year, and in 1956 stood at nearly 90% of total consumption. The volume of petrol consumed annually

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TABLE 72

MOTOR GASOLINE - COMPARATIVE CONSUMER ANALYSIS

1951 and 1957.[x]

(1,000 Gallons)

		1951	%	1957	%
1.	Resellers	252,269	75.24	353,854	80.66
2.	Agriculture	23,751	7.08	24,186	5.51
3.	Mining	2,343	.70	4,431	1.01
3.	Railways	9,346	2.79	9,065	2.07
5.	Government				
	Central	15,378	4.59	15,639	3.56
	Local	4,905	1.46	5,917	1.35
6.	Fishing and Marine	64	.02	88	.02
7.	Miscellaneous	27,241	8.12	25,547	5.82
8.	TOTAL ALL USES	335,297	100%	438,727	100%

(x Union and South West Africa)

(Compiled from estimates made by The Shell Company of South Africa Limited)

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by government departments and by farmers does not show any marked variation over recent years, the inference being that industry, commerce and private consumers are mainly responsible for the continuing growth in demand for motor gasoline. Unfortunately no further statistics are available to show the separate consumption trends of these latter three categories but, from the vehicle figures given in Table 46, there would seem to be little doubt that the continuing growth in numbers of motor cars is the main reason for the steady annual increase in total motor gasoline consumption. The equally rapid rise in numbers of petrol-engined commercial vehicles (Table 47) represents a growing outlet for gasoline which should not be underestimated although there is some divergence of views amongst the oil companies as to the relative importance of motor-cars and commercial vehicles in the gasoline market. The position will be examined in the following paragraphs when discussing estimates of consumer demand.

A breakdown of petrol consumption by main sections of the economy is given in Table 72, compiled from information supplied by The Shell Company. The gallonage shown against item (1) is mostly that sold on a retail basis through petrol pumps situated at garages or country stores. This represents a large part of the "General Trade" discussed earlier in connection with Table 71, and the increasing percentage share of the total market follows the pattern of the official statistics given in the latter Table.

The consumption attributed to "Agriculture" in Table 72 covers direct sales to agricultural co-operative societies, market gardeners, citrus estates, sugar plantations and farmers of all kinds. Most of the petrol is used for transport purposes in cars, lorries and vans although a small amount may be used in farm machinery or in stationary pumping engines. It will be noticed that the agricultural consumption of petrol is not large in relation to the consumption of automotive diesel oil (Table 52, Page 193) or power kerosene (Table 61, Page 218) but nevertheless the aggregate consumption of all petroleum products by this sector of the economy represents a considerable share of the total inland market. The gallonage figures for "mining" cover the Union, South West Africa and the Protectorates. Furthermore the total relates to <u>all</u> mines and there is therefore no direct relationship between Table 51 (Page 191) and Table 72 in this regard.

Railway and Government consumption figures reflect total quantities mentioned in official Tenders. Central and Provincial Government needs, including the requirements of the S.A.R., are not subject to import duty but Local Authorities must obtain their supplies in the normal market by means of competitive tendering by the oil companies.

Estimates of the quantities of petrol consumed by type of vehicle are provided in Table 73, having been compiled from information supplied by Vacuum Oil Company. It will be noticed that well over 99% of total sales are for road vehicles of one sort or another. Column (3) of this Table shows that about 51% of petrol sales were for motor cars and nearly 46% for commercial vehicles. The latter estimate would appear to be somewhat on the high side, particularly when it is considered that passenger buses and commercial vehicles represent only about 22% of total vehicles licensed (Table 35, Page 156) and that nearly half of the buses and 6% of the commercial vehicles are diesel-engined. (Table 45, Page 181).

6 See Part 9 of this Chapter and Table 79

TABLE 73 - MOTOR GASOLINE - END USE ESTIMATES 1957

(1,000 Gallons)

	UNION OF SOUTH AFRICA (1)	%	SOUTH WEST AFRICA (2)	%	TOTAL	%
1. Motor Cars	218,785	51.30	5,127	46.60	223,912	51.18
2. Buses, Trucks, Vans	195,328	45.80	5,600	50.90	200,928	45.93
3. Tractors	9,382	2.20	66	0.60	9,448	2.16
4. TOTAL ALL VEHICLES	423,495	99.30	10,793	98.10	434,288	99.27
5. Miscellaneous	2,986	0.70	209	1.90	3,195	0.73
6. TOTAL, ALL USES	426,481	100.00	11,002	100.00	437,483	100.00

(Compiled from information supplied by Vacuum Oil Company of South Africa (Pty.) Limited)

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TABLE 74 - MOTOR GASOLINE - ESTIMATES OF CONSUMPTION BY TYPE OF VEHICLE [x]

(In tons of 2,240 lbs and thousands of gallons)

	1956				1961				1966			
	No.	Tons	Gallons	%	No.	Tons	Gallons	%	No.	Tons	Gallons	%
1. Buses	3,729	30,000	9,300	2.2	5,000	35,000	10,850	2.1	7,000	49,000	15,190	2.4
2. Motor Cars	642,326	803,500	249,085	59.9	875,000	1,028,000	318,680	61.3	1,100,000	1,270,000	393,700	61.4
3. Comm.Vehicles	187,517	480,500	148,955	35.8	230,000	575,000	178,250	34.3	280,000	700,000	217,000	33.9
4. Motor Cycles	39,927	8,000	2,480	0.6	80,000	16,000	4,960	1.0	120,000	24,000	7,440	1.1
5. Tractors	5,000	10,000	3,100	0.7	5,000	10,000	3,100	0.6	5,000	10,000	3,100	0.5
6. Other Uses	-	10,200	3,162	0.8	-	12,000	3,720	0.7	-	14,000	4,340	0.7
7. TOTALS	878,499	1,342,200	416,082	100%	1,195,000	1,676,000	519,560	100%	1,512,000	2,067,000	640,770	100%
Percentage increase on 1956 figures:	-	-	-		36%	25%	-		72%	54%	-	

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd)
(Vehicle Statistics for 1956 taken from Bureau of Census and Statistics Special Report No.216)

(x Union and South West Africa.)

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A more detailed analysis is provided in Table 74, which has been compiled from information supplied by Atlantic Refining Company. This Table endeavours to arrive at an average consumption figure per type of vehicle, thus providing a basis for future estimates. The vehicle statistics shown in this Table for 1956 were taken from Bureau of Census and Statistics Special Report No. 216 which gives a breakdown of petrol and diesel engined vehicles licensed in each category. Government vehicles are exempt from licensing but the total numbers of such vehicles are shown in the Report and estimates based on roughly 75% petrol-engined to 25% diesel-engined were adopted for tabulation purposes where necessary. An overall estimate of 5,000 petrol-engined tractors was considered by Atlantic to be more realistic than the 8,500 shown as licensed in the Report, on the grounds that there were known discrepancies in the official tractor statistics. However in view of the comparatively small consumption of this group the actual number is not material. The 1956 consumption analysis was calculated on the following approximate basis:-

a) Buses	8.00 tons p.a.	(2480 gallons)
b) Motor Cars	1.25 " " "	(390 gallons)
c) Comm. Vehicles... ...	2.56 " " "	(800 gallons)
d) Motor Cycles	0.20 " " "	(60 gallons)
e) Tractors...	2.00 " " "	(620 gallons)

In the above figures allowance is made for an average bus doing ten miles to the gallon of petrol and covering about 25,000 miles per annum. Admittedly in reality a city bus might cover 40,000 miles per annum and a country bus between 20,000 and 30,000 miles per annum, but the term "bus" includes School-buses and many small capacity personnel carriers such as European-made Kombi-buses and Mini-buses. Under these circumstances an average of about 25,000 miles per annum for a bus does not seem unreasonable. The other petrol figures quoted above would give an average car between 8,000 and 10,000 miles; a commercial vehicle between 8,000 and 16,000 miles; a motor cycle or scooter about 4,000 miles. It could perhaps be held that some of these estimates are low, but it was mentioned in earlier paragraphs that there are large numbers of small European cars, commercial vehicles and motor scooters coming on to the roads in the Union and these have a much greater milage per gallon of petrol than their larger American counterparts. These smaller and more economical vehicles are increasing in numbers, thus causing a downward trend in the estimates of average petrol consumption per vehicle.

The extent to which the ratio of smaller European cars to the larger American models has changed during the post-war decade is shown in Table 75. At the end of the war, in 1946, the South African car licensing statistics showed 82% American/Canadian vehicles and only 18% British/European models. By 1956 this ratio had changed to 58% from North America and 42% from Britain and Europe. Import control certainly hampered the

Ref. 69, Page 10
Ibid, Page 3
For licensing purposes a bus is defined as a vehicle capable of carrying eight or more passengers in addition to the driver.

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TABLE 75 - UNION OF SOUTH AFRICA

MOTOR CARS LICENSED BY COUNTRY OF ORIGIN 1946 - 1956

	U.S.A.	CANADA.	TOTAL	%	U.K.	EUROPE	TOTAL	%
1946	?	?	250,978	82	43,183	11,478	54,661	18
1948	274,967	58,838	333,805	81	64,078	15,883	79,961	19
1950	288,954	66,028	354,982	75	96,943	19,449	116,392	25
1952	283,429	66,034	349,463	69	128,560	30,863	159,423	31
1954	279,530	72,904	352,434	63	162,383	41,468	203,851	37
1956	283,219	77,367	360,586	58	207,105	59,214	266,320	42
Percentage Increase 1956 on 1948:	3%	31%	8%		223%	273%	233%	

(Source: Bureau of Census and Statistics - Annual Special Reports on Motor Vehicle Statistics)

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TABLE 76 - UNION OF SOUTH AFRICA

COMMERCIAL VEHICLES LICENSED BY COUNTRY OF ORIGIN 1946 - 1956

	U.S.A.	CANADA	TOTAL	%	U.K.	EUROPE	TOTAL	%
1946	?	?	74,345	95	3,509	430	3,939	5
1948	68,978	34,554	103,532	94	6,103	450	6,553	6
1950	77,142	36,653	113,795	92	9,392	362	9,754	8
1952	78,579	35,890	114,469	86	17,260	1,585	18,845	14
1954	82,544	36,413	118,957	80	26,230	2,657	28,887	20
1956	93,003	38,757	131,760	74	39,860	5,694	45,554	26
Percentage Increase 1956 on 1948:	35%	12%	27%		553%	1,165%	595%	

(Source: Bureau of Census and Statistics - Annual Special Reports on Motor Vehicle Statistics)

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maintenance of the original merican share of the car market but it was devaluation of sterling in 1949 and the subsequent higher prices of merican cars that made many users change over to British models. The percentage increases shown in this Table have been calculated on 1948 as a base year, for two reasons. In the first place 1946 figures are artificially low because of the shortage of new cars during the war years and, in the second place, 1948 is the year before devaluation and the introduction of import control (1949). The comparison of 1956 with 1948 thus gives a more realistic assessment of real rate of growth following the adjustments made necessary by the events of 1949. The improvement of the Union's main roads and the lower capital and operating costs of smaller cars are two important features which will probably ensure continuance of the trend towards more small cars, and estimates of future petrol consumption must take into account this continuing change in vehicle preferences on the part of the motoring public.

The same trend towards more British and European models is evident in the numbers of commercial vehicles licensed (Table 76). Most of the smaller light delivery vans come from Britain but in the range of heavy trucks there is keen competition between America and Britain, with Germany emerging as a third contender especially where diesels are concerned. In the long run the gradually growing number of light commercial vehicles with their greater milage per gallon of petrol will inevitably cause further reduction in the average consumption per vehicle. However this will be a slower process than in the case of motor cars because of the specialised nature of a large number of heavy-duty commercial vehicles. The use of 1948 as a base year for comparison with 1956 statistics was prompted by the same reasons as those discussed above in relation to Table 75. It will be noticed however that, whereas the total number of American/Canadian cars increased only by 8% during the period, the number of commercial vehicles rose by 27%. One of the reasons for this was that British and European manufacturers were not able to compete in the field of heavy transport with the greater experience of American manufacturers. However that position is now changing and several of the better known British and Continental manufacturers are now able to offer a range of commercial vehicles fully comparable with their American competitors in both performance and price.

The estimates of future consumption in Table 74 were prepared in such a manner as to make allowance for gradually increasing numbers of smaller vehicles in most categories and consequently a slightly decreasing average petrol consumption per vehicle. However the drop in average consumption will be more than compensated by the rapid rise in the number of vehicles in service in the Union. The vehicle figures for 1961 and 1966 were arbitrarily assessed, using the trends shown in Table 46 as a guide but bearing in mind that in certain categories such as Buses, Commercial Vehicles and Tractors there was likely to be considerable future demand for diesel-engined vehicles.

It will be observed that the total 1966 petrol consumption is estimated at 54% in excess of the 1956 figure, whilst the increase in total vehicles is estimated at 72% during the same period. The latter includes provision for a large increase in light motor cycles and motor scooters which have a relatively low average petrol

consumption. In general it is felt that the estimates are realistic but, as there is no way of checking the average petrol consumption of the average bus or car or commercial vehicle, Atlantic's figures may be queried although they cannot at this stage be either proved or disproved. However Table 74 does set out, if in insufficient detail, a possible method for calculating future demand and when more perfect knowledge of the relevant data has been obtained it should be possible to estimate the potential market for petrol with a fair degree of accuracy.

