



REPORT OF THE
COMMITTEE OF EXPERTS
ON THE
ECONOMIC PRODUCTION & UTILISATION
OF PALANA LIGNITE DEPOSITS

JULY, 1959

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Appointment of Committee and Terms of Reference :

The Government of India, in consultation with the Government of Rajasthan, constituted * a Committee of experts to study all the available data from the Palana lignite deposits with a view to finding out the technical feasibility and economic viability of mining the lignite at Palana in Rajasthan, by open cast methods and if the scheme is found to be technically and economically feasible, to under-take the preparation of a comprehensive project report.

The Committee consisted of the following:—

1. Shri A. B. Guha,
Coal Mining Adviser,
Government of India,
Department of Mines & Fuel,
(Ministry of teel Mines & Fuel)
New Delhi, Chairman.
 2. Dr. A. Lahiri,
Director, Central Fuel Research Institute,
Dhanbad, Member.
 3. Shri S. S. Growal,**
Chief Inspector of Mines,
Dhanbad, ”
 4. Dr. B. C. Roy. *
Director, Geological Survey of India,
Calcutta, ”
-

* As per annexure 1-a & 1 -b

** —do—

5. Shri H. R. Dewan,
Director, Indian Bureau of Mines,
Nagpur-

6. Shri M. L. Sethi,
Director of Mines & Geology,
Government of Rajasthan,
Udaipur.

Convenor.

The Convenor circulated the following papers to the Chairman and other members of the Committee:—

1. A study of the Palana lignite field in Rajasthan, by Sarva Shri M. L. Sethi and A. B. Mukerjee.
2. Investigation of Palana lignite for establishment of open-cast mining and briquetting plant by Shri M. L. Sethi.
3. The Development of Palana Opencast Colliory-Planning report by Mr. W. L. Opic.

Thereafter the Chairman accompanied by the Convenor visited Palana Colliory on the 18th April, 1958, with a view to study on the spot the actual conditions of the working of mine and for studying the broad geological features of the Palana lignite bearing area.

It was decided that certain drilling investigations (as per the plan at annexure '3') should be undertaken immediately to ensure that the lignite in the worked area had not burnt out and also to fix the limit of extension of the lignite bed. Bore holes Nos. 12, 13 and 14 placed on west of the Silver shaft proved the area to be barren. In view of the above findings the bore holes Nos. 15 and 19 were drilled on the north and north west of the Silver shaft. No. 15 hole proved lignite of 45 ft. thickness, while in bore hole No. 19, lignite of 10 ft. thickness was found.

Lignite Field:

Introduction:

The lignite occurrence at Palna (27.51 'Lat : 73-19' long) near Bikaner city has been well known amongst the Tertiary deposits of India, and it has been worked continuously over the past half century

Mining operations are now being carried out by the Department of Mines & Geology, Government of Rajasthan, but before this, up to the year, 1949, it was exploited by the then Bikaner.

Palana lignite has gained great importance particularly, due to the fact that the Rajasthan state suffers much from fuel shortage. The States has a great future ahead, if the lignite deposits could be successfully exploited in order to meet the existing and the growing fuel needs of the region.

Topography,

This lignite field is situated in North Rajasthan, practically in the heart of the Thar desert. There is a complete absence of exposure of any geological formations, except the overlying aeolian sands, with a cover varying in thickness from 2-10 ft., and sometimes more at places. The terrain is absolutely flat, except for slight undulations in the ground, and the presence of sand dunes here and there.

Beneath this layer of sand-kankar beds have been found generally in association with ferruginous nodules. which extend to depths of upto 70 ft. They are followed by weathered sandstones and clays of about 20-40 ft.. thickness.

Below these hard, compact, and buff coloured limestone, is found, underlain in order of sequence, nummulitic limestone, shales, impure ferruginous limestone, clays and about 50 ft. thickness of fuller's earth.

These are followed by a 10-30 ft. thickness incomplete section of bluish grey and pink shales, with a thin band of friable sandstone, followed by lignite.

A typical section of strata encountered is given below:-

- | | |
|---|--------------|
| 1. Sand. | 2 to 10 ft. |
| 2. Kankar with ferruginous nodules. | 50 to 70 ft. |
| 3. Weathered sandstone & clay. | 20 to 40 ft. |
| 4. Fuller's earth with intercalated bands of limestone. | 50 to 70 ft. |

- | | |
|---|--------------|
| 5. Blue grey and pink shale with friable sandstone. | 10 to 30 ft. |
| 6. Lignite. | 25 to 40 ft. |
| 7. Under clay. | 2 to 4 ft. |

Below the lignite deposit, there is an occurrence of a 2 to 4 ft. band of soft clay, grading into a kind of crumbling sandstone. This clay is poaty in appearance, and is interstratified with sand, at places. Tests conducted at the Central Glass and Ceramic Research Institute, indicate that it is quite a good fire clay, with a P. C. E value of Orton 31, i. e. 1680° C, which is suitable for manufacture of high grade refractory wares.

Where the lignite deposit is not present, the beds of fuller's earth and shales, are directly underlain by coarse sand.

It will be seen from the plan (annexure 3) that two deposits occur almost contiguously, on an axis running NW-SE through the property, separated by a small barren area. These two areas have been thoroughly proved either by means of shafts, as in the old area, or by extensive, number of bore holes, drilled during the last seven years, as in the new area. The same plan showing the location of the shafts and bore holes, establishes that the average thickness of lignite is 22 ft. in the old area and 13 ft., in the new area. The average thickness throughout the field comes to 17.5 ft., but with an average thickness of 22 ft. in the old area (length along the strike 12,300 ft. and width : 1750 ft.,) the tonnage of lignite in this area is computed to 13.91 million tons. The new area-bounded in RED-contains 8.44 million tons.

The total tonnage of Lignite available in the two areas is 13.91 million tons in the old area and 8.44 million tons in the new area. Allowing for a deduction of 15% on account of the quantity already extracted in the old area, the net tonnage expected to be available will be 13.91 million tons less 15% i. e. 11.83 million tons. But as an abundant measure of precaution, this quantity is further reduced by an extra 10%. Thus the reserves which would definitely be available for winning would be 13.91 million tons less 25% or 10.43 million tons in the old area.

Life of the Colliery.

Though the total estimated reserves appear to be 20.35 million tons, the ratio of lignite to overburden in the new area being high, the Committee came to the conclusion that open-cut mining is economically feasible only, in the old area, where the ratio of lignite to overburden is 1 to 9. With an available tonnage of approximately 10.43 million tons and the overburden ration of lignite to overburden 1.9 the Committee further observed that estimated production of 0.5 million tons per annum can be won by open cast mining methods. The estimated life of the Colliery, from the open cut mine in the old area, on the above production will be about 20 years.

Coal Requirements of Rajasthan

The coal consumption in Rajasthan, at the present, is distributed over the following important heads :—

1. Power generation,
2. Lime, brick and tile making,
3. For small industries.

From the data supplied by the Chief Engineer, Electrical and Mechanical Department, Rajasthan, Jaipur (Annexure No. 4) it can be seen that so far as Power supply is concerned, both Bikaner and Jodhpur are two important load centres. There is an apprehension that the supply of power from Bhakra Nangal may not be wholly dependable. In order to ensure the continuity of power supply, it may be essential to back up by generating thermal power near about Palana with a capacity of about 50,000 K. W., to start with which could be expanded to about 1,50,000 K. W. in due course. The lignite from Palana could be used in this power station. This power station could feed back power in the Bhakra Nangal grid system and ensure a regular power supply both for Bikaner and Jodhpur regions.

Water for such a power station would also be available at a slightly additional cost as per report of the Chief Engineer, Rajasthan Canal (Annexure No. 5). Chief Engineer, P. W. D., has mentioned that the demand of coal for P. W. D., is about 50,000 tons per annum and it is going to increase to 1,00,000 tons per annum, which is equivalent to about 1,80,000 tons of Palana lignite.

Again the Rajasthan Canal project will be utilising a large quantity of coal lignite for various purposes such as brick and lime burning, tile burning and locomotive etc. In this connection a statement showing the quantities of lignite required for the purpose mentioned

above, is enclosed (as obtained from the Chief Engineer, Rajasthan Canal annexure 6.)

In addition to these demands there is a constant demand from the public for brick and lime burning and for stationary boilers in ginning factories and oil mills etc. So it can be seen at a glance that the demand for Palana lignite will be much more than what can be raised from the known deposit after providing for a reasonable life of the colliery. Total requirement of coal by the small industrial consumers is estimated to be about 60,000 tons per annum.

Palana lignite has been found exceedingly suitable for burning bricks and lime, and on actual tests it has been found that nearly 45 tons of lignite is required to burn 1 lac bricks of standard size. Likewise its use in kankar and lime kilns has been well established. There is also no suitable road metal readily available in Bikaner division and, therefore, overburnt bricks have to be used as road metal. Construction of a number of roads in the state is already included in the plan of the State Public Works Department. In addition, as new townships spring up along and adjacent to the Rajasthan Canal area, bricks will be in great demand not only for road making but also for building construction.

Thus the total quantity of lignite required is :—

(i) Power generation	52,000 tons.
(ii) Lime & Brick.	4,68,000 „
(iii) Small Industries.	60,000 „

Growth of Demand and Supply-Possible Expansion.

It will thus be seen that the total requirements of lignite for various purposes comes to the projected out-put of the Palana Colliery from the open cast mining i. e. 42,000 tons per month or 0.5 million tons a year (42,000 × 12).

After scrutinising the various documents presented before the Committee, alongwith the further technical data, collected at the instance of the Committee and also wherever necessary after visiting the various

sites as also after discussions with the technical officers and also other administrative officers of the State, the Committee came to the conclusions which are set-forth in the following paragraphs. —

- (i) In the old working area, the Committee estimated that, after allowing for the lignite that has been taken out or which has burnt out there is even now at least an estimated quantity of about 10.43 million tons of lignite. A few bore holes sunk so far to determine the extent of burn-outs have proved that losses on account of fires have been negligible.
- (ii) From the study of the bore hole data collected in respect of the adjoining virgin area, the Committee estimated the total reserve to be approximately of the order of about 8.44 million tons.
- (iii) The lignite in both the areas is of high rank and good quality. But it contains some sulphur. The following are the analysis carried out by the Central Fuel Research Institute, Joalgora:-

Approximate Analysis.

	Air dried,	Dry basis,
Moisture.	26.7%	Nil
Ash.	4.4%	6.0%
Volatiles.	45.2%	61.7%
Fixed Carbon.	23.7%	32.3%
	<hr/> 100.00%	<hr/> 100.00%

Calorific value in B. Th. U. per pound—9,740 13,290

Ultimate Analysis.

Moisture.	26.7%	Nil
Mineral matter.	4.84%	6.60%
Carbon.	52.32%	71.29%
Hydrogen.	4.74%	6.47%
Sulphur.	1.68%	2.30%
Nitrogen.	0.91%	1.24%
Oxygen by difference.	8.81%	12.10%
	<hr/> 100.00%	<hr/> 100.00%

The low moisture and low oxygen and high calorific value shows that Palana lignite is more mature than normal lignite and in fact nearer in composition to sub-bituminous coals.

Extraction with P. E. and benzene mixture :-30.70 P. C. extract on dry lignite 16.6 about 25%, which was insol in Ether.

Ash fusion range in mildly reducing atmosphere :-1120° to over 1300° C.

Sp. gr. :-1.213 at 40°/44° C.

- (iv) The lignite seam in this area is of considerable thickness. Only a portion of the lignite seam generally 6 ft., at the bottom could be worked entailing considerable loss of coal due to collapse, non-recovery of the top portion of the lignite seam and other causes. In fact it had not been possible to recover nearly 9/10 of the reserves from the underground mining operations.

To enable better extraction of the lignite Committee considered the feasibility of introducing stowing either hydraulic or pneumatic, but the Committee observed that it was not possible to introduce hydraulic stowing for (i) shortage of water (ii) absence of suitable stowing material (sand seems to contain clayey material) (iii) mild gradient soft nature of the lignite, superincumbent strata and floor (swelling of the floor takes place during normal mining operations). The pneumatic stowing would be far more expensive than hydraulic stowing and will not be so effective either and for a large output of 1500 to 1600 tons a day as envisaged, the amount of stowing material that will have to be handled would be enormous and will not be worthwhile under taking in relation to the slightly higher recovery by introduction of stowing.

- (v) From the history of mining in this area, as well as from inspections and discussions with technical personnel, the Committee came to the conclusion that further underground mining of the lignite in the old area will not be an economic or even a safe proposition. The Director of Mines & Geology Government of Rajasthan has informed that at the basis of cost analysis, carried out by

the Accountant General, Rajasthan, the cost of mining the ton of lignite by underground mining is Rs. 24/- per ton. From the project report (part II), the cost of production of a ton of lignite by open cast mining has been estimated at Rs. 19/- There is therefore, a distinct advantage in winning the coal by the open-cast mining method, as not only the cost of production is less by Rs. 5/- but the recovery by open cast method is nearly cent per cent.

