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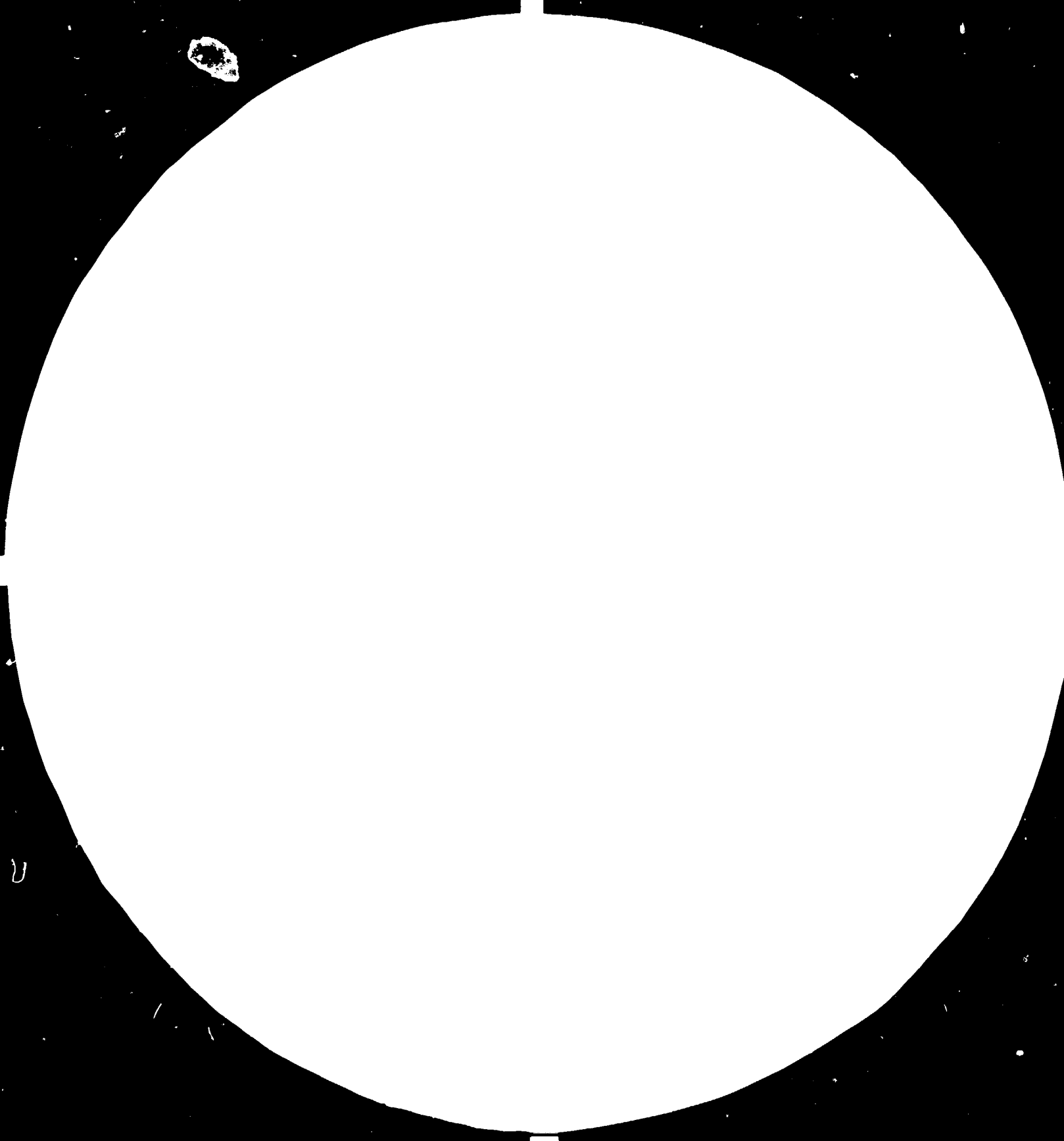
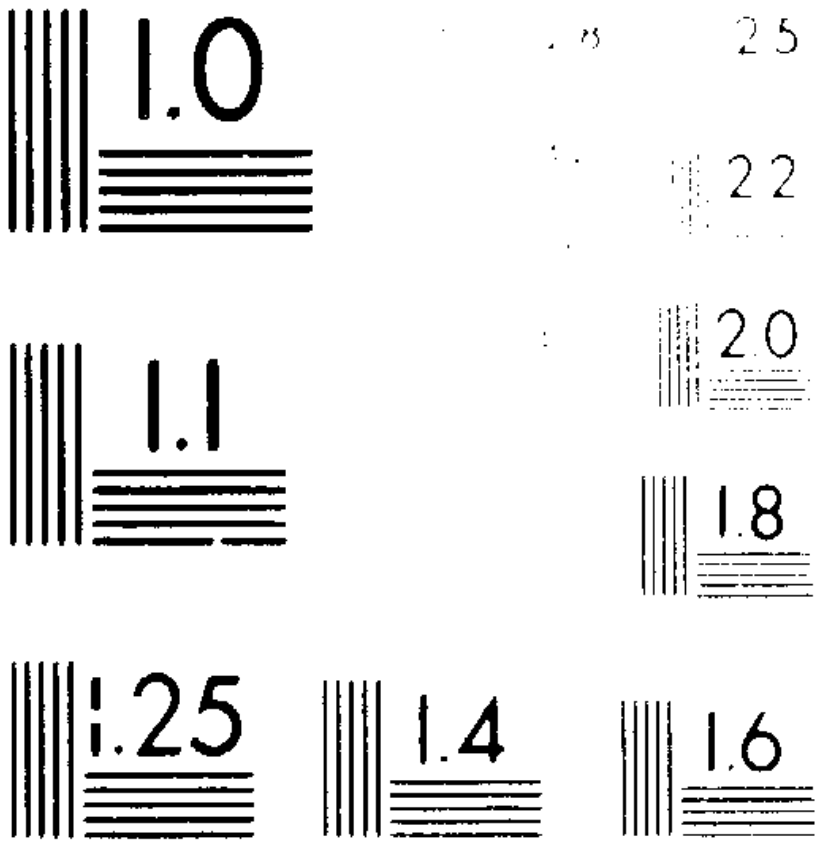
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Colombia.

Report on the Disagregation of Mining Projects for Coal in Colombia.

Project SI/COL/82 - Special Industrial Services

by

Dr. Nilo Milocco
Sr. Consultant, Mining Engineer
Mineral Economist

Bogotá, Dec. 1983

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I. ORIGIN AND PURPOSES OF THE UNIDO COMMITTMENT.

The Government of Colombia, through the Foreign Trade Institute, INCOMEX, requested UNIDO authorities one expert in mining equipment "to carry out basic techno-economic investigations in the preparation for the sectoral plan of development for the Capital Goods Industries and work out programmes which clearly define the requirements for such a development."

Further to the confirmation of the committment, details on the mission were requested to the UNIDO Resident Representative in Bogotá, who turned the questions to INCOMEX officials who precised that the main consultancy was connected with state-owned company CARBOCOL, coal mine operator in the country.

Preliminary meetings were promoted by UNIDO with INCOMEX and CARBOCOL executive staffs, and a work plan was defined. In particular, CARBOCOL precised that the consultancy was expected to lead to: 1) "methodology criteria in the preparation and discussion of future mining projects as for characteristics, type, quantity of equipments, etc. which might be considered", and: 2) "analysis of the possibility of participation of the local industry to the supply of such implementation, spare parts and consumables".

Reference data were collected from projects and reports in CARBOCOL's hands mainly referred to the Cerrejón mining area where preparatory works are being completed and coal exploration is being commenced.

The situation of said mines is still in evolution, so the projects are being consequently modified as and when necessary; for instance, our conslusions and suggestions

too may be subject to variations in future studies. A more complete analysis of the situation should be made in the near months when mining works will allow a better vision of the problems concerned and more hints for a discussion with the local mechanical industries which are expected to participate to the future projects in a substantive way.

Time at our disposal was too short for extending our study to underground and other mining operations which are scattered in the country. Even if much more complicated, such study should be carried out to give INCOMEX authorities a more complete picture of the situation since underground coal mining is not going to stop operating by the nearest future and for instance a solid participation of the local mechanical industry is to be expected also in this field.

Nor we had the possibility of carrying out investigations on the real potential of Colombian mechanical sector, although talks with Group Association FEDEMETAL allowed us to gather that industries are interested to assist the coal project and any other mining project as well, starting with the supply of consumables, spare parts and other essential minor implementation such as pipes, electric components, steel structures, etc., a broad argument that we could not deepen to the detail.

II. SUMMARY AND CONCLUSIONS.

The term "Disagregations" of a mining project may be supposed to mean also its "interpretation". For instance our study was supposed to have such an object.

As for the first part of recommendations from INCOMEX and CARBOCOL, the summary of our considerations follows:

Whatever mining operation (but we bind the discussion to open-pit coal mines only) may be split into the three essential anywhere and ever valid phases:

1. Exploration
2. Preparation
3. Exploitation

Each of these phases may be divided into a large number of operations (stages, etapas), but not all of these components are always present, since someone may be avoided, and not all of them may have the same extension in all the projects. It depends from one case to another.

And finally, the accomplishment of every Stage requires implementation, equipments and human resources which may vary from one case to another in terms of quality, quantity and timing schedule. After all, this depends from the characteristics of the mineral and of the mine, expected production diagramme, etc.

In the second part of above memorandums, CARBOCOL and INCOMEX requested our analysis of the possible participation of the local mechanical industry to mining "plan de desarrollo" in Colombia. We verbally anticipated our view that solitary sophisticated machinery and sophisticated technologies for exceptional applications are not worth to be processed in the country at the time being; maybe it is better to aim simplier ones applicable in a mass-scale dimension (normal spares and consumables as for an example) which probably do not require any particular transformation or implication in the local mechanical sector, and represent an important volume of work for it.

III. FOREWORD

The potential of coal deposits in Colombia was glimpsed mainly at the end of the last century. Field investigations from the end of the 19th century to aproximately 1950 led to partial conclusions as for the location of deposits scattered in several provinces, but the relative poverty of such studies did not bring to the knowledge of the real resources as for cubages, shape, quality and mineability.

A determining factor that did not allow to continue and to deepen such researches and investigations in time was due to the scarce interest in coal during the sudden explosive growth of appeal from oil in the past decades, so that coal mining and technologies were nearly set aside all over the world.

The more recent oil crisis brought to the resumption and to a decisive development of said studies, to begin from mining explorations other than preparation and/or exploitation of coal deposits.

New techniques and machinery allowed to exploit mines once considered to be uneconomical, and the foreseeable growth of demand and prices were another important hint to these initiatives.

So it was for Colombia, now considered to happen one of the most important coal producers in the world. The recent and determining investigations and discoveries in Colombia were made by local authorities with the participation of foreign mining companies and finally brought to the giant Cerrejón project in the northern province of La Guaira. Other initiatives are expected to be developed in El Cesar.

The latest studies and projects at Cerrejón were carried out by Montreal Engineering Co., Montreal, Canada. Mining operations are being developed by INTERCOR, Co., a CARBOCOL EXXON joint venture.

Studies and investigations will be extended to other areas as soon as practicable, according to a plan of "desarrollo" which is expected to take also "minor" open pit or underground deposits into consideration by the near future.

The reference data for the present preliminary report were taken from CARBOCOL's files concerning its mining works at Cerrejón (Zona Norte and Zona Central) and from geological studies at Cesar (La Loma, Patilla and Descanso), but it must be noticed that exploitations are still at initial low-production stage (Zona Norte is supposed to start 2 Mt Coal production next year) and consequently above technical references may be not reliable for full-size operations.

The two main coal-bearing areas now taken into consideration following the sectoral "plan de desarrollo" (provinces of La Guaira and Cesar) are likely to have several features in common according to the studies and investigations carried out to nowadays.

It must be precised that only Cerrejón claim was explored to a sufficient extent although not in its whole area, and doubts and perplexities persist for certain non-primary questions which are expected to be cleared during the exploitation.

By the time the available data from those areas do permit to extrapolate only tentative mining pre-projects or drafts for some other coal areas where preliminary geological

investigations led to reasonably suppose sufficient similitude with the main Cerrejón orebody.