Estimates of the total consumption of motor gasoline in each of the years 1957 to 1966 are set out in Table 77. During the first five years the annual increments in demand have been framed on a conservative basis in accordance with observed short-term cyclical trends and also with a measure of prudence in view of the present slowing down in the rate of expansion of the general economy of the Union. From 1961 onwards the current expansion programme of the South African Railways should have been completed and thereafter it is felt that exports should expand, particularly mineral exports. In estimating the annual increments of motor gasoline consumption during the second five year period Atlantic assumed that the Union's export markets would be firmer and that the tempo of general economic development would have improved as a result of better internal transportation facilities. This also takes into account the ever growing number of private cars and commercial vehicles which forms the backbone of demand for motor gasoline.

The foregoing discussion has been summarised in a consumption trend diagram, Figure 23. The tonnage figures for the twenty year period have been taken from Tables 33 and 77. It will be noticed that the estimates for the second decade (Table 77) postulate a continuance of the trend revealed during the first ten year period. The graph clearly shows how the post-war surge in demand for motor gasoline was arrested after the devaluation of sterling in 1949, and that thereafter the consumption pattern has closely followed the trend line. The overall trend is not quite that of a straight line and the curve indicates a future expectation that volumetric increments will continue to increase very slightly each year. The position is however very close indeed to that of a straight line curve and the long term trend (i.e. beyond 1966) may very well reveal such a tendency. The more or less constant percentage increments shown for the years 1960-1966 foreshadow such an eventuality.

9. SUMMARY AND TEN YEAR FORECAST.

The previous eight sections of this Chapter have considered the pattern of consumer demand for petroleum fuels, under the following headings:-

1. Total Union demand for petroleum fuels.
2. Ocean bunkers.
3. Industrial diesel oil and furnace oil.
4. Automotive diesel oil.

TABLE 77

ESTIMATED CONSUMPTION OF MOTOR GASOLINE

1957 - 1966 [x]

(Thousands of Long Tons)

YEAR	AMOUNT	ANNUAL INCREMENT
1957	1406.9	-
1958	1475.3	68.4
1959	1542.2	66.9
1960	1608.3	66.1
1961	1675.5	67.2
1962	1747.9	72.4
1963	1823.7	75.8
1964	1901.0	77.3
1965	1982.0	81.0
1966	2067.0	85.0
Annual Average Rate of Increase	4.37%	

(x Union and South West Africa)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Limited.)

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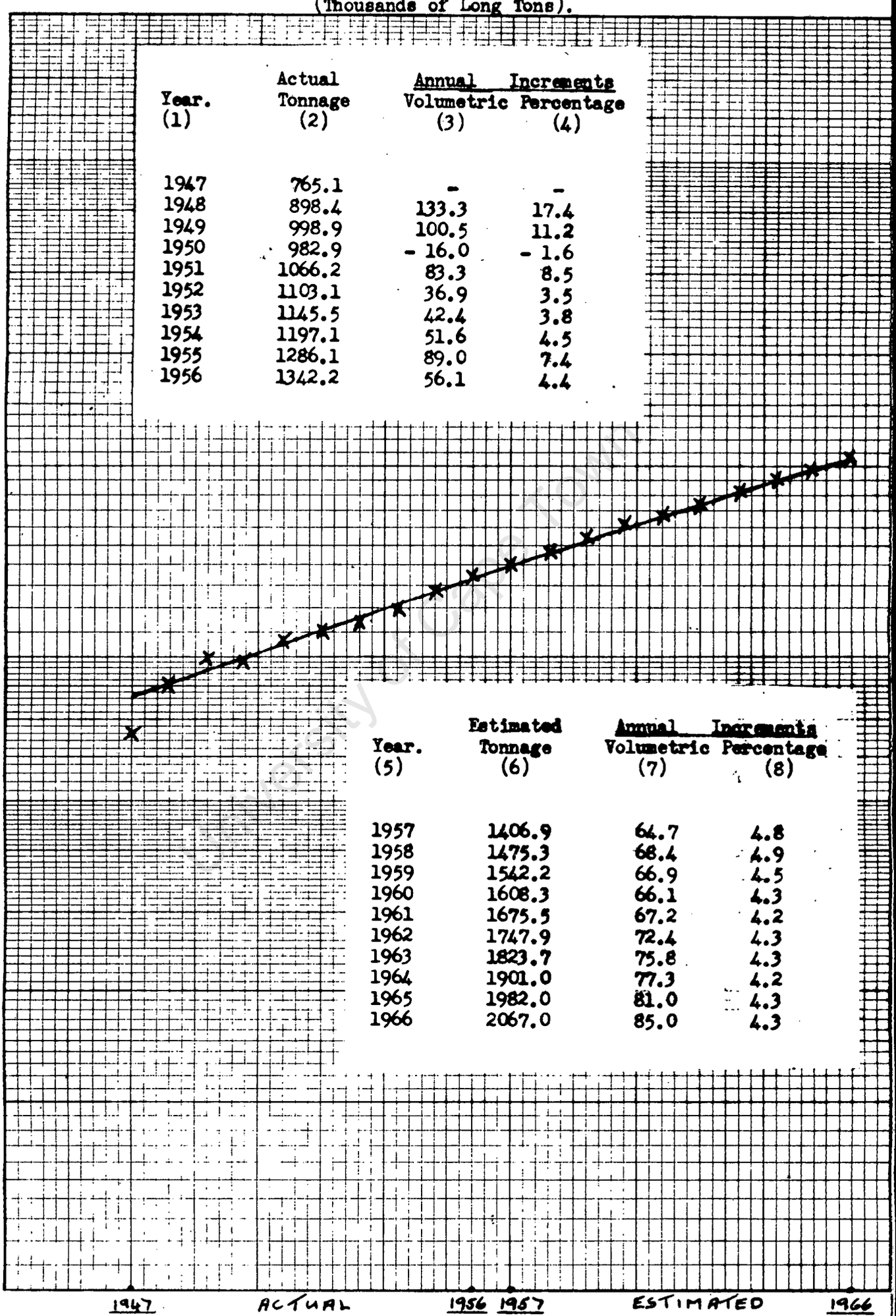
FIG. 23 MOTOR GASOLINE

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	765.1	-	-
1948	898.4	133.3	17.4
1949	998.9	100.5	11.2
1950	982.9	- 16.0	- 1.6
1951	1066.2	83.3	8.5
1952	1103.1	36.9	3.5
1953	1145.5	42.4	3.8
1954	1197.1	51.6	4.5
1955	1286.1	89.0	7.4
1956	1342.2	56.1	4.4



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	1406.9	64.7	4.8
1958	1475.3	68.4	4.9
1959	1542.2	66.9	4.5
1960	1608.3	66.1	4.3
1961	1675.5	67.2	4.2
1962	1747.9	72.4	4.3
1963	1823.7	75.8	4.3
1964	1901.0	77.3	4.2
1965	1982.0	81.0	4.3
1966	2067.0	85.0	4.3

5. Aviation gasoline and turbine fuels.

6. Power Kerosene.

7. Illuminating Kerosene.

8. Motor Gasoline.

At the beginning of the Chapter mention was made of the problem of "where" and "how" to obtain detailed information to augment the meagre official statistical data on petroleum consumption. It was stated that each of the four main oil companies had offered help in the provision of information relevant to the total market, although for obvious reasons they could not make available any data concerning their own sales. Largely as a result of this co-operation it has been possible to piece together an outline of demand for each of the main petroleum fuels and, at the same time, to discuss future trends. However one of the indisputable findings of this Chapter must be that although something is known about the pattern of demand for each product, there is much more that must be learned before a complete picture can be presented. In some cases it has been possible to provide a fairly adequate analysis of demand for one year only. In other cases a superficial examination of consumption over a number of years was all that could be presented. One main statistical deficiency seems to be in the detailed breakdown of the field of domestic, commercial and industrial consumption; in this respect knowledge of the market for petroleum energy seems to be no more advanced than that for coal energy.

In making an assessment of market demand for each of the fuels mentioned in this Chapter it has been possible to draw upon data made available by the Shell Company of South Africa Limited. The data has been assembled and presented in a series of Tables which have in turn been summarised in Tables 78 and 79. These two Tables present interesting information regarding the consumption of petroleum fuels by certain sections of the national economy, on which the following observations may be made:-

a) The total of all fuels distributed through resellers amounts to only a little over half the annual volume of sales. Moreover, notwithstanding the advent of automotive diesel oil to the reseller market, the quantity of fuels distributed in this manner would seem to be accounting for a falling percentage of the total sales, the figure for 1951 being 55.1% and for 1957 54.3%. More data would be necessary before this could be claimed as a statistical trend but, in view of the many thousands of pounds being spent on the development of retail gasoline outlets (for example) it should certainly be in the interests of the oil companies to obtain more detailed information about trends in this section of the market.

b) Agricultural consumers account for about 20% of all petroleum fuels sold. This percentage seems to be rising slightly but more data is necessary before this can be shown to be a definite trend. What

TABLE 78 - CONSUMPTION ANALYSIS OF MAIN PETROLEUM FUELS 1951 x

(Thousands of Gallons)

		MOTOR GASOLINE	AUTOMOTIVE DIESEL OIL	POWER KEROSENE	ILLUMINATING KEROSENE	INDUSTRIAL DIESEL OIL	FURNACE OIL	TOTAL	MARKET PERCENTAGE
1.	Resellers	252,269	-	-	29,295	-	-	281,564	55.1
2.	Agriculture	23,751	9,503	64,629	3,617	997	33	102,530	20.1
3.	Railways	9,346	1,264	-	663	428	1,934	13,635	2.7
4.	Mining	2,343	8,629	-	396	3,674	320	15,362	3.0
5.	Fishing and Marine	64	2,630	165	2	215	1	3,077	0.6
	Government								
6.	Central	15,378	4,707	604	569	505	205	21,968	4.3
7.	Local	4,905	5,456	502	318	302	18	11,501	2.2
8.	Unspecified	27,241	18,260	4,680	3,830	3,579	3,889	61,479	12.0
9.	Total Sales	335,297	50,449	70,580	38,690	9,700	6,400	511,116	100%
10.	Product Percentages	65.6	9.9	13.8	7.6	1.9	1.2	100%	

(Compiled from information given by The Shell Company of South Africa Limited in Tables 41, 42, 52, 61, 67, 72)

(x Union and South West Africa)

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TABLE 79 - CONSUMPTION ANALYSIS OF MAIN PETROLEUM FUELS 1957 x
(Thousands of Gallons)

		MOTOR GASOLINE	AUTOMOTIVE DIESEL OIL	POWER KEROSENE	ILLUMINATING KEROSENE	INDUSTRIAL DIESEL OIL	FURNACE OIL	TOTAL	MARKET PERCENTAGE	PERCENTAGE INCREASE ON 1951 ϕ
1.	Resellers	353,854	5,627	-	39,829	-	-	399,310	54.3	42
2.	Agriculture	24,186	40,378	81,626	4,656	620	2	151,468	20.6	48
3.	Railways	9,065	5,107	-	807	114	2,263	17,356	2.4	27
4.	Mining	4,431	17,554	-	527	585	1,100	24,197	3.3	58
5.	Fishing and Marine	88	5,230	61	112	280	1,060	6,831	0.9	122
	Government:									
6.	Central	15,639	9,354	645	917	65	187	26,807	3.6	22
7.	Local	5,917	10,736	418	287	205	140	17,703	2.4	54
8.	Unspecified	25,547	46,432	7,713	5,002	1,531	5,348	91,573	12.5	49
9.	TOTAL SALES:	438,727	140,418	90,463	52,137	3,400	10,100	735,245	100%	44
10.	Product Percentages	59.7	19.1	12.3	7.1	0.5	1.3	100%		
11.	Percentage increase on 1951 ϕ	31	178	28	35	(65)	58	44		

(Compiled from information given by The Shell Company of South Africa Limited in Tables 41, 42, 52, 61, 67, 72). (x Union and South West Africa) (ϕ See Table 78)

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does seem to be significant is the dependence of agriculture on petroleum products of all kinds for the provision of power, light and heat for nearly all farming and domestic purposes. The scale of this demand is shown quite clearly in Tables 78 and 79 which also indicate that there was a 48% increase in total consumption by this section of the economy during the six years 1951 - 1957. The agricultural community is, for the most part, remote from alternative forms of energy and from public transport systems. The mechanisation of farming has brought with it a dependence on the use of petroleum fuels which might cause serious problems in the event of war, or any other happening leading to a shortage of fuel supplies. Under such conditions there could be a considerable diversion to rail of urban and inter-urban road transport and oil could be replaced by coal or electricity as a form of energy for many domestic and industrial purposes. There is, however, no alternative for agriculture. The days of horse and oxen power are virtually finished and it is now a matter of oil fuels for the farmers or else food production must cease. The oil companies are aware of the importance of their products to agriculture and have recently constructed many bulk depots in farming areas from which such fuels can be obtained. If the present rapid growth in demand continues during the next ten years, these "agricultural depots" will assume considerable importance as centres for the bulk distribution of petroleum fuels. This should help to eliminate drums and enable each farmer to store his own reserve of fuels in bulk. Such a move will be of benefit both economically and strategically.

c) The consumption of the Railways, the mines, the fishing industry and central and local Government constitutes what might be called the "contract group", as most of the petroleum needs of these sectors are supplied under contract from the oil companies. Their various percentage shares of the market have changed little during the 1951-57 period, but the introduction of diesel locomotives in 1958 should cause a considerable increase in railway consumption of oil fuels in future. The consumption of "Fishing and Marine", whilst relatively very small, shows a 122% increase between 1951 and 1957. Most of this increase is in automotive diesel oil and furnace oil, the former being fuel for coastal shipping and trawlers, the latter for fish canning and processing factories. It is not expected that this rate of expansion will be maintained during the next decade and, in any case, the present consumption of this group is less than 1% of total demand.

d) It is to be regretted that there is such a relatively large "unspecified" figure in Tables 78 and 79 as this tends to distort the market shares of the various groups. It would seem that most of the quantity so

described should probably be attributed to "Commerce and Industry" as this category of consumer is conspicuously absent from the tabulation - possibly on account of the difficulty of obtaining any accurate statistics of the energy needs of this consuming group. It will be remembered from Chapter Two, Part Eight, that the same problem of inadequate statistical data arose in regard to coal consumption, and it seems that there is no easy solution to the problem. However, the oil companies are endeavouring to improve their statistical knowledge of demand from this Sector, particularly insofar as commercial road transport is concerned.

e) Other points of interest in a comparison of Tables 78 and 79 concern the relative product shares of the total market. Motor Gasoline dropped during the six year period from 65.6% to 59.7%, whilst automotive diesel fuel rose from 9.9% to 19.1%. In terms of percentage increase, demand for the latter fuel rose 178% compared with an increase of only 31% for petrol. This lends emphasis to the previously reported trend towards more and more diesel-engined vehicles, particularly in the spheres of commercial transport and agricultural tractors.

