The planning and establishment of the Grootegeluk Coal Mine

by B. C. ALBERTS†, B.Sc. (Min. Eng.)

SYNOPSIS
This paper indicates how the South African Iron and Steel Industrial Corporation Limited (Iscor), as a major consumer of raw materials, determines the tonnage and quality of essential raw materials required to satisfy an increasing demand for steel and how this led to the establishment of a coal mine with a highly sophisticated beneficiation plant in the Waterberg coalfield, near Ellisras in the Transvaal.

The planning of the project, with specific reference to the limited reserves of metallurgical coal in South Africa, the quality and quantity of the coal to be produced, and the way in which the project was managed is discussed briefly.

SAMEVATTING
Hierdie refera toon aan hoe die Suid-Afrikaanse Yster en Staal Industriële Korporasie (Yskor), as 'n groot verbruiker van grondstowwe, die tonnemaat en gehalte van noodsaaklike grondstowwe bepaal wat nodig is om te voor- stien in 'n toenemende vraag na staal, en hoe die behoeftebeplaging geleë het tot die daarmee van 'n groot steenkool-myn met 'n hoog gesofistikeerde veredelingsaanleg in die Waterbergse steenkoolveld naby Ellisras in Transvaal.

Die beplanning van die projek, met spesifieke verwysing na die beperkte reserves van metallurgiese steenkool in Suid-Afrika, die gehalte en hoeveelheid van die steenkool wat geproduceer moet word en die manier waarop die projek bestuur is, word kortliks aangedui.

Introduction
The purpose of this paper is to describe the Grootegeluk Project from its conception, based on corporate planning, through all the phases up to the commissioning of the beneficiation plant in July 1980. Special reference is made to the management of the project, as well as to the organizational structure.

Raw Materials

Quantity
The steady growth of 7.8 per cent per annum in the demand for steel products in the years 1964 to 1974 is illustrated in Fig. 1. So that the predicted growth could be met, State approval was obtained in the late 1960s for the South African Iron and Steel Industrial Corporation (Iscor) to embark on an ambitious expansion programme. This programme commenced in 1969 and culminated in

(i) a completely new steelworks on a greenfield site at Newcastle with an initial production capacity of 1.5 Mt of liquid steel per annum, and

(ii) additional steel-making and steel-processing capacity at the Vanderbijlpark Works to increase its production by 1.7 Mt of liquid steel per annum.

This expansion programme was necessary to fulfil its enterprise objective:

To supply the local market with the residual requirements, taking into consideration the other local manufacturers of steel, and to export surplus production, of the full range of good quality drawn, forged, semi- and finished flat and profile type steel products, pig iron and ferromanganese manufactured from scrap and raw materials at prices which are compatible with economic principles.

To provide reliable and competitive deliveries and an efficient service to the customers.

To mine and supply coking coal, iron ore and other raw materials required to manufacture iron and steel and to export iron ore to the world market taking into consideration available reserves.

In turn, this increase in the production of steel necessitated a corresponding increase in the tonnages of raw materials supplied to the iron- and steel-making plants at Iscor's three works (Pretoria, Vanderbijlpark, and Newcastle). To satisfy these requirements, detailed plans were prepared for the procurement of the various special-quality raw materials required over the next twenty to thirty years. (The life of the new blast furnace at Newcastle is estimated to be at least thirty years.)

Production at Iscor's Iron Mine at Sishen was increased from 3.3 to 25 Mt/a. Of this vast tonnage of iron ore, 7 Mt/a was required locally, and 18 Mt/a was earmarked for the Sishen–Saldanha Export Scheme.

The production of the Glen Douglas Dolomite Mine had to be increased from 400 to 800 kt of metallurgical dolomite per annum.

In addition, as the Corporation is dependent on metallurgical coal (cooking coal) for its steel-making process, the increased steel-making capacity required an increase of 2.5 Mt of metallurgical coal per annum.

The demand for raw materials necessitated by the expansion programme is summarized in Table I.

<table>
<thead>
<tr>
<th>Raw material</th>
<th>Before expansion programme, kt/a</th>
<th>After expansion programme, kt/a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore</td>
<td>5300</td>
<td>8500</td>
</tr>
<tr>
<td>Dolomite</td>
<td>400</td>
<td>800</td>
</tr>
<tr>
<td>Metallurgical coal</td>
<td>3700</td>
<td>6200</td>
</tr>
</tbody>
</table>

New Supply of Metallurgical Coal
At the time the expansion programme was initiated, Iscor produced only 20 per cent (i.e. 800 kt/a) of its total coal demand, while the balance (80 per cent) was provided by private industry. Iscor was thus compelled to embark on a large-scale exploration programme aimed at locating and acquiring exploitable reserves of metallurgical coal. An area in the Waterberg coalfield was selected as

† South African Iron and Steel Industrial Corporation Limited, P.O. Box 450, Pretoria 0001.
© 1982.