So, for an example, as for coal in Cesar, a rather courageous interpretation of the still scarce geological knowledges was made in order to imagine a possible mining flowsheet which, at the end, appeared to be comparable to that of Cerrejón - Zona Norte.

Cerrejón and Cesar have in fact many topographical, structural, hydrological and other characteristics in common,and in particular the geological, tectonical and stratigraphical ones at first sight appear to be rather similar, so equivalent problems are believed to bring to similar solutions.

All above formations consist in interbedded coal and rocky seams disturbed by joints, partitions and unpredictable variations of direction, inclination and thickness, other than by folds and faults of both type, and by suspected or verified waterbearing intercalated stratifications. One important and rather negative general factor is the inclination of the coal seams variable from nearly the horizontal to a 30° or more, sufficient enough for disturbing or complicating the mining design (loading, haulage) but insufficient for planning long-hole blastings.

Montreal Co. concluded that the key-implementation at Cerrejón Z.N. and Z.C. had to be crawler hydraulic electric loaders and diesel dumper trucks; we think that these equipments have to be considered for Cesar area too.

However, since we had not the opportunity and time of deepening our report to detail, minor divergences may

be noticed here and there with Montreal's project. Whenever they occur notes of explanation and comment were added.

IV. PREMISES FOR A COAL MINING OPEN PIT PROJECT IN COLOMBIA.

The development of any mining project is made according to a general flowsheet articulated in three main phases, as follows:

Phase 1: Exploration: Preliminary technical-economical-financial studies and investigations to the final operative detailed project;

Phase 2: Preparation: Preparatory works (technical/organizative) to the mining exploitation;

Phase 3: Exploitation: Exploitation works according to the plan (excavations)

These phases, as said, are ever-present in whatever project and may be subdivided into a number of "steps" of variable size according to the real situation. Taking for an example a mine as Cerrejón and similar into consideration, these steps can be listed as follows:

Phase 1 - Exploration

Subphase a)

Step:
1. General and detailed surface geological survey.
2. Topographical survey, as appropriate,
3. Surface samplings from trenches, pits, etc.
4. Core drilling,
5. Essaying (chemical, physical)
6. Geographical survey as appropriate, if necessary,

7. Pre-project;

Subphase b)

8. Technical section: final design, list/ description of the equipments and works, list of required personnel, schedule of operation,
9. Economical section = list of imobizations and current expenditures for the operation (personnel, spaces, consumables) costs, dividends, commercial programme, etc.

Phase 2 - Preparation

Subphase a)

Steps: Acquiring the mining areas and claims, recruiting personnel, searching-dealing-purchasing machinery and parts and their delivery on the spot according to scheduling, contracts for transportation, etc.

Subphase b) (General)

Steps: Housing, offices, accesses, roads, canalization, water and electricity supply, stores, workshop, etc.

Subphase c) (Specific)

Step: 1. Foundations, assembly, other specific construction works,
Step: 2. Preparation of spacefloors for coal storage,
Step: 3. Removal of overburden atop the mining deposit for an area which might be sufficient for to a six - twelve month exploitation, plus (eventual) extra safety area in the proximity, according to the situation and actual necessity.

Phase 3 - Mine Exploitation

Step: 1. Primary basting (when necessary) or ripping-scrapping or other system of excavation.

Step: 2. Secondary blasting. (when necessary, whatever the system of excavation) to reduce the dimensions of the run-of-the-mine or for secondary works in the mine.

Note: Both primary and secondary blasting are foreseen for coal and sterile (overburden and intercalated). Operations in coal and sterile are contemporarily carried out in different positions in order not to interfere each other.

Step: 3. Loading
Loading operations are contemporarily driven in coal and sterile in separate positions.

Step: 4. Haulage (coal)
Transportation to the plant by trucks.

Step: 5. Haulage (sterile)
Transportation of sterile to tail-disposal site.

Step: 6. Crushing, screening (plant)

Step: 7. Stockpiling.
Deposits according to coal sizes quality.

Step: 8. Continuation of the removal of overburden per alternate compaigns or continuous work in order to renew the availability of surface free from sterile atop the deposit; regularization of mining fronts, accesses floor to floor, etc.

Step: 9. Continuation of detailed investigations within the deposit (core drillings and other verifications) to ascertain position, direction, thickness, quality, inclination of coal seams in order to better organize the following exploitation in detail.

Step: 10. Maintenance works, road, quarry floors, coal storage spaces, waste tail disposals; mechanical, electrical, and other general.

The list of the steps may be reduced of some units, depending from one structure to another.

The implementation and general organization of these "Steps" may be qualitatively described and coded in terms of equipments, tools and personnel, but their quantification will vary from one situation to another.

May we now outline the following general remarks:

1. In phase 1 (preliminary studies and investigations) the factors affecting the field operations are: surface characteristics such as accessibility, geological and structural situation and other surface technical conditions, and finally extension of the area to be investigated and proposed time for terminating the exploration.

   In general, geological investigations should lead to findings in the range of 25-30 years of expected production to allow a reasonable period of time for amortizations and viceversa, the verified (measured) cubage will indicate which maximum annual production may be expected from findings to assure a 25-30 years exercise. The mine operator has them to decide whether this is enough or not and manage accordingly.

   It is normally accepted as a first approximation, that when a certain cubage is being delimited by appropiate works (measured cubage), its credibility may be in the range of $\pm 10 - 15\%$ - Beyond these limits in nearby surroundings areas one may normally suppose that an extra

indicated (probable) 50% of said cubage, plus another extra inferred (possible) 30% are existing.

We spoke about connections between cubage and amortizations: apart from this, there is also an optimum-maximum ratio between production and cubage, not to be exceeded. In fact a faster development of mining explotations brings not only to faster exhaustion of the mine and abnormal amortizations, but mostly to irrational systems of excavation with lower unitary production and higher costs. In other words we say again that the annual possible production is related to the measured cubage of the deposit, and viceversa the cubage allows to know the maximum possible annual production. For instance every mine has its optimum work-rythm that one must not exceed, and the first feeling of this dimension is being given by the measured cubages. The consideration is valid both for open pits and for underground mines.

2. In phase 2) (preparatory works), we cannot anticipate generally speaking, extension, costs, timing of operations for all steps therein listed since they can vary a lot from one mine to another; using simplifications we can however, tentatively anticipate our views only for the removal of alluvial overburdens in the minesites under consideration since the geologists do guess a certain similitude with Cerrejón, and their tentative interpretation leads us to suppose typical implementations and tentative operational schedule.

3. In phase 3) (Mine Exploitation), we don't have many reliable data reference as for the step 1 (primary blasting) in coal and in sterile, since the present excavations are still mainly bound to superficial seams and stratifications with possible wheathrings and substantive structural alterations; changes in structure and mineability are expected in the depth,

and more extensive blasting is foreseen in compact materials , both coal and intercelations. As repeated in the present report , we are inclined to indicate light rotary/percussive drilling rigs of high mobility and flexibility, rather than heavier rotary machines since short holes are expected to be drilled in too relatively thin seams, whereas big units do appear to be best choice for blasting in overburden. The preliminary projects foreseen showed that overburden possibly might be blasted only 40% of the total. We suppose that, similarily, only a percentage of coal (that we do not know by the tine) has to be blasted the remaining portion being stripped by bulldozer-ripper-scraper equipments.

Step 2) (Secondary blasting) was officialy ignored in the existing projects; we mentioned it in the flowsheet since we think it possible that in more solid materials primary blasting possibly will not always ensure proper fragmentation, although this may be considered an incidental fact.

The relative implementation (which is not an important inmobilization) is also foreseen for secondary blasting operations in blocks and boulders, as well as in rectification works or small exploitations where moving a heavier machinery may be considered not convenient or possible.

4. At steps 3), 4) and 5) (loading and hauling) we share Montreal's suggestion that the hardest sterile material has to be possibly blasted, hauled and stockpiled apart and used for road paving and maintenance. This complication is convincing us that at the beginning of the operations it is better to consider two or more smaller loaders of high mobility rather than one or two of bigger capacity but smaller maneuvility. This obviously against the

general principle that few bigger machines are to be preferred - in terms of general economy - to several smaller ones totalling equal capacity, but our suggestion is for the initial stage, and the development of the exploitations will tell which is the point where a compromise can be achieved.

5. In step 6) the consultants indicated a crushing plant and a screening section, plus conveyors to carry the coal to stockpiles. We are inclined to think that secondary crushers are advisable almost in any crushing plant where size limitations are requested, so secondary roll crushers following the primary were suggested.

For better understanding the following mining tentative projects, we imagined that operations have to be developed in subsequent stages, and calculated which organization and main implementation had to be considered in each stage until reaching the final production. (5 MTA in the first project 10 MTA in the second.)

These stages were arbitarily named "modular projects", and differ in the cases we considered, because of the final dimension of the operations.

It may be seen that efforts have been made to adopt unification of equipments whenever possible, to make situations comparable and the "modular projects" applicable one after the other by simple multiplication of the standard modular equipments. However, it must be repeated that the "modular project" is merely a simplification in the approach to the real project. As for an example, one has to take into account that not all the equipments which are foreseen in one "module" have to be supplied and used at the same time;

they will be put in operation as far as they are really needed, in progression according to the production. So for the same reason, our "module" does not consider all the implementation which is being needed at that stage, but only the main one. And, finally, as for the type of machinery described in each modular project, our suggestion is exemplificative , not indicative, and reference was made to the existing equipments in Cerrejón or - when we thought it advisable - to similar machines whose characteristics were taken from catalogues and previous foreign reports.

V. TENTATIVE DRAFT OF MODULAR MINING PROJECT FOR A 5 MTA COAL OPERATION AT PATILLA - LA LOMA.

Patilla and La Loma coal deposits are still under exploration and for instance the following tentative planning will be subject to further verifications. Production is expected to be in the range of 5 MTA in both areas.

General similitude with Cerrejón's Zona Central is supposed, and technical data were taken for instance from Montreal's project with some modifications for a better adaptability to the situation in Cesar.

Work is considered three shifts a day, per 330 days/A (e.g. 365 days minus 10% force majeure and unforeseen events). Working capacity etc, is calculated on the above basis which includes maintenance time. We have different opinions from Montreal as for the works in Cerrejón organized in 2 12-hours shifts day, 358 work days/A and think that such an organization way not be repeated indefinitely in other projects.

Since labour situation in Colombia is in evolutive stage Such work plan may be admitted in contingent works where time is an essential factor (hydroelectric plants for an example), but not in a normal mining exercise.

The final goal being a plafond production of 5 MTA, we are supposing that this might be reached in a certain number of years which varies according to more or less optimistic evaluation and following the development of in-sequence modular units of project, of a 1.0 - 1.2 MTA each, with total sterile: coal ratio of meanly 7 cu mts/1 ton coal.

The adoption of these criteria implies that the principle of unification of machinery and implementation is accepted

at all in-sequence production stages whenever feasible. This is obviously also a simplification for our estimates. However, unification in the future projects will be kept in mind whenever practicable in order to facilitate the implementation, in technical and economical terms.

Notes:

A. Preparation (overburden)

Informations on the alluvial overburden are scarce, and tentatively we supposed that its mean thickness is in the range of 14 mts at Patilla, and a 25 mts at La Loma, as anticipated by the geologists. The ratio overburden: coal, total sterile: coal have been extrapolated from Montreal's reports for Zona Central. The tables in the following pages contain the data for the modular project, the estimated units of main machinery, time schedule and manpower units foreseen for the preparation period on Patilla and La Loma.