A ten-year forecast of future demand is presented in Table 80. It will be recalled that in Part One of this Chapter the consumption of petroleum fuels in the Union and South West Africa during the post-war decade was discussed in general terms, and Table 33 (Page 153) was prepared to give a statistical summary of such consumption during the period 1947 to 1956. In succeeding portions of the Chapter estimates of product consumption ø were given for the decade 1957 to 1966 and these have been summarised in Table 80 in such a manner that comparison may be made with Table 33. The following points are relevant:-

i) The Total of Inland Sales in 1966 is expected to reach 4145.2 thousand tons of petroleum fuels, being a 72% increase on the 1956 total of 2409.4 thousand tons.

ii) The demand for motor gasoline is expected to rise by some 54% during the same period and that for automotive diesel oil by about 200%. This is a measure of the rapidly increasing demand for diesel oil and its growing strength as a serious competitor to motor gasoline as a fuel for internal combustion engines.

iii) Consumption of three petroleum products is expected to decrease during the 1957-66 period. The demand for aviation gasoline, which showed a strong upward trend during the first decade, is expected to decline during the next ten years as the demand for turbine fuel increases. However, it is likely that aviation gasoline will still account for about one-third of

ø See Tables 39, 44, 56, 58, 63, 68, 77.

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TABLE 80 - ESTIMATED CONSUMPTION OF PETROLEUM FUELS 1957 - 1966[x]
(Thousands of Long Tons)

		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	Average Annual Rate of Increase 1957 - 1966 [6]
1.	Motor Gasoline	1406.9	1475.3	1542.2	1608.3	1675.5	1747.9	1823.7	1901.0	1982.0	2067.0	4.37
2.	Aviation Gasoline	31.6	30.2	20.8	20.4	19.1	19.8	20.5	21.3	22.2	23.0	(3.47)
3.	Illuminating Kerosene	183.0	193.0	201.4	209.4	217.7	226.0	234.7	243.7	253.2	262.4	4.10
4.	Power Kerosene	328.3	319.5	313.3	307.2	301.3	295.4	289.8	284.4	279.0	273.6	(2.01)
5.	Aviation Turbine Fuels	8.1	12.0	26.5	27.9	33.9	35.6	37.4	39.4	41.4	43.4	20.50
6.	Automotive Diesel Oil	526.0	596.5	707.1	833.6	944.4	1033.4	1123.5	1215.5	1309.0	1403.7	11.52
7.	Industrial Diesel Oil	13.1	10.2	8.1	6.8	5.8	5.7	5.7	5.7	5.7	5.7	(8.83)
8.	Furnace Oil	38.9	45.8	49.4	51.5	53.6	55.9	58.2	61.0	63.7	66.4	6.12
9.	INLAND SALES	2535.9	2682.5	2868.8	3065.1	3251.3	3419.7	3593.5	3772.0	3956.2	4145.2	5.61
10.	Ocean Bunkers											
	Marine Diesel Oil	224.4	117.1	119.0	122.0	125.0	128.0	131.0	134.0	137.0	140.0	-
	Fuel Oil	1014.5	379.1	370.0	385.0	400.0	414.0	427.0	439.0	450.0	460.0	-
11.	TOTAL SALES	3774.8	3178.7	3357.8	3572.1	3776.3	3961.7	4151.5	4345.0	4543.2	4745.2	-

(x Union and South West Africa)

([6] For comparative purposes only - See Table 33)

(Compiled from information supplied by Atlantic Refining Company of Africa (Pty.) Ltd. and The Shell Company of South Africa Ltd.)

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all aviation fuel sold in 1966. The demand for Power Kerosene, which is predominantly a tractor fuel, is expected to suffer a progressive gradual decline of about 2% per annum as a result of the increasing demand for diesel tractors. Industrial diesel oil will also face a declining market until demand levels out at about 5.7 thousand tons, this being the estimated quantity required to fuel the number of slow-speed diesel generating units still in service in rural power stations.

iv) Consumption of illuminating kerosene is expected to show an average rate of annual growth of about 4.1% per annum. The total increase in demand over the ten-year period should be about 77 thousand tons which is the same as in the previous decade.

v) Consumption of furnace oil is expected to show a fairly steady increase during the 1957-66 period mainly as a result of the continuing industrial expansion in the Union. During the first decade after the war consumer demand increased by some 16 thousand tons helped by the pronounced change-over from industrial diesel oil to other products. The additional demand for furnace oil during the next ten years is expected to total some 27.5 thousand tons at an average rate of growth of about 6.12% per annum.

In the foregoing sections of this Chapter various diagrams have been presented to illustrate the trends of consumption for the different petroleum products. The time has now arrived to consider the overall trend in relation to the total consumption of all petroleum products. This Thesis is mainly concerned with the pattern of demand for inland consumption (i.e. excluding Bunkers) and in Figure 24 such consumption is illustrated as a semi-logarithmic trend curve. The plotted figures have been obtained from line 9 of Table 33 (Page 153) in respect of the first ten year period, and from line 9 of Table 80 (Page 259) in respect of the second decade.

The significant feature of Figure 24 is that after considering each petroleum product in individual detail, and after making separate forecasts for the future consumption of each fuel, the overall total forecast trend for the period 1957-1966 continues the trend established by the actual total of inland sales during the previous decade. It would be rash to claim this as proof of the accuracy of the forward forecasts but it does at least illustrate that the individual estimates have been calculated in conformity with established patterns of consumption and are not based solely on arbitrary assumptions. The increasing annual percentage increments shown for the period 1957-1960 are due mainly to the rising consumption of automotive diesel oil and aviation turbine fuel, as discussed earlier. The rate of increase in demand for these fuels is expected to ease somewhat from about 1960/61 and this is expected to lead to decreasing percentage annual increments in the inland sales figures thereafter. This study does not go beyond 1966, but it is considered unlikely that the long term trend will fall

FIG. 24 INLAND SALES OF PETROLEUM PRODUCTS

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons).

Year. (1)	Actual Tonnage (2)	Annual Increments Volumetric (3)	Percentage (4)
1947	1143.4	-	-
1948	1346.5	203.1	84.9
1949	1534.6	188.1	13.9
1950	1564.7	30.1	1.9
1951	1732.3	167.6	10.7
1952	1817.9	85.6	4.9
1953	1939.4	121.5	6.7
1954	2090.5	151.1	7.8
1955	2257.9	167.4	8.0
1956	2409.4	151.5	6.7

Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	2535.9	126.5	5.3
1958	2682.5	146.6	5.8
1959	2868.8	186.3	6.9
1960	3065.1	196.3	6.8
1961	3251.3	186.2	6.1
1962	3419.7	168.4	5.2
1963	3593.5	173.8	5.1
1964	3772.0	178.5	4.9
1965	3956.2	184.2	4.9
1966	4145.2	189.0	4.8

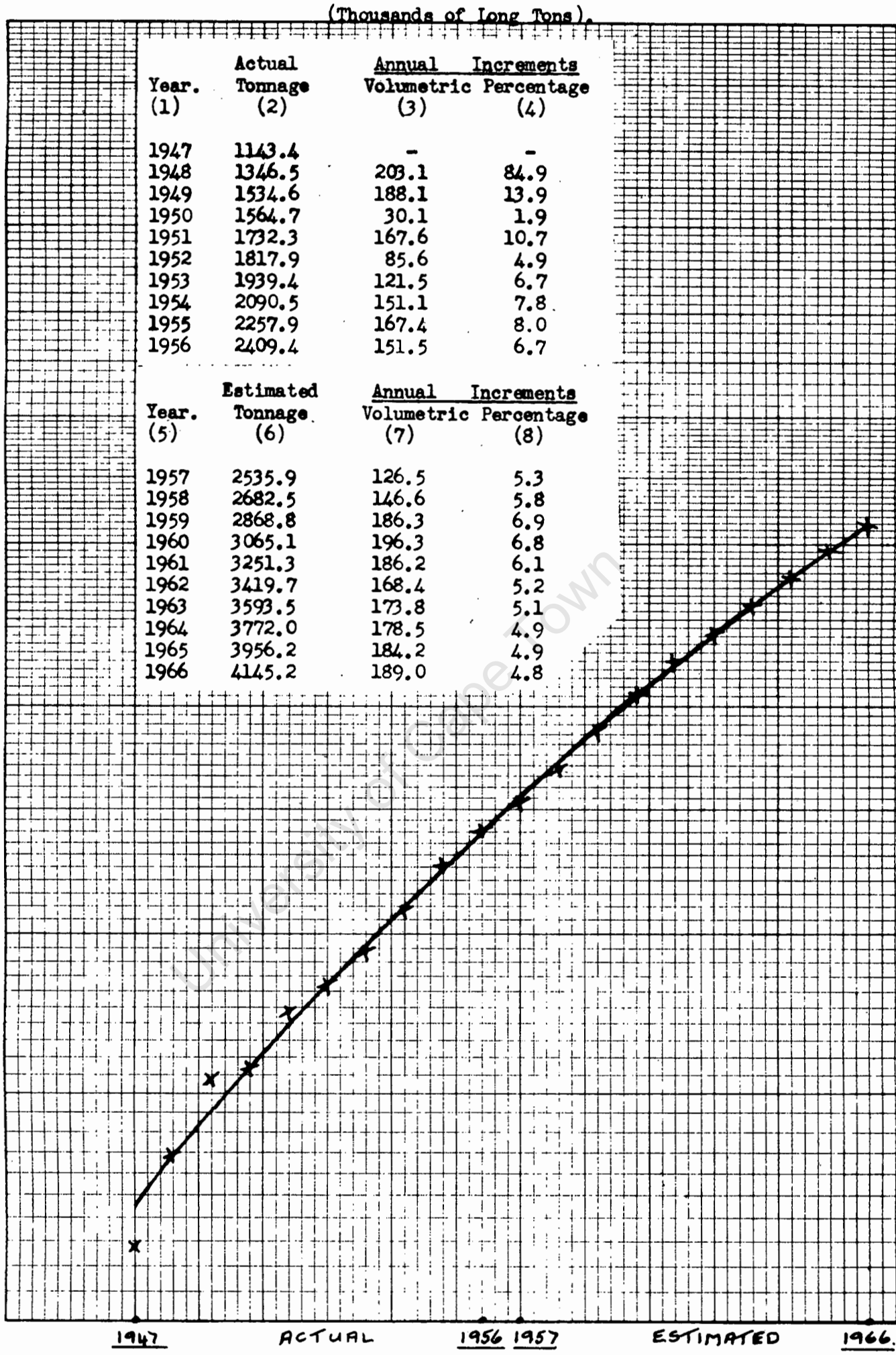

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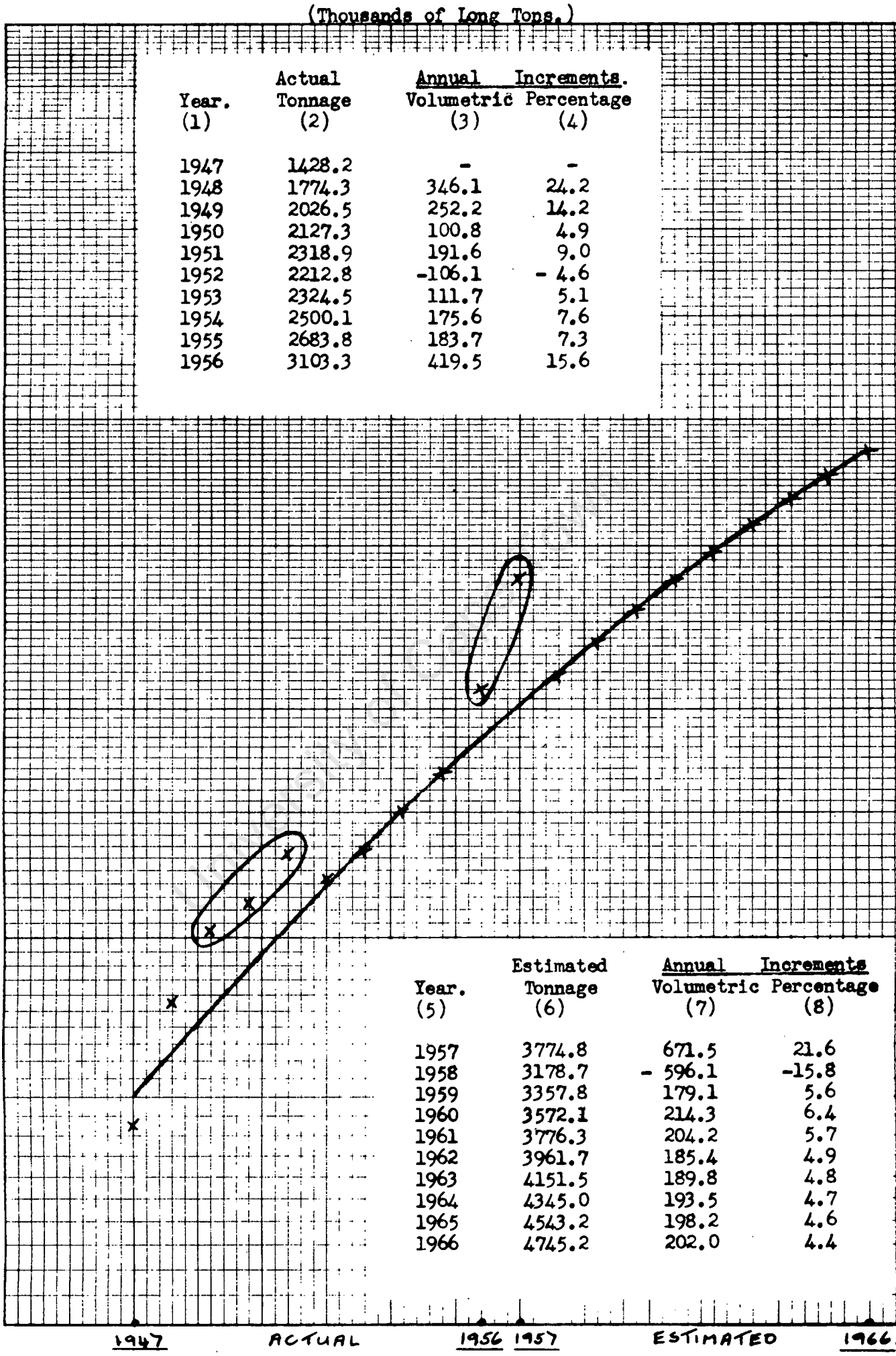
FIG. 25 TOTAL SALES OF PETROLEUM PRODUCTS