JOURNAL OF THE SOUTH AFRICAN INSTITUTE OF MINING AND METALLURGY

DECEMBER 1982 341
Fig. 1—Estimates of the long-term demand for profile and flat products.
first target, and vast reserves of coal of suitable physical and chemical quality were proved by Iscor's Mining Department in collaboration with the Research and Process Development Department.

The findings of the exploration programme and the results of the studies on feasibility and economic viability culminated in the approval by the Iscor Board in February 1974 of the opening of a coal mine in the Waterberg coalfield for the supply of metallurgical coal.

Quality

The co-ordination and compilation of short- and long-term plans on a corporate basis are the responsibility of Iscor's Department of Planning and New Development, which integrates the planning of the Mining, Steel-making, and Steel Marketing Departments. Iscor's annual production budget and long-term plan are largely based on forecasts made by the market research personnel of the Steel Marketing Department. The supply of raw materials required at a particular time is determined from a forecast of the rolled steel sections and flat steel products that will have to be produced over a ten-year period.

To assist Iscor in the proper preparation of these plans, a sophisticated computer program was developed by the Department of Planning and New Development that indicates the demand for raw materials for any given set of conditions and production rates. Numerous alternative plans can readily be compiled to enable Iscor's management to determine the best and most economical production plan for the prevailing circumstances.

The tonnages of raw materials required for a given steel production are influenced by the quality of the raw materials, especially the quality of the metallurgical coal. By the use of parameters obtained from other steel-making companies and adjusted for South African conditions, the tonnages of metallurgical coal and coke needed for the production rates incorporated in the ten-year corporate long-term plan can be established in advance. It is thus possible to determine a composite blend with known chemical and metallurgical properties once the tonnage of coal from the various mines is known.

The establishment of the best possible blend for optimum and most economical blast-furnace production is a formidable task in view of South Africa's limited supply of good metallurgical coal. At present, Iscor obtains coking coal from 18 different sources with varying life expectancies and in amounts that range from 1 to 29 kt per week. Coal is currently obtained from Natal (mostly straight coking coal) and the Transvaal Highveld (blend coking coal). These types of coal are defined in Table II.

In the optimization of metallurgical coal blends, various related factors have to be considered to ensure a practical approach. The most important are the quality of the metallurgical coal, the available reserves, the progress in steel-making technology, and the life of the existing facilities and supplies.

The result of many years of steel-making experience, as well as a better knowledge about the availability, qualities, and quantities of metallurgical coal, resulted in a corporate approach that can be stated in a few sentences:

Iscor notes or realizes the fact that the availability of good straight coking coal is very limited and therefore blending must be done with blend coking coals in such a way that the life of the Natal coal mines supplying straight coking coal can be maximized. The resulting corporate blend of metallurgical coal must still be of the best quality that can be obtained in view of the shortcomings of the coals making up the very limited supply choice.

<table>
<thead>
<tr>
<th>TABLE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINITIONS OF COKING COAL</td>
</tr>
<tr>
<td>Coal</td>
</tr>
<tr>
<td>Coking coal</td>
</tr>
<tr>
<td>Blend coking coal</td>
</tr>
</tbody>
</table>

* It should be noted that this definition can be very misleading, and can be countenanced only when used in relation to small blast furnaces. For medium furnaces, blend coking coal can be used only in small proportions to extend the reserves of good coking coal. In fact, Iscor now finds that the traditional definitions of these coking coals are too broad for technical use, and this terminology will probably fall into disuse and coking coals will be specified accurately in the future.

In summary, South Africa's metallurgical coal reserves are limited and it is therefore important that Iscor should use all the available coal to obtain blends that, based on the knowledge, experience, and information available, will give optimum blast-furnace production.

Other practical considerations in the planning for blend optimization are the cost of transport to the works, and the cost and quality of the coal. The effect of the first two factors (cost of transport and of the coal) is quite obvious and largely beyond Iscor's control. However, the blends at the three Iscor works are determined by a computer program developed by Research and Process Development to optimize the ash and sulphur contents, the Roga, and any other parameters that influence production. Table III shows a computer printout giving the percentage of certain coals in a blend, as well as the quality resulting from the particular blending ratio.

All the quality parameters that can influence the quality of the steel product, as well as the production rate of the blast furnace, are being tested on a routine basis. The influence of these quality parameters on the production results is of paramount importance, as the following example clearly indicates: an increase in the ash content of metallurgical coal that results in an ash increase of 1 per cent in the coke would decrease the production of liquid iron by 1.3 per cent.