Technical Data		PAT.	LAL.
Estimated thickness of overburden (alluvium)	mts	14	25
Possible ratio total sterile to coal	cu.m./T	7:1	7:1
Possible ratio overburden to coal	cu.m./T	1:1	2:1
Total area to be initially uncovered from overburden	sq.m.	100.000	100.00
Preliminary removal of overburden atop the deposit and for coal stockpiling, etc.	cu.m.	1.400.000	2.500.000
Excavation of overburden during exercise	cu.m/A.	1.000.000	2.000.000
Area to be uncovered during exercise	sq.m/A.	75.000	80.000
Cubage of Coal in deposit initially cleared from Overburden	T.	1.400.000	2.500.000

Main Equipment	Pat.	Lal.
Mobile Rotary Drilling Rig, holes 0 200/250 mms	1	1
Air-track percussion Drill Rig, hol. 0 40/45 mms	1	1
Hammerdrills	1	1
Air Compressors, cap. 10-15 cmts/' at 6 Kgs/sqcm	1	1
Crawler front loader, bucket 14 cmts	1	1
Bulldozers, 400 HP front blade	1	1
Ripper, 400 HP	1	1
Dumper Trucks ab. 90 tons cap./35 cu.m.	4	4
Trucks for various services at the works	1	1
Timing		
For the total area to be initially uncovered theorical, mos	6	12
Personnel (Manpower and Foremen -Approx. Estim)	Pat	Lal
Drillers (Rotary) and helpers 2x3 sh	6	6
Drillers (Air-track) and helpers 2x3sh	6	6
Drillers (Hammerdrills) and helpers 2x3sh	6	6
Mechanic-Motorits (Compressor) 1x3sh	3	3
Excavators drivers and helpers 1x3 sh	3	3
Bulldozer and Rippers drivers 2x3 sh	6	6
Dumper drivers 4x3 sh	12	12
Service-Truck drivers 1x3sh	3	3
Labourers, for roads maintenance (estm)	9	9
Blasters and helpers	6	6
Labourers for various works not above mentioned	7	7
Foreman 1x3 sh	3	3
Total, dayly workmen units and foremen	70	70

Note:
Implementation and manpower are the same in the two projects, only time of operation being the difference, due to the different thickness of overburden to be removed.
Conservative round figures of 6 or 12 months are assumed to take initial losses of time and low production into account; manpower for general services is not included. Management administration etc also not included.

Phase 3) (Mine Explotation)-

1. Technical Date

Coal production	MT/A	1.000.000	1.000.000
Ratio Total Sterile to Coal	cum/T	7:1	7:1
Total sterile to be excavated	Mcum/A	7.000.000	7.000.000

2. Main Equipment

Mobile Rotary Drilling Rig, hol 100 mms (coal)	1
Mobile Rotary Drill. Rig hol 200/250 mms (sterile)	2
Airtrack perc.Drill Rig. hol 40/45 mms	2
Hammerdrills	2
Air Compressors cap.10-15 cu mt 1/6 kgs/sqcm	2
Crawler front excavator, bucket 5,5 cu mts(coal)	1
Crawler rear excavator, bucket 14 cu.mts (sterile)	2
Crawler front excavator, bucket 14 cu.mts	2
Bulldozers, Rippers (coal)	1
Bulldozers, Rippers (Sterile	3
Motorscrapers, 600 M (coal)	2
Front End loader 5-6 cu.mts (coal)	1
Dumpers, ab.30T.cap. (coal)	3
Dumpers, 90T. cap. (Sterile)	9
Service Trucks	2

Note: At Patilla the overburden is ab. 14-15% of the total sterile; at La Loma it's twice as much. Patilla will be faster to be prepared but we suspect that La Loma will be more economical at the end, when in exercise, because of lesser interbedded sterile.

The following organigramme is supposed to be adopted..

Table in Annex 3 reports a production programme is supposed to reach the 5MTA top in 5-6 years (Maximum-minimum).

Annex 4 reports the relative graphic Diagramme.
The more conservative figures are close to Montreal preliminary project but we consider also a faster achievement of the expectations.
Table in Annex 7 resumes temporary views as for type of main implementation to achieve a conservative schedule of 6 years.

2. The above production/excavation is supposed to be achieved in the second year exercise at Patilla, between second and third year at La Loma, according to above mentioned table and diagramme.

Personnel (Manpower and Foremen - Approx Estimate)	PAT/LAL
Drillers (Rotary) and helpers (coal) 2x3sh	6
Drillers (Rotary) and helpers (Sterile) 4x3sh	12
Drillers (Airtrack) and helpers 4x3sh	12
Drillers (Hammerdrills) and helpers 2x3sh	6
Motorists(compressors) 1x3sh	3
Drivers, excavators (coal) and helpers 4x3sh	12
Drivers, excavators (sterile) and helpers 4x3sh	12
Drivers, bulldozers and Rippers 4x3sh	12
Drivers, Motorscrapers 2x3sh	6
Drivers, F.E. Loader 1x3sh	3
Drivers, dumpers (coal) 3x3sh	9
Drivers, dumpers (sterile) 9x3sh	27
Drivers, Service Trucks 2x3sh	6
Labourers for road maintenance (estim)	12
Blasters and helpers	10
Labourers for various works not above ment. (mine)	14

Crushing plant: at crushers 1x3sh	3
conveyors 1x3sh	3
screens 1x3sh	3
Foremen: mine 1x3sh	3
Foremen: plant 1x3sh	3
Total, daily workmen units and foremen dayly present at work	177

As said, two diagrammes were traced to figure how production could be developped until the final goal after completing the preliminary remove overburden.
The diagrammes are similar for Patilla and La Loma , the difference is that the first starts at a point figuring 6 mos. after the go-ahead (time that we suppose to be necessary for the preliminary overburden operations), the second starts 12 months after same go-ahead.
Both projects are supposed to reach the final top production of 5 MTA between the 4th and the 5th year or between the 5th and the 6th year with more conservative estimate. The real schedule will more or less differ according to the real situation at the mines (overburden,coal and interbeddings, etc).

Crushing Plant

Annex 14 summarising our views on the crushing plant. For both Patilla and La Loma we suppose to split the operation into two stages:

- the first, installing only one primary roll cusher of 300/330 T/h capacity (ab. 2,5 MTA) and one secondary of about 60 T/h (20% primarys capacity); this will be sufficient up to a 2,5 MTA production being foreseen ab. at the 3rd year of exercise in both mines;
- In the second, installing one second primary cusher and one secondary, of capacity equal to the previous one, doubling the production.

Screening section will be developped and belt conveyors extended in the second stage, accordingly.

VI. TENTATIVE DRAFT OF MODULAR MINING PROJECT FOR 10 MTA COAL PRODUCTION AT DESCANSO (CESAR).

Extrapolation from previous 5 MTA draft-projects to one of 10 MTA cannot be reasonably made.

A typical modular implementation as that considered applicable per consecutive stages from 1 to 5 MTA is not valid beyond these limits, since its equipment is expected to assure the maximum output capacity within them.

For instance, if the premises bring to suppose that a 10 MTA production has finally to be expected, studies and organization have to be carried out in view of such deadline. In other words one cannot exceed and extend a 5 MTA project to one of 10 MTA simply multiplying the number of equipments; even supposing this feasible, it is not a rational and economical solution. Therefore the modular draft project which might be considered valid to achieve 5 MTA, is not applicable beyond this limit.

At Descanso a project of a 10 MTA size is expected. Although the geological and mining knowledges of the area are again very scarce, the few ones which may be relied on are very attractive and promising.

Complete investigations are being planned to verify the real situation and to develop the final project accordingly. Present expectations are that the deposit will last 30 or more years at said annual production.

Quite possibly, Descanso is going to appear more attractive than Cerrejón, because is expected to have probably less

than 7:1 ratio sterile :coal as foreseen at least in one area and inspite that overburden is being estimated in the range of 50 mts thickness (double than La Loma, quadruple than Patilla), but with a more favourable situation as for interbedded steriles :coal ratio which is going to compensate that unfavourable of the overburden.

Apart from this, soil seems to have aspects and problems similar to those of Patilla and La Loma as for hydrology, accessessibility, etc.

As said, little is known as for geology, stratigraphy, tectonics, etc. of Descanso area, but what we know leads to suppose that it can be compared to the above mentioned mines with no other significant differences except dimensions.

We consider again that work will be three 8-hrs shifts-day, per 330 day/A as in the previous draft project. The equipment implementation is summarized in annex 1?.

Notes:

A) Preparation (overburden)

A more relevant overburden: coal ratio, will consequently imply a longer time of preparation, independantly from the other two ratios overburden: total sterile and total sterile: coal, and a more relevant immediate expenditure for these preparation works. The following table summarizes a comparison between the figures which were supposed for Patilla and La Loma and those that we are supposing in Descanso at the beginning of the operation (first year).

	Patilla	La Loma	Descanso
Estimated thickness of overburden ms.	14	25	50
Possible ratio total sterile/ coal cu.m./T	7:1	7:1	7:1
Possible ratio overburden/coal cu.m./T	1:1	2:1	4:1
Total area to be initially cleared from overburden sq.ms.	100.000	100.000	100.000
Preliminary removal of overburden atop the deposit, for coal stocks, etc. m.cu.ms.	1.4	2.5	5.0
Cubage of coal-in-desposit cleared from the overburden during preparation M.T.	1.4	1.25	1.25
Time for preparation (approx) for PAT/La Loma mos.	6	12	12
Dayly M.P. Units for the preparation (approx) WKm/d	70	70	100
Total M.P. days for preparation ab.	11.500	23.000	33.000
Mean average output, cu.mts. overburden X wkman-day	121	108	151

However, the years following the first exercise, excavation of overburden has to assure a sufficient area atop the deposit clear from such steriles, and the relative figures may be as follows in the final stage of 5 MTA and 10 MTA respectively for Patilla, La Loma and Descanso.

	Patilla	La Loma	Descanso
Production expected at final stage MTA	5.0	5.0	10.0
Total sterile to be removed from mine Mcu m/A	35.0	35.0	70.0
Overburden removed Mcu m/A	5.0	10.0	40.0
% of the tot. sterile	14-15	28-30	56-60

	Patilla	La Loma	Descanso
Area to be cleared from overburden in the final-stage exercise sq.m./A	350.000	400.000	800.000
Cubage of coal-in deposit cleared from overburden during final stage M.T.	5.0	5.0	10.0

The above figures are giving an approximate idea of where equipments have to be concentrated for blasting loading and hauling the steriles: it can be seen that overburden operations are predominant at Descanso but a minor question at Patilla where interbedded steriles represent 85% of the total.

An obvious normal rule is that the annual quantity of removal of overburden must clear a surface equalising that occupied by the in-pit excavations during the year, and/or assuming a clear area sufficient for the expected production of the following year. In other words, removal of overburden will follow coal production diagramme with equal appropriate increments upto the final expected production, where it will stabilize.

Equipments:

Mobile rotary drilling rig, for holes Ø 200/250 m/m	2
Air-track percuss, drill rig, holes Ø 40-hs m/ms	2
Hammerdrills	2
Air compressors, 10-15 cu.m./'at 6 Kgs./ sq.cm.	2
Crawler front loader, bucket 27 cu.mts.	1

Bulldozers, 400 HP	1
Ripper 400 HP	1
Dumper trucks ab. 154 tons = 60 cu.mts.	5
Service trucks	2
Front-end loader 18 cu.mts.	1

Timing

For the total area to be initially uncovered = ab. 12 mos.

Personnel (manpower + foremen - aprox. estim.)

Drillers (rotary) and helpers	12
Drillers (air track) and helpers	12
Drillers (hammerdrills) and helpers	12
Mechanics-motorists (compressor)	3
Loaders, drivers and helpers	6
Bulldozers/rippers drivers	12
Dumper truck drivers	15
Labourers (road maintenance-estim.)	9
Service truck drivers	6
F.E.L. drivers	3
Labourers for other works not above specified	7
Foremen	3
Total, dayly workmen + foremen	100

The influence of an implementation with bigger equipment at Descanso is evident in the above approximately estimates, where we supposed that mean average output (in terms of cu.mts. of overburden removed per workman-day) is varying from 108 cu.mts at La Loma to 151 cu. mts. at Descanso.

B) Phase 3) (Exploitation)

Annexes 8 and 9 summarize expected annual productions from the first year to the 10 MTA top which is supposed to be

achieved within 7-10-13 years from "go-ahead" according to more or less conservative projects.

Some extrapolations from Cerrejón-Z.N. recent technical reports were adopted for planning the main equipments and work schedule.

The following tables are referred to the first year of exercise. Annexes 10 and 11 summarize the main equipments units foreseen in the period necessary to reach the final production of 10 MTA.

For such a big project we had to take precautions and plan the implementation according to three possible solutions which considered a minimum - a medium and a maximum annual increment of production, as said.

Technical data (1st year of exercise)

Coal production	MT	1
Total sterile to be excavated	M.cu.mts.	7

The first year of exercise is following 1 full year of preparatory works (overburden) now considered. The figures refer to a mean situation during the first year.