Further, the coal which was considered to have been lost by underground mining method would now be possible to recover. This is an added advantage in operating the mine by open cast methods. The landed cost of coal at Bikaner, from Bengal and Bihar, is approximately Rs. 45.33 nP. The cost of coal in the coal producing areas is likely to rise in view of recent investigation of price structure of coal in these areas. Even allowing for a lower calorific value of lignite it can be seen that the lignite can be produced and supplied at a cheaper rate than imported solid fuel in Rajasthan area (allowing for the equivalence of 1.8 tons of lignite to one ton of bituminous coal).

Taking the physical and economical factors into consideration the Committee recommends that in the old worked-out area **mechanised opencast mining should be undertaken for a production of approximately 1600 tons a day.** The type of equipment machinery, etc., to be used is dealt with in detail in Chapter No.X(part II). The cost on the basis of the present labour wages, power, water, fuel, stores and machinery etc., is likely to be of Rs. 19/- per ton. In view of the nature of the superincumbent strata the Committee felt that the major part of the overburden could be removed by draglines or bucketwheel excavators. Only for the intercalated strata (with limestone) some blasting will have to be undertaken. The additional cost for drilling and blasting has been allowed for in the estimate.

- (iv) The Committee however, felt that the existing method of underground mining in the new area should in any case continue until the opencast mining comes into full production and the question

whether the underground mining method should continue thereafter may be reviewed in the light of the then existing and potential demand and the percentage of recovery that can be achieved by that method.

- (vii) In arriving at the above conclusions, the Committee has taken into consideration the immediate and urgent requirement of solid fuels in Rajasthan area (page 9) These are given in the relevant Chapter. The production of 0.5 million tons a year would cater for the immediate requirements of this area and supply solid fuel requirements at a cost comparable (caloric to caloric) to the cost of imported fuels. The Rajasthan Government propose to set up a thermal power station in the Bikaner area of a capacity of 50,000 K.W., rising to 1,50,000 K. W. in the III Plan. Even for the first phase of the power station, nearly 900-1000 tons of raw lignite proposed to be mined by opencast will be consumed daily. The Committee, however, felt that in view of the location of the lignite deposits, a much larger output would be feasible provided additional deposits of lignite are discovered. This is likely to lower the cost of mining and make the scheme further attractive.
- (viii) The Committee had examined certain relevant facts regarding occurrences of lignite in areas from Palana and the Committee is of the opinion that high priority should be given to intensify the exploration in these areas in order to prove the extent of the lignite deposits. Lignite has been known to occur in wells and cuttings in areas as far as 36 miles north-west of this area. This would, indeed, be a large area and there is, at present, no scientific reason to assume that in the intervening areas lignite does not occur. If the extent of deposits is proved to be larger than what is at present known, as it may very well be, then the scope of enquiry would be completely changed. At present, the Committee has merely taken into account the immediate and local needs of solid fuels. Since the lignite deposits of Rajasthan occur in an area far away from other sources of fuel, the lignite deposits, if proved to occur over larger area, would offer scope for development at par with or even on a greater scale than at Neyveli. The Rajasthan and the neighbouring areas contain

mineral resources of varied nature and are adjacent to several other industrialised areas. The lignite deposits of Rajasthan are also of better quality, as far as maturity is concerned, though higher in sulphur. But, even the sulphur content could be put to use advantageously in certain types of plants. Rajasthan possesses large deposits of gypsum and with abundant lignite, could become one of the largest fertilizer producing centres of India.

- (ix) One of the paramount needs in Rajasthan and, indeed, in any other part of India, is domestic fuel. In Rajasthan the need is more so in view of the lack of vegetation and desert conditions. Every tree, if it could be saved should be saved. The desert of Rajasthan could smile provided there is supply of water and reforestation. In a rural area devoid of solid fuel resources for domestic use, afforestation is a hazardous task. As at Neyveli, lignite can be briquetted and carbonised to produce smokeless domestic fuel, similar in quantity to charcoal, for Rajasthan and adjoining areas. The surplus gas can be used for steam raising or power generation. Tar can be used for chemical industry and production of diesel oil.
- (x) The requirement of power in the next Five Year Plan in the Rajasthan itself is of the order of 2,51,800 K.W., of which, at present, only 67,800 K. W. are generated. Even then, generation of power will be only 1/1000 K. W. per person. In view of the situation, Rajasthan can supply power to other areas apart from her own needs, if the lignite could be exploited cheaply for generation of power. Large scale generation of power is essential for development of other industries in this area. It may also be necessary, in future, to back up and stabilise hydro power from Bhakra and Chambal by thermal power from sources located either in Rajasthan or in other neighbouring areas. With the estimated cost of production of lignite by open-cast mining at Rs. 19/- per ton, the cost of power generated from this source cannot be substantially cheapened as far as fuel costs are concerned. If lignite could be exploited for generation of power at a cost substantially cheaper than cost of imported fuels,

then large scale power generation in Rajasthan would not only help Rajasthan itself for founding new industries, for lift irrigation, etc., but could help other areas in the neighbourhood, such as Delhi, Ahmedabad, etc., which have to import fuels from the Bengal Bihar areas, at present, for generation of power. In this regard it is worthwhile considering, for future exploitation, virgin areas adjacent to areas proposed for opencut mining.

- (xi) **Underground Gasification:**—In the area adjoining the working area, the reserves are stated to be of the order of 8.44 million tons occurring at a depth of about 238 ft. The thickness of the lignite here is only of the order of 10-12 ft. and even less. The lignite to overburden ratio is of the order of 1:13 and the Committee concluded that having regard to the losses in the recovery of lignite by underground method a scheme for developing an underground mine in that area would not be economically sound. It appears that it may be worthwhile to consider other methods of exploitation than mining for winning the energy that is stored in this fossil fuel. One such method, developed extensively in the U. S. S. R. and recently tried in several other countries particularly in U. K. (where Commercial undertaking is being planned). is underground gasification.

In this technique holes are drilled from the surface at the chosen distances and air under pressure is pumped through the holes, after setting fire to the seam. The incomplete combustion results in complete gasification of the coal and the resulting gases are withdrawn through other holes and used on the spot for generation of power either in steam boilers or in gas turbines. No mining is involved in this technique. Large scale gasification has been undertaken successfully of lignite deposits at Tula near Moscow under more difficult conditions than those exist at Palana.

From a general scrutiny of the conditions of the deposit and of the strata, there does not seem to be any special difficulty about undertaking underground gasification in the new area, particularly in view of the fact that much of the deposits cannot possibly be recovered by other methods. It is, therefore, suggested

that an Export Team be invited from the U. S. S. R. and / or U.K., who have extensive experience in this matter, in order to examine and submit a report in regard to the feasibility of underground gasification of lignite in this area and, if feasible, to indicate costs of such production of energy and of power by this technique.

- (xii) Recent developments in the U. S. S. R., in underground gasification has also indicated the possibility of manufacturing synthesis gas by use of oxygen in underground gasification instead of air. Production of fertilizers is a priority for the country and possibly should receive the topmost priority in Rajasthan. In view of the fact that the cost of mining of lignite will not be cheap, a method by which power and/or synthesis gas can be produced at a cheap cost is worth consideration.

Underground gasification of lignite in Rajasthan in the new area should be a very attractive proposition.

- (xiii) Rajasthan is one area which contains large deposits of gypsum. If production of synthesis gas, which is one of the most expensive part in production of fertilizers can be cheapened by uaderground gasification in future, then Rajasthan can become one of the largest producers of fertilizers in India.
- (xiv) By technological application, the desert can be made to change its own face as well as to bring prosperity to other adjoining areas, but bold decisions and experimentation are necessary to bring about such a revolution.

The project report, (Part II) prepared by the Directorate of Mines and Geology, Government of Rajasthan has been scrutinized by the Committee and is in general agreement with the same.

The immediate recommendations of the Committee are, therefore, limited to :—

- (1) Opencast mining in the area marked 'A' i. e. the workedover area.

- (2) In view of the extreme shortage of fuel in Rajasthan area, the present mining of coal by underground mining methods, even though difficult and wasteful should, in our opinion, continue. The question whether underground methods should continue after full production by opencast mining has been reached, should be reviewed thereafter.
- (3) Invite a team of experts preferably from the U. S. S. R and / or U. K. to examine the feasibility of under-ground gasification in virgin areas difficult to mine;—
- (4) Intensive prospecting should be undertaken in the Bikaner and adjacent areas in view of the likelihood of the existence of lignite over a vast area. We feel that high priority should be given for this programme of drilling in view of the scarcity and requirement of fuel in the north western part of India.
- (5) Central Fuel Research Institute should be requested to prepare a project for integrated development of industries in Rajasthan based on exploitation of the lignite resources.

The Committee acknowledges with thanks the valuable assistance rendered by the Directorate of Mines and Geology, Government of Rajasthan, particularly officers and staff, including the management of the Palana Colliery, who have collected all the necessary technical data required by the Committee from time to time.

1. (Sd.) A. B. Guha,
2. (Sd.) A. Lahiri.
3. (Sd.) S. S. Grewal.
4. (Sd.) B. C. Roy,
5. (Sd.) H. R. Dewan,
6. (Sd.) M. L. Sethi,

Annexture 1-a

GOVERNMENT OF INDIA

DEPARTMENT OF MINES & FUEL
(MINISTRY OF STEEL, MINES AND FUEL)

No. 16 (3)/ 57-Lignite.

New Delhi-2, the 17th May, 1958,

27th Vaisakha, 1880 (Saka).

OFFICE MEMORANDUM

Subject:— Appointment of a Committee of Experts to examine *inter alia* the problem of economic production and utilisation of the Palana Lignite Deposits.

The Government of India, in consultation with the Government of Rajasthan, are pleased to constitute a Committee of Experts to study all the available data on the Palana lignite deposits with a view to finding out the technical feasibility and economic viability of mining the lignite at Palana in Rajasthan, by open cast methods and, if the scheme is found to be technically and economically feasible, to undertake the preparation of a comprehensive Project Report.

2. The Committee will consist of the following and/or their representatives:—
 - (1) Shri A. B. Guha, Coal Mining Adviser,
Department of Mines and Fuel,
(Ministry of Steel, Mines and Fuel),

- (2) Dr. A. Lahiri, Director,
Fuel Research Institute,
P. O. Jealgora, Dhanbad.
- (3) Shri V. P. Sondhi, Director,
Geological Survey of India.
- (4) Shri H. R. Dewan, Director,
Indian Bureau of Mines.
- (5) Shri M. L. Sethi, Director,
Mines & Geology,
Government of Rajasthan.

3. Shri A. B. Guha, Coal Mining Adviser, in this Ministry, will be the Chairman of the Committee, while the Director, Mines and Geology, Government of Rajasthan will be the Convenor. The members are authorised to depute their representatives or bring any other officer or officers with a view to obtaining their advice technical, financial, or otherwise and for this purpose the Committee is authorised to co-opt additional members from time to time.

4. Each of the members (excepting Dr. A. Lahiri, and/or his representatives) who attends meetings of the Committee and undertakes any tour in connection with the work of the Committee will draw his T. A. and D. A. at the rates admissible under the rules of the Government under whom they are employed from his own Office/Department. A separate communication will follow with regard to the drawal of T. A., D.A. etc., by Dr. Lahiri. Other incidental charges pertaining to this Committee will be borne by the Government of Rajasthan.

Sd/-R. N. Chopra,
Deputy Secretary to the Govt. of India.

To

- (1) Shri A. B. Guha,
Coal Mining Adviser,
Department of Mines & Fuel,
Ministry of Steel, Mines & Fuel,
New Delhi.

- (2) Dr. A. Lahiri, Director,
Fuel Research Institute,
P. O. Jealgora, **Dhanbad.**
- (3) Shri V. P. Sondhi, Director,
Geological Survey of India,
27 Chowringhee, **Calcutta.**
- (4) Shri H. R. Dewan, Director,
Indian Bureau of Mines,
New Delhi.
- (5) Shri M. L. Sethi, Director,
Mines & Ceology,
Government of Rajasthan,
Udaipur.

Copy forwarded to :—

- (1) All Ministries of the Government of India, and the Planning Commission.
- (2) Secretary to the Government of Rajasthan, Industries, Mines & Labour Department (B), Rajasthan, Jaipur.
- (3) Council of Scientific & Industrial Research, New Delhi.
- (4) Mines I Section.
- (5) Mines III Section.

Sd/- R. N. Chopra,
Deputy Secretary to the Govt. of India.

(Annéxture 1-b)

GOVERNMENT OF INDIA

DEPARTMENT OF MINES & FUEL
(MINISTRY OF STEEL, MINES & FUEL)

No. 8 (14)/58-Lignite

Dated New Delhi-2, 23rd July, 1958

11st Sravana, 1880 (SAKA)

To

Dr. B. C. Roy.,
Director,
Geological Survey of India,
27, Chowringhee Road,
Calcutta:-13.