In essence, Iscor's corporate long-term plans for 1974 to 1984 indicate that a large tonnage of additional metallurgical coal will be necessary for the required increase in steel-making tonnage (Fig. 2), and that corporate planning is required to establish the quality of the raw materials.
### Table III

<table>
<thead>
<tr>
<th>Coalfield</th>
<th>Pretoria</th>
<th>Vanderbijlpark</th>
<th>Newcastle</th>
<th>Newcastle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hlobane</td>
<td>18.6</td>
<td></td>
<td>20.2</td>
<td></td>
</tr>
<tr>
<td>Indumeni</td>
<td>18.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRC</td>
<td>11.1</td>
<td>32.7</td>
<td>21.4</td>
<td>23.2</td>
</tr>
<tr>
<td>Northfield-Burnside</td>
<td>7.1</td>
<td>12.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vryheid Coronation</td>
<td>5.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tongela</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TCOA</td>
<td>5.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platberg</td>
<td>5.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SACE</td>
<td>15.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Springbok Main</td>
<td>22.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blesbok</td>
<td>4.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highveld</td>
<td>5.8</td>
<td></td>
<td>18.6</td>
<td></td>
</tr>
<tr>
<td>Kleinkopje</td>
<td>9.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Springbok Hope</td>
<td>(8.6 % ash)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grootegeluk</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wankie</td>
<td>2.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kihamasan</td>
<td>45.0</td>
<td>2.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kempshouth</td>
<td>10.0</td>
<td>13.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### Solutions for the blends

<table>
<thead>
<tr>
<th>Coal</th>
<th>Ash (DB)</th>
<th>Volatiles (DB)</th>
<th>Volatiles (DAF)</th>
<th>Sulphur</th>
<th>Roga index</th>
<th>Inerts</th>
<th>Optimum inerts</th>
<th>Composition-balance index</th>
<th>ROR index</th>
<th>ROY index</th>
<th>ROV</th>
<th>ROR</th>
<th>ROVV</th>
<th>Vitrinite</th>
<th>Organic inert</th>
<th>Coke yield</th>
<th>Coke ash</th>
<th>Coke SiO₂</th>
<th>Coke Al₂O₃</th>
<th>Coke FeO</th>
<th>Coke (Ca,Mg)O</th>
<th>Coke K₂O</th>
<th>Coke Na₂O</th>
<th>Coke phosphorus</th>
<th>Coke sulphur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>10.7</td>
<td>10.3</td>
<td>11.9</td>
<td>11.9</td>
<td>10.7</td>
<td>13.2</td>
<td>17.4</td>
<td>17.6</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>70.5</td>
<td>15.2</td>
<td>8.12</td>
<td>4.32</td>
<td>0.80</td>
<td>0.93</td>
<td>0.20</td>
<td>0.10</td>
<td>0.01</td>
<td>0.82</td>
</tr>
<tr>
<td>Coke</td>
<td>73.0</td>
<td>14.1</td>
<td>6.7</td>
<td>8.0</td>
<td>7.1</td>
<td>4.2</td>
<td>6.7</td>
<td>8.0</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>70.5</td>
<td>15.2</td>
<td>8.12</td>
<td>4.32</td>
<td>0.80</td>
<td>0.93</td>
<td>0.20</td>
<td>0.10</td>
<td>0.01</td>
<td>0.82</td>
</tr>
</tbody>
</table>

### Project Phases

Projects can be subdivided into phases depending on the definition of related activity and time interval.

In expansion projects with a major metallurgical content undertaken by mining companies, use is often made of specialized project-management companies like Bechtel, Fluor, E.M. Bateman, Mitchell Cotts Projects, etc., for either the whole project or part of the project. However, it is not commonly realized that, even though the management of the project is delegated to a contractor, it is still necessary for the company to maintain overall control and to ensure the timeous training of production personnel.

The establishment of the Grootegeluk Coal Mine with special reference to the coal-beneficiation plant illustrates Iscor's approach to project management in the metallurgical industry.

**Pre-feasibility Phase**

During this phase the various target areas and beneficiation processes are compared, and the available information is used to determine any additional areas or processes to be investigated before a final decision is taken. During the pre-feasibility phase, preliminary budget figures are used for beneficiation and mining yields and for plant efficiencies.

Because of all the uncertainties, significant allowance is made for contingencies during this phase on the estimates of both capital and working costs. A figure of 25 per cent is commonly applied for contingencies in both these estimates. As the estimates used for the preparation of a pre-feasibility study are usually based on certain assumptions, it is necessary that such assumptions be specifically qualified with reference to those aspects that need further investigation.

The pre-feasibility study must therefore be seen as the first approach to the problem, and is usually done by the responsible personnel in a very short period in order to screen various possibilities and select the most viable areas for further investigation.

Iscor's pre-feasibility investigations indicated the Waterberg coalfield as the most promising source to supply the quantity and quality of metallurgical coal needed. The information on the Waterberg coalfield at that stage had been obtained as follows.