CONSUMPTION TREND 1947 - 1966

(Thousands of Long Tons.)

Year. (1)	Actual Tonnage (2)	Annual Increments. Volumetric (3)	Percentage (4)
1947	1428.2	-	-
1948	1774.3	346.1	24.2
1949	2026.5	252.2	14.2
1950	2127.3	100.8	4.9
1951	2318.9	191.6	9.0
1952	2212.8	-106.1	- 4.6
1953	2324.5	111.7	5.1
1954	2500.1	175.6	7.6
1955	2683.8	183.7	7.3
1956	3103.3	419.5	15.6



Year. (5)	Estimated Tonnage (6)	Annual Increments Volumetric (7)	Percentage (8)
1957	3774.8	671.5	21.6
1958	3178.7	- 596.1	-15.8
1959	3357.8	179.1	5.6
1960	3572.1	214.3	6.4
1961	3776.3	204.2	5.7
1962	3961.7	185.4	4.9
1963	4151.5	189.8	4.8
1964	4345.0	193.5	4.7
1965	4543.2	198.2	4.6
1966	4745.2	202.0	4.4

much below a 5% per annum rate of increase, unless there are major economic or political upheavals in the country.

Estimates of demand for bunker fuels have been shown in Table 80 for comparative purposes only. It was explained in Part One of this Chapter that the erratic nature of demand for bunkers made forecasting an extremely difficult proposition and that these figures were given merely to illustrate the anticipated basic trend. In any one year, or even over a number of years, the actual demand can vary widely due to circumstances outside the range of normal predictions.

The effect of the erratic demand for bunkers in determining trend patterns was graphically illustrated in Figure 15 when discussing bunker fuels. The influence that this can have on total market consumption trends is shown in Figure 25. The diagram shows that the shape of the consumption trend curve for total sales of all petroleum products (i.e.:- inland sales plus bunkers) corresponds closely to that shown in Figure 24. This, however, is only because the abnormalities due to increases in bunker fuel consumption during the Korean War period and the Suez crisis have been eliminated from the trend. The only reliable comparisons that can be made between past and future consumption must, of necessity, eliminate abnormalities and uncertainties as far as possible. For this reason the comparison of energy consumption to be discussed in the next Chapter will be based on a comparison of coal and oil sales on the inland market only. Bunker fuels and coal export figures have been eliminated from the discussion in order to provide a fair comparison of actual inland energy consumption during the past ten years and estimates of such consumption in the next decade.

Table 80 represents the best estimates of oil company statisticians and economists in regard to the probable levels of demand for various petroleum fuels during the ten year period 1957-1966. It summarises the analysis and discussion which has taken place in this Chapter concerning trends in consumer demand and it purports to be an authoritative schedule for comparison with coal consumption estimates for the same ten year period. In the Chapter which follows, Table 80 will be compared with Table 25 on a basis of energy content of the various fuels in an effort to determine the relative roles played by coal and petroleum in meeting the growing demand for commercial energy in the Union of South Africa.

It should be noted that, insofar as this proved to be possible on the information available, the estimates of future energy consumption have taken account of known major trends in the substitution of oil for coal and vice versa. Typical examples are the decline in coal bunkers now that most of the world's shipping is oil fired; and the expected increase in oil consumption by the S.A.R. when diesel engines are brought into service to replace coal locomotives on certain routes. In these, and in other known cases of substitution or the expected substitution of one fuel for another, appropriate adjustments have been made to the estimates to take into account the changing pattern of energy consumption.

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In addition to the substitution of oil for coal and vice versa, there have been many instances of substitution in form of energy used. An example in this category is the decline in coal consumed directly by the mining industry, which is offset by an increase in thermal electricity consumption. Here the coal energy is merely being used in a changed form. Another such example is the substitution of turbine fuel for aviation gasoline in the air transport industry.

It must be admitted that it has not been possible to assess all substitution trends, particularly in sectors such as "Domestic and Industrial" where reliable information is sadly lacking. However, on balance, it is felt that most major trends in substitution have been taken into account and that, in the period up to 1966, there are unlikely to be any other substitutions of sufficient magnitude to upset the comparisons which are to be made in the following Chapter.

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C H A P T E R F I V E

ENERGY CONSUMPTION IN SOUTH AFRICA

1. Coal equivalent method of comparison.

2. Determination of total coal energy.

3. Analysis of energy from petroleum.

4. Total energy consumption.

5. Comparison of energy costs.

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CHAPTER FIVE

ENERGY CONSUMPTION IN SOUTH AFRICA

1. COAL EQUIVALENT METHOD OF COMPARISON

The investigation into the position of coal as a source of energy for the Union occupied the whole of Chapters One and Two and culminated in the two schedules of coal consumption contained in Tables 23 and 25 (Pages 95 and 104). These Tables cover the periods 1947 to 1956 and 1957 to 1966 respectively and provide a year by year analysis of demand for coal grouped according to various sectors of the economy. A similar investigation into the role of petroleum occupied Chapters Three and Four and produced a corresponding twenty-year record of petroleum consumption as shown in Tables 33 and 80 (Pages 153 and 259). Comparison of the energy value of coal and petroleum can only be made by conversion to some common unit, but there is the added problem that in South Africa coal is reckoned in short tons of 2,000 lbs. whereas petrol is reckoned in British tons of 2,240 lbs. Therefore in addition to finding a suitable factor for comparing the energy content of oil and coal, it will also be necessary to convert long tons to short tons, or vice versa, to obtain a common basis of measurement.

Table 81 gives a schedule of accepted "coal equivalent" values for various fuels in common use, as compiled and published by the Statistical Office of the United Nations Organisation. Such a schedule forms a handy basis for approximate comparisons of various forms of energy in terms of coal. It will be noticed from this Table that anthracite and bituminous coals are given unit value (1.0) whilst manufactured gasoline, kerosene and fuel oils are rated at 1.5. In other words, one ton of petroleum fuels has an energy content approximating to one and one-half tons of coal. The term "approximate" is used deliberately because the average calorific value of coal varies considerably from country to country and from grade to grade, whilst different petroleum fuels also possess different calorific values. However as a rough and ready comparison of energy values it can be accepted that one ton of petroleum fuels is the approximate equivalent of about one and one-half tons of coal.

It follows from this that if the total of petroleum fuels consumed in the Union is converted from long tons to short tons and then multiplied by one and one-half, the resulting figure will give the comparative energy content of petroleum in terms of "coal equivalent". Table 82 sets out a comparison of South African energy consumption determined in this manner and, for convenience, only the four years 1951, 1956, 1961 and 1966 have been illustrated. The figures for coal consumption were taken from Tables 23 and 25, whilst those for petroleum products were

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Ref. 22, Page 106

TABLE 81

ENERGY VALUES EXPRESSED IN COAL EQUIVALENT

ENERGY SOURCES (per metric ton, except as otherwise indicated)		COAL EQUIVALENT METRIC TONS
Anthracite and bituminous coal		1.0
Coal briquettes		1.0
Coke		0.9
Lignite:	Czechoslovakia, France, Hungary	0.6
	Austria	0.5
	Germany, Netherlands, Poland	0.3
	Other	0.33
Crude Petroleum and shale oil (See Note 1)		1.3
Natural Gasoline		1.5
Manufactured gasoline, kerosene, fuel oils		1.5
Liquified petroleum gas		1.67
Natural gas (thousand cubic metres)		1.33
Manufactured gas and coke-oven gas (thousand cubic metres) (See Note 2)		0.6
Bagasse (dry basis)		0.5
Peat (dry basis)		0.5
Fuelwood (per cubic metre solid measure)		0.25
Other wood and agricultural wastes (dry basis)		0.5

Notes:

1. The refined oil equivalent of crude and shale oils has been calculated at 87 per cent of the weight of the crude.

2. The manufactured gas equivalent of natural gas has been calculated at 2.22 times the volume of natural gas.

Ref.22, Page 106.

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taken from Tables 33 and 80 - the latter Tables being converted to short tons to give a true comparison and then multiplied by one and one-half to give "coal equivalent".

Table 82 is significant in that it is believed that this is the first time that any detailed study of the energy position in the Union of South Africa has ever been carried to the stage where a direct comparison could be made of the parts played by coal and petroleum in meeting energy demand. Later in this Chapter a similar comparison will be made in terms of British Thermal Units and this will give a more exact picture of the trends of energy consumption but, for the time being, certain interesting facts can be learned from the admittedly approximate "coal equivalent" method.

In the first place this method of comparison shows up the Union's heavy reliance on coal as a source of energy. In round figures, about 90% of demand is met from coal as the basic fuel, whilst only about 10% of energy consumed is in the form of petroleum fuels. However it should be remembered that these two energy sources are not necessarily interchangeable in all applications. Coal, for example, could not be used directly as a motor fuel and there are numberless instances in the field of transportation where there is no substitute for petroleum products in the internal combustion engines of road vehicles or tractors. Similarly in the sphere of power driven machinery there are many items of equipment which cannot operate on coal energy or which require to be mobile in use and these depend almost entirely on petroleum fuels for their motive power. It is interesting (but perhaps at this stage rather fruitless) to speculate on how the relative ratios of demand for coal energy and petroleum energy as shown in Table 82 might change, if the protection from road transport competition afforded to the railways in terms of the Motor Carrier Transportation Act of 1930 should ever be removed. ƀ

A second point of interest in Table 82 is to note the trend in consumption of coal and petroleum when measured in terms of "coal equivalent". Over the fifteen year period 1951 to 1966 the consumption of petroleum products as a percentage share of total energy shows a gradually rising tendency, whilst the share attributable to coal is gradually falling. Admittedly the variation is slight, being only 1.14% over the period, but it may nonetheless be significant. The very small percentage difference between 1961 and 1966 may indicate a genuine levelling-out tendency or it may be just a short-term variation of the observed trend. On the other hand it may be due, in part, to the methods employed in independently estimating 1957-66 coal consumption and oil consumption. It was mentioned in the preceeding Chapter that full information concerning trends in the likely substitution of oil for coal (and vice versa) could not always be obtained and, although every effort was made to take such substitution into account (wherever data was available), observations over a much longer period would be necessary before establishing any definite trend in regard to the relative shares of coal and oil in the energy market. The ratios shown in Table 82 however, are nevertheless considered to give a fair approximation of the current short-term position.

It will be noticed from Table 82 that the average annual

ƀ See discussion in Chapter 3, Part 5.

TABLE 82

SOUTH AFRICAN ENERGY CONSUMPTION - 1 [x]

COAL EQUIVALENT METHOD OF COMPARISON

(Thousands of tons of 2,000 lbs)

COAL AND PETROLEUM	1951	%	1956	%	1961	%	1966	%
1) Coal (Thousands of tons)	26,868.4	90.23	34,678.5	89.55	44,649.0	89.10	56,880.0	89.09
2) Petroleum Products (Coal Equivalent)	2,910.3	9.77	4,047.8	10.45	5,462.2	10.90	6,963.9	10.91
TOTAL ENERGY CONSUMPTION								
3) Coal and Oil Fuels (Coal Equivalent)	29,778.7	100%	38,726.3	100%	50,111.2	100%	63,843.9	100%
Average Annual Rates of Increase based on 1951	-		5.40%		5.34%		5.22%	

(x Union And South West Africa inland market only)

(Compiled from tonnage figures given in Tables 23, 25, 33 and 80 - see text of Chapter 5)

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rates of increase in total consumption reflect the following pattern:-

1951 - 1956 ..... 5.40%

1951 - 1961 ..... 5.34%

1951 - 1966 ..... 5.22%

However, the following quantitative figures provide the best illustration of the expected growth of energy demand, measured in terms of short tons coal equivalent:-

Increase 1956 over 1951 ..... 8,947,600 tons

Increase 1961 over 1956 ..... 11,384,900 tons

Increase 1966 over 1961 ..... 13,732,700 tons

Once again it must be emphasised that the trend over fifteen years cannot be accepted as a long-term indication without further statistical evidence of past demand to substantiate the findings. However the observed trend over the period is a significant advance in available knowledge of energy demand in terms of coal equivalent and should be compared with similar findings measured in British Thermal Units which will be discussed in Part Four of this Chapter.