Subject—Committee of Experts to examine *inter alia* the problem of economic production and utilisation of Palana Lignite deposits.

Sir,

I am directed to refer to your letter No. 13384 M, dated the 14th July, 1958, and to forward herewith a copy of this Department's letter No. 16 (3)/57 Lignite, dated the 17th May, 1958. I am to clarify here that it is intended that *inter alia* the Director, Geological Survey of India should be a member of the Committee. As Shri Sondhi was the Director, when orders were issued, his name was mentioned in these

orders. Since he has now retired from service, I am to state that you will be the member of the Committee.

As regards the venue, date and time of the postponed first meeting of the Committee, I am to add that the convenor of the Committee, viz. Shri M. L. Sethi will inform you in due course.

Yours faithfully,

Sd/-R. N. Chopra,

Deputy Secretary to the Govt. of India.

Copy forwarded for information to:—

- (1) Shri A. B. Guha, Coal Mining Adviser,
Department of mines & Fuel,
Ministry of Steel, Mines & Fuel,
New Delhi.
- (2) Dr. A. Lahiri,
Director, Fuel Research Institute,
P. O. Jealgora, Dhanbad.
- (3) Shri H. R. Dewan, Director,
Indian Bureau of Mines,
New Delhi.
- (4) Shri M. L. Sethi, Director,
Mines & Geology,
Government of Rajasthan. Udaipur.

As it appears that the present Director, G. S. I. has not received the set of reports on the Palana Lignite Deposits forwarded to Shri V. P. Sondi, it is requested that an additional set of these documents may kindly be forwarded to Dr. B. C. Roy.

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- (5) Secretary to the Government of Rajasthan,
Industries, Mines & Labour Department (b),
Rajasthan, Jaipur.
- (6) Mines I Section.

Sd/- R. N. Chopra,
Deputy Secretary to the Govt. of India.

(Annexure 2)

GOVERNMENT OF INDIA

DEPARTMENT OF MINES & FUEL
(MINISTRY OF STEEL, MINES & FUEL)

No. 19 (10) / 53-Lignite.

New Delhi-2, the 27th October, 1958
5th Kartika, 1880 (Saka)

OFFICE MEMORANDUM

Subject :-- Appointment of a Committee of Experts to examine *inter alia* the problem of economic production and utilisation of the Palana Lignite Deposits.

The undersigned is directed to refer to this Department's O. M. No. 16 (3)/57- Lignite, dated the 10th May, 1958, on the above mentioned subject and to state that the Government of India are pleased to nominate Shri S. S. Grewal, Chief Inspector of Mines, Government of India, as a member of the Committee of Experts, constituted to examine *inter alia* the problem of economic production and utilisation of the Pala Lignite Deposits.

2. Shri Grewal will draw his T. A. and D. A. at the rates admissible to him as Chief Inspector of Mines from his own office for attending the meetings of the Committee and for undertaking any tour in connection with the work of the Committee.

Sd/-R. N. Chopra,

Deputy Secretary to the Govt. of India.

To

Shri S. S. Grewal,
 Chief Inspector of Mines,
 Department of Mines,
 Ministry of Labour and Employment,
Dhanbad.

Copy forwarded to :—

1. Shri A. B. Guha, Coal Mining Adviser, Department of Mines & Fuel, Ministry of Steel, Mines & Fuel, **New Delhi.**
2. Dr. A. Lahiri, Director, Fuel Research Institute P. O. Jealgora, **Dhanbad.**
3. Dr. B. C. Roy, Director, Geological Survey of India, 27 Chowringhee, **Calcutta.**
4. Shri H. R. Dewan, Director, Indian Bureau of **New Delhi.**
5. Shri M. L. Sethi, Director, Mines & Geology, Government of Rajasthan, **Udaipur.**
6. Ministry of Labour and Employment with reference to their O. M. No. MI. 4 (11)/58, dated the 10th October, 1958,
7. Secretary to the Government of Rajasthan, Deptt. of Industries, and Mines, **Jaipur** with reference to his letter No. F. 3 (11) I (M)/56/4864 dated the 5th September, 1958.
9. Council of Scientific and Industrial Research. New Delhi.
10. Mines I Section.
11. Mines III Section.

Sd/- R. N. Chopra,
 Deputy Secretary to the Govt. of India.

(Annexure 4)

No. PA/CE/960

Dated 6. 4. 59.

RAJASTHAN STATE ELECTRICITY BOARD

Note on possibility of use of Lignite for fairly large Thermal generation near Lignite Mines at Palana.

Rajasthan is a partner in the Bhakra Nangal Project to the extent of 15. 22%. As per the present Plans, out of the total generation of power at the two power houses at Nangal and the left bank Power House at Bhakra, after deducting power to be supplied to Delhi and to the Nangal Fertilizer Factory, Rajasthan would receive 16,500 KW of power. The furthest major load centre to which Bhakra Nangal power would be delivered in Rajasthan is Bikaner. Bikaner is to receive power over a single circuit 132/66 K. V. line.

2. Bikaner is an important load centre, but the development of industries in the Bikaner area has been slow on account of non-availability of power in adequate quantities and scarcity of water. Water is proposed to be supplied to Bikaner from the Rajasthan Canal Project which is under execution. Supply of power to Bikaner would be inadequate from the Bhakra Nangal Project. It would also not be reliable on account of a single circuit coming over a long distance. There would, thus be always shortage and insecurity of power supply in Bikaner for development of major industries even after water becomes available from the Rajasthan Canal. Some steps have to be taken to plan supply of power from an alternate source to Bikaner.

3. Since Lignite deposits have been proved in the vicinity of Bikaner at Palana, it naturally suggests itself that a large thermal station may be located at the Palana Lignite Mines for meeting the shortage of power in the Bikaner region.

4. The size of the power station would naturally depend on the demand of power and on the proved reserves of lignite in the Palana mines.

5. As regards demand of power, in addition to meeting the demand of power in the Bikaner region, if lignite deposits are enough, the power station could be sufficiently big to feed back power in the Bhakra Nangal grid system to meet the shortage of power in the Delhi area. The entire power potential of the Bhakra Nangal Project is practically booked. Indications are that power to be generated from Right Bank Power Station of Bhakra would be cons that as soon as it becomes available. Delhi may have to depend upon thermal generation of power for meeting its growing demands. Coal for this power station, if located at Delhi, will have to be brought from the Coal fields of Madhya Pradesh, Bihar and or Bengal. Since the lignite deposits of Palana have been proved and indications are that the reserves would be enough, a large thermal power station located at Palana could supply power to the Delhi region.

6. Another load centre in Rajasthan which is not served with power from any Hydro Schemes is Jodhpur Division. Jodhpur is located at a distance of only 120 miles, as the crow flies, from Palana. If a large thermal station is located at Palana, it could meet the demand of power from the whole of the Jodhpur division. The demand of power from the Jodhpur Division may be of the order of 20,000 to 25,000 kw in about 15 years' time.

7. If the lignite reserves are definitely proved, and water becomes available, we could think in terms of a thermal power station with an installed capacity of about 50,000 kw to start with which could be extended to about 1,50,000 kw in due course.

8. The present position of the power stations in Rajasthan is roughly indicated.

Total installed capacity of power houses in Rajasthan :—

1 End of year 1958 (Steam & Diesel) :—

(a)	State owned power houses	39,800 kw
(c)	Other licensees for public supply.	9,000 „

(c)	Cement Factories.	14,500 kw
(d)	Textile Mills, railways and other Industries (approximate)	4,500 ,,
		Total:— 67,800 kw.

**II Additional Plant under installation as per the present Plans
(Steams & Diesel) :—**

(a)	State owned power houses.	26,000 kw
(b)	Others (as per information available)	6,000 ,,
		Total :— 32,000 ,,
Total of I & II.		99,800

III Rajasthan share of power in Hydro Schemes as per Plans under execution.

(a)	Bhakra. Nangal	16,500 kw.
(b)	Chambal.	37,500 ,,
		Total:— 54,000 ,,

**IV Additional Hydro Power available to Rajasthan from II Stage
Development :**

(a)	Right Bank Power House of Bhakra.	
(i)	Common Share.	28,500 kw
(ii)	For Fertiliser Factory at Hanumangarh	25,000 ,,
(b)	Chambal—Rana Pratapsagar.	44,500 ,,
		Total:— 98,000 kw
Total installed and planned I to IV.		2,51,800 kw

Note :—

On the availability of Hydro power, some thermal units would be put out of commission.

9. Two blue prints showing various transmission lines and generating stations in Rajasthan are attached herewith.

Sd/- N. J. Balani,
Chief Engineer,
Technical Member,
Rajasthan State Electricity Board
Jaipur.

(Annexure 5)

Attended meeting of the Lignite Experts Committee held at 11.00 A. M. on the 5th April, 1959, in the Committee room of the Secretariat, Jaipur. Discussions took place about the requirements of slack coal for brick manufacture, and coal required for thermal plant and factories in the State.

The Chairman (Shri A. B. Guha, Coal Mining Adviser, Government of India) and Dr. A. Lahiri, Director, Central Fuel Research Institute, Jealgora, were of the opinion that the transfer of lignite in mined form would be very dangerous particularly in Rajasthan where heat and storms range and lignite catching fire would be inescapable. They therefore, advocated that a big thermal power station may be set up at the site of the mines so that lignite taken out from the pits can be sent straight for consumption in the thermal plant. They were satisfied about the necessity of power generation in Rajasthan as the existing power used per capita is very low, total being only about 38,000 K. W. The prospective power that would mature in about 10 years time is likely to be only 2,00,000 K. W. in the entire State including the Chambal Power. Mr. A. K. Roy, Secretary for Industries and Mines and Mr. M. L. Sethi, Director of Mines & Geology, Rajasthan were strongly advised to procure at least 6 nos. diamond core drills and explore the lignite area round about Bikaner. It was thought that the area of lignite is enormous. For want of investigations the Committee could not proceed further. The exploratory work may take about one year or more but it was considered to be important that this should be completed so that the use of lignite at the quarry site in generating power could be made possible, instead of incurring further expenditure on transport. The lignite is to be mined by open cut removing about 9 to 13 times of over burden which would raise the cost of the fuel.

The installation of fertilizer factory and a power plant in this area could be possible if a minimum discharge of 5 cs. could be given from the Rajasthan Canal. As this is exploiting the mineral resources

in the best interest of the State, the Chief Engineer, Rajasthan Canal Project, agreed that 5 Cs discharge would be given from the canal so long as the canal would be in flow. He also pointed out that it would be possible to run the canal after construction during the non-perennial stage for about 4 to 5 months in a year and that the canal is likely to become perennial after about 10 years. He also pointed out that there was no need to abandon the project on the question of water supply, because after the construction of the canal it would be possible even to pump water from the tube-wells and drainages in Ferozepore District, in case river supplies were not available. The Chief Engineer said that in Punjab the charges for water given for such purposes are 1/8/- per 6000 cft.. This rate applies to water supplied by flow. As the Palana Coal fields would be about 175 ft. higher than the canal levels, the cost of pumping water from the canal to the site of the factory will have to be borne in addition by the lignite project. It was indicated by the Director of Mines & Geology, Rajasthan that the anticipated cost lignite by open cut is likely to be Rs. 18/8/- per ton. The cost of pressing lignite into briquettes was likely to be about 3/- per ton. But this would require setting up of a big plant and capital investment. It was also brought out that the caloric value of lignite is about half of slack coal and the actual quantities of lignite to be used would be at least double the quantity of slack coal grade II.

The transport by road would also be double because of rates. Therefore, the use of lignite from stations away from the sources particularly because of its inflammable properties was not recommended.

Sd/- B. R. Lamba.

(Annexure 6)

The abstract of letter No. M/18/RCP/1454, dated 12-6-1958, from the Chief Engineer, Rajasthan Canal Project, Jaipur.

Subject :—REQUIREMENT OF SLACK COAL FOR
RAJASTHAN, CANAL PROJECT.

It is anticipated that 80 Nos. of kilns will be manufacturing tiles for lining of Canal and bricks for other constructional purposes at one time. Each kiln will be burning about 7,000,000 tiles per month thereby consuming 200 tons of slack coal per kiln per month. Thus the requirement of slack coal per brick manufacture alone will not be less than 16,000 tons per month. If slack coal were to be wholly substituted by lignite, then it will be necessary to mine 24,000 tons of lignite per month, this really means that 1 to 2 meter gauge Good rakes full of slack coal or lignite will be utilized on the Canal every day for next about 6 to 7 years.

If about 6,000 to 7,000 tons of lignite is made available from Palana it will indeed be helpful to the Canal construction. The use of Palana Coal will be very convenient particularly in the narrow gauge steam locomotives proposed to be obtained for the working of tramway trains on the excavation of the Rajasthan Canal. If Palana colliery can give greater output, the entire production would be consumed on the canal say for the next 10 years.