Equipments

Mobile rotary drill rig, hole Ø 100 m/m (coal)	1
Mobile rotary drill rig, hole Ø 200/250 (sterile)	2
Air track perc.drill rig, hole Ø 40/hs	2
Hammerdrills	2
Air compressors 10-15 cu.mts/', 6 Kgs. sq.cm.	2
Crawler front loader, bucket 27 cu.mts. (sterile)	1

Bulldozers 400 HP	1
Rippers 400 HP	1
Back Hoe loader 10 cu.mts (coal)	1
Motorscrepers ab. 600 HP (coal)	1
F.E. loader ab, 18 cu. mts.	1
Dumper trucks, 154T, ab. 60 cu.mts (sterile)	7
Dumper trucks, same, (coal)	4
Service trucks	2
Crawler front loader, bucket 21 cu.mts. (coal)	1

Personnel (manpower + foremen - approx. estim)

Drillers (rotary) and helpers (coal)	6
Drillers (rotary) and helpers (sterile)	12
Hammerdrills	12
Drillers (air track) and helpers	12
Motorists (compressors)	3
Drivers (loader 27 cu.m.) and helpers (sterile)	6
Drivers (bulldozers and rippers)	12
Drivers (B.H.L.) and helpers	6
Drivers (motorscrap ers)	6
Drivers (F.E.L.) and helpers	3
Drivers (Dump trucks) (sterile)	21
Drivers (dump trucks) (coal)	12
Service trucks	6
Drivers (loader 21 cu.m.) (coal) and helpers	6
Drivers (service trucks)	6
Labourers for roads maintenance	12
Blasters and helpers	10
Labourers for works not above mentioned	14
Crushing plant - at crushers	3
- at conveyors	3
- at screens	3
Foremen mine	3
Foremen plant	3
Total	177

It is evident that organigramme is equal to that considered for Patilla and La Loma, where expected initial production is more or less the same. This means also that the bigger implementation at Descanso will be less utilized (in %) than the smaller one in the other two mines, at the beginning, as normal, as they have been foreseen for the bigger productions of the following years.

Crushing Plant

Annex 15 is reporting our proposed flowsheet, which is articulated into three phases, the first upto 3.3 MTA production, the second from 3.3 to 6.6 MTA, the third from 6.6 to 10.0 MTA.

Remarks made in annex 14 for the smaller plant remain valid. In the case of minimum annual production increments (see annex 8, graphic I) the second and the third steps might be foreseen between 6th and 7th year and at 10th year respectively.

In the case of a maximum increment, the second step is foreseen between the 3rd and 4th year, the third step at 5th, so in practice only one plant amplification might be planned after 3-4 years of exercise.

VII. SHORT NOTES ON THE PREMISES FOR UNDERGROUND COAL MINING OPERATIONS

We already said that underground mining is much more complicated than that open-pit, and the few following notes are supposed to be a first guideline for the disagregation of future projects.

The phases in the development are still the same considered in open-pit works, and are equally split into steps requiring a certain implementation of equipment; the main differences are being listed in the following notes.

1st. Phase = Exploration.

Subphase a)

Steps concerning surface works are the same but may have or not the same extension than those in open pit minings, however, much accuracy has to be given to the studies since the whole preparatory works are much costlier and their incorrect dimmensioning or/and positioning can badly affect the whole mining operation.

Subphase b)

Design of the preparatory works refers to: pits, inclines, tunnels, raises, etc. from surface to the orebody, for haulage, ventilation, drainage and other services; dimmensioning of these works depends upon the type and size of the machinery to be installed (skips/cages in pits, trucks in inclines, etc.) or to be utilized (trackless mines, and vice versa; once a decision is taken and these works are progressing, it is very difficult (or impossible) to change mind.

2nd. Phase = Preparation.

Subphases a) and b) are similar to those of open pit mining.

Subphase c)

Is a very binding one, and includes the accomplishment of all the accesses to the orebody, and other works for ventilation, drainage, safety purposes with the relative implementation, haulage pits or inclines or tunnels, etc. Said works normally require a lot of time to be terminated (much more than the removal of any overburden in an open-pit operation) that cannot be reduced below certain limits whatever the organization and implementation because of many factors such as limited workspace and possible other negative impredictable implications during the work: rockfalls, water springs, gas, etc.

This phase is normally including other works such as drifts, raises, inclines, crosstunnels, etc. to make portions of orebody in conditions of being practicable and exploitable.

3rd. Phase = Exploitation.

A lot of systems of exploitation are possible depending upon the features of the deposit, permitting a more or less intensive mechanization in order to get maximum production at minimum cost. This choice is being made generally when studying and planning the mine but it normally happens that during the exploitation the system of excavation may be modified according to actual situation.

Excavations may be made with or without explosives, with or without backfilling, with or without roof-wall reinforcements (permanent, mobile) and each mine has its own particular requirements, never equal to another's.

Mechanization is a technical-economical question which is mainly required to respond to the necessity of lowering the costs, increase production, or both.

The ever increasing salaries are the first reason, so mechanization and automatization may be convenient or may be a must in countries of highest salaries, whereas - by the time - may be not convenient at all in the countries where salaries are still low (but these cases are dissapearing day by day).

The technical question in mechanization is first the possibility of local bigger production in a small mine-front (savings are mainly in the general services expenditures) and ,second,where the extension of the mine front allows to achieve mass-scale outputs.

At step 4 (haulage) a more or less intense mechanization is adopted anywhere today and a rather large variety of solutions is possible as for size and type of machinery involved in the underground transportations as well as in the main haulage pits, so implementation may largely vary according to the case being.

Other very important steps are complicating the operational flowsheet, as for an example ventilation (with dust and gas controls), drainage, reinforcement (temporary at the excavation fronts, permanent along main haulage ways, by timbering, roof bolting, concrete or steel structures and frames), electric safety ducts and accessories, water and compressed air sypply as and where necessary, general safety implementation and organization, sterile backfill sypply it and when necessary, accurate continuous survey update, etc.

It is evident that disagregation of a underground mining project is much more complicated than in open pit not only for the variety and number of "steps" but, and mainly, for that of the equipments involved which vary from one mine to another, and consequently such a study has to be carried out per each mine. Nor it will bring to uniform conclusions in all mines but rather to a set of solutions that the expert will try to reduce to a minimum in order to achieve fewer and uniform recommendations.

VIII. FINANCIAL INVESTMENTS AND PARTICIPATION OF THE LOCAL CAPITAL GOODS INDUSTRIES.

Our attention in previous considerations was drawn mainly to the primary equipments to be taken into account for the accomplishment of the projects.

These equipments are formed by high-technology machinery in the whole. As far as we know there is any practical possibility of their local make by the time, nor it is advisable to concentrate particular efforts for their future local fabrication.

Rather, we are convinced that local industries are in conditions of manufacturing an important percentage of their constituents, under form of spare parts and consumables, once design is provided.

It is too arduous, in the present conditions, to state which and how many of those components may be locally processed since this depends not only upon the capability of the manufacturers but also upon the variety of machinery in use at the mines.

Generally speaking, amortizations of mine machinery working in overall work-conditions like those at Cerrejón may be considered at 15-20% per year.

In fact, this kind of machinery is subject to intensive daily work and even if with regular maintenance periodically carried out, it is not foreseen to last more than a 6 - 7 years such a maintenance is a heavy economical factor.

In round figures and approximate evaluation, one can suppose that the amount of the annual exercise expenditures might range also 100% the cost of the machine or more, a 15-20% or more being represented by spares, the remaining part from consumables (energy, etc). Those figures and estimates obviously vary from one machine to another according to the type (shovels, trucks, drill rigs, etc) size; intensity of operation; frequence, tempestivity, accuracy of reparations; reliability of the spare parts, etc, all factors that are suitable to modify to the double or maybe more the above estimates, but which are explanatory enough as for the possibility of the local participation.

As said, it is arduous to try to define such a participation to underground mining projects, since the types, and size of the machinery therein involved are variable a lot, even limiting the discussion to the "normal" implementations setting aside the ever-present pathetical "do-it-yourself" machinery and its extemporary modifications and adaptments.

For this reason, our study was limited to open pit Cerrejón and Cesar areas, although underground mining cannot

be indefinitely set aside since the present knowledge is that ab. 80% of the Colombian coal potential is expected to be exploited that way in mines scattered all over the country.

Less "sophisticated" or minor implementation is concerning infrastructural supplies such as metallic and rubber - plastic pipes and hoses, rails, electric cables and wires steel structures and parts, conveyor belts and accesories, drilling rods and insert bits, core drilling implements, hammerdrill spares, workshop implements and accesories, electric motors and transformers with the usual implementation of accessory equipments, pumps, etc., and we think that the local industry is in condition to supply all these without any difficulty, or that will be in conditions to do it in a short time once designs are made available.

And, last but not least, participation in seen in the supply of all the normal consumables such as cement, sand, clay bricks, dimension stone, explosives and accesories, fuel, lubricants, greases, tires, not to speak of intervention with works such as canalizations, buildings, assembly, foundations, transportations, etc. that all required practically 100% of local participation.

Most of such "minor" interventions cannot be preliminarily defined in terms of quantities, even tentatively, but the enumeration may be sufficiently representative of their importance in the operational budget. And, as a conclusion it may be stated that local participation would represent at the end, a very big percentage of all the economical mining operation, even it is not possible to translate it into monetary terms, in a preliminary study like this of ours.

A tentative pictoral representation to fix our ideas may be made limiting our considerations only to some of the main equipments that we considered in the draft projects above reported, just to have the order of magnitude of such a participation, and in very approximate round figures, at the final stage of the projects, and as for the only operations at the mine front.

	Total cost of equip. delivered at mine, in US$ (x 000) approx.
Patilla	
Coal drills, No. 2	350
B.H.Loader 3.5 cu.m. No. 3	2.900
Bulldozers/rippers 400 HP, No. 12	5.200
Scrapers 650 HP, No. 2	1.100
F.E.L. 6 cu.m., No. 4	1.300
Hammerdrills w.accessories, No. 10	50
Air-track drills, No. 2	150
Air compressors, No. 5	650
Rotary drills (sterile), No. 3	1.700
F.Loaders 14 cu.m. No. 9	
Dumper trucks 90T, No. 50	26.000
Total (partial)	39.400
La Loma	
as above,	
Total (partial)	39.400
Descanso	
Coal Drills, No. 3	550
Bulldozers/rippers 600 HP, No. 12	7.500

Scrapers, No. 4	1.650
F.E. Loader 18 cu.m. No. 2	4.000
Air Tr. Drills, No. 3	225
Hammerdrills No. 20	100
Air compressors No. 10	1.300
Rotary (drill sterile) No. 6	3.400
F.Loaders 18 cu.m. No. 2	6.500
Total (partial)	25.225

For instance, the cost of the above partial implementation might be approximately US$ 39.4 millions at Patilla and La Loma (each) and ab. 25.2 millions at Descanso.

Assuming that 20% of such amount has to be spent annually in spares and consumables, it derives that local industrials may have an annual trade of ab. 7.9 millions USA $ for Patilla, 7.9 for La Loma and 5.5 for Descanso. A figure of four times that than is foreseen for consumables.

And if the above calculation will be extended to the whole mining machinery implementation the figures will raise to much more important values, which cannot be underestimated by any colombian industrial. We think that no further comment is required, since conclusions are obvious when extending the local participation to other future projects too.

IX. FINAL RECOMMENDATIONS

The first part of the report has been given a rather extended comment, and was deepened to details as it was possible and reasonable to do in the present situation.

A further and more detailed disagregation is not feasible by now, nor would be of any utility due to the many unknown variables to be considered.

INCOMEX and CARBOCOL's efforts in studying the disagregation of the mining projects are bound to bring to better understandings with the participants, to the unification of work systems, and to the promotion of local participation in larger scale.

Unification of whatever implementation, primary and secondary machines and tools, is strongly recommended because will bring to uniform "modular" projects and will facilitate all future dealings with the suppliers of the equipment and of their component.

INCOMEX and the other authorities are recommended to "sensibilize" the mechanical industrial sectors in order to promote their interest to the developing projects. Technical premises for this participation do exist and are possible to be extended in the future, should appropriate technologies be acquired to allow also the production of more sophisticated implements. The value of the trade involved in such a participation is really considered and means an equally important volume of manwork in the Colombian mechanical sector.