2. DETERMINATION OF TOTAL COAL ENERGY

The calorific value of a fuel is a measure of the quantity of heat energy it contains and such energy is frequently expressed in terms of British Thermal Units per pound weight. Table 83 shows the B.T.U. values of the more commonly used fuels and it will be noticed that average figures are quoted for certain petroleum products, whilst a range of 10,200 to 14,600 B.T.U. is given for coal. These figures represent typical world averages but are only broadly applicable to South African coals and to petroleum fuels marketed in the Union. One of the problems which this Thesis set out to solve was concerned with the quantitites of various fuels sold annually and the energy content of such fuels as consumed in the Union. For this latter purpose it was necessary to obtain more exact figures of energy content than the world averages given in Table 83 and the information gathered previously must be examined in some detail with a view to determining energy values applicable to fuels marketed in the Union of South Africa.

In Part One of Chapter One discussion centred on the standards of quality applicable to South African coals and it was there shown that coals sold for export and bunker purposes were graded by the Fuel Research Institute according to certain specifications which included, inter alia, calorific values expressed in lbs/lb units. Such export and bunker gradings are as follows:-

1) First Grade - Minimum Calorific Value 12.8 lbs/lb. (12,416 B.T.U.)

2) Second Grade - Minimum Calorific Value 12.3 lbs/lb. (11,931 B.T.U.)

3) Under Second Grade - below minimum for second grade.

[6] See Ref.17, Page 924. One B.T.U. equals the amount of heat required to raise the temperature of one pound of water one degree fahrenheit.

TABLE 83

ENERGY VALUES EXPRESSED IN BRITISH THERMAL UNITS

(Rough Gross Values in B.T.U's per lb)

Coal (Bituminous)	10,200	to	14,600
Lignite	3,720	to	7,440
Crude Oils	18,300	to	19,500
Gasoline (Petrol)			20,500
Kerosene			19,800
Benzole			18,100
Gas Oils			19,200
Fuel Oils (Bunker)			18,300
Ethyl Alcohol			11,600
Petroleum Fuel (Average)			18,900
Natural Gas (per cu. ft.)			1,000
Electricity (per kwh)			3,410

N.B. As the B.T.U. is a very small unit, it is usual to consider the various energy sources in terms of one hundred million million at a time, or 10^{14} B.T.U.

(Compiled from:- Petroleum Press Service, London and Shell Magazine, January 1956 (World Energy Outlook 1954 - 1965")

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It was also mentioned in Chapter One that the grading of coal sold on the Inland market was not compulsory and that no certificates of this nature had been issued. It follows therefore that whilst the grading of export and bunker coals must conform to certain specifications there are no such controls over coal sold on the inland market, the calorific value and other properties being a matter for negotiation between buyer and seller. This absence of a uniform grading system for the inland market makes it very difficult to determine the average calorific values of coal sold as each transaction could be on a different basis and, in practice, the coal produced by each colliery possesses different heating characteristics.

In view of the absence of official coal grading regulations for the inland market it became necessary to attempt to arrive at average calorific values for coal used by the major consuming groups using information supplied from other sources. Some of this information was collated in Chapter Two when discussing patterns of coal consumption and some has been obtained by personal contact with officials concerned with the purchase or distribution of coal. The following is a brief review of the position insofar as it affects the approximate average calorific value of coal used in the inland market:-

a) Railways - In Part Two of Chapter Two it was shown that 83% of the coal purchased by the Administration during 1946/47 possessed a calorific value of 12.20 lbs/lb or more, of which over 50% fell within the range of 12.20 to 12.80 lbs/lb. During discussions with S.A.R. officials in regard to present calorific value it was mentioned that whilst they had (in some instances) to accept coal of about 12.00 lbs/lb, the general average calorific value remained fairly high and could reasonably be compared with the 1946/47 figures. Railway officials pointed out that the chief complaint nowadays was not so much in regard to calorific value as in regard to the supply of mixed sizes of coal, the "smalls" having an adverse effect on the efficiency of firebox and boiler operation. It was agreed that a weighted average calorific value of about 12.5 lbs/lb for locomotive coal used during 1956/57 would not be unreasonable, and in terms of British Thermal Units, this approximates to 12,100 B.T.U./lb.

b) Gas - Table 14 shows that over 70% of all coal consumed in gas production was used in the Johannesburg Municipal Gas Works. In Chapter Two, Part Four it was shown that this plant was using gas coking coal of 12.5 lbs/lb calorific value obtained from the Witbank area. In future a semi-coking coal will be used, because of the need to conserve high grade coking coal for Iscor, but it is unlikely that this will differ greatly in calorific value from the coal at present in use. Of the other Gas companies, Cape Town and Port Elizabeth will continue to use good quality semi-coking coal, but Grahamstown and Springs are using coal of a lower calorific value. All in all the weighted average calorific value of coal used in the

6 During 1946/47 the average was 12.58 lbs/lb. See Ref. 9, Para. 323.

4 To convert lbs/lb units to B.T.U. multiply by 970

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production of town gas is probably a little less than 12.5 lbs/lb (12,120 B.T.U.) and the figure of 12,000 B.T.U. has been adopted for calculation purposes.

c) Electricity - The discussion which took place in Part 5 of Chapter 2 showed that, in general, there were two categories of coal used for thermal electricity production - low grade coal used by Escom, and medium/high grade coal used by municipal electricity undertakings. Table 15 (Page 66) summarises the position insofar as Escom is concerned and shows an average calorific value of about 10,000 B.T.U./lb for coal consumed during the years 1947/56. Table 16 (Page 67) gives similar figures for thirty-four municipalities and estimates the average calorific value of coal consumed at about 11,500 B.T.U./lb. However Escom consumed more than four times the quantity of coal consumed by municipalities each year, hence the weighted average calorific value of all coal used in electricity production will be much nearer to Escom's 10,000 B.T.U. than to the municipalities figure of 11,500 B.T.U. An approximate calculation suggests that the figure 10,300 B.T.U./lb is reasonably representative of the weighted average energy content of coal used in electricity production.

d) Coking - When discussing coking coal in Part 6 of Chapter 2 it was shown that the available reserves of high grade coking coal from Natal were being eked out by admixture with blend coking coals from the Witbank field. Iscor is by far the largest consumer of coking coal and in private correspondence it was indicated that the average calorific value of blend coking coal used was about 12,500 B.T.U./lb. This figure has been adopted as the measuring yardstick for all coals used for coking purposes.

e) Mining - Officials of the Transvaal and Orange Free State Chamber of Mines were unable to give an average calorific value for coal purchased by their members, but they indicated that varying grades were used according to the proximity of mines to various coalfields. For comparative purposes it was suggested that an average of 12,000 B.T.U./lb would be reasonably correct on a Union-wide basis and this figure has been adopted for energy calculations. As a matter of interest, the 1946/47 Coal Commission reported that the average calorific value of coal used for mining purposes approximated to that used by the Railways. It can be accepted that the new Orange Free State gold mines consume a certain amount of local coal of lower calorific value and therefore a 1956 average of 12,000 B.T.U./lb for all coals used by the mining industry, in comparison with the railways average of 12,100 B.T.U./lb, does not seem out of place.

6 Letter reference CP/MM dated 21.11.57.
4 Ref.9, Para. 388 (d)

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f) Domestic, Industry and General - This category of consumer was discussed at length in Part 8 of Chapter 2 where it was shown that very little data concerning demand patterns could be obtained. It was possible to arrive at an approximate coal consumption estimate only be deducting other known figures from the annual total of inland sales and allocating the residual balance to "Domestic, Industry and General". However this method could not be used for computing average calorific values and it was found necessary to approach selected coal merchants in the major cities for further information. Their comments can be summarised as follows:-

i) As a general rule industrial consumers in all parts of the Union purchase the higher grades of coal because calorific value is an important factor in industrial usage. Furthermore, in places where freight charges form a large part of the delivered prices of coal, the demand is invariably for the best quality available. Calorific values of coal sold for industrial purposes during 1956/57 varied between 12.0 and 13.5 lbs/lb but most coal merchants agreed that 12.5 lbs/lb would represent a fair weighted average on an approximate Union-wide basis. Typical figures for coal supplied to the industrial areas of the Transvaal (ex Witbank coal field) were as follows:-

Round and cobbles ..... from 12.1 to 13.1 lbs/lb.
Nuts and peas ..... from 12.2 to 12.9 lbs/lb.

ii) Coal merchants in coastal areas remote from coalfields were emphatic that because railage costs form such a large part of the selling price to customers there was no point in selling anything other than the best quality coal. Railage on all grades of coal was the same, and customers would not be satisfied with low grade coal at the prevailing few pennies price differential per ton. Once again there seemed to be a fair measure of agreement that, for the period 1956/57, 12.5 lbs/lb represented a reasonable average calorific value for coals sold at coastal ports, although in Natal calorific values were somewhat higher than this.

iii) The position in regard to domestic and general customers in the Transvaal provided a different picture. The 1946/47 Coal Commission reported that a considerable quantity of low grade coal was being sold for domestic purposes in Reef Areas, and the coal merchants

ƀ See G.N. 552 in G.G. No. 5852 d.d. 12.4.1957.
ƒ Ref.9, Paras. 388 (c) and 343

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reported as follows in regard to the 1956/57 sales:-

a) Coal supplied from the Witbank area for domestic and general consumption in the Northern Trasnvaal and East Rand districts possessed calorific values varying from 11.1 to 12.0 lbs/lb (say 11.5 lbs/lb average).

b) Coal supplied from the Vereeniging area for domestic and general consumption in Johannesburg and the West Rand districts possessed calorific values varying from 9.6 to 10.1 lbs/lb (say 9.8 lbs/lb average). The lower calorific value of coals sold for domestic purposes in the Reef areas was apparently of little consequence to consumers as they were accustomed to this type of coal which, in any case, possessed a reasonably high volatile matter content.

Having regard to the above evidence of approximate calorific values of coal as sold for the "Domestic, Industrial and General" market, the next step was to determine a figure which could be used as a guide when calculating the total energy content of all coal sold under this heading. It was assumed that the Transvaal accounted for about half the total coal consumed by the category of "Domestic, Industrial and General", the rest being sold mainly at the larger coastal cities. A number of calculations were made attributing arbitrary estimates of tonnages to the various calorific values outlined above, and in each case the resulting overall average was in the region of 11.9 to 12.0 lbs/lb. On conversion to British Thermal Units it was decided to use the figure of 11,600 B.T.U./lb as being conservatively representative of the weighted average energy content of coal sold in this section of the inland market.

It should be emphasised that the various average calorific values of coal discussed above are only approximate estimates obtained by rule of thumb methods (in the absence of any more reliable indicators) in an effort to find some basis for calculating energy consumption. The conclusions reached can be summarised as follows, in terms of approximate weighted average calorific values of coal consumed by each sector during the years 1956/57:-

1) Railways ..... 12,100 B.T.U./lb

2) Gas Production ..... 12,000 B.T.U./lb

3) Electricity ..... 10,300 B.T.U./lb

4) Coking ..... 12,500 B.T.U./lb

5) Mining ..... 12,000 B.T.U./lb

6) Domestic, Industry and General ..... 11,600 B.T.U./lb

TABLE 84 - COMPARISON OF COAL CONSUMPTION BY TONS AND ENERGY CONTENT: 1956 AND 1966

(Thousands of Short Tons and British Thermal Units x 10^9)

	1956				1966				
	Tons (1)	%	B.T.U. (2)	%	Tons (3)	%	B.T.U. (4)	%	Average B.T.U./lb (5)
1. Railways	7,076.9	20.41	171,261.0	21.84	9,305.0	16.36	225,181.0	17.74	12,100
2. Gas	168.5	0.48	4,044.0	0.52	254.0	0.45	6,096.0	0.48	12,000
3. Electricity	12,984.5	37.44	267,480.7	34.10	27,171.0	47.77	559,722.6	44.10	10,300
4. Coking	2,457.4	7.09	61,435.0	7.83	5,119.0	9.00	127,975.0	10.08	12,500
5. Mining	2,364.0	6.82	56,736.0	7.23	1,931.0	3.39	46,344.0	3.65	12,000
6. Domestic Industry and General	9,627.2	27.76	223,351.0	28.48	13,100.0	23.03	303,920.0	23.95	11,600
7. TOTAL CONSUMPTION	34,678.5	100%	784,307.7	100%	56,880.0	100%	1,269,238.6	100%	
Average Calorific Value (B.T.U./lb)			11,308				11,157		
Percentage increase on 1956 -			-		64.02		61.83		

(Compiled from Tables 23, 25 and 85 using 1956 calorific values as stated in Chapter 5)

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The 1946/47 Coal Commission found that the average calorific value of all coal sold during March 1947 was 12.04 lbs/lb, equal to 11,679 B.T.U./lb. The Commission further stated that this could be "said to present a fairly representative summary of the quality position in the industry as a whole". Table 84 shows that on the basis of the 1956 average calorific values discussed above and shown in column 5 of the Table, the average calorific value of all coal sold during 1956 was 11,308 B.T.U./lb, i.e. - a decrease of 371 B.T.U./lb on the 1947 figure. Having regard to the millions of tons of low grade coal now being used by Escom for the generation of electricity it is felt that the average figure of 11,308 B.T.U./lb is by no means unrealistic for 1956 consumption conditions. It will be noticed from the same Table that if the 1956 calorific values are applied to the estimated 1966 coal consumption, the average B.T.U. value of the total drops again to 11,157 B.T.U./lb. This further drop in average calorific value is again brought about mainly by the increasing demand for low grade coal used in the generation of electricity. Item 3 of the Table shows that whereas coal consumption under this heading accounted for 37.44% of 1956 output, by 1966 the generation of electricity is expected to require no less than 47.77% of total inland coal sales.