PART II

PART II

CHAPTER I

THE LIGNITE FIELD

Introduction

The Lignite occurrence at Palana (27.51' Lat: 73°.19' Long) near Bikaner City has been well known amongst the Tertiary deposits of India, and it has been worked continuously over the past half a century.

1. The lignite field of Palana, is situated in North Rajasthan, practically in the heart of the Thar Desert. There is a complete absence of exposure of any geological formations, except the overlying Aeolian sands, with a cover varying in thickness from 2-13 ft. and sometimes more at places. The terrain is absolutely flat, except for slight undulations in the grounds, and the presence of sand dunes here and there.
2. (a) Beneath this layer of sand, Kankar beds have been found, generally in association with ferruginous nodules, which extend to depths of upto 70 ft. They are followed by weathered sandstones and clays of about 20-40 ft. thickness.
(b) Below these hard, compact, and buff coloured limestone is found underlain in order of sequence, Nummulitic Limestone, shales, impure ferruginous Limestone clays, and about 53' thickness of fuller's earth.
3. These are followed by a 10-30 ft. thickness incomplete section of bluish grey and pink shales, with a thin band of friable sandstone, and then lignite appears.

Below the lignite deposit, there is an occurrence, of a 2 to 4 ft. band of soft clay, grading into a kind of crumbling sandstone. This clay is peaty in appearance, and is inter stratified with sand, at places. Tests conducted at the Central Glass and Ceramic Research Institute, indicate that it is quite a good fire clay, with a P. C. E. value of Orton Cone, 31, i. e. 1680 C⁰ and suitable for manufacturing high grade refractory wares.

Where the lignite deposit is not present, the beds of fuller's earth and shales, are directly underlain by coarse sand, locally called 'BAJRI'. The latter is generally followed by a stratum of black shale.

If a reference is made to the plan it will be seen that two deposits occur almost contiguously, on an axis running NW-SE through the property, and separated by a small barren area. These two areas have been thoroughly proved either by means of shafts, as in the old area, or by extensive number of bore holes, drilled during the last five years, as in the new area. The same plan showing the location of the shafts and bore holes, establishes that the average thickness of lignite of 22 ft., in the old area and 13 ft., in the new area bounded in RED contains 8.44 million tons (9.23 million cu. yards).

With an estimated output of 0.5 million tons per annum, by open cast mining methods, the estimated life of the colliery will be about 20 years.

It can be seen from the same plan, the seam is abruptly cut off by a wash out in the south side and is nipped out on the North side. A wash-out can be best described as that part of the deposit "Washed away" at the time of formation, and soil brought in, in its place. A deposit is 'nipped' out in the sense that the 'thickness' thins out due to probably ground movements, or faulting,

In the old area the average thickness of the overburden is 205 ft. and with an average thickness of 22 ft., of

3

lignite, the overburden lignite ratio comes as already mentioned to 9.3 to 1 (205 ft./22 ft.)

5. The thickness of overburden and lignite have been arrived at very precisely on the basis of data obtained during core drilling operations which have been very extensive over these last several years, and from the old and very many shafts put down over a period of sixty (60) years.
6. The barren area in the immediate vicinity of the deposit consists of sandy desert terrain, with little or no agricultural land of any great value. Therefore, there will be *unlimited space* at our disposal to accommodate the overburden spoil, as obtained during overburden removal by mechanised methods. This matter of available dumping space need not be taken into consideration as an issue of any importance.

CHAPTER II

THE TYPES OF EXCAVATORS IN GENERAL USE FOR EARTH MOVING.

7. The types of excavators in general use now, for earth moving are :—

- (1) Bucket shovels (Diesel or electrically operated).
- (2) Bull-Dozers (Diesel operated),
- (3) Drag Lines (Diesel or electrically operated).
- (4) Scrapers loaders (Diesel operated)
- (5) Bucker Wheel (Electrically operated). Excavators.

Item No. 5 belongs to the specialised type of machines of comparative recent development and design.

Item (1) to (3) vary in capacity and power; the smaller capacity machines item (1), (2), are usually driven by diesel engines, whereas larger capacity ones are driven by electric motors.

8. *Types of Transports:*

The type of transports are so, only in name, such as :—

- (1) Dumpers type heavy trucks.
- (2) Ordinary type of end tipping, diesel trucks of 5/10 tons capacity.

Item (1), (2) are commercially known as Rear or Bottom Dumpers. They are usually diesel driven and vary in capacity.

One other method of transport is the belt conveyor, which is usually employed for transporting coal or any other mineral, on the surface or underground.

9. In the initial stage of overburden removal in the 1st cut and before installing the ultimate specialised equipment bottom dumpers will transport the O. B. spoil and dump on the surface.

After lignite is exposed and some extraction done the O. B. spoil will be dumped back into the quarry using conveyor belts which will be more economical in the long run.

10. Plan No. 1 shows the position of the Development cut. This point has been selected for the following reasons.
- (a) It is nearest to the Railway Station.
 - (b) Extension and placing of the loading siding will be shortest and quickest.
 - (c) The Lignite is 40 ft. thick and O. B. only 131 ft.
 - (d) Lignite will be exposed very quickly and an appreciable output obtained before June 1963.
 - (e) Near to the existing colliery Water well, and the machine workshop.

11. In previous pages, the various types of excavators and transports have been described, but before selecting the type of equipment most suitable, we have to go in to the pros and cons of the use of a certain types of combination of machines.

Scraper Loaders combined with shovels and Rear Dumpers,

12. This is one combination of two types of excavations, one being an excavator cum transport vehicle (The Scraper Loader) and the other being the conventional shovel served by Rear Dumpers, to dispose of the material.
13. With the Scraper Loader, the first 50 ft. of O. B. could be scraped up, transported and dumped at selected sites, along both the Northern and Southern edge of the cut. One of the alternative will be that the remainder of the O. B. average 171 ft. thick the shovel with Rear Dumper may be used to remove the material.

With shovels however, which have a maximum LIFT of 30 ft., this latter removal would mean having at least 5 benches each served by one or more shovels and a fleet of Rear Dumper too.

This would be very costly and at the same time impracticable for the following reasons :—

- (1) Heavy capital expenditure.
- (2) Heavy Power or Fuel consumption.
- (3) Increased difficulties for the Lower Benches in the matter of quick turn round of transport or alternatively more number of Rear Dumpers to meet the needs.
- (4) Long hauls with steep climbs for the lowest bench to the top most and then to the dumping site, on the surface.
- (5) Whether the shovels are electric or diesel driven power and fuel consumption costs would be high and the work could be affected by short or or late supply of the latter, or break downs on the electric side.
- (6) More machines means more sustained and careful maintenance with subsequent increase in the cost on the maintenance side.

This combination is not therefore, recommended.

Scraper Loaders shovels with Rear Dumpers and finally Dragline.

14. This combination will have the effect of reducing the number of shovel benches, and thereby the number of machines on each bench. It would also reduce costs on maintenance, fuel etc.

The Draglines would then come into remove the last so many feet of O. B. and dump the material back into the cut, or into Rear Dumper to haul to surface.

Since however, Drag Lines are now being manufactured with long beams (upto 286 ft. and more) and buckets of 7/9 cu. yds. 10/12 cu. yds. and more, the necessity of having shovels with Rear Dumper operating intermediate benches does not seem necessary at all.

In this system there will be a combination of 3 different types of machines doing the same type of work and any break down of one or more machines of any of the three types, would only hinder the work of the remainder. Chiefly, however, with long beam Drag Lines, the importance of the shovel is nullified. Hence, this system is not recommended, for reasons already stated.

Scraper Loader with Drag Line and Rear purpose

15. This system is also not recommended because :-
- (1) The affective utility of the dragline machine would be greatly diminished if it has to discharge into rear dumpers for transportation of the spoil.
 - (2) Double handling will not be avoided even if the draglines dump the spoil direct into the quarry, because one or more machines may have to be stationed on the spoil dumped in the quarry, to pick up the material and cast it further back in order to make room for dumping by the machine standing on the O. B. bench ahead.

It would be much easier to use conveyor belting, This system of transport require a continuous food which can be best obtained by the latest type of **Bucket Wheel Excavator** which is capable of discharging load at one angle to the working face which would still be convenient for loading into a belt conveyor situated parallel to the working bench.

16. The **Time Table** shows how the supply of excavating machinery will arrive. As such the plan of operations will be as under :—
- (a) Workshop to be fitted up: Power Sub-Station and **Transmission lines** to be installed : water well sunk and fitted up pumps, diesel storage tanks fitted up and filled. These works should be completed by July 1961.
 - (b) Scraper, Bull Dozers, Trucks, Jeeps etc., as enumerated on page 18 of the **Time Table** will have arrived by March 1962.

- (c) O. B. removal operations will be commenced by April 1962 and this job pushed on with, to have the first out scrapped 70' deep by 450 ft. along the axis of the deposit and 2100 ft. wide from Southern to Northern boundaries.
 - (d) It is estimated that 2.5 million cu. yds. of O. B. will have to be removed in the 1st strip, and this will take 6 months time, bringing us to November 1962.
 - (e) To get the Bucket Wheel benches ready, the scraper will proceed downwards taking a further strip 52' deep by the length and breadth of the cut removing 1.2 million cu. yds. of O. B. This will take 3 months bringing us to January, 1963.
 - (f) Some scrapers will still be engaged to form the last Bucket Wheel Excavator bench by digging down the last 52' to top of lignite removing .36 million cu. yds. which will take about 2 months brings us to April, 1963.
17. The amount of overburden to be removed in the 1st cut comes to 3.5 million cu. yds to come to top of lignite, and exposing a width of 100' containing 1,28,000 tons of lignite.

After removal of overburden in the 1st cut, the amount of overburden to be removed to expose a further 100' length of Lignite (1,28,000 tons), 1.25 million cu. yds. of overburden will be removed (see dig. 1).

The amount of 1,28,000 tons of Lignite will last 3 months at the rate of 42,000 tons per month, therefore, the amount of overburden to be removed per month onwards after the 1st cut and first exposures of Lignite, will be 1.25 million cu. yds. divided by 3 comes to .42 million cu. yds.

The overburden to be removed per day in a month of 25 days — $.42/25$ 16,850 cu. yds. per day.

Taking Swell factor of 33 % the overburden spoil to be removed per day come to $16.800 \times 133 / 100 = 22,400$ cu. yds.
per day.

16,000 cu. yds of overburden is to be removed per hour, allowing a effecting working day of 14 hours for a total of 22,400 cu. yds. per day.

18. For this rate of removal we suggest to utilise 8 Nos. of 'Scrapers with a working capacity of 200 cu. yds. per hour each based on the actual performance of 400 cu. yds per hour. It is pointed out that the capacity should be such as to dispose off 1600 cu. yds. of spoil per hour, we suggest the use of 'Bottom' Dumpers.

At Neyveli the total haul for any bottom dumper to and fro in 5 miles, where as at Palana it will be approximately 2 miles allowing for a maximum gradient of 1 in 10 from top of Lignite to surface, to dumpside and back.

At Neyveli the actual performance of the Bottom Dumpers over 5 miles was 4 trips per hour inclusive of loading time. Hence in the case of Palana we can easily take 8 trips per bottom dumpers per hour and therefore the number of Bottom Dumpers required to transport 1600 cu. yds. of spoil per hour works out to 12 Nos. As these machines will be the hardest worked we should allow 4 more dumpers bringing a total of **16 Bottom Dumpers** to serve 8 Scrapers.

19. These Scrapers will be used in the initial cut not only to expose Lignite but also to form the benches for the bucket Wheel Excavators. After Bucket Wheel Excavator are installed the scrapers will still be used to remove the top 70' thickness of overburden of a head of operations.
20. We suggest the use of 2 Bucket wheel Excavaters one on each bench below the 1st 70' thickness which will be removed by Scrapers.

At a rate of removal of 1600 cu. yds. per hour then each machine would be required to remove 800 cu. yds. per hour.

Bucket Wheel Excavaters are manufactured in various sizes and the size recommended to us at Neyveli was the BAV

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1106 which has a rated capacity of 900 cu. meters per hour or 1200 cu. yds. per hour. Allowing for 75% overall efficiency including operational breakdown difficulties, etc. even then 900 cu. yds. per hour could be easily removed by each machine which suits our purpose.

21. Bucket Wheel Excavators, since they deliver the cuttings on to a belt conveyor embodied in the machine it-self, another machine known as the 'Spreader' is required to pick up the spoil as fed by the bucket wheel on to the conveyor system, and dispose off the same in the void of the pit, We recommend one such 'Spreader' which will be able to serve the two 'Excavators'.
22. The 'Spreader' will be stationed on the other side of the cut and will keep on disposing of the spoil from the Bucket Wheel-Excavator.