Should the present preliminary study be followed and deepened, as it is advisable, it should be made when more informations are available from Cerrejón's operation now in semi-preparatory stage, (in order to have more reliable elements for other similar projects such as those in La Guaira and Cesar) and when an appropriate analysis in underground mines will be feasible, in order to finally have a picture of all the coal mining sector.

Particular attention is recommended in recuiting and training the operational technical staff. We do not overevaluate the difficulty in recruiting new graduated mining engineers or in recovering specialists from underground mines; the exercise of open pit works is from far less complicated than underground ones, after all, and not a long time is normally required to change the mentality.

When hearing that in Colombia there is a lack of know how of open pit operations we rather were convinced that the actual difficulty is not the exercise of said works, but their planning, due to the fact that their structural situation is rather complicated and requires experience, and methods of computation that probably are not part of the know how of the available experts. However, this difficulty may temporarily be overcome with the help of foreign established consultants having that capacity. The same consideration is valid for manpower, which can be trained in reasonable period of time to all the works connected with open pit excavations.

A major ever present problem will be probably recruitment and formation of the intermediate-level staff (superindendants, foremen) as they form here and all over the world the and more delicate "interstructure" in the organigramme. Emphasis is to be given to this real problem (which exists in any mining operation).

Finally, one must not expect to develop mines rapidly, in other words the financial sector must not expect fast returns from whatever new mine, because time for its preparation and for the achievement of the optimum production is question of years, say 4 - 5 years and

up, just to speak of a simple limestone quarry.

And as for underground mining, may we say again that the disagregation (interpretation, unification) of the projects will be much more complicated than in open-pits. In particular, we think that such a "disagregation" cannot be planned in national-scale, nor in sectoral-scale, since it is impossible to find (not only in Colombia, but all over the world) two mines having the same capacity, same problems, same general characteristics; so-forgetting abaout such ambitious aims- better to think to "disagregate" projects one by one separately, and finally to try to find out - if possible - common points where unification may be applied.

A simple consideration is sufficient to make one convinced of this: in open pit operations there are few big equipment-units, representing the majority of the investments, escorted by a minor implementation of small machinery; in this case it is relatively easy to get a certain uniformity and unification in projects, supplies, organization. But underground exactly the opposite is what happens: a multitude of small-medium equipments of any kind represents the majority of the investments and mostly are never the same from one mine to another. So for mine design and general organization, which may be expected to be similar in open pits, but never in underground mining.

As a final recommendation, we note that it is absolutely necessary that the Planning Offices are in constant contact with the technical management of the mines and are periodically informed on the development of the operations by means of simple but essential formats.

The planning section will basically need two kinds of information: 1) abstract from the annual budget project and, 2) summary quarterly report from mine.

The first document should be forwarded in time enough by the last year-quarter, and contain data referring production and new main implementation units foreseen in the following year; these data must be precise and reliable, responding to real expectations and necessities.

Previsions should be extended to 2 - 3 or more following years, with the precision which is possible at report's date.

The second document is expected to periodically refer production, manpower days, and expenditures met in the work steps and main equipment groups (such for an example: front loaders, bulldozers and rippers, etc.)

The purpose of those informations is double. First, the Abstract from Annual Budget Project will inform the planning section in time about the expected situation in the following exercise, and allow to plan contracts, purchases and supply schedules for machinery, spares and consumables, jointly with the competent purchasing services.

Second, the periodical report will let the planners verify how and how much the realization of the budget is responding to the previous project. This will eventually allow to intervene in the preparation of the following budget project as advisable.

Annexes 16 and 17 are a draft of the proposed format which, in our opinion, may contain the required informations allowing the necessary speculations as reported. These data are essentially limited to the "Exploitation" phase, which is the "normal" one in all mining projects, and are grouped according to the "steps" concerned with. However the list is exemplificative, in the sense that the Planning Office may modify it and request other or different informations, according to the real occurring necessity. The phases, steps and typical equipments are the same considered in our report. As it will be seen in the format at annex 16, the above "informations" regarding spares and consumables have to be translated into values in pesos colombianos, since the Planning Office needs this essentially; eventual clarifications concerning quantities may be separately requested when necessary. In the format at annex 17, on the contrary, the essential data refers to the quantity and type of equipments foreseen in the following exercise whose value can eventually be verified at the purchases section.

SPECIAL RECOMMENDATIONS FOR THE PARTICIPATION OF THE LOCAL CAPITAL GOODS INDUSTRIES.

The previous considerations brought to advices and suggestions which were summarily expressed in the present and other paragraphs. We think it advisable, however, to clarify the argument.

From a general point of view nobody in Colombia may deny that a more incisive participation of the local capital goods industries to the Mining developing projects has to bring to indisputable benefits on a national scale, nor objections were noticed at this purpose.

Difficulties arise when priority criteria have to be fixed in order to break the actual system of crystalization, whether the first step has to be made by miners or by metal-mechanics. In fact one has to convince the manufacturers to process the materials (spares, etc.) necessary to the mining industry, and the miners to buy such production.

We said that first of all it is necessary to foresee to proceed step by step from both parts, that the operation requires time to be carried out, that it cannot be generalized and extended to 100% of the prevedible necessity nor in qualitative nor quantitative terms, that efforts from the mechanical sector should be concentrated in the simpliest components of minor sophistication and maximum prevedible quantity.

Some mining industrials object that experience is rather negative as for this all. Spares, accessories etc. of

make require too much time to be delivered, and not always respond to the specifications as for tolerances, material, etc. This is obliging to consider noticeable stocks of said parts and subsequent inmobilizations, other than abnormal expenditures for more frequent maintenances and changes, whereas whatever original sparepart may be got from the USA by a telephone call, in a couple of days.

The mechanical industrials reply that sometimes this all cannot be avoided completely because the spares are not uniform as for design and for material, and mostly are required in one or few pieces at once. It is not thinkable that the mechanical industrials have to implement their factories with any possible quality of stocks ,bronzes and machinery for a "24 hour service" of one of few units of the same features or, worst, of a multitude of units of any kind and material. Should even a rough standarization be achieved in these parts, then things might be reconsidered.

But even the most passable standarization in the spare parts will involve that of the relative machinery, and sometimes this could and should be made, but sometimes not at all.Just to consider the first possibility a mining operation may have a rather important implementation of a certain type and size of loaders and the new requests be made for machines only a bit larger or smaller than the existing ones, whereas uniformity could be mantained by a minimum good will. But it is not always easy to convince the technical staff of the global convenience of the operation even if by means of a limited sectoral loss. And if it is so difficult to manage this process of unification in one limited concern, one may imagine the difficulty of getting it in a nation-wide sector, although strictly bound to the open pit operations.

However we are convinced that this is the only way to get the purpose of crushing the close-circle of mutual accusations and prejudices, and that the first step should be made by the miners.

This standarization process might be driven and coordinated by a government authority, more or less according to the three in-sequence steps as follows:

1) To collect statistical data on the existing machinery, (type, main mech. features, working capacity, number of units, main spares and consumables per year, etc.)

2) Tentative grouping of types for standardization purposes, selection according to the predominant types, previsional study of the machines needed in the following years, and of their spares etc;

3) To fix general limitations, within and not beyond these groupings the mine operators may select their machinery- except than when particular necessities do request different considerations.

This work requires qualified cooperators for INCOMEX and/ or the authority concerned, and the cooperation of the mine operators. Should an external consultancy be requested (UNIDO) we think that one specializing mining engineer could carry out the work in approximately 3-4 months, (with possible extension), with the help of 1 local mining engineer and 1 metal-mech. engineer; intense travelling and visiting mines through the country is foreseen and a proper organization is to be prepared to avoid idlings and losses of time.

After this has been accomplished, a new and more fruitful approach with the mechanical sector is possible.

One further step should be considered in sequence in the continuation of the present study, and that is the analytical "desagregation" of the selected standardized machinery into indivicual components in order to verify and list them according design, material, quantity. This may be achieved simply verifying and eventually compieting the catalogues which are normally supplied together with the machines, and finally may bring to know, even aproximately, which and how many (also in terms of percentage of value, material, weight) do require a certain processing work such as carting, term-fraising-drilling finish, etc.)

It must be again repeated that the miners have to draw out periodical (annual) programmes at least for the main strategic spare parts to be purchased and kept stored for the "normal" maintenance, leaving the extraordinary one aside and bound to extraordinary and unpredictable events. Only in such a way one can pretend full cooperation from the local industry.

This is not a new fact, as it may be realized, since it has to be made, and probably is being already made, in other sectors where mechanization and standardization exist (agriculture, cement industry, transportations, etc.)

A guideline may be recovered, as for an example, also from the lists of main spares and consumables that are suggested by the same machine suppliers.

We cannot enter into more details - since this is out of our competence - about something else which should be taken into consideration, equally important to enable the local industry to participate to the mining projects, namely the question of the custom tariffs on the imports of spare parts (which, it seems, are not protective of the local make products), and the more intrincate one concerning the obligations arising from commercial balances and treaties with foreign countries where machinery is being purchased.

At the end, however, one can understand that the technical aspect of the "participation" is not the only one to be considered, even if it is the first in the file.

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ANNEXES

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ANNEX 1

TERMINOS DE REFERENCIA

CONSULTORIA DE LA ONUDI PARA EL PROGRAMA DE DESAGREGACION DE PROYECTOS DE CARBON

I. INTRODUCCION

Carbocol, interesada en promover el desarrollo tecnológico del sector carbón y con el propósito de mejorar cada vez más su capacidad de negociación con firmas nacionales y extranjeras, ha iniciado el programa de desagregación de proyectos de carbón. Dentro de los aportes que hace el estado colombiano para apoyar el desarrollo de estos programas, el Incomex ofreción vincular y Carbocol aceptó, a un experto internacional (ONUDI) en el área de minería, que adelantará una Consultoría de acuerdo con el objetivo y el programa de trabajo que se presentan a continuación .

II. OBJETIVO

La Consultoría, adelantada por el experto de la ONUDI, tendrá el objetivo de preparar para Carbocol , con el apoyo de un equipo de trabajo de profesionales Colombianos, la metodología que permita a la empresa y al país, programar y evaluar la desagregación tecnológica de los futuros proyectos de carbón .

III. METODOLOGIA

Teniendo en cuenta que la Desagregación de los proyectos de carbón tiene características particulares para cada uno de ellos, es conveniente que las entidades extranjeras que adelanten contratos de exploración - explotación con Carbocol en el futuro, presentan una desagregación de los procesos y equipos que utilizaran en el desarrollo de dichos proyectos .

Por esta razón, el Consultor preparará para Carbocol :

1. La forma de exigir a las entidades como uno de los elementos - del estudio de factibilidad, la desagregación de procesos y - equipos, como un anticipo básico para el desarrollo de las ordenes de compra y contratación de servicios. Este punto tendrá en cuenta la legislación colombiana y las normas sobre contratación internacional .

2. La metodología de presentación de la desagregación, incluyendo documentos, formatos, cronogramas generales y cualquier otro - documento que facilite la captación de información .

3. Una recomendación sobre criterios y herramientas que faciliten el análisis y evaluación de las desagregaciones recibidas .

IV. PLAN DE TRABAJO

El plan se definirá conjuntamente con el Consultor. La duración - de la Consultoría es de 13 meses a partir del 17 de Octubre .

ANNEX 2

1. Características, tipo, cantidad de equipos que se requerirán en los futuros proyectos de CARBOCOL (equipos principales y periféricos de exploración, explotación y transporte).