Another item of interest from Table 84 is to note how the calorific value of the coal affects the corresponding share of total energy consumed. Demand for coking coal in 1966, for example, is expected to amount to 9.00% of coal output, but in terms of energy units coking will consume 10.08%. Similarly coal used in the generation of electricity in 1956 amounted to 37.44% of output expressed in tons, but because of the low average calorific value of such coal the energy content only represented 34.10% of total energy consumed. Similar interesting comparisons can be made for the six consuming sectors in both the 1956 and 1966 tabulations.

The final point of interest in Table 84 is that although the tonnage of coal consumed in 1966 is expected to be 64.02% higher than the 1956 figure, the energy contained in this quantity of coal will only be 61.83% greater. This is due to the decreasing average energy content of the coal as shown by the average B.T.U. values for the two years.

A study of the consumption pattern of energy derived from coal has been presented in Table 85 for each of the years 1951, 1956, 1961 and 1966. The study has been grouped according to the sectors of the economy discussed in Chapter Two and the energy figures shown have been based on the tonnages of coal given in Tables 23 and 25. Energy content of the coal was calculated on the basis of the 1956 average calorific values discussed earlier and it is interesting to note how the percentage share of the total varies for each consuming sector in each year. Railway consumption, for example, is calculated to drop from 23.25% of the 1951 total to 17.74% of the 1966 total. On the other hand the consumption of energy for electrical generation rises during the same period from 29.95% to 44.10%. This latter figure prompts the thought that by about 1970, roughly half of all the coal energy produced in the Union will be used in the production of thermal electricity - a striking illustration of the transformation of energy from one form to another in order to give it greater utility to the consumer. Table 85 also shows that over the fifteen year

Ref. 9, Para. 308

TABLE 85 - CONSUMPTION OF ENERGY FROM COAL ACCORDING TO CONSUMER GROUPINGS x

(British Thermal Units x 10^9)

		1951	%	1956	%	1961	%	1966	%
1.	Railways	142,308.1	23.25	171,261.0	21.84	197,084.8	19.61	225,181.0	17.74
2.	Gas	3,460.8	0.56	4,044.0	0.52	4,776.0	0.48	6,096.0	0.48
3.	Electricity	183,333.3	29.95	267,480.7	34.10	385,446.6	38.35	559,722.6	44.10
4.	Coking	51,800.0	8.46	61,435.0	7.83	108,950.0	10.84	127,975.0	10.08
5.	Mining	66,208.8	10.82	56,736.0	7.23	51,288.0	5.10	46,344.0	3.65
6.	Domestic, Industry and General	165,028.6	26.96	223,351.0	28.48	257,520.0	25.62	303,920.0	23.95
7.	Total Energy from Coal	612,139.6	100%	784,307.7	100%	1,005,065.4	100%	1,269,238.6	100%
	Percentage increase on 1951	-		28.13		64.19		107.34	

(x Union and South West Africa inland market only, i.e. excluding coal required for export and bunkers. Coal consumed by Sasol is also excluded as this is not subject to normal trends of market demand - See Chapter 2 Parts 3 and 9, also Tables 23, 25.)

(Compiled from tonnage figures given in Tables 23 and 25 using 1956 calorific values as stated in Chapter 5).

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period the total increase in energy requirements will be some 107.34%. This should be compared with the 61.83% shown in Table 84 for the estimated increase in energy consumption during the period 1956-1966.

3. ANALYSIS OF ENERGY FROM PETROLEUM.

In Part Two of this Chapter it was necessary to make a number of assumptions and estimates in order to arrive at approximate figures for the energy content of various coals sold on the inland market. Insofar as the energy content of petroleum products is concerned the position is very much easier, as each of the major oil companies keeps accurate records of the calorific values of its various fuels. Furthermore, since there is a certain measure of uniformity in the calorific content of competing brands of petroleum fuels sold on the inland market, it is not difficult to arrive at average figures of B.T.U. values acceptable to all companies. The following tabulation therefore sets out approximate average calorific values as determined by the major oil companies:-

1.	Motor Gasoline	20,400 B.T.U./lb
2.	Aviation Gasoline	20,400 B.T.U./lb
3.	Illuminating Kerosene	20,000 B.T.U./lb
4.	Power Kerosene	19,800 B.T.U./lb
5.	Aviation Turbine Fuel	19,900 B.T.U./lb
6.	Automotive Diesel Oil	19,700 B.T.U./lb
7.	Industrial Diesel Oil	19,500 B.T.U./lb
8.	Furnace Oil	19,300 B.T.U./lb

It should be noted that these specifications refer to the inland market only, and the 19,300 B.T.U./lb shown against Furnace Oil (for example) is not applicable to marine bunker fuel although the latter is certainly a type of "furnace oil".

The average calorific values shown above have been used in calculations to determine the energy content of the various petroleum fuels sold in 1951 and 1956 and also in similar calculations of the probable demand for such energy in the years 1961 and 1966. A comparison of tons of fuel and energy units for the years 1956 and 1966 is given in Table 86, arranged in similar manner to Table 84. The higher calorific values of petroleum fuels as compared with coal are immediately noticeable from a comparison of column (5) in each Table. It is also significant that whereas the difference between the lowest and highest calorific values for petroleum fuels is only 1,100 B.T.U./lb the corresponding difference in average coal values is 2,200 B.T.U./lb. Hence a marked increase in the consumption of "low grade" petroleum fuels such as automotive diesel oil does not have such a pronounced effect on the average calorific value of total

The calorific value of marine bunker fuel as sold at South African ports is approximately 18,500 B.T.U./lb.

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TABLE 86 - COMPARISON OF PETROLEUM CONSUMPTION BY TONS AND ENERGY CONTENT: 1956 AND 1966

(Thousands of Long Tons and British Thermal Units x 10^9)

		1956				1966				Average
		Tons (1)	%	B.T.U. (2)	%	Tons (3)	%	B.T.U. (4)	%	B.T.U./lb (5)
1.	Motor Gasoline	1,342.2	55.71	61,333.2	56.46	2,067.0	49.87	94,453.6	50.68	20,400
2.	Aviation Gasoline	29.7	1.23	1,357.2	1.25	23.0	0.55	1,051.0	0.56	20,400
3.	Illuminating Kerosene	179.5	7.45	8,041.6	7.40	262.4	6.33	11,755.5	6.31	20,000
4.	Power Kerosene	332.3	13.79	14,738.2	13.57	273.6	6.60	12,134.7	6.51	19,800
5.	Aviation Turbine Fuel	4.7	0.20	209.5	0.19	43.4	1.05	1,934.6	1.04	19,900
6.	Automotive Diesel Oil	464.9	19.30	20,515.1	18.89	1,403.7	33.86	61,942.5	33.23	19,700
7.	Industrial Diesel Oil	19.6	0.81	856.1	0.79	5.7	0.14	249.0	0.13	19,500
8.	Furnace Oil	36.5	1.51	1,578.0	1.45	66.4	1.60	2,870.6	1.54	19,300
9.	TOTAL CONSUMPTION	2,409.4	100%	108,628.9	100%	4,145.2	100%	186,391.5	100%	
	Average calorific value B.T.U./lb			20,130				20,070		
	Percentage increase on 1956	-		-		72.04		71.59		

(Compiled from Tables 33, 80 and 87 using 1956 calorific values as stated in Chapter 5)

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consumption as does increased consumption of low grade coal. Between 1956 and 1966 the petroleum average drops from 20,130 to 20,070 a decrease of only 60 B.T.U./lb, whilst the coal average drops from 11,308 to 11,157, a decrease of 151 B.T.U./lb. This point is of some importance when the long term trends in demand for the two forms of energy are under consideration (See Table 88).

The smaller variation in average calorific value of petroleum fuels means that percentage shares of total consumption based on units of volume do not show a great deal of variation from percentage shares based on energy units. Columns (1) and (2) of Table 86 can be compared thus for 1956 and Colums (3) and (4) for 1966. It is more revealing however to compare the major contributors to energy supply in 1956 with the major contributors to such supply ten years later. In the former year petrol supplied 56% of demand, power kerosene 13½% and automotive diesel oil nearly 19%. By 1966 it is expected that the contribution of petrol will have dropped to a little over half, whilst automotive diesel oil will be supplying about one third of total demand for petroleum energy. The total consumption of such energy is expected to rise by about 72% during the ten year period.

A study of the consumption pattern of energy derived from coal was presented in Table 85 and a somewhat similar presentation for energy derived from petroleum is given in Table 87. The main point of difference is that whereas Table 85 was grouped according to main consuming sectors in order to determine average calorific values, a product grouping system has been adopted in Table 87 for the same purpose. The latter tabulation, incidentally, is believed to represent the first time that any study of the Union's petroleum requirements has been carried to the stage of complete energy analysis and, although details are given for four years only, the pattern can easily be adapted for other periods. Quantitative units of energy and percentage shares of total consumption are shown for each product in each of the years 1951, 1956, 1961 and 1966. The respective trends can be clearly seen for the eight products over the fifteen year period, and it should be noted that the increase in total consumption between 1951 and 1966 is expected to amount to 138%. This can be related to the 72% shown in Table 85 for the period 1956-1966. The expected increase in coal energy consumed between 1951 and 1966 was shown as 107% in Table 85, compared to the 138% shown in Table 87 for energy from petroleum consumed during the same period. This indicates a faster rate of growth in demand for petroleum energy than for coal energy, although in absolute terms coal energy accounts for a much greater tonnage of fuel than does petroleum energy (See Tables 84 and 86).

4. TOTAL ENERGY CONSUMPTION

In earlier chapters every effort was made to build up a complete picture insofar as the two main energy resources of the Union were concerned. Chapter One dealt with the production and distribution of coal, whilst Chapter Three outlined the South African Oil Industry. Similarly Chapters Two and Four discussed patterns of consumer demand for coal and petroleum respectively. It was shown that statistical records of supply were reasonably adequate in terms of tons of coal and tons or gallons of petroleum,

TABLE 87 – CONSUMPTION OF ENERGY FROM PETROLEUM ANALYSED BY PRODUCT [x]

(British Thermal Units x 10^9)

		1951	%	1956	%	1961	%	1966	%
1.	Motor Gasoline	48,721.1	62.25	61,333.2	56.46	76,563.6	52.33	94,453.6	50.68
2.	Aviation Gasoline	968.8	1.24	1,357.2	1.25	872.8	0.60	1,051.0	0.56
3.	Illuminating Kerosene	6,038.8	7.77	8,041.6	7.40	9,753.0	6.67	11,755.5	6.31
4.	Power Kerosene	11,385.2	14.55	14,738.2	13.57	13,363.3	9.13	12,134.7	6.51
5.	Aviation Turbine Fuel	22.3	0.03	209.5	0.19	1,511.1	1.03	1,934.6	1.04
6.	Automotive Diesel Oil	8,371.1	10.70	20,515.1	18.89	41,674.5	28.48	61,942.5	33.23
7.	Industrial Diesel Oil	1,633.6	2.09	856.1	0.79	253.3	0.17	249.0	0.13
8.	Furnace Oil	1,072.2	1.37	1,578.0	1.45	2,317.2	1.59	2,870.6	1.54
9.	Total Energy from Petroleum	78,258.1	100%	108,628.9	100%	146,308.8	100%	186,391.5	100%
	Percentage Increase on 1951	–		38.81		86.96		138.18	

(x Union and South West Africa inland market only, i.e. excluding bunker fuels for ocean shipping)

(Compiled from tonnage figures given in Tables 33 and 80 and using 1956 calorific values as stated in Chapter 5)

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but that data concerning demand by various sectors of the national economy were often not available in sufficient quantity to allow detailed analysis and discussion. Nevertheless, by dint of assembling all the available statistics and enlisting
ϕ the co-operation of many different authorities it was possible to draw up Tables of consumption covering the period 1947 to 1956, and to forecast probable demand for the following ten years. The forward estimates were for the most part based on the opinions of the authorities concerned with consumption and distribution of coal and petroleum and, whilst every effort has been made to obtain independent predictions to support these forecasts, it has sometimes not been possible to obtain relevant supporting data.

Typical of the problems that arose in regard to the use of supporting indicators is one concerning the consumption of locomotive coal by the South African Railways. It was realised that demand for coal could be related to ton-miles operated and perhaps to the relative milage of the permanent way that was served by steam traction as compared to that which was electrified. In following up these lines of thought however it was found that railway figures for ton-miles operated are quoted only in relation to freight traffic. No such figures are given for passenger traffic and the ton-mile indicator for freight is not sub-divided as between electric and steam traction. Similarly, although statistics for the relative milage of electrified route could be compared to the milage under steam traction, there are no corresponding statistics to show the relative density of traffic on particular routes and, in any case, steam traction is often used on electrified routes. It was therefore not possible to use these indicators in support of estimates of demand for locomotive coal, owing to insufficient data being available.