CHAPTER III

OPERATION OF THE MINES

23. The initial production pit, will be 450 ft. wide on the surface allowing for 45° slope on all sides.

It will be situated at the point marked "PP" on the surface plan, (annexure 3) which also shows the outline of the area in which open cut operations will commence.

As lignite is touched and commenced to be extracted, the procedure of O. B. removal will proceed forward along the axis of the Deposit, with the lignite extraction following up.

The top or Scraper bench (70 ft. in thickness) will advance ahead of the Bucket Wheel Benches.

The work on these two benches will be synchronised so that the top or scraper bench face is always a minimum of 100 ft. ahead of the Bucket Wheel bench faces.

The B. W. E. recommended by us, as a useful cut of 1.5 meters up and 5 meters down, or a total of 20 meters, which in feet means 66 ft.

Thus with the 1st 70' thickness of O. B. being removed by Scrapers the B. W. E. between them could tackle 132' in 2 benches of 66' each, bringing the total thickness to 202'.

Where this thickness may increase in places, we could instead of removing 70' thickness by Scrapers, remove a greater thickness in two benches, so that a regular 132' of O. B. thickness could remain for the Bucket Wheel Excavator,

Drilling in Advance.

This does not arise in Palana as no blasting will be done.

We have "under—Clay" below the Lignite bed. This may be extracted as and when required even by manual labour.

CHAPTER IV

LAY OUT OF DEVELOPMENT PIT

23. (A) There will be only one production bench at Palana as the average thickness of Lignite is 22 ft.

Since lignite is very soft, a greater thickness need not cause any anxiety, from the point of view that the maximum LIFT of a shovel is 30 ft.

It is not as if the shovel is operating a Rock Bench which, when blasted, provides material for loading to the extent that the face has been blasted, and no more. Bits and pieces of rock may be broken and still roasting on the top of the bench, which ordinarily a shovel with a lift of 30 ft, would not reach, drop down and load up.

The lignite will "Keep on falling" to the shovel whether the bed be of the thickness more than the average.

Plan No. 1 shows cross sectional three dimensional impression of the first cut. From this it will be observed that the lignite bench face will or should always be kept at least 100 ft. wide (measured along the axis of the deposit) from the foot of the Bottom B. W. E. bench.

This is necessary to allow for the spoil conveyor system to lie kept well away from the lignite working face.

Development Benches.

23. (B) (a) O. B. will be removed by scrapers over the whole area in the first cut up to a depth of 70'.
- (b) After this operation same scrapers will be engaged in removing O. B. along the 70' face and others will be engaged in deepening the cut further 50' to form the bench for the first Bucket Wheel Excavator.
- (c) After this depth has been reached some scrapers will be mentioned to advance this 2nd 50' face and others

will be engaged to remove the remaining 50' thickness of O. B to top of lignite (see diagram 1).

In the operation for (a) approximately 2.04 million cu. yds. of O. B. will have to be removed.

In the operation for (b) approximate .92 million cu. yards of O. B. will have to be removed.

In the operation for (c), approximate .58 million cu. yards of O. B. will have to be removed.

These development benches will be formed chiefly by scrapers, but as and when B.W.E. arrives they will be put on their respective benches and the scrapers will be used entirely for removing the first 70' thickness of O. B.

Untill the 210' width of Lignite deposits exposed in the first cut is more or less entirely removed, there will be no room for the B. W. E's in combination with spreaders to dispose off the spoil into the void. untill this situation is reached the spoil from both scrapers and B.W.E's will be disposed off on the surface by means of Bottom Dumpers and the conveyors system in respect of the B. W. E's.

CHAPTER V.

METHOD OF SPOIL DISPOSAL FROM DEVELOPMENT PIT—THE SITE,

23. (C) As the country around the cut is more or less flat, with a very few undulations, as stated in Chapter I, on the Topography of the Field,—there will be no difficulty at all in selecting the Dumping Sites.

The Dump Sites will be parallel to the run of the cut. The foot of the spoil heaps will be kept clear of the "working edge" of the cut.

Bottom Dumpers will be used for the transportation of spoil practically throughout the 1st cut, until the B. W. Excavators are brought into operation.

Bottom Dumpers will continue servicing the scrapers in the removal of the 1st bench (70' thickness of O. B.) and the spoil dumped at convenient sites either on one side or both sides of the cut.

Until such time as lignite has been sufficiently extracted to permit of B. W. E. spoil being emptied back into the void, a suitable arrangement of the conveyor system will enable the B. W. E. spoil to be conveyed out of the cut and using any of the scraper-spoil-heaps as a ramp, such spoil could be disposed of by the spreader on the surface.

The plan mentioned herein, will clarify the position.

23. (D) Suitably graded roads into the cut will be provided

for the Bottom.^s Dumpers to negotiate keeping any one gradient not more than 1' to 10'.

This gradient of 1' to 10' is the maximum slope on which Bottom Dumpers work efficiently.

As the land on both sides of the cut is barren and very little cultivated the spoil heaps could be formed and maintained at convenient intervals and size during the first cut so as to reduce the haulage distance.

After the first Lignite exposure has been completely removed, than only the spoil of the B. W. E. will be dumped or spread back into the void.

The spoil as obtained from the scrapers will have to be dumped on the surface, as the first 70' of O. B. will be exclusively removed by these machines.

23. (E) As will be seen from the time table (Annexure-6) lignite for a length of 210' along the strike and the full width of the cut will be obtained by April 1963. In the meantime however, when the last 50 ft. of overburden on top of Lignite is commenced to be removed, arrangements will be taken in hand to install the lignite conveyor from surface loading plant into the mine. It, therefore, seems possible that first lignite production should commence by a few months before the whole length of the lignite seam (21) is exposed i. e. before April, 1963, or by April, 1963, at the latest.
23. (F) The volume of O. B. to be removed to Start producing lignite will be 3.54 million cu. yards, which is also the total volume of O. B. to be removed in the first cut.
23. (G) Referring to Plan No. 1 the site has been shown as close as possible to Palana Railway Station.

This is necessary to enable quick assembly of the machines, —from which point (walking Dragline and

19

Shovels) will propel themselves to the site of work 800 yards away.

This will necessitate the putting in an additional aiding to meet the purpose,

CHAPTER—VI

ELECTRICAL DISTRIBUTION

Power supply will be obtained from the Bhakra Nangal Hydel Station through the Bikaner Grid Sub-Station. A branch Sub-Station of adequate capacity may have to be constructed in lieu of the present Sub-Station near the colliery water area, The present sub-station is a small building with a small transformer and will be totally unsuitable for our purpose.

Cost of Power is given in the letter of the Superintending Engineer, (Projects) Rajasthan State Electricity Boards, Jaipur.

The following machinery, with their approximate H. P. will constitute the Collicryes equipment.

- (1) 2 B. W. E. of maximum A. P. 600 each of erall.

The above is according to the specification of the RAU
1106 B. W. E.

(2) *Belt Conveyor (Lignite)*

Capacity : 150 tons per hour.

 : 2.5 tons per minute.

Belt speed : Approx. 200 ft. per minute.

Therefore H. P. of driving.

$$\text{Motor} - \frac{2.5 \times 2240 \times 200}{33000} - 34 \text{ H. P.}$$

Allow 60% efficiency.

$$- \frac{34 \times 100}{60} - 56 \text{ H. P.}$$

Say 60 H. P,

(3) Belt Conveyors (P. B.)

For a maximum of 8,000 ft. of belt conveyor in 1000' sections, the H. P. would be 60 H. P. \times 8 which will bring the complete exposers of lignite by August, 63

(210' wide 1510' long)

= 480 H. P.

or say 500 H. P.

Water Well Pumps.

25. We have at present 2 pumping units of 40 H. P. each, delivering approx. 8,000 gallons per hour each.

Our requirements for open cut operations will be much more due to the following factors :—

- (a) Spraying of Lignite in storage area and in the seam itself.
- (b) More drinking water consumption due to a larger labour force, more staff and
- (c) Washing of about 50 Nos. units of machines from Draf Line to Jeep.
- (d) Workshop requirements.
- (e) Incidentals.

In our opinion the pumping capacity should therefore, be a good 3 times the present capacity i.e. 24,000 gallons per hour.

The head of pumping is 350 ft.

Therefore, H. P. of pump motor will work out to

$$= \frac{24,000 \text{ gallons} \times 10 \text{ lbs.} \times 350 \text{ ft. head}}{33,000 \times 60}$$

$$= 42.4 \text{ H. P.}$$

Allowing 60% efficiency.

$$= 70.6 \text{ B. P.}$$

Note:—It will not be necessary to work more than one pump at a time.

Workshop.

In the absence of specific details of the H. P. for each unit of machinery including welding sets etc., we take a maximum of 50 H. P.

Lighting

26. The township will be large ; the open-cut workings at night in the Hot season, will require flood lights etc., of high C. P. the loading siding will also require adequate lighting, Bangalows, Street Light etc, etc., and therefore, we are allowing approximately 75 K. W. for Lighting.

Total H. P. of machine.

- (a) 1200 H.P. for 2 Nos. of B. W. E
- (b) 60 H.P. for lignite conveyer.
- (c) 500 H. P. for O. B. conveyer.
- (d) 70 H. P. for water well pump.
- (e) 50 H. P. for workshop machinery.

Thus total H. P. of machines.

= 1880

say 2000 H. P.

Therefore total watts for 2,000 H. P.

= $2,000 \times 746 = 14,92,000$ Watts.

= 1.492 K. W.

Lighting 75 K. W.

Total 1567 K. W.

Allowing 25% extra for unforeseens

The supply is secure say 2,000 K. W. as it will be obtained from the Bhakra Nangal Hydel Station.

Lignite Storage

27. This is a very important issue, as we must provide for adequate and Safe Storage of Lignite to allow for variations or

drop in consumption ; late or irregular supply of Railway wagons, and other unforeseen factors. With a maximum output of 0.5 million tons per annum or 42,000 tons per month the average daily output taking 25 working days in a month, would come to 1680 tons or say 1700 tons.

It would, therefore, appear necessary to have a storage capacity equivalent to several days output, and as such a suitable storage place for 12,000 tons of Lignite is recommended.

As the Palana Field lies in a flat expanse of desert land, sandy, and in the hot seasons, lashed with hot winds, sandstorms etc. It will be necessary to provide a storage system which would **protect** the stock from the wind and at the same time be situated at a point near the main discharge of the lignite conveyor belt, to enable quick and easy disposal.

The position of this storage Bunker could be decided later on.

The storage Bunker should be cemented area, surrounded by high walls to protect the stock from the hot winds, and be provided with adequate water pipe lines and branch connections with flexible hoses etc. so that the stocks of lignite could always be kept **Damp**. An overhead water reservoir would also have to be provided adjacent to the storage area in order to ensure a continuous and adequate supply of water. This will also give sufficient pressure head for the water to be **sprayed** on to the stock of lignite, from near or far, at all times.

The design of this storage area, would, apart from the broad idea given, depend on the actual needs.

CHAPTER—VI

MISCELLANEOUS OPERATIONS.

28. The spraying of the Lignite deposit itself as exposure of the seam proceeds, will be a necessity. Since the open-cut operations will also be conducted in the old area (over a worked out Zone) in which there will be galleries, and pillars in unknown stages of collapse, a system of spraying the Lignite bed as exposure continues is deemed a necessity. Air percolating through the breaks and crack in the deposit, may very well initiate slow heating inside. Therefore, we will have to be on our guard against this very likely, and dangerous feature.

The attached plan will show how this will be done.

29. As there will be no 'stock' of Lignite left (as such) in the cut, because the output will be conveyed (wagons or no wagons) to the surface this contingency will not arise. The 'Bunker' arranged for in the cut, is chiefly meant for ensuring a constant and regular "Food" on the conveyor belt, and will not, ordinarily, be meant for storing large quantities of - Lignite.
30. In any case, a small branch pipe-line, (as a precautionary measure) could be fixed to enable the "Bunker" and its contents to be sprayed and cooled, should the necessity arise.
31. Water will be supplied to the Benches for drinking and other purposes, from the same water main, as will be taken into the "Cut" to spray the Lignite. As this 'Main' will best be laid on Top of the Dragline bench (to have additional pressurehead for adequate 'Spray' showering all over the surface of the lignite deposits," adequate branch pipes will enable water to be supplied drag to the Dargline bench and for the scraper-loader bench, an Extension of the surface main, running alongside the surface

edge of the cut, with branches to the scraper Loader bench, will deal with the requirements thereon.

32. The major dust problems that will have to be contended with, at Palana, are those arising out of the sandstorms in the dry and hot seasons, and whatever clouds may be formed by the Scraper-Leaders in the process of scraping the O. B. as also the Rear-Dumper traffic.

On the Drag-Line bench, there will be little or no dust formation as the nature of O. B. consisting of 'Clayey' textured material, will not cause such, or any clouds of dust.

Dust suppression - again - can be adequately dealt with by the water pipe arrangements laid out for 'Spraying' the Lignite Exposure, drinking and other water for the machine benches etc.