2. Recomendaciones sobre la forma de presentar la desagregación de equipos por parte de los contratistas principales.

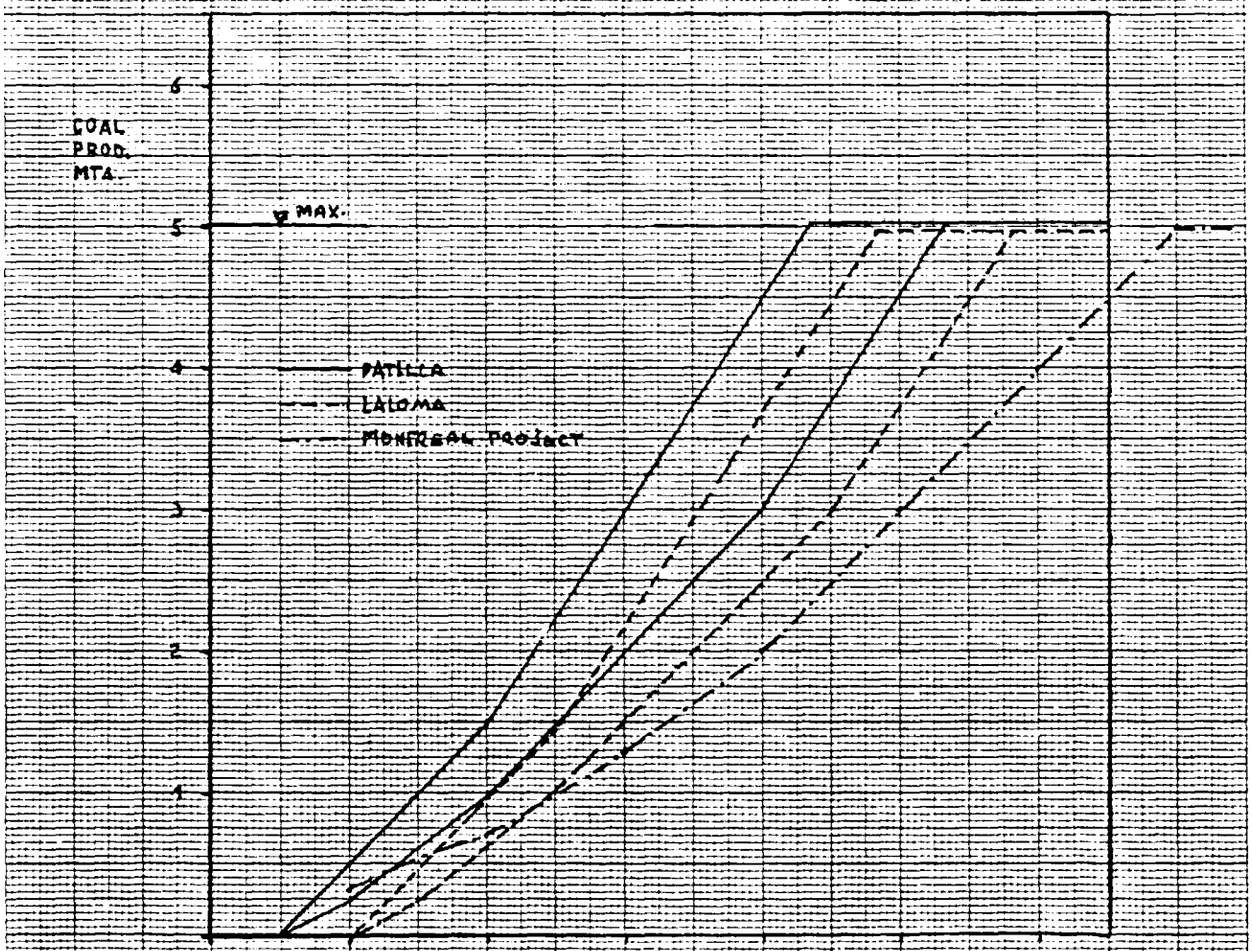
3. Análisis de las posibilidades de participación local en la provisión de los equipos precitados, teniendo en cuenta la experiencia acumulada en este campo por CARBOCOL.

ANNEX 3

COAL AND STERILE EXCAVATION PROGRAMME AT PATILLA/LA LOMA

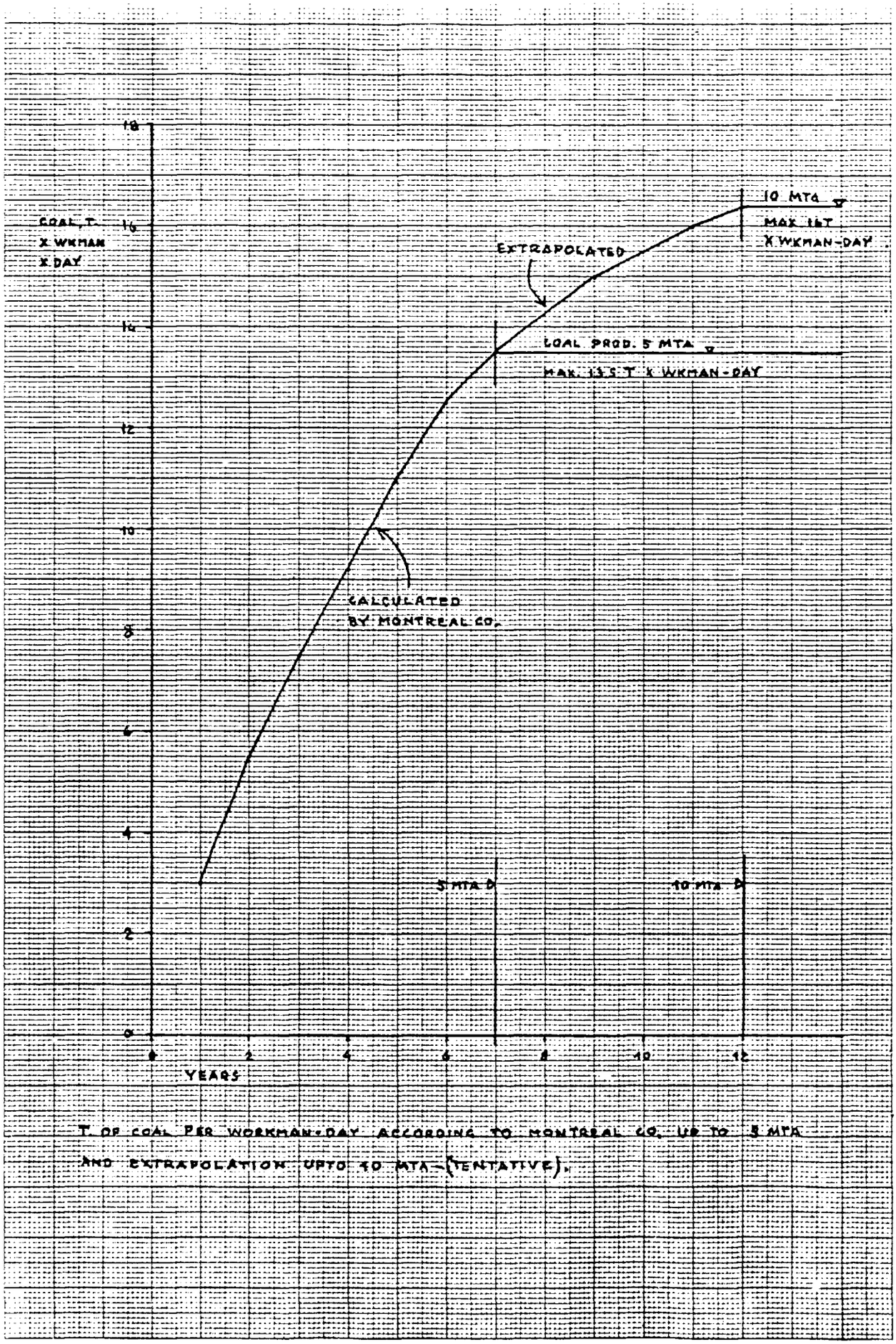
YEAR	COAL PRODUCTION MTA				STERILE EXCAVATION McumA			
	PATILLA		LA LOMA		PATILLA		LA LOMA	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.
1	0.25	0.50	-	-	1.75	3.50	-	-
2	1.00	1.50	0.65	1.00	7.00	10.50	4.55	7.00
3	2.00	3.00	1.50	2.15	14.00	21.00	10.50	15.05
4	3.00	4.50	2.50	3.65	21.00	31.50	17.50	25.55
5	4.50	5.00	3.75	5.00	31.50	35.00	26.25	35.00
6	5.00	5.00	5.00	5.00	35.00	35.00	35.00	35.00

ANNEX 4



POSSIBLE YEARLY PRODUCTION PROGRAMME AT PATILLA AND LA LOMA MINES UPTO 5 MTA

ANNEX 5



T OF COAL PER WORKMAN-DAY ACCORDING TO MONTREAL CO. UP TO 5 MTA AND EXTRAPOLATION UPTO 10 MTA - (TENTATIVE).

ANNEX 6

ORGANIGRAMME PLANNED BY MONTREAL CO. FOR CERREJON - ZONA CENTRAL

Year	1	2	3	4	5	6	7
Coal production MT	0.3	0.7	1.3	2.0	3.0	4.0	5.0
Management Staff	30	40	58	71	82	82	82
Manpower, Foremen	331	383	532	665	831	973	1126
Total	361	423	590	737	913	2055	1208
% Manag. staff.	8.3	9.4	9.7	9.7	9.0	7.7	6.7
M:P.+F.M. Mean prod. T/d (coal)	3.0	5.5	7.5	9.0	11.0	12.5	13.5

Management (Technical, administrative, etc.) represents 7-8% meanly of all the organigramme.
Manpower may be tentatively divided according to the following percentages when mines are in exercise. (excluding preliminary preparations, and transportations to the port/delivery).

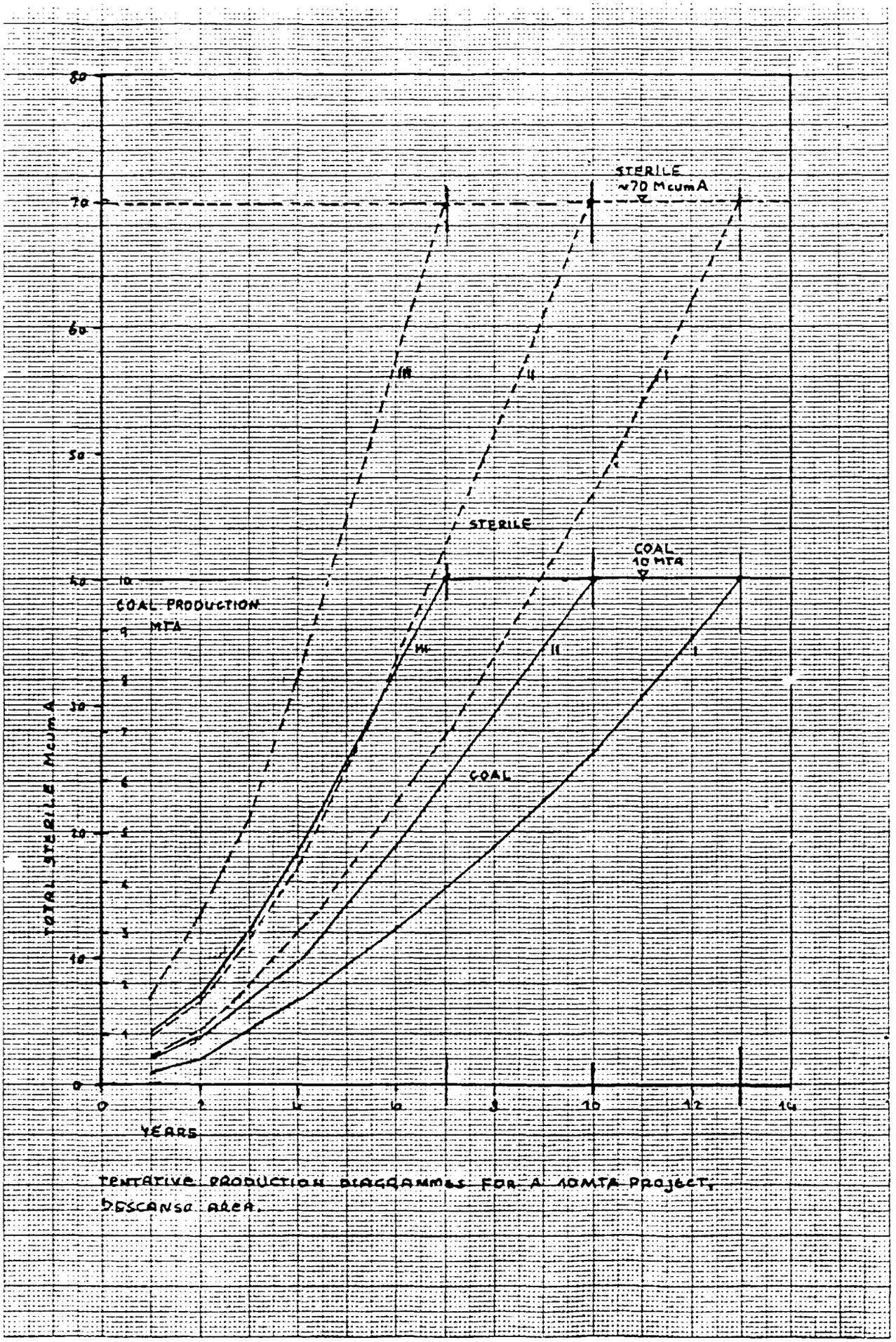
Coal (mine + plant)	30.5	Mine total 67.5
Sterile (total)	37.0	
Gen. Services	32.5	