In March 1920 the intersection of thick coal seams was reported from a water-boring operation on the farm Grootegeluk 459 LQ, 25 km west of the present village of Elleras in the Transvaal. A few shot drill holes were drilled soon after this discovery, the results being summarized by Trevor and Du Toit. During the period 1941 to 1952, the Geological Survey Division of the Department of Mines determined the extent of the Waterberg coalfield and the properties of the coal by means of geological mapping, 143 boreholes, and two prospecting shafts. The results of this work indicated vast reserves of metallurgical and non-metallurgical coal.

In 1955, coal on 29 farms was reserved by the Minister of Mines for Iscor and Sasol, 2 more farms were added in 1961, 5 in 1964, and a further 89 in 1965. As a result of this reservation, Iscor and Sasol are the only two parties qualifying to apply for prospecting or mining leases in respect of coal over a total of 125 farms in the Waterberg coalfield.

Although Iscor's interest in the Waterberg coalfield dates from the later phases of the pioneering work by the Geological Survey, the first extensive drilling subsequent to the original 143 boreholes by the Geological Survey was a programme of 120 boreholes by Sasol during 1965/66. Over a period of years Iscor obtained several bulk samples of coal for coking tests from the prospecting shaft on the farm Grootegeluk 459 LQ. Additional samples of coal for coking tests were obtained from 22 large-diameter boreholes (254 mm core) along a line between the prospecting shafts on Grootegeluk 459 LQ and Hieromtrek 460 LQ during 1959/60. In May 1973 Iscor
started an intensive drilling programme on the six 'Iscor farms' (Leeuwdrift 312 LQ, Grootegeluk 459 LQ, Hierontrent 460 LQ, Daarby 458 LQ, Enkelbult 462 LQ, and Turfvlakte 463 LQ) for a final assessment of the reserves and quality of metallurgical coal on these farms.

Numerous coal seams occur over a stratigraphic thickness of 129 m. The lower 31 m is predominantly arenaceous, with three well-developed seams (zones) of dull coal, and is considered equivalent to the Middle Ecca. The three zones, numbered 1 to 3 from the bottom upwards, have average thicknesses of 1.55 m, 3.73 m, and 7.82 m respectively. Zone 1 contains hardly any bright coal, but the bottom 1 to 2 m of zones 2 and 3 contain some bright coal and yield a low-ash (5 to 6 per cent) fraction (r.d. 1.40) that could be suitable for form coke. Overlying the Middle Ecca is a thickness of 37 m of shale, carbonaceous in the upper part, with two zones of dull coal: zone 4A, 1.52 m thick, and zone 4 averaging 4.02 m thick. This predominantly shale succession is considered to be a transition between the underlying Middle Ecca and the overlying 61 m of alternating layers of bright coal and shale subdivided into 7 zones (zones 5 to 11) and correlated with the Upper Ecca. The bright coal developed in zones 5 to 11 is the source of coking coal in the Waterberg coalfield.

Drilling on the six Iscor farms proved in situ reserves for zones 5 to 11 of 578 Mt of coking coal and a similar reserve of middlings suitable for steam generation, as well as 1457 Mt of raw coal in zones 1, 2, 3, 4A, and 4. A profile of the coal-bearing succession tabulating in situ reserves and quality parameters for coking coal, middlings, and raw coal is shown in Table IV.

Feasibility Phase

During this phase of the project, all the information required for the preparation of a final feasibility report has to be obtained. This task may take anything from a year to a few years depending on the size and/or complexity of the project, and usually includes a fair amount of research on raw materials and plants.

In the case of Grootegeluk, the following aspects had to be thoroughly investigated before a final feasibility report could be submitted: geological reserves, mining methods, beneficiation processes, coal-quality tests, availability of infrastructure, capital costs, and working costs.

The final feasibility report submitted to the Iscor Board indicated the following.

(1) Reserves. As indicated by the exploration programme, the reserves consist of some 500 Mt of metallurgical coal and 1700 Mt of power-station coal on the six 'Iscor farms'. (The mine is situated on the farm Enkelbult 462 LQ, but is named Grootegeluk because the six 'Iscor farms' have been referred to collectively as the Grootegeluk area, and perhaps also because the original discovery was made on the adjoining farm Grootegeluk 459 LQ.)

(2) Physical and chemical suitability. The initial test-
work aimed at obtaining the necessary quality parameters indicated that the coal was suitable for use in the present Iscor blend. Bulk tests still had to be performed to confirm the laboratory testwork.

(3) Infrastructure. Water could be made available from a dam in the Mogol River, about which a White Paper had already been published, and electrical and rail connections were possible from the Thaba-zimbi area.

(4) Marketing of middlings. A middlings fraction consisting of steam coal would arise from the envisaged beneficiation process and would have to be marketed or otherwise disposed of.

(5) Capital and working costs. Estimates of capital and working costs prepared in the standard Iscor format indicated that the planned mine could provide the necessary coking coal at a production cost comparable with what was being paid to some of the existing suppliers.