A suitable water tank truck with sprinkling arrangements will be used for damping the roads, etc. and a unit has been provided for in our capital requirements.

33. **Water** - at Palana Colliery, is found in an **inexhaustible** supply - 150' or so **below** the lignite deposit.

As Such :-

- (a) There will be no pumping out of the cut.
- (b) Surface drainage in any large sense of the term will be non existant.
- (c) Whatever **Minor** drainage will be required, will be of a periodical nature in the sense that the drains of the drainage system will be made to suit requirements as the O. B., faces--advance. Such drains too, will, therefore, be of temporary construction, as their location will be shifted from place to place.

34. What water is to be drained from the O. B. benches will be done by cutting 'Kucha' drains in the soil, guiding the over flow

eventually on to the lignite deposit, down the slope of the Drag-Line bench.

This water, as also, the lignite spraying water, will 'Loose' itself inside the old mine workings, and will, therefore, not constitute any major problem of re-disposal.

35. (a) There will be No pumping in the cut itself. Whatever pumping will be done, will be at the water-well where there are already permanent arrangements for Power supply to the pumps.

The new water well (20 ft. dia) provided for in the Capital Expenditure on Buildings will be situated adjacent to the present water welland therefore, no special additional arrangements will be necessary on this account.

35. (b) These buildings will be constructed as phased in the 'Time Table' of this project. The situation thereof, are given on the surface Plan, attached herewith, and, therefore, no further comments are necessary on this account.

CHAPTER VIII

STAFF & LABOUR

37. Plan No. 1 A (Annexure-1) shows the lay-out of the labour quarter colony, the staff quarters, and officer's residences. These will be 'Phased' constructed according to the

'Time Table'

- ANNEXTURE (1). Shows the cost per ton of Coal.
- ANNEXTURE (2). Salaries and wages of staff.
- ANNEXTURE (3). Cost of Lignite Mining and loading by conventional Haulage.
- ANNEXTURE (4). Cost of Mining and loading of Lignite (Shovel, Dumpers, belt-conveyors)
- ANNEXTURE (5). Cost of Removal of over-burden.
- ANNEXTURE (6). Time Table.

CHAPTER—IX

EQUIPMENT-CAPITAL & OPERATING COSTS

A. *Specialised Mining Equipment.*

Specialised equipment that is going to be used is as follows:-

(1) Bucket wheel Excavator:—	2 Nos.	Rs. 70,00,000/-
(2) Spreador,	1 No.	Rs. 25,00,000/-
		<u>Rs. 95,00,000/-</u>

B. *Conventional Earthmoving Equipment.*

Capital Cost :

(a) Scraper.	8 Nos.	Rs. 16,40,000/-
(b) Bottom Dumpers,	16 Nos.	Rs. 35,20,000/-
(c) Crawler Tractor	8 Nos.	Rs. 10,00,000/-
(d) Bulldozers	6 Nos.	Rs. 7,50,000/-
(e) Conveyor Belting at Rs. 3,00,000/- per 1,000'.	8,000'	Rs. 24,00,000/-
(f) Diesel Shovel 2½ Cu. Yds.	2 Nos.	Rs. 4,00,000/-
(g) Rear Dumper	4 Nos.	Rs. 6,00,000/-
(h) Lignite belt conveyor.	2000'	Rs. 6,00,000/-

Total Rs. 1,09,10,000/-

CHAPTER X

TOTAL CAPITAL EXPENDITURE

Interest on Capital during Development.

Development machinery, including provision for spare
totals as under:—

1. Scraper.	8 Nos.	16,40,000/-
2. Bucket Wheel Excavator	2 „	70,00,000/-
3. Spreader.	1 Nos.	25,00,000/-
4. Bottom Dumpers.	16 Nos.	35,00,000/-
5. Crawler Tractors.	8 „	10,00,000/-
6. Bull Dozers.	6 „	7,50,000/-
7. Spare Parts.	— —	30,00,000/-
8. Pumps & Pipe fitting.	— —	1,00,000/-
9. Electric Cable, Transformers and Switch gears.	— —	2,70,000/-
10. Jeep with tractor.	2 Nos.	28,000/-
11. Trucks 5 Tons	2 „	80,000/-
12. Low Loaders.	1 No.	2,00,000/-
13. Diesel Storage Tanks.	2 Nos.	50,000/-
14. Mobile Crane.	2 „	1,00,000/-
15. Road Roller.	1 No.	25,000/-
16. Tank Lorry with Water Sprinkler.	2 Nos.	50,000/-
17. Electric Welding Set.	4 „	60,000/-
19. Ambulance Van.	1 No.	20,000/-
18. Workshop Machinery.		4,00,000/-

20. Diesel Shovel 2½ Cu. Yds.	2 Nos.	4,00,000/-
21. Rear Dumpers 10 Tons.	4 „	6,00,000/-
22. Belt Conveyor for B.W.E		24,00,000/-

Total	<u>2,41,03,000/-</u>
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Total Capital
Cost Of
Development &
Equipping the Mine.

See Shedule of Machinery.

Rs. 2,50,00,000/-

Other Capital
Items

Nil.

Housing.

Rs. 26,40,000/-

Total	2,76,40,000/-
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Annexure 1

PROVISIONAL COST PER TON OF COAL FOR AN ANTICIPATED TARGET OUTPUT OF 5,00,000 TONS PER ANNUM

Head of Accounts:

	Cost per Ton.	
	Rs.	nP.
A. 1 Colliery Establishment.		
(a) Pay of officers.	0 . 24	
(b) Pay of Establishment.	0 . 31	
<i>Allowance & Honoraria.</i>		
(c) Travelling Allowance.	0 . 01	
(d) Dearness Allowance.	0 . 10	
<i>Other Charges.</i>		
(e) Contingencies.	0 . 03	
(f) P. F. Gratuity Compensation etc.	0 . 03	
A II. Mining Charges.		
(a) Coal Cutting & Loading.	0 . 80	
(b) Removal of overburden.	4 . 76	
(c) Coal Mines Bonus.	0 . 10	
(b) C.M.P.F.	0 . 05	
(e) Coal for Colliery consumption.	0 . 08	
(f) Oil & Sundry Stores.	0 . 10	
(g) Fuel & Powers.	0 . 50	
(h) Rent, Royalties and cess.	0 . 50	

(i) Renewals and repairs to plant and machinery and buildings.	1 . 00
(j) New minor works.	0 . 10
(k) Miscellaneous charges.	0 . 10
(l) Insurance, Port & landing charges.	0 . 25
(m) Drilling & Blasting.	1 . 00

A III. *Interest on Capital @ 4%*

Building and Machinery.	2 . 20
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P IV. *Depreciation Charges.*

Machinery	5 . 00
Building.	0 . 10
	<hr/>
Total.	17 . 36
Allowance 10% for contingencies etc.	1 . 74
	<hr/>
	<u>19 . 10</u>

Say Rs. 19/- per ton.

Annexure 2

1. Pay of officers.

Agent.		1,900/-
Dy. Agent.		1,700/-
Manager.		1,000/-
U. Manager.		700/-
Asstt. Manager.	2 Nos.	1,200/-
Electrical & Mechanical Engineer.		1,700/-
Accounts Officer.		537/-
Welfare Officer.		537/-
Doctor.		325/-
Asstt. Electrical Engineer.		537/-
Fire Fighting Officer.		250/-
Total		<u>10,386/-</u>

Cost per ton on Officers.	<u>10,386</u>	Rs. 0.24
	42,000	

(b) Pay of Establishment.

1. ADMINISTRATIVE:

(a) Higher Subordinate.	5 U.D.C.	Rs. 1,128/-
(b) Subordinates.	10 L.D.C.	Rs. 950/-
(c) Compounders.	1 No.	Rs. 95/-
(d) Dressers.	2 Nos.	Rs. 80/-
(e) Nurses.	2 Nos.	Rs. 190/-
Total		<u>Rs. 2,443/-</u>

2. *Technical Mining.*

(a) Inspector. (W.W.)	1 No.	Rs. 250/-
(b) Senior subordinates (Pits Supervisors).	2 Nos.	Rs, 800/-
(c) Section Officer.	1 No.	Rs. 225/-
(d) Subordinates. (4 Mines sardars, 2 Loading Supervisors)	6 Nos.	Rs, 840/-
	Total	Rs. 2,115/-

3. *Maintenance.*

(a) Electrical Foreman.	1 No.	Rs. 400/-
(b) Mechanical Foreman.	1 „	Rs. 400/-
(c) Electrical Fitter.	3 Nos.	Rs. 675/-
(d) Mechanical Fitter.	10 „	Rs. 2,250/-
(e) Fitter Helper.	26 „	Rs. 1,040/-
(f) Mazdoor,	30 „	Rs. 1,200/-
	Total	Rs. 5,965/-

4. *Workshop.*

(a) Latheman.	2 Nos.	Rs. 200/-
(b) Mechanic.	6 „	Rs. 600/-
(c) Electric Welder.	4 „	Rs. 400/-
(d) Blacksmith Head.	1 No.	Rs. 100/-
(e) Mazdoors.	15 Nos.	Rs. 600/-
	Total	Rs. 1,900/-

5. *Transport (Drivers).*

(a) Jeep Drivers.	4 Nos.	Rs. 300/-
(b) Truck Drivers.	4 „	Rs. 300/-

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(c) Crane Drivers.	2 Nos.	Rs. 150/-
(d) Road Roller Driver.	1 No.	Rs. 75/-
(e) Tank Lorry Driver.	1 „	Rs. 75/-
(f) Ambulance Driver.	2 Nos.	Rs. 150/-
	Total	Rs. 1,050/-
	Grand Total	Rs. 13,473/-

Cost per ton. $\frac{13,473}{42,000}$ Rs. 0.32

Annexure 3

COST OF LIGNITE MINING AND LOADING BY CONVENTIONAL HAULAGE

As per discussions held at Delhi during the last meeting of the Committee, the costings for transporting lignite from the pit to the surface by conventional haulage has been calculated. It will be seen that the cost of transporting lignite by haulage comes to Rs. 6.66 per ton. The cost of transporting lignite by belt conveyors comes to Rs. 0.80 (as per annexure No. 1) which is very low as compared with the cost by conventional haulage.

The total capital investment on machinery to be used for haulage comes to Rs. 2,48,500/- while that of belt conveyor is Rs. 16,50,000/-. Though the initial investment in case of belt conveyor is more but the operational cost is very low and thus the lignite transportation by belt conveyor is much cheaper.

The details of calculations of conventional haulage are as given below :—

The total tonnage of lignite to be excavated is 1,700 tons in 24 hours. Allowing only 16 hours for actual haulage the quantity to be removed per hour is 1,700 divided by 16 which is equal to 106 or say 110 tons.

Length of the haulage plane say 1050 ft.

Rope speed 5 miles an hour or 440 ft. per minute.

Therefore, for one journey is $1050 \div 440 = 2.4$ minutes; for coupling etc. 3.6 minutes.

6 minutes per trip.

or 10 trips an hour.

or 11 tons per trip.

Capacity of tubs 36 cu. ft. = $36/54 = 2/3$ tons per tub.

Therefore, tubs per trip = $11 \div 2/3 = 11 \times 3/2$

= 16 tubs per trip.

Weight of an empty tub = $2/5$ of $2/3$ ton.

= $4/15$ or say $1/4$ ton.

Weight of rope of say $7/8$ " diameter

$W = C^2$ per fathom.

= $(2.8)^2 = 7.84$ or say 8 lbs per fathom.
or 1.3 lb per foot.

$1050 \times 11.3 = 1365$ lbs. weight of rope.

$\frac{1}{4}$ ton per one tub.

Weight of 16 tubs = $16 \times \frac{1}{4} = 4$ tons.

Weight of lignite = 11 tons.

Rope pull D can be calculated by using the formula

$$D = (Tl - T_e + R) \sin \alpha + (TR + T_e + R) (f \cos \alpha + P)$$

Where Tl = Wt. of loaded tub.

T_e = -do- empty tub.

α = Angle of inclination, i. e. 14° In the haulage plane
it is proposed to be kept 14° .

R = Weight of the Rope.

F = Co-efficient of friction here taken as 0.025

P = Coefficient of acceleration taken as 0.1

$$\therefore \text{Rope pull } D = \{ (15-4) \times 2240 + 1365 \} \times 0.24192 + \{ (15+4) \times 2240 + 1365 \} \times (0.025 \times 0.97030 + 0.1) \text{ lb.}$$

$$= 6291.1296 + 5458.0107 \text{ lbs.}$$

$$= 11749.1403 \text{ lbs.}$$

or say 11750 lbs.

$$\text{H. P. of the haulage} = \frac{11750 \times 440}{33000} = 157$$

$$\text{H. P. of motor} = \frac{157 \times 100}{70} = 225$$

Machinery.