ANNEX 7

MAIN IMPLEMENTATION AT THE MINE IN THE YEARS NECESSARY TO REACH THE FINAL PRODUCTION OF 5 MTA

	COAL						IN-COMMON IMPLEMENTATION					STERILE			
Years	Rotary drive ø 100	Front excav 3.5 cu.m.	Rear excav. 3.5 cu.m.	Bulldozers & rippers	Mot.Scrapper	Dumpers 30 T.	F.E. Loaders	Trucks	Air Tr. drills	Hammer drills	Air compr.	Rotary drills ø200	Front exc. 14 cu.m.	Bulldozers & rippers	Dumpers 90
PATILLA															
1	1	1	1	1	1	1	1	2	2	2	2	1	1	1	2
2	1	1	1	1	1	3	1	2	2	2	2	2	2	3	9
3	1	2	1	2	2	5	2	2	2	4	2	2	4	5	19
4	1	2	2	2	2	8	3	2	2	6	3	2	6	7	28
5	2	3	2	2	2	10	4	2	2	9	4	3	7	10	42
6	2	3	3	2	2	12	4	2	2	10	5	3	9	12	50
LA LOMA															
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	1	1	1	1	2	1	2	2	2	2	1	2	2	6
3	1	1	1	1	1	4	1	2	2	2	2	2	4	4	14
4	1	2	1	2	2	6	2	2	2	4	2	2	5	7	23
5	2	2	2	2	2	8	3	2	2	6	3	3	7	9	34
6	2	3	3	2	2	12	4	2	2	10	5	3	9	12	50

ANNEX 8



TENTATIVE PRODUCTION DIAGRAMMES FOR A 10MTA PROJECT, DESCANSO AREA.

ANNEX 9

TENTATIVE PRODUCTION PROGRAMMES FOR A 10 MTA PROJECT ACCORDING TO MINIMUM - MEDIUM - MAXIMUM ANNUAL INCREMENTS OF PRODUCTION

Year	I Min.		II Med.		III Min.	
	Coal	Ster.	Coal	Ster.	Coal	Ster.
MT/A						
1	0.25	1.75	0.50	3.50	1.00	7.00
2	0.50	3.50	1.00	7.00	1.75	12.20
3	1.10	7.70	1.60	11.20	3.00	21.00
4	1.65	11.70	2.40	16.80	4.60	32.20
5	2.40	16.80	3.50	24.40	6.40	44.60
6	3.00	21.00	4.70	32.70	8.30	57.50
7	3.80	26.40	6.00	42.00	10.00	70.00
8	4.70	32.70	7.30	51.00		
9	5.60	39.20	8.60	60.00		
10	6.60	46.20	10.00	70.00		
11	7.70	53.60				
12	8.80	61.50				
13	10.00	70.00				
14						

ANNEX 10

MAIN IMPLEMENTATION AT THE MINE IN THE YEARS NECESSARY TO REACH THE FINAL PRODUCTION 10 MTA

1) Minimum Annual Increment of Production — Table 4

	COAL						IN-COMMON IMPLEMENTATION					STERILE			
Years	Rotary drills ø 100	Front exc. 21. cu.m.	Rear exca. 10 cu.m.	Bulldozers & rippers	Mot. scrappers	Dumpers 154 T	F.E.Loaders 18 cu.m.	Trucks	Air tr. drills	Hammer drills	Air comp. 10/15 cum/	Rotary 200/ drills 250	Front exc. 27. cu.m	Bulldozers & rippers	Dumpers 154 T. 60cu
1	1	1	1	1	1	1	1	2	2	2	2	1	1	2	2
2	1	1	1	1	1	2	1	2	2	2	2	1	1	2	4
3	1	1	1	1	1	4	1	2	2	2	2	1	1	2	8
4	1	1	1	1	2	6	1	2	4	2	2	2	1	2	12
5	1	1	1	2	2	8	1	2	4	2	2	2	2	4	17
6	1	1	1	2	2	10	1	2	6	2	3	3	2	4	21
7	2	1	1	2	2	13	1	2	8	2	4	3	2	4	27
8	2	1	1	2	2	16	1	2	10	2	5	4	3	4	33
9	2	2	2	3	3	19	2	4	12	3	6	4	3	6	39
10	3	2	2	3	3	22	2	4	14	3	7	5	4	6	46
11	3	2	2	3	4	25	2	4	16	3	8	5	4	6	54
12	3	2	2	4	4	28	2	4	18	3	9	6	5	8	62
13	3	2	2	4	4	33	2	4	20	3	10	6	5	8	70

ANNEX 11

MAIN IMPLEMENTATION AT THE MINE IN THE YEARS NECESSARY TO REACH THE FINAL PRODUCTION OF 10 MTA

Medium and Maximum annual increment of Production

Years	COAL					IN-COMMON IMPLEMENTATION							STERILE		
	Rotary drills	Front ex. 21 cu.m.	Rear ex. 14 cu.m	Bulldozer & rippers	Mot. scrapper	Dumpers 154 T	F.E. Loaders	Trucks	Air Tr. drills	Hammer drills	Air comp. 10/15 cu	Rotary drills	Fr. exc. 27 cu.m.	Bulldozer & ripper	Dumper 154 or 60cum
II) MEDIUM ANN. INCREM. OF PRODUCTIONS															
1	1	1	1	1	1	2	1	2	2	2	2	1	1	1	4
2	1	1	1	1	1	4	1	2	2	2	2	1	1	1	7
3	1	1	1	1	2	6	1	2	2	4	2	2	1	2	12
4	1	1	1	1	2	8	1	2	2	4	2	2	2	2	17
5	2	1	1	1	2	12	1	2	2	6	3	3	2	3	25
6	2	1	1	1	2	16	1	2	2	10	5	4	3	2	33
7	2	2	2	2	3	20	2	4	3	12	6	5	4	4	42
8	3	2	2	3	4	25	2	4	3	14	7	5	4	6	51
9	3	2	2	4	4	28	2	4	3	17	9	6	5	8	60
10	3	2	2	4	4	33	2	4	3	20	10	6	5	8	70
III) MAXIMUM ANN. INCREM OF PRODUCTION															
1	1	1	1	1	1	4	1	2	2	2	2	1	1	2	7
2	1	1	1	1	2	6	1	2	2	4	2	1	1	2	12
3	1	1	1	2	2	10	1	2	2	6	3	2	2	4	21
4	2	1	1	2	2	15	1	2	2	10	5	3	3	4	33
5	3	2	2	2	3	22	2	4	3	14	7	4	4	4	45
6	3	2	2	3	4	28	2	4	3	18	9	5	5	6	58
7	3	2	2	4	4	33	2	4	3	20	10	6	5	8	70

ANNEX 12

LIST OF THE MAIN MINE EQUIPMENT CONSIDERED FOR A 5MT/A COAL PRODUCTION PROJECT

DRILLING

Electric Rotary DrillRig, for holes Ø 200-250 mms capacity ab.2 drillholes/hr 5-6 mts ea. blasting 330 cu. mts ea. of sterile, annual capacity 5,2 M.cu.mts.

Electric Rotary Drill Rig, for holes Ø upto 100mms capacity ab. 4 drillholes/hr 5-6 mts ea., blasting 100 T ea. of coal, annual capacity 3,2 MT.

Air-Truck Percussion Drills, for holes Ø 40-45 mms, considering 2 units upto 5 MT/A.

Hammerdrills, for holes Ø 40-45 mms (secondary blasting), considering 2 units per MT/A of Coal.

Air compressors, capacity 10-15 cu. mts/min at 6 kgs.sq.cm, considering 1 unit per MT/A of Coal.

LOADING

Backhoe Excavator bucket 3.5 cu.mts capacity 600.000 T/A of Coal.

Front Excavator, bucket 5.5 cu.mts. capacity 1,2 MT/A of Coal.

Front-End Loader, bucket ab. 6-7 cu.mts. estimated capacity ab. 1,0 M cu.mts/A of Sterile, ab 2,0 MT/A of Coal.

Bulldozer, 400 HP capacity 2,5 M cu.mts/A of Sterile; 3,0 MT/A of Coal

Ripper, 400 HP capacity 2,5 M Cu.mts/A of Sterile; 3,0 MT/A of Coal.

Motorscraper, 650 HP capacity n.e.

HAULAGE

Dumper Truck, cap. 30T capacity 450.000 T/A of Coal

Dumper Truck, cap. 90T=35 cu.mts. capacity 760.000 cu.mts/A of Sterile.

Service Trucks

COAL CRUSHING PLANT

Primary roll crusher to #50mms capacity 1,25 MT/A

Secondary roll crusher to #50mms. capacity 0,5 MT/A

LIST OF THE MAIN MINE EQUIPMENT CONSIDERED FOR A 10MT/A COAL PRODUCTION PROJECT.

DRILLING

Same machinery as in the 5MT/A project.

LOADING

Front Excavator, bucket 21 cu.mts. capacity 9.5 MT/A in Coal.

Front Excavator, bucket 27 cu.mts. capacity 13.5 M cu.mts. in Sterile.

Front-End-Loader, bucket cap. 18 cu.mts. capacity 9.0 MT/A in Coal, 4.5 M. cu.mts/A in Sterile.

Backhoe Loader bucket cap. 10 cu.mts. capacity 9.5 MT/A in Coal, 7.0 M cu.mts/A in Sterile.

Bulldozer-Ripper same as in the 5 MT/A project.

HAULAGE

Dumper Trucks, cap. 154T or 60 Cu.mts. for Coal and Sterile capacity 300.000T/A in Coal, 1.000 cu.mts/A in Sterile.

Service Trucks, same as in the 5 MT/A project.