The standard way in which the production costs are...
The establishment of infrastructure for a mine at a greenfields site can be a demanding but very gratifying experience. Surveyors and civil and electrical engineers, supported by men of legal and other related disciplines and controlled by a project leader, execute the planning for the establishment of infrastructure, negotiate with the responsible authorities, and eventually obtain the necessary servitudes for the establishment of some of the facilities that are required. Certain of these must be provided by the State and provincial authorities after representations by the project team. More detail about the establishment of infrastructure at the Grootegeluk Coal Mine is provided in a paper by Buermann.  

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
<th>Price</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Salaries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salaries</td>
<td></td>
<td>1 103 761</td>
<td>1 289 120</td>
</tr>
<tr>
<td></td>
<td>Allowances</td>
<td></td>
<td>50 433</td>
<td>51 211</td>
</tr>
<tr>
<td></td>
<td>Overtime</td>
<td></td>
<td>96 546</td>
<td>98 134</td>
</tr>
<tr>
<td>2</td>
<td>Wages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salaries</td>
<td></td>
<td>379 618</td>
<td>754 586</td>
</tr>
<tr>
<td></td>
<td>Allowances</td>
<td></td>
<td>100 000</td>
<td>100 000</td>
</tr>
<tr>
<td></td>
<td>Overtime</td>
<td></td>
<td>75 263</td>
<td>76 000</td>
</tr>
<tr>
<td>3</td>
<td>Consumables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diesel fuel</td>
<td></td>
<td>1 194 974</td>
<td>1 541 000</td>
</tr>
<tr>
<td></td>
<td>Petrol</td>
<td></td>
<td>9 438</td>
<td>10 663</td>
</tr>
<tr>
<td></td>
<td>Power paraffin</td>
<td></td>
<td>110 815</td>
<td>216 970</td>
</tr>
<tr>
<td></td>
<td>Lubricants</td>
<td></td>
<td>75 350</td>
<td>81 135</td>
</tr>
<tr>
<td></td>
<td>Flocculants</td>
<td></td>
<td>175 813</td>
<td>273 125</td>
</tr>
<tr>
<td></td>
<td>Explosives</td>
<td></td>
<td>265 783</td>
<td>269 309</td>
</tr>
<tr>
<td></td>
<td>Drill bits</td>
<td></td>
<td>38 684</td>
<td>44 824</td>
</tr>
<tr>
<td></td>
<td>Tyres</td>
<td></td>
<td>384 587</td>
<td>387 540</td>
</tr>
<tr>
<td></td>
<td>Food</td>
<td></td>
<td>57 628</td>
<td>111 218</td>
</tr>
<tr>
<td>4</td>
<td>Spares</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depreciation on spares</td>
<td></td>
<td>25 824</td>
<td>25 824</td>
</tr>
<tr>
<td></td>
<td>Insurance</td>
<td></td>
<td>16 396</td>
<td>16 396</td>
</tr>
<tr>
<td></td>
<td>Extraordinary maintenance</td>
<td></td>
<td>80 000</td>
<td>80 000</td>
</tr>
<tr>
<td>5</td>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electricity</td>
<td></td>
<td>410 421</td>
<td>631 958</td>
</tr>
<tr>
<td></td>
<td>Water</td>
<td></td>
<td>86 429</td>
<td>110 357</td>
</tr>
<tr>
<td></td>
<td>Royalties</td>
<td></td>
<td>5 760</td>
<td>5 760</td>
</tr>
<tr>
<td></td>
<td>Miscellaneous</td>
<td></td>
<td>311 150</td>
<td>390 780</td>
</tr>
</tbody>
</table>

---

Prepared are shown in Table V. (More details of this and the capital requirements are given in a paper by Ferreira and Coreejas.)

Establishment Phase

Early in 1974 the Iscor Board of Directors approved in principle the establishment of a coal mine in the Waterberg coalfield. Final approval by top management to establish the mine and beneficiation plant as detailed and recommended in the final feasibility report initiated the third phase of the project, and was obtained in 1975.

For the successful execution of any project, the timeous establishment of infrastructure is of utmost importance.
The Grootegeluk Project

Initial Period: November 1974 to February 1976

The commissioning date of the Grootegeluk Coal Mine was set for the 1st of July, 1978, as predetermined by Iscor’s Raw Materials Provision Plan. Contracts were therefore placed in 1975 for the various infrastructural facilities, consulting engineering firms being responsible for the planning, as well as the preparation of enquiries according to Iscor’s Standard Procedures. They handled contracts for housing facilities, as well as for the provision of water, electricity, and sewerage in the townships, workshops, and mine offices.

Enquiries for the coal-beneficiation plant were issued in October 1975 after Iscor had made extensive use of the services of its own personnel, as well as of overseas coal-beneficiation experts. Tenders for the plant were received in January 1976 on a turnkey enquiry. A contract for the first area of the beneficiation plant, i.e. the crushing and screening plant and storage silos, was placed in January 1976, the successful tenderer being E. L. Bateman. It was envisaged that the following remaining contracts would be placed in February 1976: heavy-medium drum plant, primary and secondary heavy-medium cyclone plants, froth-flotation plant, stacking and reclaiming plant, load-out station, and waste-handling system.