1. Haulage machine.	225 H. P.	Rs.	1,75,000/-
2. Rope, 3000'			6,000/-

9. Friction rollers.	100 Nos.	Rs.	1,500/-
4. Switches.	-		25,000/-
5. Spares, 20% of the total cost.			41,500/-
	Total	Rs.	2,48,500/-

Staff.

1. Engine Drivers.	3 Nos. @ 5/- per day.	Rs.	15/-
2. Cleaners.	3 Nos. @ 2/- per day.		6/-
3. Trammers.	64 " @ 4/- " "		256/-
4. Friction Rubber	4 " @ 4/- " "		16/-
	Mistri & Coolies		
5. Haulage Cleaners.	4 " @ 2/- " "		8/-
6. Loaders.	2500 ' @ 4/- " "		10,000/-
	Total.	Rs.	10,301/-
			per day.

Cost per ton = Rs. 6/- per ton.

Electricity.

$$\text{KWH} = \frac{22 \times 745 \times 16}{1000} = 2685 \text{ units per day.}$$

$$= \text{Rs. } 110/- \text{ per day.}$$

$$\text{or Rs. } .06 \text{ per ton.}$$

Maintenance.

10% of the operational cost and the running expenditure

$$= \text{Rs. } .606 \text{ per ton.}$$

Therefore total cost on lignite transportation by haulage

$$= \text{Rs. } 6.66 \text{ per ton.}$$

ANNEXURE 4

COST OF MINING AND LOADING OF LIGNITE BY SHOVEL REAR DUMPERS AND BELT CONVEYORS.

1. Diesel Shovel.

(a) Operating :

Wages.	Rs.	800/-
D. A.	Rs.	266/-
Total.		10.6/-

∴ Cost per ton = Rs. 0.02

(b) Fuel = 0.18

(c) Maintenance = 0.02

Total. 0.22

2. Rear Dumpers.

(a) Operating Rs. 0.02

(b) Fuel. Rs.

210 H. P.

$$= \frac{210 \times .33 \times .80}{10}$$

= 6.33 gls. per hour per machine.

= 6.33 × 4 × 14 × 25 per month for 4 machines.

= 8932 gls. per month.

= 17864 rupees per month.

∴ cost per ton = Rs. .12

(c) Maintenance = 0.04

Total, 0.48

3. *Belt Conveyors, 2000'*

$$(a) \text{ Operation} = \text{Rs. } 0.001$$

$$(b) \text{ Fuel \& Power.} = \\ \text{h20 H. P.}$$

$$\text{Unit consumed} = \frac{120 \times 746 \times 14}{1000}$$

$$= 1253 \text{ units per day.}$$

$$= 1253 \times 25 = 31225 \text{ units per month}$$

$$= 32/ \frac{31225 \times .65}{16}$$

$$= \text{Rs. } 1268 \text{ per month.}$$

$$= \text{Rs. } 0.03 \text{ per ton.}$$

$$(c) \text{ Maintenance} = \underline{0.003}$$

$$\text{Total} = 0.034$$

Grand total.

$$= 0.22 \text{ plus } 0.48 \text{ plus } 0.034$$

$$= \text{Rs. } 0.734$$

$$10\% \text{ for loading} = 0.07$$

$$\therefore \text{ Total cost for cutting and loading per ton.} = \text{Rs. } 0.80$$

ANNEXURE—5

REMOVAL OF OVERBURDEN COSTS.

1. *Hand Operation.*

A total of 1600 cu. yds. of overburden is to be removed per hour to expose lignite for a production of 42,000 tons per month.

An average tipping tub's capacity is 27 cft. or 1 cu. yard.

This would mean that haulage arrangements and equipment would have to be such that 1,600 tipping tubs per hour would be hauled and emptied, and supplied back for loading.

This in itself is a colossal job, and would need practically double the number of tubs, long lengths of tram lines on each bench, and as many haulage engines as there are benches.

Taking a workable height of 30' for a bench, this would mean 6 or 7 benches and the same number of haulage engines; each with its complement of attendants, trammers, tubs etc..

As such we are of opinion that hand removal of over-burden is impracticable and need not be taken into account at all.

2. *Removal by Shovels and Bottom Dumpers.*

Taking a workable height of bench as 30 ft. for a shovel to work on, then with an average thickness of overburden of 205 ft. we would require to make & operate 7 (seven) benches.

The width of overburden face in on the average 1950 ft
(bottom 1750 ft. plus top 2150')

At a rate of removal of 1600 cu. yads per hour overall; we would require to remove $\frac{1600}{7} = 228$ or 230 cu. yds. per hour per bench.

Taking 40 passes per hour for a shovel, then for a 5 cu. yd. shovel, we would require 2 shovels per bench, or 14 shovels for all the benches. Allow 3 spares, the number of shovels required would be 17 Nos.

Bottom Dumpers:—

Taking the mid-point of the overburden faces, as the average starting point for any dumper travel to and fro, then the maximum distance any one dumper would have to travel (including the gradient out of the mine at average depth 100'), would be $\frac{(1750 + 2150)}{2} = \frac{1950}{2 \times 2} = 975$ say 1000 ft. horizon'al. At a gradient of 1 in 15 out of the mine, for 100 ft., average = 1500 ft. Dumping would be done at least 1000 ft. further away leaving a 300 ft. clear space adjacent to the quarry working edge. Allow 150' - 200 ft. turn round, then the total distance travelled by any one dumper in a complete trip, would be $(1000' + 1500' + 1000' + 200') \times 2 = 7400$ ft. or say $1\frac{1}{2}$ mile.

Taking a workable average speed of 10 miles per hour, then the time taken to and fro out of the mine would be 15 minutes. Allowing 50% of this again for unloading etc., each trip would take 22 minutes, or 3 such trips would be made per hour. Each bottom dumper, being of 17 cu. yd. capacity, would then be able to dispose of 51 cu. yds. per hour. Hence to remove at the rate of 230 cu. yds. per bench, we require $\frac{4}{5}$ bottom dumpers per bench, or for 7 benches, 30 bottom dumpers. Allowing for spares, say 36 such. Hence, operational costs would now work out as under for the following machines.

- | | |
|-------------------|---------|
| 1. Shovels | 14 Nos. |
| 2. Bottom Dumpers | 28 „ |
| 3. Bull Dozers. | 4 „ |

The above will all be diesel operated.

Costs.

Shovels (approximately 250 H. P. each machine).

- (a) Driver's wages, including D. A. and other allowances, such as -/8/- per day, as diet allowance.

28 drivers @ Rs. 225 basic per month.)
 Rs. 75 D. A.)
 Rs. 15 Diet allowance.) each.
 = 28 × Rs. 315/- = Rs. 8,820/-

(b) 28 Helpers - Rs. 40/- per month basic.)
 13/- ,, D. A.)
 15/- ,, Diet allowance.) each
Rs. 68/-
 = Rs. 1,904/-

(a) & (b) Rs. 10,724/-
 Cost per ton. = Rs. 10.25

Fuel.

- (c) per machine.

Diesel $\frac{250 \text{ H. P.} \times .38 \times .80}{10}$ per hour.

= 7.6 galls. per hour per machine.

Therefore, for a 14 hours working day, consumption of diesel :—

= 7.6 × 14 × 14

= 1489.6 gallons per day or 1500 gallons.

(a) Rs. 2/- per gallons.

= Rs. 3,000/- per day.

= Rs. 75,000/- per month of 25 working days.

Cost per ton Rs. 1.80

Maintenance costs. 10% (a plus b plus c)

= Rs. 8,572/-

Total Rs. 94,297/-

Total cost per ton Rs. 2.25

Electric Shovels

H. P. 250.

Elec. Energy for 14 machines.

$$= 250 \times 14 \times 746 \text{ watts.}$$

for 14 hours.

$$= 250 \times 14 \times 746 \times 14 \text{ hours.}$$

$$= 36,564 \text{ K. W. Hours or units.}$$

∴ in one month of 25 working days

$$= 36,564 \times 25 \text{ units of elec. consumed.}$$

$$= 9,13,850 \text{ units per month.}$$

say 10,00,000 units.

Cost as per unit costs given by the Elec. Tariff Advisory Committee

$$= \frac{10,00,000 \times 55}{16} \quad \text{Rs.}$$

Rs. 34,375/- per month.

Cost per ton Rs. 0.81

Maintenance costs @ 10% of operational & fuel costs.

Cost per ton Rs. 0.10

Total = Rs. 1.2 per ton.

Bottom Dumpers : 28 Nos.

(a) Drivers 56

Wages Rs. 11,200/-

D. A. Rs. 3,733/-

Diet allowance. Rs. 840/-

Rs. 15,773/-

Cost per ton Rs. 0.37

$$\text{Fuel} \quad \frac{.38 \times .8 \times 300}{10}$$

= 9.12 gallons per hour per machine.

= 127.6 gallons per day per machine.

=3,572 gallons per day for all machines.

Rs. 7,144 per day.

Rs. 1,78,600/- per month.

= Rs. 4.2 ton.

Maintenance = Rs. 0.46 (10% of a & b)

Therefore total =5.03

Bull dozers :-

Operating cost = Rs. 0.01

Fuel & Power = 0.75

Maintenance 10% of operating & Fuel.

= Rs. 0.07

Total Rs. 0.83

Cost per ton using diesel shovels.

= Rs. 2.25 + 5.03 + 0.83

= Rs. 8.11 per ton on overburden removal.

Add Rs. 1/- per ton drilling & blasting = Rs. 9.11 per ton.

Cost per ton using electric shovels.

Rs. 1.20 + 5.03 + 0.83

Rs. 7.08 per ton on overburden removal.

Rs. 1.00 drilling and blasting

= 8.08.

Investment.**1. Shovels & Bottom Dumpers.**

(a) Shovels 5 cu. yd. capacity		
Rs. 4,00,000/- each	- 17 Nos. @ Rs. 68,00,000/-	
(b) Bottom dumpers 17 cu. yd. capacity	36 Nos.	Rs. 78,00,000/-
(c) Bull dozers,	5 Nos.	Rs. 6,25,000/-
	Total	Rs. 1,52,00,000/-

2. Draglines.

(a) Draglines, 5 Nos. @ Rs. 30,00,000/-	Rs. 1,50,00,000/-
(b) Scraper-Loaders, 4 Nos. @ 4,74,000/-	Rs. 18,96,000/-
(c) Rear Dumpers, 15 tons, 25 Nos.	40,00,000/-
(d) Bull dozers, 4 Nos.	5,00,000/-
	<hr/>
Total	Rs. 2,13,96,000/-

3. Bucket Wheel-Excavators.

(a) Scraper 'Sierra',	8 Nos.	Rs. 16,40,000/-
(b) Bucket Wheel Excavators,	2 Nos.	Rs. 70,00,000/-
(c) Spreader,	1 Nos.	Rs. 25,00,000/-
(d) Bottom Dumpers.	16 Nos.	Rs. 35,00,000/-
(e) Crawler Tractors.	8 Nos.	Rs. 10,00,000/-
(f) Bull dozers.	6 Nos.	Rs. 7,50,000/-
	<hr/>	
Total		Rs. 1,63,90,000/-

Investment on Capital.**1. Shovels & Bottom Dumpers.**

Total cost Rs. 1,36,25,000/-

Interest on capital @ 4%

= 5,45,000/- per year.

Cost per ton = $\frac{5,45,000}{5}$ Rs. 1.09 nP,

Depreciation.

$$\frac{1,36,25,000/-}{10} = 13,62,500/-$$

$$\text{Cost per ton} = 13,62,500$$

$$\text{Rs. } 2.72 \text{ nP.}$$

Operational cost as calculated above

$$\text{Using diesel shovels} = 9.11$$

$$\text{Using elec. shovels} = 2.08$$

∴ Total cost per ton

$$\text{Using diesel shovel} = 9.11 + 2.72 + 1.09$$

$$\text{Rs. } 12.92 \text{ nP.}$$

$$\text{Using electric shovel} = 8.08 + 2.72 + 1.09$$

$$= \text{Rs. } 11.29 \text{ nP.}$$

2. Drag Lines.

(a) Draglines.

Operating Cost = 0.09

Fuel & Power = 1.80

Maintenance 10% of the operating cost & fuel = 0.18

Total — Rs. 2.07 per ton.

(b) Scraper Loaders.

Operating cost 0.02

Fuel & Power 0.92

Maintenance 10% of operating cost & fuel, = 0.10

Total - Rs. 1.04 per ton.

(c) Bull Dozers.

Operating cost = 0.61

Fuel & Power = 0.75

Maintenance 10% of operating cost & fuel = 0.07

Total Cost = 0.83

(d) Rear Dumpers.

Operating cost = 0.11

Fuel & Power = 2.10

Maintenance 10% of operating cost & fuel = 0.28

Total = 2.43

Rs. 1/- per ton for drilling and ballasting.

Grand Total - Rs. 7.37 nP. per ton.

COST FOR REMOVAL OF OVERBURDEN

1. *Bucket Wheel Excavators.*

(4 Drivers).