The above example illustrates the difficulty of obtaining independent checks on consumption estimates and is typical of the problems that were met at all stages and in regard to all predictions. The result has been that a large measure of reliance has perforce had to be placed on the opinions of experts, unsupported by independent statistical indicators. In a pioneer work of this nature it is perhaps inevitable that this should be the case to a certain extent, but it is to be hoped that future investigators into problems of energy economics in the Union will be able to rely upon more accurate and detailed statistics than are presently available.

The consumption Tables which were established in Chapters Two and Four dealt with coal and petroleum in units of short and long tons respectively. In the preceeding portions of this Chapter it has been possible to convert such figures to show the energy contained in the various grades and types of fuel (expressed in British Thermal Units) and thus build up a picture of total energy demand for each type. Table 85 summarises the findings of Chapter Two in terms of British Thermal Units whilst Table 87 performs a similar function for Chapter Four. It remains to combine these two Tables for coal energy and oil energy into one master Table representing the overall consumption position for primary commercial energy in the Union of South Africa.

ϕ See "Acknowledgements" in Preface.

TABLE 88

SOUTH AFRICAN ENERGY CONSUMPTION - 2 [x]

(British Thermal Units x 10^9)

	1951	%	1956	%	1961	%	1966	%
Energy from Coal	612,139.6	88.66	784,307.7	87.83	1,005,065.4	87.29	1,269,238.6	87.20
Energy from Petroleum	78,258.1	11.34	108,628.9	12.17	146,308.8	12.71	186,391.5	12.80
Total Energy Consumption	690,397.7	100%	892,936.6	100%	1,151,374.2	100%	1,455,630.1	100%
Average Annual Rates of Increase based on 1951	-		5.28%		5.25%		5.10%	

(Compiled from Tables 85 and 87)

(x Union and South West Africa - inland market only)

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The final Table in this Thesis, Table 88, represents the culmination of all the work that has gone before. It sums up in three lines the end result of three years of research and with its aid it is now possible to compare the total consumption of coal energy and petroleum energy in the economy of the Union. This Table shows firstly that energy from coal represents roughly seven-eighths of the total consumed, compared to one-eighth for energy from petroleum. Admittedly the latter is increasing slightly over the years in its percentage ratio to coal energy, but the effect is slight and quantitatively insignificant. Table 88 in terms of British Thermal Units should be compared to Table 82 where a comparison was expressed in terms of "coal equivalent" and it will be noticed that the former shows an 8 to 1 energy ratio for coal and oil compared to a 10 to 1 comparative ratio in the latter Table. This is perhaps a measure of the relative degree of accuracy of these two methods of calculating total energy demand.

The average annual rates of increase applicable to Table 88 show the following pattern:-

1951 - 1956 ..... 5.28%

1951 - 1961 ..... 5.25%

1961 - 1966 ..... 5.10%

Although the percentage rate of growth is declining, figures of total consumption reveal a distinct and progressive growth in the absolute rate of demand. The following figures taken from Table 88 (expressed in terms of British Thermal Units x 10^9) are self-explanatory in this regard:-

Increase 1956 over 1951 ..... 202,538.9

Increase 1961 over 1956 ..... 258,437.6

Increase 1966 over 1961 ..... 304,255.9

It follows from this that the absolute consumption of energy in terms of British Thermal Units is rising annually. There is however a growing demand for both coal and oil products in the lower calorific value ranges, which is sustained by the lower prices generally applicable for such fuels. Increasing use of these fuels of lesser energy value means that consumption figures in terms of units of quantity (tons) will tend to rise more rapidly than consumption figures calculated in energy units. (See Tables 84 and 86 for a comparison of 1966 estimated consumption compared with 1956 figures in tons and British Thermal Units.)

To conclude this portion on South African energy it is fitting to consider the relationship between the average annual rates of increase for energy consumption in the Union, as revealed by Table 88, and those estimated by eminent authorities for the world in general. Perhaps the most up-to-date information of this nature is contained in papers submitted to the

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International Conference on the Peaceful Uses of Atomic Energy in 1955 and, in particular, in a paper on "World Energy Requirements in 1975 and 2000", prepared by the United Nations Secretariat. This paper showed that during the period 1860 - 1953 ϕ the rate of growth in world supplies of commercial sources of energy had averaged 3½ per cent compounded annually. After analysing world requirements in terms of energy usefully consumed (as distinct from total energy supplied) the paper concluded that in order to meet future energy demand it would probably be nec- ∠ essary for the supply of conventional energy fuels to be increased at an average rate of 3½% per annum, until such time as nuclear energy became economically available for widespread use.

Other authorities have prepared estimates of world energy consumption which differ from those expressed above. Professor E.A.G. Robinson of Cambridge University, for example, has estimated that during the first half of this century world con- x sumption of conventional energy fuels rose by about 2% per annum compounded, and this agrees with some earlier United Nations ⌘ estimates given in "World Energy Supplies in Selected Years 1929 - 1950". However Ronbinson feels that the trend of growth in world energy demand is likely to approximate an average compound // rate of 2½% per annum during the foreseeable future.

The problem now is how to reconcile these estimates of rate of growth in world energy requirements (which vary from 2½% per annum to 3½% per annum) with the figure of over 5% per annum average increase shown for South Africa in Table 88. The answer to this problem lies in the fact that growth in energy consumption is closely related to rate of economic growth, and that for particular countries the former may be above or below world averages.

E.S. Mason, Professor of Economics at Harvard University and a recognised authority on world energy problems, has examined this aspect of energy economics in some detail. His method of approach is to divide the countries of the world into three groups, according to observed patterns of economic development. Mason ϕϕ categorises countries such as the United States, Great Britain, and most nations of Western Europe as "mature industrial economies" and shows that these account for over 60% of world energy consumption. However because of the stable nature of the main energy consuming sectors of their economies - manufacturing, transport and mining - the probable rate of growth in energy consumption is estimated at only 2 to 2½ per cent per annum. In arriving at this estimate Mason reviews other independent regional predictions made by United States and European authorities (varying xx between 1¼% and 3%) and also takes pains to define the main energy consuming characteristics of a mature industrial economy.

At the other end of the economic scale Mason considers the under-developed areas of the world, including most of Asia and Africa and some parts of Latin America. This area accounts for about 15% of world energy consumption at present and Mason hazards a guess that a projected rate of increase in future energy consumption of 4% per annum would not be far out.

ϕ Ref.52, Page 16.
∠ Ibid, Page 30.
x Ref.55, Page 3.
⌘ Ref.22, Page 32.
// Ref.55, Page 9.
ϕϕ Ref.53, Chapter 1
xx Ibid, pp. 12-14

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The third group of countries especially concerns South Africa and it is categorised as "those whose economies are currently subject to rapid increase in industrialisation"[6]. This group of countries accounts for about 25% of world energy consumption and Mason feels that the average annual rate of growth in energy requirement is a figure somewhat in excess of 5% per annum compound. There can be no doubt that South Africa is a country whose economy is "currently subject to a rapid increase in industrialisation", as the patterns of demand for energy fuels discussed in Chapters Two and Four have shown. It is therefore worthy of note that the average annual rates of increase in energy consumption shown for South Africa in Table 88 are in general agreement with the world average as propounded above by Professor Mason.

5. COMPARISON OF ENERGY COSTS

This Chapter would not be complete without some reference to the comparative costs of energy from coal and energy from petroleum fuels. In making such a comparison it is necessary to take into account three variable factors:-[7]

i) the cost of the fuel at pit-head or at oil company depot;

ii) transportation charges to the place of consumption, where applicable;

iii) the energy content of the fuel.

It will be appreciated that the transportation charges on coal and oil fuels vary according to distance from the source of supply and the mode of transport employed. Therefore in order to simplify the problem of comparing unit costs of energy it is proposed to discuss the position at one inland and one coastal centre, say Johannesburg and Cape Town, as being typical examples. To further simplify the problem examples will be restricted to fuel used for industrial purposes, domestic use, electricity generation and transport. A comparison of energy costs for these purposes in these two cities will therefore offer a representative selection of high and low calorific values and long and short-haul transportation charges. The energy content of the fuels will be calculated in British Thermal Units but, as this is a very small amount, it is proposed to base comparisons on the respective costs of one million British Thermal Units, which will be expressed as $B.T.U. \times 10^6$.

It should be stressed that the calculations to be made in this section are intended to compare only the delivered cost of coal energy and petroleum energy in Johannesburg and Cape Town. No allowance will be made for the amount of useful energy actually obtained from the fuel, as insufficient data is at present available to compare the efficiencies of different forms of energy in use under South African conditions. Similarly no allowance can be made for "convenience" as it is not possible to measure satisfaction in terms of pence. Domestic consumers, for example,

[6] Ibid, Page 3

[7] There is a fourth variable factor in the cost of equipment and labour required for the transformation of fuel into energy. This however varies according to the circumstances of each case and cannot be taken into account for present purposes.

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may prefer to pay relatively more for the convenience and cleanliness of using paraffin energy in their kitchens rather than be faced with the task of storing, handling and burning coal. This however, is an expression of personal preferences which may have some indirect bearing on total costs in specific instances, but which cannot be related to the direct costs of energy contained in the respective fuels.

The calorific values used in the following examples are, unless otherwise stated, taken from the estimates made in Parts 2 and 3 of this Chapter. The controlled prices of coal are those given in Government Notice 1070 of 25th July 1958 and railage costs are taken from the official S.A.R. Tariff Book. Cost figures for petroleum fuels have been supplied by Atlantic Refining Company of Africa (Pty.) Ltd. (as at July 1958)

a) Energy Costs in Johannesburg

The calculation of coal energy costs in Johannesburg is complicated by the fact that both rail and road transport are used for the conveyance of coal and that different pit-head prices are applicable for the two modes of transport. Road transport of coal from Witbank to Reef towns was introduced to relieve congestion on the railways and to release trucks for other services. The cost of such road transport is subsidised from a levy of 1/- per ton payable on all coals sold at the pit-head. In the following examples therefore the 1/- levy will be added to pit-head cost but, for simplicity, calculations will be based on rail transport costs in every case. The rail distance from Witbank to Johannesburg is about 90 miles and from Vereeniging to Johannesburg about 48 miles.

i) Industrial consumers use coal with an average calorific value of 12.5 lbs/lb which is equal to about 12,100 B.T.U./lb (in round figures). The pit-head price of this grade of coal is 12/9d. per ton of 2,000 lbs and the rail charge from Witbank to Johannesburg is 12/- per ton. Thus the cost in terms of British Thermal Units of energy can be expressed as follows:-

$$\frac{\text{12/9d plus 12/-}}{2{,}000 \times 12{,}100} = \frac{\text{app. 12.0d./B.T.U.} \times 10^6}{}$$

The equivalent petroleum fuel for industrial heating purposes would be furnace oil, which has a calorific value of 19,300 B.T.U./lb, a specific gravity of about 0.865, and which sells for 97/6 per drum of 45 gallons. Comparable energy costs would therefore be:-

$$\frac{\text{97/6d.}}{45 \times 8.65 \times 19{,}300} = \frac{\text{app. 156d./B.T.U.} \times 10^6}{}$$

The ratio of direct cost of coal energy and oil energy used for industrial purposes in Johannesburg is thus 12 : 156 or, say 1 : 13 in favour of coal.

ϕ See G.N. 1070 d.d. 27.7.58. (G.G. 5852)

ii) Domestic consumers in Johannesburg mostly use low grade coal from the Vereeniging area, having a calorific value of about 9.8 lbs/lb equal to about 9,500 B.T.U./lb. The pit-head price of this grade of coal is 11/4d per ton of 2,000 lbs and railage from Vereeniging to Johannesburg costs 9/1d per ton. However these costs only apply when coal is purchased by the truckload, and since most domestic consumers buy coal in relatively small quantities they usually make their purchases through a coal merchant, at the controlled price of 42/6d per ton. Using this information, the cost of coal energy to the domestic consumer can be calculated as:-

$$\frac{42/6d}{2{,}000 \times 9{,}500} = \text{app. } 27.0d./B.T.U. \times 10^6$$

Illuminating kerosene (paraffin) is the equivalent petroleum fuel for domestic use. This has a calorific value of 20,000 B.T.U./lb and a specific gravity of 0.790. The pattern of paraffin purchases varies in accordance with the standard of living and buying habits of different sections of the population, but most purchases are made retail in small quantities. One gallon of paraffin can be obtained in this manner for about 2/9d, provided the customer has his own container. A bottle of paraffin costs about 5½d and, on the basis of six bottles to the gallon, this is also equivalent to 2/9d per gallon. Using this figure as the typical average price, the cost of paraffin energy in Johannesburg would be:-

$$\frac{2/9d}{1 \times 7.9 \times 20{,}000} = \text{app. } 209d./B.T.U. \times 10^6$$

The ratio of direct cost for coal energy and oil energy used for domestic purposes in Johannesburg would thus be about 27 : 209 or roughly 1 : 8 in favour of coal.

iii) Electricity - The Rosherville power station is situated close to Johannesburg, and the Escom Annual Report for 1957 states that the average cost per ton of coal used at Rosherville was 18/9d, the weighted average calorific value being 9,820 B.T.U./lb. Assuming that the calorific value remained the same, and adding about 2/- per ton for increased railage costs in 1958, the present cost of coal energy would be:-

$$\frac{20/9d.}{2{,}000 \times 9{,}820} = \text{app. } 12.5d./B.T.U. \times 10^6$$

The alternative petroleum fuel for use in modern high-speed diesel generating units is automotive diesel oil. This product has a calorific value of 19,700 B.T.U./lb., a specific gravity of 0.84 and costs 2/1½d per gallon delivered in bulk in Johannesburg. A lower contract