At that stage the economy in South Africa was very depressed, capital became scarce, and Iscor considered it wise to complete the major projects that were nearing completion before proceeding with new capital projects such as the Grootegeluk Coal Mine. The major projects nearing completion in 1976 were the building of a new steelworks at Newcastle, major extensions at Vanderbijlpark, the Sishen-Saldanha export scheme, and increasing of the capacity of the Durban Navigation Collieries and of the Glen Douglas Dolomite Mine.

Iscor’s Board therefore decided that the Grootegeluk Project, with the exception of the contracts that had already been placed, should be stopped. Endeavours were made by the Financial Department to obtain overseas loans and manufacturers’ credit to enable the project team to continue with the establishment of the mine. All these efforts were of no avail, and the demand for steel kept on dropping, making the situation even worse.

The whole situation was re-investigated. The new long-term plans, based on the latest information, indicated that the demand for steel was going to be much lower for some time and that the commissioning date of the Grootegeluk Coal Mine could be postponed without adversely affecting the steel-supply situation. In any case, the non-availability of funds had already caused the postponement of the commissioning, which had been planned for mid 1978.

Fight for Survival: February 1976 to January 1978

When the decision was taken to stop the Grootegeluk Project, key personnel had already been appointed and prestripping of the overburden was successfully under way. It was decided to continue the prestripping up to a stage where the production of coal could begin, and to continue with the design of the planned coal-beneficiation plant until such time as funds would be available. This kept the project team together and productive until financing, through a lease agreement, was arranged between Iscor and the Standard Bank Group, and finally authorized by the Iscor Board in January 1978.

Completion Period: January 1978 to July 1980

After the signing of the lease agreement with the Standard Bank Group, the construction programme was revised to suit the demand of the long-term coal-supply plan. The Government Departments responsible for various elements of the infrastructure had to be triggered to proceed with the elements for which they were responsible.

The completion date of the railway line to be constructed by the South African Railways was then set to coincide with the commissioning date, and everything was planned for the mine to be commissioned by the middle of 1980.

Organizational Structure

The management philosophy obviously differed for the three periods of the project. The staffing for the initial and completion phases is discussed in detail to give an indication of two of the many ways in which a project can be managed.

Initial Period: End of 1974 to Beginning of 1976

Two major factors that had a decisive influence on the philosophy of the project management were Iscor’s commitment to other major construction projects that were nearing completion at other centres, and the fact that the mine had to be brought into production in a very short time.

The time originally allowed for the establishment of the mine was from about May 1975 to the middle of 1978, which allowed 38 months for the execution of all the project activities. This programme therefore largely determined the management philosophy according to which the mine and beneficiation plant would be established. This philosophy can be described as a turnkey approach.

The term turnkey in engineering terminology normally refers to the design, erection, and commissioning of a plant by a company specializing in a particular field for and on behalf of a second party, which normally specifies only the quantity and quality of the product to be produced and manufactured. Turnkey projects for Iscor are slightly different. Standard specifications that Iscor has developed over the past 52 years for conveyor designs, painting, bearings, overhead cranes, substations, switchgear, etc. form part of any turnkey enquiry, and this ensures that plants erected for and on behalf of Iscor satisfy predetermined standards in certain areas. To ensure that this is done, Iscor’s project personnel form part of any turnkey contractor’s team for the total establishment period.

The project team was therefore assembled in such a way that it included Iscor supervision and control of turnkey contracts. The organizational structure for this task is shown in Fig. 3. The staff required to operate the mine eventually were used as key members of the project team, namely the Mine Manager, Manager (Mining), Mine Secretary, and Mine Industrial Engineer.

The only specialist members of the project team were
the Manager Projects and Construction, the Manager Project Planning, and the Progress Control Manager, who were seconded to the project. The project team had at its disposal the services of the departments of the Consulting Mechanical and Electrical Engineer, Consulting Civil Engineer, Contracts Division, Financial Evaluation Division, and Financial Control Division. Members of staff from these departments either were seconded to the project on a full-time basis or rendered services on a part-time basis as requested.

As the project was going to be handled on a turnkey basis, the organization of the Manager Projects and Construction made provision for staff to assist him in quality control, project planning and progress control, and contract management. Members of the eventual plant personnel were used as far as possible as members of the project management team to undertake these activities, the idea being that they would become acquainted with the plant that they were going to operate.