Operating Cost.

(a) Drivers' wages.	Rs. 1,541/-
D. A	Rs. 516/-
	<u> </u>
	Total Rs. 2,064/-
Approximate cost per ton	<u>2,064/-</u>
	42,000/-

(b) Fuel & Power.

Electricity @ 0.65 annas per KWH

Taking 600 H. P. overall.

for 2 Bucket Wheel Excavators of 1200 H. P.

$$\text{K.W.H.} = \frac{1200 \times 746 \text{ Watts} \times 14 \text{ Hours.}}{1000}$$

= 12532 Units per day.

= 12532 × 25 per month.

= 313300 units/month

= $\frac{313300 \times .65}{16}$ Rupees per month.

= Rs. 12,728/-

$$\text{Fuel cost per ton} = \frac{12728}{42,000} = \text{Rs. } 0.30 \text{ nP.}$$

(c) Maintenance.

10% of operating cost, fuel & power = .03

Total cost Rs. 0.38 nP.

2. *Scrapers.*

16 Drivers.

(a) Operating cost

Wages	Rs. 1,600/-
D. A.	Rs. 539/-
Total	<u>Rs. 2,135/-</u>

Operating cost = 0.05

(b) Fuel & Power.

(8 Scrapers).

H. P. = 100

Fuelconsumption per hour = $\frac{100 \times .38 \times .80}{10}$

= 3 gls. per hour

= 14 × 3 gls. per day per machine.

For 8 machines = 42 × 8 = 336 gls. per day.

= 336 × 25 gls. per month

= 8,400 gls. per month

@ Rs. 2/- per gallon = 16,800/- Rupees per month

Cost per ton. = Rs. 40/-

(c) Maintenance

10% of (a & b) = 0.04-

Total = 0.40 per ton.

3. Bull dozers.

12 Drivers.

(a) Operating cost

Salary	1,200/-
D. A.	400/-
Total.	<u>1,600/-</u>

Cost per ton Rs. 0.04 nP.

(b) Fuel & Power.

180 H. P.

$$\frac{180 \times .38 \times .80}{10} \text{ gls. per hour}$$

$$= 5.5 \text{ gls. per hour per machine.}$$

$$= 5.5 \times 6 \times 14 \text{ gls. per day.}$$

$$= 462 \text{ gallons per day.}$$

$$= 462 \times 25 \text{ gls. per month.}$$

$$= 11550 \text{ gls. per month.}$$

$$= 11550 \times 2 \text{ Rs. per month}$$

$$= 23100 \text{ rupees per month}$$

$$= \text{Rs. } 0.55 \text{ nP. per ton.}$$

(c) Maintenance.

$$0.06$$

$$\text{Total } 0.65 \text{ Rupees.}$$

4. Bottom Dumpers.

12 Nos. and 24 Drivers.

(a) Wages	Rs. 2,400/-
-----------	-------------

D. A.	Rs. 800/-
-------	-----------

Total	Rs. 3,200/-
-------	-------------

$$\text{Cost per ton.} = 0.04$$

(b) Fuel & Power.

H. P. 300 per machine.

$$\text{Fuel consumption} = \frac{.88 \times .80 \times 300}{10}$$

$$= 9.12 \text{ gls. per hour.}$$

$$= 127.6 \text{ gls. per day per machine.}$$

$$\text{for 12 machines} = 127.6 \times 12$$

$$= 1530 \text{ gls. per day.}$$

$$= 38,150 \text{ gls. per month.}$$

$$\text{Cost} = 66,300 \text{ Rupees.}$$

$$= 1.80 \text{ per ton.}$$

(c) Maintenance.

Rs. 0.10

Total = 2.02 per ton.

5. *Crawler Tractors.*

Drivers 8 Nos. (191 H.P.)

(a) Wages Rs. 1,600/-

D. A. Rs. 533/-

Total Rs. 2,133/-

Cost per ton = Rs. 0.05 nP.

(b) Fuel & Power

$$\frac{191 + .38 + .80}{10} = 5.8 \text{ gls. per hour.}$$

For 8 machines & 14 hours operation cost = $5.8 + 8 + 14$
= 650 per day

or = 16,259/- gls. per month,

Cost per ton = 0.80

(c) Maintenance.

10% of (0.05 + 0.80) = 0.08

Total = 0.93

6. *Spreader,*

1 machine and 2 drivers.

(a) Operation cost

Wages Rs. 450/-

D. A. Rs. 160/-

Total Rs. 600/-

Cost per ton = Rs. 0.01 nP.

(b) Fuel & Power.

H. P. 300

Units of electricity consumed = $\frac{300 \times 746 \times 14}{1000}$

$$\begin{aligned}
 &= 3133 \text{ units per day.} \\
 &= 3133 \times 25 \\
 &78,325 \text{ units per month.} \\
 \text{Cost} &= \frac{78,325 \times .65}{16} \\
 &= \text{Rs. .03 nP. per ton.}
 \end{aligned}$$

(c) Maintenance.

$$\begin{aligned}
 &10\% \text{ of } 0.09 \\
 &= .01 \\
 \text{Total} &= 0.10
 \end{aligned}$$

7. *Belt Conveyors.*

8000' (16 attendents, 8 sections)

(a) Operating Cost

Wages	Rs. 1,202/-
D. A.	Rs. 400/-
Total	Rs. 1,600/-

Cost per ton = Rs. .04 nP.

(b) Fuel & Power.

Total H. P. of 8 sections = 500 H. P.

(60 H. P. per section)

$$\begin{aligned}
 \text{Units consumed per day} &= \frac{500 \times 746 \times 14}{1000} \\
 &= 5222 \text{ units per day.} \\
 &= 5222 \times 25 \text{ per month.} \\
 &= 1,30,550 \text{ units per month.} \\
 &= \frac{130550 \times .65}{16} \\
 &= \text{Rs. } 5304 \text{ per month.} \\
 &= \text{Cost per ton} = \text{Rs. } 0.13 \text{ nP.}
 \end{aligned}$$

(c) Maintenance.

10% of (.04 × 0.13).

= 0.01

Total cost = Rs .18 up. per ton.

Grand Total of operating cost-

for removal of overburden. =Rs. 4.76 per ton of lignite raised.

Rs. 1/- for drilling & blasting.

∴ Grand Total Rs. 5.76

Interest on Capital.

1. *Shovels & Bottom Dumpers etc.,*

Total cost Rs. 1,52,25,000/-

Interest on capital @ 4% = Rs. 6,09,000/-

$$\text{Cost per ton} = \frac{5,09,000}{5} = 1.21$$

2. *Draglines etc.,*

Total cost Rs. 2,13,96,000/-

Interest on capital @ 4% = 8,55,840/-

$$\therefore \text{Cost per ton} = \frac{8,55,840}{5} = \text{Rs. } 1.71$$

3. *Bucket Wheel Excavators etc.,*

Total cost Rs. 1,87,90,000/-

Interest on capital @ 4% = Rs. 7,51,600/-

Cost per ton = 1.50

Depreciation on Machinery.

(Taking life of the machines 10 years)

1. *Shovels & Bottom Dumpers.*

Total cost Rs. 1,52,25,000/-

Depreciation per year = 15,22,500/-

$$\therefore \text{Cost per ton} = \frac{15,22,500}{5} = 3.04$$

2. *Draglines.*

Total cost Rs. 2,13,96,000/-

Depreciation per year = 21,39,600/-

$$\therefore \text{Cost per ton} = \frac{21,39,600}{5} = \text{Rs. } 4.27$$

3. *Bucket Wheel Excavators.*

Total cost Rs. 1,87,90,000/-

Depreciation per year = Rs. $\frac{18,79,000}{5}$

∴ Cost per ton = Rs. $\frac{18,79,000}{5}$
= Rs. 3.75

Thus the comparative cost per ton for different combination of machines is as given below:—

Diesel shovel and bottom dumper, Draglines.

Bucket wheel excavators.

1. Operation cost including fuel or power, and maintenance.	Rs. 9.11	7.37	5.76
	Rs. 8.08	(for Elec. shovel)	
2. Interest on Capital.	Rs. 1.21	1.71	1.31
3. Depreciation.	Rs. 3.04	4.27	3.27
Total cost per ton.	Rs. 13.36	13.35	11.01

ANNEXURE—6

Land

The whole area, and also the contiguous land is owned by the Government of Rajasthan, and therefore, there will be absolutely no hindrance or time lost on the land acquisition question, as this issue does not now arise.

TENDERS

As the procurement of machinery, linked with the matter of foreign exchange, availability of funds etc., is of prime importance, it would be necessary to call tenders and finalise the same, as early as possible. In the meantime, the funds would be arranged, and orders for the machinery placed on FIRM basis.

It is estimated that the initial production of Lignite will commence within 12 months and after 3.5 million cu. yards of over burden has been removed. Taking the commencement of mechanised removal of overburden to be round about April, 1962, and allowing full 18 months for the machines to be supplied and reach Palana, this would mean that orders for the machines should be placed round about October, November, 1960.

We should allow a period of three months for the scrutiny of tenders to be gone through and a decision arrived at. This brings the opening date of the tenders to round about July, 1960.

Calling tenders will take up some time in order to permit the firms to give their best and correct rates. Moreover, these tenders will be of a 'Global' nature, hence a good 6 months should be allowed for the calling of and receipt of tenders for opening round about early Feb. 1960.

Summarising, the above written, we come to a time table as under:—

- (1) Tenders to be called-round about Jan-Feby. 1960
- (2) Tenders to be opened—May, 1960
- (3) Tenders fully scrutinised July 1960.
by end of July.
- (4) Orders for machinery
placed by Sept. 1960.
- (5) First supplies of machinery should commence by
July, July 1960.

ARRIVAL OF MACHINES.

Since the first 70 ft. thickness of over bur-len will be removed by "Scrapper Cum Grawler tractor and some Bull Dozers will be required for surface levelling, road making etc. etc., the FIRST supply of machinery. COMMENCING JULY 1961 (LATEST) should consist of the following:—

- (a) 7 Nos. Scrapers
- (b) 8 Nos. Crawler Tractors.
- (c) 2 Nos. 5 ton Truks.
- (d) 2 Nos. Jeeps with trailers.
- (e) 1 No Low Loaders.
- (f) 1 No. Road Roller.
- (g) 2 Nos. Tank Lorry with water sprinkler.
- (h) 2 Nos. 10 Tons Mobile Crane.
- (i) 6 Nos. Bull Dozers.
- (j) 16 Nos. Bottom Dumpers.
- (k) Ambulance Van 1 No.
- (l) Electric Cable & Transformers etc.
- (m) Pumps pipe fittings & spare parts.
- (n) Workshops machinery.

The remaining machinery which will commence operations at a later dates are :—

- | | | |
|-------------------------------------|-------|-------------------|
| (a) Bucket Wheel Excavators, 2 Nos. |) | SHOULD REACH |
| (b) Spradder Machine | 1 No, |) PALANABY END OF |
| (c) Conveyer belting 8000' |) | DECEMBER 1962 |

Housing etc.,

Building construction work should definitely commence by April 1960 so that all accomodation, colliery buildings, roads water supply etc., are ensured by Jan. 1962.

The work will be phased and discriminated as under :-
Intitnl and Essential works.

- | | | |
|--|---|-----------------|
| (1) Workshops. |) | To be completed |
| (2) Stores. |) | by September/ |
| (3) Power Sub-Station. |) | January 1962 |
| (4) Garages for lorries etc. |) | |
| (5) 20 ft. dia water well. |) | |
| (6) Installation of diesel
storage tanks. |) | |

Residential & otl er Buildings.

- (1) Office.
- (2) Hospital.
- (3) Rest House.
- (4) Canteen.
- (5) Pit Head Bath.
- (6) Market.
- (7) Lavatories.
- (8) Workers shed.
- (9) Bungalows.
- (10) Staff quarters.

Progress of O. B. Removal.

With the arrival of the 'Scraper' etc. as mentioned in the para on machinery arrival removal of O B. should commence in April 1962 at the latest.

- (1) The Scrappers will commence work in April 1962 and at a rate of removal of .42 million cu. yds. per month. The first 70 ft. thickness of O. B. containing 2.04 million cu. yds. through-out the length and breadth of the 1st cut should be removed by November 1962.
- (2) To get the 1st bench ready for the 1st bucket wheel excavator a further .92 million cu. yds. of O. B., 52' in thickness will have to be removed by scrappers which will take approximate 3 months.
- (3) Therefore the 1st bucket wheel could be got into position by about February 1963.
- (4) The last cut to expose Lignite should not take more than 2 months and therefore Lignite should be exposed gradually to a final area of 1510' long by 210' wide containing 2,70,000 tons of Lignite, by about April 1963 but again to allow for unforeseen circumstances, we would not be wrong in allowing another 4 months which will bring the complete exposer of lignite by August 1963 (210' wide 1510' long).