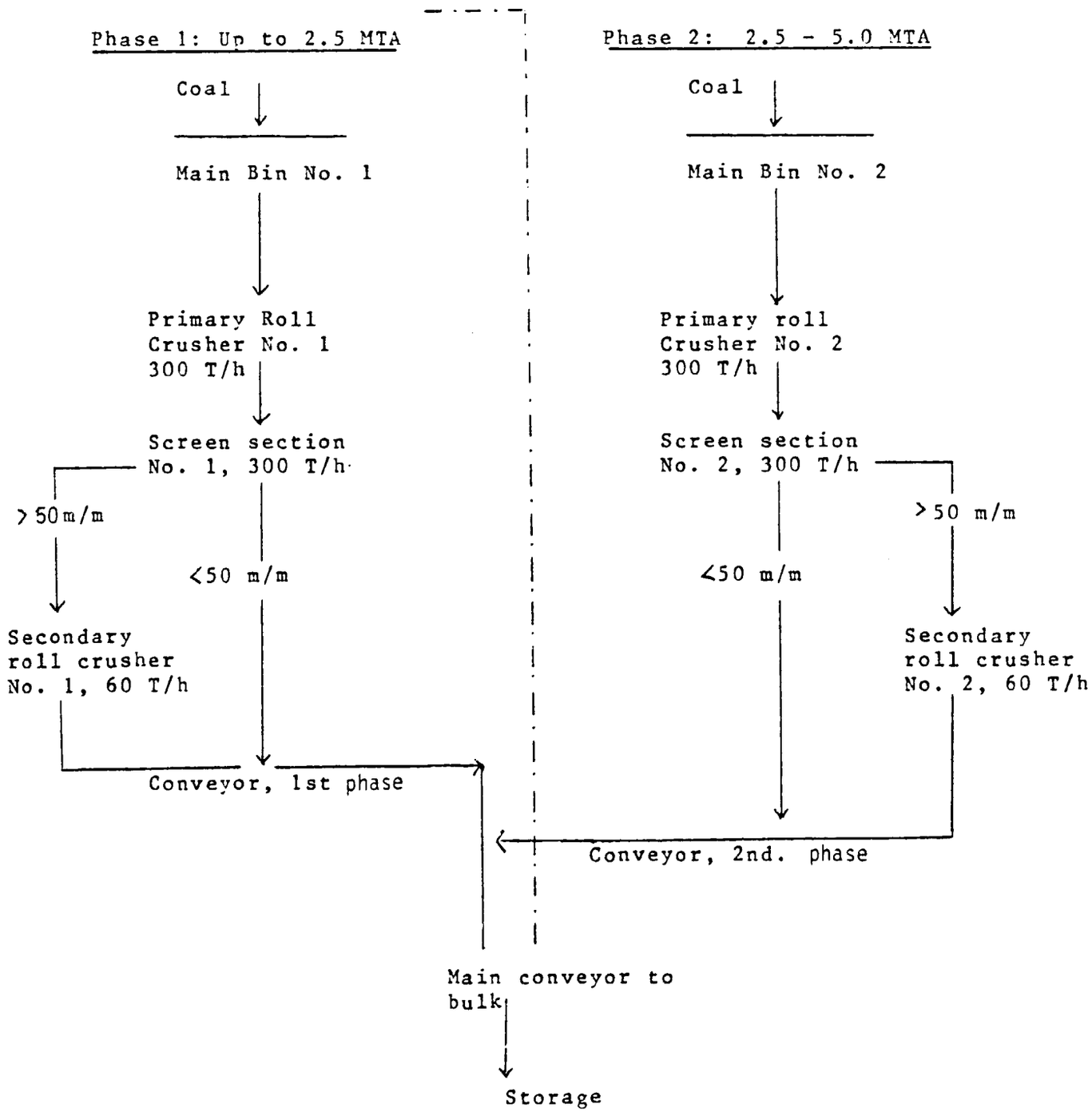
COAL CRUSHING PLANT

Primary roll crusher to # 50m/m capacity 3,3 MT/A

Secondary roll crusher to #50 m/m capacity 1 MT/A

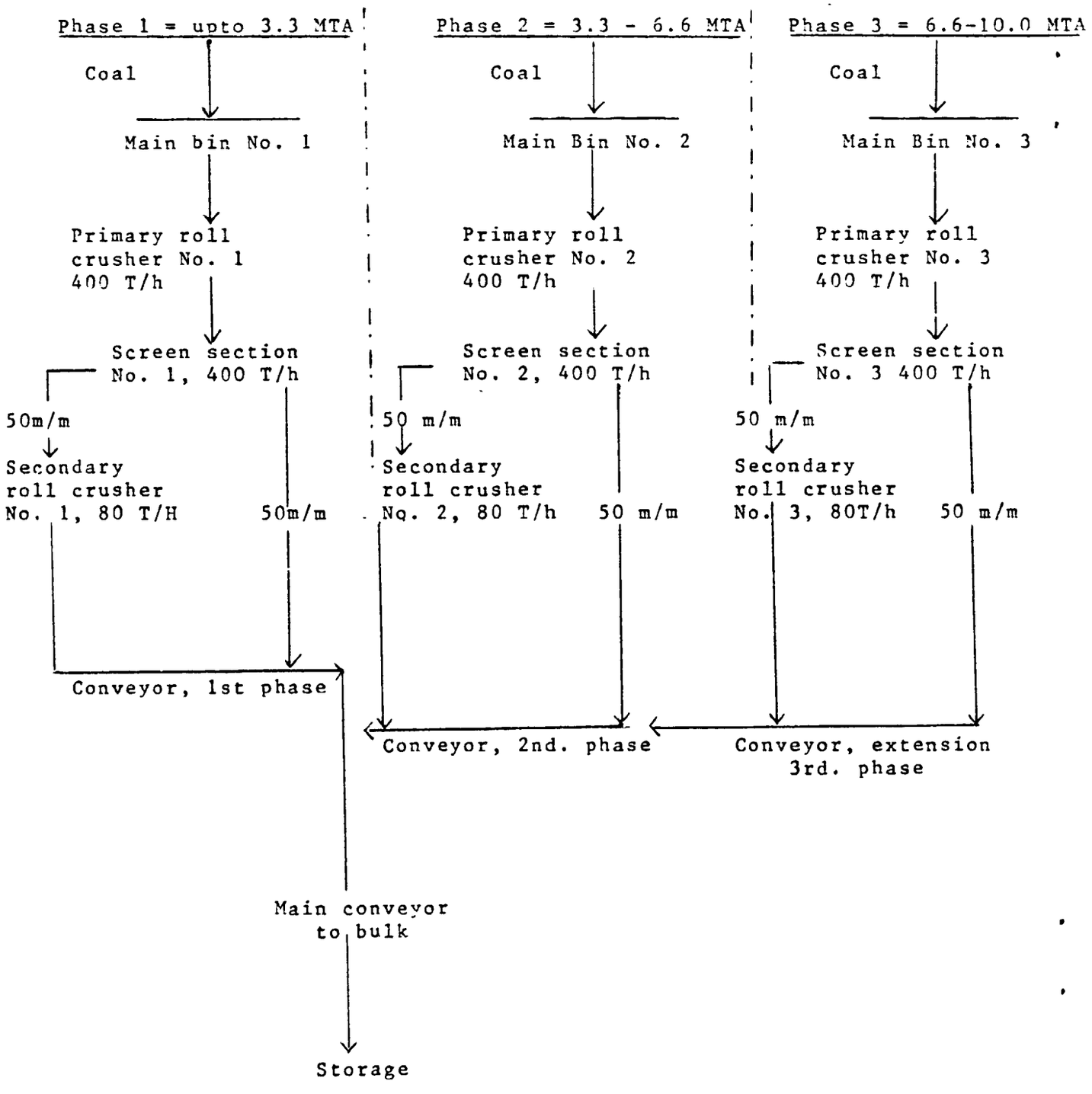
ANNEX 14

CRUSHING PLANT (PATILLA AND LA LOMA)



ANNEX 15

CRUSHING PLANT (DESCANSO)



ANNEX 16

PROPOSED FORMAT FOR PERIODICAL REPORT FROM MINE TO THE PLANNING SECTION.

PERIOD _____ 19___

WORKDAYS NO. _____ PRODUCTION COAL T _____ STERILE ____

MANPOWER - W.M. DAYS -

Driling	Loading	Haulage	Crush.	Mine	Transp.	Gener.	Total

Drilling		COAL	STERILE	TOTAL
Energy (Kwh)	$			
Fuels, lubricants (gal, kgs...)	$			
Consumables/Spares: Rotary drills	$			
Compressors	$			
Hammerdrills	$			
Total	$			

Loading		COAL	STERILE	TOTAL
Energy (Kwh)	$			
Fuels, lubricants (GAls, Kgs...)	$			
Consumables/Spares: Front loaders	$			
BM.Loaders	$			
F.E. Loaders	$			
Bulldozers/ Rippers	$			
Scrapers	$			
Total	$			

Haulage		COAL	STERILE	TOTAL
Fuel, lubricants (Gals., Kgs...)	$			
Consumables/spares	$			
Total	$			

		CRUSHING	MINE DEPOSIT	TRANSPORT.
Energy (Kwh)	$			
Fuel, lubricants	$			
Consumables/spa.	$			
Total	$			

ANNEX 17

PROPOSED FORMAT FOR ANNUAL BUDGET PROJECT ABSTRACT FROM MINE TO THE PLANNING SECTION

DATE_____

Year	----	----	----	----	----
Expected Coal Prouction MT	----	----	----	----	----
New Implementation:					
Drilling: Rotary drills					
Compressors					
Hammerdrills					

Loading: Fr. Loaders					
B.H. Loaders					
F.E. Loaders					
Bulldozers/Ripp.					
Scrappers					

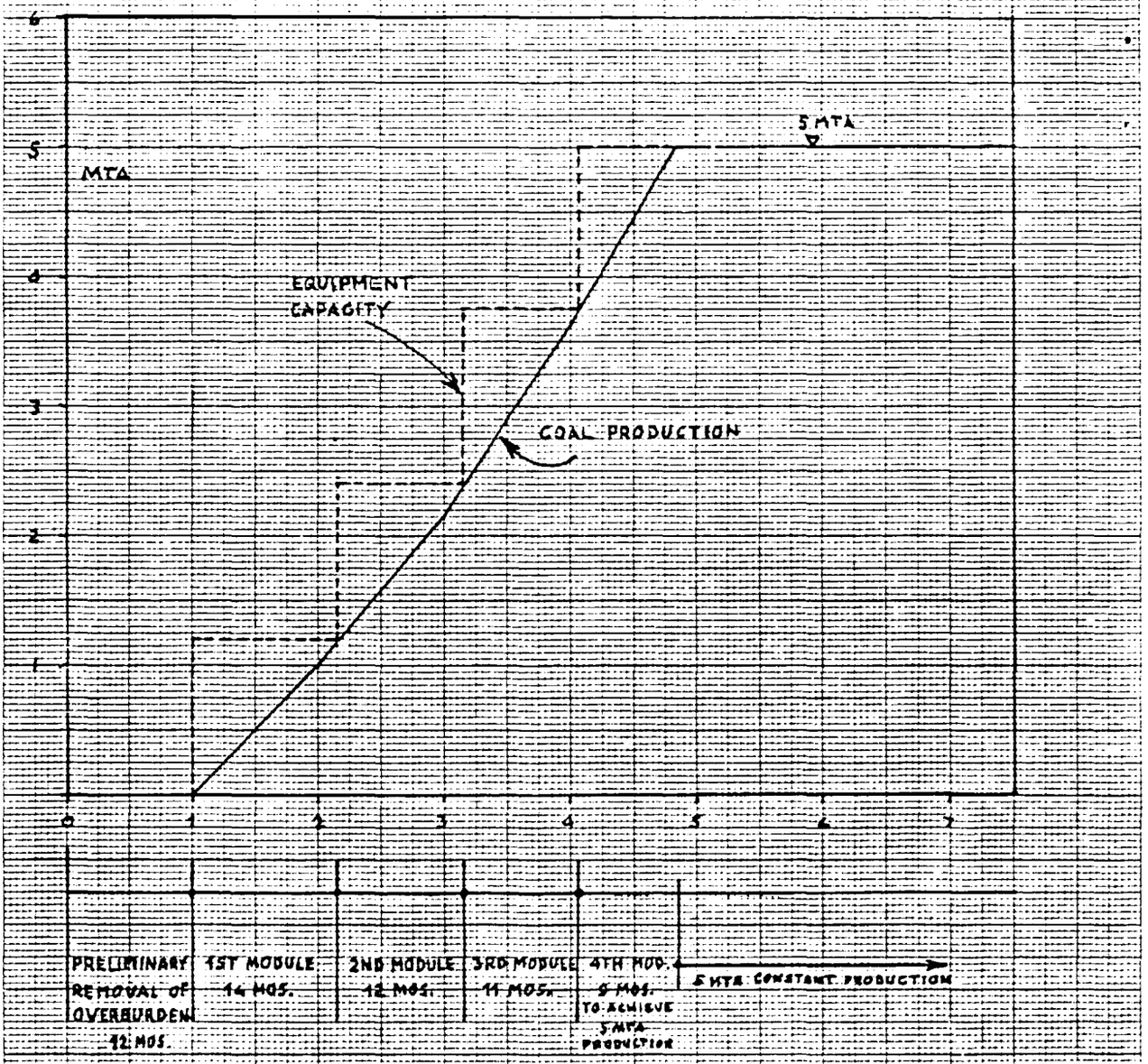
Haulage: Trucks.....					
Trucks.....					

Crushing ----------					

Mine Dept.----------					

Transport ----------					

ANNEX 18



TENTATIVE DIAGRAMME OF THE APPLICATION OF THE "MODULAR PROJECT" TO A 5 MTA COAL PRODUCTION PROGRAMME.

ANNEX 19

STATISTICAL SURVEY (Example) - LOADING -

MINE, LOCALITY _____ MINERAL _____

OPERATION _____

ANNUAL PRODUCTION _____ SIZE OF PRODUCT _____

DATE OF SURVEY _____

LOADER TYPE _____ BUCKET CAP. _____

MOTOR HP _____ FUEL, ENERGY _____

HAULAGE TYPE _____

ANNUAL COSTS: SPARES$ _____ CONSUMABLES$ _____

LOADING CAPACITY/MR _____

MAIN SPARES LISTS

Year _____

IDENTIFICATION-REMARKS	No. Pieces

LOADER IDENTIFICATION	Bucket capac. cu.m.	Motor HP	Loadin. capac. T/h	Machine Cost $	Annual Spares $	


4.05.02
AD. 85.03