[4] Ref.41, Statements 5 & 9

price would probably be arranged for large quantities but for purposes of illustration, the energy cost can be calculated on the current bulk price:-

$$\frac{2/1\frac{1}{2}d}{1 \times 8.4 \times 19,700} = \text{app. } 154d./B.T.U. \times 10^6$$

Based on the above information the ratio of direct cost for coal energy and oil energy used in electricity production in the Johannesburg area would be roughly $12\frac{1}{2}$: 154 or, say, 1 : 13 in favour of coal.

iv) Transport - Coal consumed by the South African Railways in 1956 cost an average of 10/8½d per ton, (f.o.r.). For calculation purposes it will be assumed that the current f.o.r. cost of coal to the South African Railways is about 11/- per ton and that the normal rail transport charges apply. The calorific value of locomotive coal has been estimated to average 12,100 B.T.U./lb. and therefore the cost of such energy in Johannesburg, assuming that the coal was railed from Witbank at 12/- per ton, would be:-

$$\frac{11/- \text{ plus } 12/-}{2,000 \times 12,100} = \text{app. } 11.5d./B.T.U. \times 10^6$$

In transportation the equivalent petroleum fuels would be diesel oil and petrol. In (iii) it was shown that the cost of energy from automotive diesel fuel was about 154 pence per million B.T.U. and this cost would be generally applicable to diesel-engined buses and other commercial vehicles. The main fuel for motorists however is petrol, the regular grade being sold to car owners in Johannesburg at 3/7½d per gallon. Using this figure as a basis for calculation, with a calorific value of 20,400 B.T.U./lb and a specific gravity of 0.72, the resultant energy cost is:-

$$\frac{3/7\frac{1}{2}d}{1 \times 7.2 \times 20,400} = \text{app. } 29d./B.T.U. \times 10^6$$

A comparison of relative costs of energy from locomotive coal, energy from diesel oil and energy from petrol gives the ratio of $11\frac{1}{2}$: 154 : 29 or roughly 1 : 13 : 26. In other words, the direct cost of energy from automotive diesel oil is about thirteen times that of coal energy, while petrol energy costs roughly double that of diesel oil. Once again, however, it should be stressed that these figures do not include any allowance for the efficiency of energy in use, nor do they take into account consumers preferences for one form of energy over another.

Ref. 38, Page 146. A more significant comparison under this heading would be between the tractive power available from (a) coal used to raise steam in a locomotive and (b) oil fuel employed to run a diesel locomotive. However the S.A.R. would not provide any information which would enable such a comparison to be made, on the grounds that it was confidential and not available for publication.

Sasol petrol can be obtained for one penny per gallon less.

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b) Energy Costs in Cape Town

The coal used in Cape Town for industrial, domestic and electricity generation purposes is railed from the Transvaal. Because of the high cost of railage, relative to the low pit-head cost, there is no demand in Cape Town for coal of low calorific value. (Railage represents 75% of the landed cost of coal in this city.)

Petroleum products are brought to Cape Town by sea and the landed cost of such products is accordingly lower than in Johannesburg. It follows, therefore, that if petroleum costs are lower and coal costs are higher at the Cape, there should be a closer relationship between comparative energy costs at Cape Town than is apparent at Johannesburg:-

i) Industrial consumers purchase their coal in truck loads at the pit-head price of 12/9d per ton. Railage from Witbank to Cape Town (about 1,040 miles) costs 37/9d, giving a total landed cost of 50/6d per ton. The estimated average calorific value of the coal is about 12.5 lbs/lb or 12,100 B.T.U./lb. Energy costs can be calculated as follows:-

$$\frac{50/6d}{2{,}000 \times 12{,}100} = \underline{\text{app. } 25.0d./B.T.U. \times 10^6}$$

The equivalent petroleum fuel, furnace oil, costs 76/11d per 45 gallon drum. The calorific value is 19,300 B.T.U./lb and specific gravity 0.865. Energy costs are:-

$$\frac{76/11d}{45 \times 8.65 \times 19{,}300} = \underline{\text{app. } 123d./B.T.U. \times 10^6}$$

The ratio of cost for coal energy and oil energy used for industrial purposes in Cape Town can therefore be expressed as 25 : 123 or approximately 1 : 5.

ii) Domestic consumers in Cape Town purchase their coal from local merchants at the controlled retail price of 71/3d per ton. The calorific value is however much higher than that for household coal in Johannesburg and averages about 12,100 B.T.U./lb. Energy costs are:-

$$\frac{71/3d}{2{,}000 \times 12{,}100} = \underline{\text{app. } 35.0d./B.T.U. \times 10^6}$$

The pattern of paraffin purchases is similar to that in Johannesburg but costs are lower. One gallon of paraffin can be purchased retail for about 2/-, provided the customer has his own container. A bottle of paraffin costs about 4d and, on the basis of six bottles to the gallon, this is also equivalent to 2/- per gallon. Using a calorific value of 20,000

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B.T.U./lb and a specific gravity of 0.790 energy costs would be:-

$$\frac{2/-}{1 \times 7.9 \times 20{,}000} = \frac{\text{app. } 152\text{d./B.T.U.} \times 10^6}{}$$

The cost ratio for energy from domestic coal and illuminating paraffin in Cape Town is therefore 35 : 152 or approximately 1 : 4.

iii) Electricity - coal used at the Salt River power station in 1957 cost, on average, 43/10d per ton, the weighted average calorific value being 11,680 B.T.U./lb. Assuming that the calorific value remained the same, and adding about 6/- per ton for increased railage costs in 1958, the present cost of coal energy would be:-

$$\frac{49/11\text{d}}{2{,}000 \times 11{,}680} = \frac{\text{app. } 25.5\text{d./B.T.U.} \times 10^6}{}$$

For electrical generation using modern high-speed diesel power plant the cost of automotive diesel oil in Cape Town would not exceed the bulk price of 1/8d per gallon. The calorific value of this fuel is 19,700 B.T.U./lb, the S.G. 0.84, and the calculated cost of energy:-

$$\frac{1/8\text{d}}{1 \times 8.4 \times 19{,}700} = \frac{\text{app. } 121\text{d./B.T.U.} \times 10^6}{}$$

A lower contract price would probably be available for large quantities of automotive diesel oil but, on the basis of the above calculations, the relative costs of coal energy and oil energy used for the production of electricity at Cape Town bear a ratio of 25½ : 121 or, roughly, 1 : 5.

iv) Transport - Locomotive coal for the South African Railways has, in recent years, been brought to Cape Town by sea from Durban. This policy was adopted in order to release the large number of trucks which would otherwise be engaged in serving the Cape Western system with coal, and which threatened to choke traffic on the main line route. No details of sea transportation charges for locomotive coal are known but, for purposes of energy comparison, it will be assumed that the cost is the same as that for rail transport of coal from Witbank to Cape Town. The average calorific value of railway coal is about 12,100 B.T.U./lb and a current f.o.r. cost of 11/- per ton will be assumed, as mentioned under (a) (iv) above. Railage charges from Witbank to Cape Town are 37/9d. per ton. The cost of energy can therefore be calculated as follows:-

$$\frac{11/-\text{ plus } 37/9\text{d}}{2{,}000 \times 12{,}100} = \frac{\text{app. } 24.0\text{d./B.T.U.} \times 10^6}{}$$

/ Ref.41, Statements 5 & 9

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Automotive diesel oil used for commercial transportation purposes would, as shown above, cost about 121d. per million B.T.U. The cost of petrol in Cape Town (regular grade) is 3/- per gallon to private motorists. Using this figure as a basis for calculation, a calorific value of 20,400 B.T.U./lb and a specific gravity of 0.72, the cost of energy from petrol in Cape Town would be:-

$$\frac{3/-}{1 \times 7.2 \times 20{,}400} = \frac{\text{app. } 245\text{d./B.T.U. x } 10^6}{}$$

The ratio of costs for coal, diesel oil and petrol used for transportation in Cape Town can then be shown as 24 : 121 : 245 or approximately 1 : 5 : 10.

c) Analysis of energy costs

The above approximate cost ratios of energy from coal and energy from petroleum fuels at Johannesburg and Cape Town can now be summarised in the following manner:-

Use	Johannesburg		Cape Town	
	Coal	Oil	Coal	Oil
Industrial	1	13	1	5
Domestic	1	8	1	4
Electricity	1	13	1	5
Transport	1	13 : 26	1	5 : 10

It will be noticed that there is a much closer relationship between relative energy costs at Cape Town than there is at Johannesburg and it is perhaps expedient to examine the influence of government taxation and railway rating policies on the ratio of energy costs in these two centres. For the purposes of the following discussion coal from Witbank will be compared with imported petrol, i.e. Sasol's sales will not be taken into account as the true breakdown of their selling price is not known and, in any case, they do not market their products in Cape Town.

i) The basic costs of Witbank coal, having an assumed calorific value of 12,100 B.T.U., is 11/9d per ton at pithead. In terms of energy cost this works out at a little less than 6d per million B.T.U. There is no excise duty on coal produced in the Union, but 1/- per ton is added to the pit-head cost as a contribution towards the subsidy paid to road transportation operators carrying coal from Witbank to Reef towns.

Unfortunately there is insufficient information to indicate whether this discrepancy in relative costs of the different forms of energy is reflected in any way in a different consumption pattern in the two towns.

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ii) The price of automotive diesel oil to commercial customers in Cape Town is made up of:-

/ 1¾d to the government in customs duty.
1/6¼d to the oil company in costs and charges

1/8d. per gallon bulk price

If the 1¾d customs duty is deducted from the bulk price the basic cost of energy from automotive diesel oil to commercial consumers is approximately 110d per million B.T.U.

/ iii) The retail price of petrol at Cape Town is made up as follows:-

1/2½d to the government in customs duty.
1/6½d to the oil company in costs and charges
3d. to the reseller to cover distribution costs

3/- per gallon retail price.

If the 1/2½d customs duty is deducted from the retail price, the basic cost of energy from petrol to the private motorist can be calculated as approximately 146d per million B.T.U.

The ratio of the above basic costs of commercial energy at source in South Africa is thus 6 : 110 : 146 or roughly 1 : 18 : 24. Any difference in these cost ratios at Johannesburg, Cape Town (or any other place in the Union) is due to subsidy contributions in the case of coal, customs duty in the case of automotive diesel oil and petrol, or transportation costs (all fuels). The effect of the subsidy contribution or the customs duty is to increase the cost of energy by a fixed amount. It will be noticed, for example, that the customs duty on petrol raises the cost of energy from this fuel in Cape Town from 146d. to 245d. per million B.T.U. - an increase of nearly 68%. Without
// such heavy taxation the competitive position of petrol energy viz-a-viz coal energy would be greatly improved but, as political considerations are largely responsible for this level of taxation, it is unlikely to be lowered in the foreseeable future.

The effect of transportation costs is to increase the cost of energy by a variable amount depending on the rail tariff

/ See Shell "Report on 1957" Page 9. These figures are still generally applicable to public utilities, farmers and passenger transport companies. For other categories of consumer the 1959 Budget raised the duty to 1/2½d. per gallon, thus bringing the energy cost for automotive diesel oil at Cape Town more or less into line with that for petrol, per million B.T.U.

/ See Shell "Report on 1956" Page 11 (import duty on petrol was increased from 1/- to 1/2½d. in 1958)

// For example, if the duty on petrol was considerably reduced the price would fall by a like amount. This might make the Government sponsored Sasol oil-from-coal project completely uneconomic in competition with imported petrol.

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charged and the distance covered. The pit-head cost per ton of coal at Witbank is approximately doubled by rail charges to Johannesburg and is increased four-fold when railed to Cape Town. On the other hand the railage charge per gallon of petrol railed from Lourenco Marques to Johannesburg represents an increase of only some 21% on the coast price of this product. In terms of energy units, however the effect of transportation costs is much more revealing:-

i) Coal having an assumed calorific value of 12,100 B.T.U./lb can be railed from Witbank (90 rail miles) at a cost of about 6 pence per million B.T.U. The cost of railing automotive diesel oil over the same distance would be about 11 pence per million B.T.U., and for petrol approximately 15 pence per million B.T.U. In other words, over a short rail haul of 90 miles the cost ratio per million B.T.U. for coal, automotive diesel oil and petrol is 6 : 11 : 15 or, very roughly, 1 : 2 : 2½.

ii) A typical long-haul is that from Witbank to Cape Town (1,040 rail miles) where the same quality coal could be carried for an energy transportation cost of about 19 pence per million B.T.U. The cost of railing automotive diesel oil over the same distance would be about 51 pence per million B.T.U., and for petrol, approximately 75 pence per million B.T.U. This gives a comparative long-haul rail cost ratio per million B.T.U. for coal, automotive diesel oil and petrol of 19 : 51 : 75, or very roughly 1 : 3 : 4.

It will be noticed from the above comparisons that the present structure of rail tariffs allows coal energy to be hauled more cheaply than oil energy over both short and long distances. Presumably this procedure is in accordance with the maxim "what the traffic will bear" and, whilst this is an accepted instrument of railway rating policy, it reacts to the detriment of petroleum energy in competition with coal energy in the Union. It is not suggested that railage charges over long and short hauls should be proportional, neither is it suggested that the charges for conveying coal and oil over a given distance should be the same, (railway rating policies are complicated topics which are outside the scope of this Thesis). Nevertheless, if transportation charges were made to bear a closer relation to the actual cost of providing the service, this discrepancy in the freight charges for the various sources of energy would be considerably reduced. As it is, it is difficult to escape the conclusion that a distortion of the energy cost-structure is introduced by differential railway rating.

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ϕ See Ref.62, Chapter 5.

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