The project was managed according to this organizational structure until finance was obtained in January 1978. The organization proved to be efficient and coped satisfactorily with the demands of a turnkey project.
Completion Period: January 1978 to July 1980

The organization for the final period was changed to suit the situation prevailing at the beginning of 1978, the most important changes being the following:

(i) Complete design and manufacturing drawings for the beneficiation plant were at the project team's disposal.
(ii) Iscor's expansion programme was virtually completed, and competent, trained project and construction supervisory personnel became available.
(iii) The Saldanha railway line was sold to the South African Railways, and senior project managers became available for placement.

The new organization that was decided upon is shown in Fig. 4.

Management of the Project

Once the final team had been assembled and the project at that stage had been properly defined, the management approach had to be tailored in such a way that the following key objectives could be accomplished with the project team performing efficiently in the established critical performance areas.

(i) To establish a coal mine in the Waterberg coalfield near Ellisras, complete with infrastructure and facilities in order to produce in accordance with the following parameters:
   - Capital required for the establishment of the mine (June 1978 prices) Rm million
   - Commissioning date 1st July, 1980
   - Full production date 30th June, 1981
   - Full weekly production (blend coking coal) 35 kt
   - Middlings per week 50 kt
   - Cost per ton at full production Ry
   - Salaried staff 453
   - Weekly-paid staff 1200

(ii) To endeavour actively, in co-operation with the Mining Products Marketing Division, to attain a market for the middlings fraction of 50 kt per week.

The project organization was made up of two teams: the A team, made up of the permanent staff of the mine, and the B team, consisting of project personnel seconded to the Grootegeluk project. The responsibilities of the various senior managers of the project team (Fig. 4) can be defined as follows.

The Consulting Mining Engineer (Project Leader) was responsible for the establishment and commissioning of the Grootegeluk Coal Mine by the middle of 1980 in accordance with the key objectives. His critical performance areas are defined in a position charter that runs into eight typed pages.

The Mine Manager was responsible for

(i) the staffing of the mine in such a way that moving from a construction phase into a production phase took place with the minimum of disruption;
(ii) the supply of the necessary administrative and store services for the whole of the project;
(iii) the instituting of the necessary procedures and systems so that the mine could perform in a well-disciplined way according to Iscor's Standard Instructions; and

(iv) the training of all personnel.

Regarding the last point, it should be mentioned, that training is a major responsibility in a greenfield project.

The Manager Projects and Construction (Coal Beneficiation Plant) was responsible for the design, establishment, and commissioning of the coal-beneficiation plant. Full details as to how this plant was designed and established and how the construction process was managed are given in a paper by Gilliland.

The Manager Projects and Construction (Civil) was responsible for the total civil infrastructure and all the services and accommodation requirements of the mine. He also rendered a consulting and supporting construction-supervision service to the Managers Projects and Construction (Plant) and Projects and Construction (Electrical).

The Manager Projects and Construction (Electrical) was responsible for the establishment of the total electrical infrastructure at the Grootegeluk Coal Mine. He also supplied a consulting and a construction-supervision service to the Managers Projects and Construction (Plant) and Projects and Construction (Civil).

The Manager Projects and Construction (Mining) was responsible, in collaboration with the Mine Manager, for the total mine planning, as well as the purchase of all the mining equipment and other major items of mobile equipment needed for production at the mine.

The Project Financial and Capital Control Manager was responsible for the administration of all the financial and capital transactions. He supplied a supporting ser-
vice to all the project disciplines for the capital control of the projects for which they were responsible.

The Project Co-ordinator was responsible for the administration of the lease contract. He played a very important part by supplying a co-ordinating service between the various head-office financial, contractual, and capital control departments and the project team as a whole.

Full details of how the Project Financial and Capital Control Manager and the special Project Co-ordinator rendered their services to the project team are given in a paper by Ferreira and Coreejes6.

The Mine Industrial Engineer

(i) rendered assistance to the Project Leader regarding the technical and financial feasibility of the various alternative designs submitted by the project personnel from time to time;

(ii) investigated the various alternatives offered by tenderers;

(iii) investigated various control and management information systems that were used by Iscor and other companies to help select the most suitable systems for the eventual management of the mine; and

(iv) co-ordinated the work in order to ensure that all preproduction back-up facilities, such as maintenance handbooks, production guidance handbooks, and ordering of spares, were conducted timeously.

The Manager Project Planning and Progress Control was responsible for project planning and the measurement of progress on all the different construction activities that were to be performed on the Grootegeluk project. The control approach was tailored according to the complexity of the work. Full information on how this was done is given in a paper by Kotzé6.

In an endeavour to ensure the attainment of this ambitious and important task, the following actions were taken.

Position charters were prepared by all the senior managers, and the acceptance and understanding of their colleagues were obtained to ensure that everybody knew what his duty was.

Scopes for all the individual projects forming the total project were prepared, and a specific person was made responsible for the total execution of each scope. This action creates a sense of responsibility and pride of ownership.

Team spirit was ensured by a special team-building effort with the specific objective of obtaining optimum work output from the team as a whole. In this instance, the programme supplied especially for this purpose by a firm called Personeelkonsultante (Edms) Beperk, headed by Dr D. Gouws, was used with great success.

Communication and control were established by the setting up of two project meetings per month, held a fortnight apart. These meetings were based on documents prepared for this purpose by the specific team members responsible.

The meetings and inspections included the following.

Project Co-ordination and Progress Control Meeting, which was held at the end of each month following the progress measurement by the personnel of the Manager Project Planning and Progress Control. This meeting used as its basis for discussion a document specifically prepared for this purpose, reporting on the progress of all the projects being handled by all the managers.

Project Management Meeting, a monthly meeting held in the middle of every month. At this meeting the financial control reports prepared by the Project Financial and Capital Control Manager were used as a basis for discussion. This meeting also had another very important function, i.e. to pay specific attention to the aspects that could be distinguished as having a detrimental influence on the effectiveness of the project team's performance of its major duties. Such problems were thoroughly discussed, programmes or actions for rectification were prepared, and the planned action was minutred. For effective and productive meetings, it was imperative that the documents for discussion at these meetings should be available timeously.

Site Inspections. As part of his preparation for the project meetings, the project leader visited the site on the day before the meeting so that he could evaluate most of the project under discussion in the presence of the responsible project managers and project engineers.

Conclusion

The coal mine and beneficiation plant at Grootegeluk were commissioned on schedule, when the first train of metallurgical coal was loaded and dispatched on 23rd July, 1980, to the Vanderbijpark Works. This was possible only because the feasibility work had been done effectively, the project management team that had been assembled had been efficient, there had been sufficient time for a thorough design of the beneficiation plant, and the critical objectives had been attained.

The results are as follows

(1) Mainly because considerable savings were effected in the capital allowance for the beneficiation plant, a comfortable capital credit was realized.

(2) The working cost in all the cost centres, with the exception of the beneficiation, was confirmed in practice. The plant working cost was not available at the time of writing.

(3) The quality and functional efficiency of the facilities established are generally satisfactory in that they are being used successfully or are giving satisfactory service (information was not available on the coal-beneficiation plant). All the indications are that the plant will meet its design parameters.

(4) Metallurgical coal was despatched to the Vanderbijpark Works seven days earlier than planned.

(5) The present manpower complement conforms to the figure used in the feasibility study. However, the maintenance situation in the coal-beneficiation plant will determine the correctness of this figure after the plant has been in service for a few years.

The plant is at present (December 1982) performing satisfactorily, and all the initial commissioning problems have been solved. The plant working cost is in line with the predicted cost that was used in the initial feasibility study.
Acknowledgement

The author thanks the management of the South African Iron and Steel Industrial Corporation Limited for permission to publish this paper. Mr M. J. Deats, Divisional General Manager (Mining), and other members of Iscor’s staff are especially thanked for assistance with this paper.

References


IMM Awards

Given below are details of the trust funds, etc., to which The Institution of Mining and Metallurgy invites applications for grants, etc., payable in 1983. Application forms, which are available on request, must be returned to the Secretary, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England. Telephone 01-580 3802; Telex 261410, before 15th March, 1983. Applicants should note that, in general, preference will be given to members of the Institution.

Bosworth Smith Trust Fund

Approximately £3300 will be available in 1983 for grants from the Bosworth Smith Trust Fund for the assistance of post-graduate research in metal mining, non-ferrous extraction metallurgy, or mineral dressing. Applications will be considered for grants towards working expenses, the cost of visits to mines and plants in connection with such research, and the purchase of apparatus.

Stanley Elmore Fellowships

Applications are invited for Stanley Elmore Fellowships, which are awarded by the Institution and tenable at United Kingdom universities, for research into all branches of extractive metallurgy and mineral processing. Fellowships to the value of between £1500 and £4500 per annum will be available from October 1983.

Precious Metals

The Seventh International Conference for Precious Metals, previously announced for Chicago in June 1983, has been rescheduled to San Francisco, California, for the week of 12th to 17th June, 1983.

Dr Donald Corrigan of Handy & Harman and President of IPMI stated that recent organizational changes by several key Chicago committee men necessitated the change. Dr Corrigan announced the appointment of Mr Robert Paise, Applied Molecular Technology, as the General Chairman of the Conference.

Mr Paise has asked that all interested authors submit to IPMI a title and brief abstract on subjects relating to the manufacture, use, economies, metallurgy, refining, and mining of precious metals. He also announced that IPMI will honour numerous member requests to have a mini-exhibit. Patron and Sustaining Member Companies will be allowed to display literature and small models of their products in a designated area.

Other programme innovations planned for the 7th Conference are that simultaneous sessions will be minimized, key international speakers will be invited, and plant visits will be organized.

Additional information can be requested from IPMI Headquarters, 2254 Barrington Road, Bethlehem, PA 18018 (215/866-1211).