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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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

PROJECT OF THE FEDERAL REPUBLIC OF NIGERIA

ASSISTANCE TO THE NATIONAL METALLURGICAL DEVELOPMENT CENTRE, JOS.

DP/NIR/87/031/11-66/JI3207

REVIEW OF DESIGN, CONSTRUCTION SUPERVISION AND OPERATION OF MINERAL BENEFICIATION PILOT PLANT.

20/12/93 TO 03/04/94

BY

G.S. RAMAKRISHNARAO
UNIDO CONSULTANT
MINERAL BENEFICIATION AND PILOT PLANT OPERATION

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SUMMARY AND CONCLUSIONS

0.1 Assignment:

The duties carried out during the assignment period of three and half months, prior to completion of the pilot plant buildings for housing, erection and commissioning of the MBPP equipment, includes the following.

0.1.1 Inspection of equipment at site

0.1.2 Scrutiny of structural and electrical engineering drawings

0.1.3 Supervision in construction of substructures of MBPP buildings.

0.1.4 Guidelines for preparation of Techno Economic Feasibility Report.

0.1.5 Assisting NMDC to publicise its services and facilities.

0.1.6 Suggestions for operating NMDC on commercial basis through collection of testing charges.

0.1.7 Offering technical advice to NMDC personnel through participation in external technical meetings along with them.

0.1.8 Training NMDC personnel with methods/procedures connected with operation of MBPP.

0.1.9 Preparation of MBPP stock inventory.

0.1.10 Preparation of salient features of erection, operation and maintenance of MBPP.

This assignment was carried out between 20th December 1993 and 3rd April, 1994.

0.2 Technical scrutiny of Bids

Based on the scrutiny of bids received so far, recommendations were already submitted in December 93, vide Phase II Report of the Consultant.

0.3 Inspection of equipment at site

0.3.1 Preliminary inspection of Equipment on receipt:

All equipment,ordered by UNIDO at a cost of US$660,000 was received in good condition without any damages/breakages.

0.3.2 Physical verification of equipment receipts as per packing Lists

Physical verification of the contents of the 80 MBPP equipment crates, checked with the packing lists, confirmed, by and large, the receipt of all equipment,its accessories and spares in tact and in good condition except a few minor discrepancies as presented in

Table I of the report. Communications were sent to the equipment suppliers asking for free replacement of the missing items.

0.3.3 Physical inventory of MBPP equipment

To facilitate inventory control and periodical physical stock verification, the inventory list as on 31.3.94 was prepared.

0.3.4 Inspection of equipment received from USA, UK, Europe and Australia in operating condition:

Excepting those equipment which are to be installed/commissioned by suppliers, the others were tested in running condition and found to be in order.

0.3.5 Salient features of Manuals for erection/ operation/maintenance of Equipment:

From the equipment manuals, the salient features were prepared as shown in the Annex.

0.4. Savings in Infrastructural Costs:

0.4.1. Need for revision of structural drawings:

a) Combining two separate slabs at 3 M level into a single slab of lesser area.

b) Uneven land sloping by about 2.5 M from SE to NW direction.

c) Presence of following adverse site conditions, revealed on excavation, necessitating strengthening of the column foundations.

- Easily friable conglomerates without presence of any hard boulder

- Filled up soil with plant roots, plastic covers, cloth rags upto 1 M depth
- Moist soil on NW side in the month of February indicating high ground water table.

0.4.2. Salient Features of Revisions in Structural Design Drawings:

a) Cutting and filling upto a specified depth using hard soil brought from outside.

b) Strengthening heights of column bases from 350 to 600 mm.

c) Need for construction of a retaining wall

d) Achieving compaction of the ground filled up with the hard soil brought from outside using dozer.

These modifications are expected to increase the building costs rather than achieving savings for ensuring the structural soundness of the buildings.

0.4.3. Electrical Engineering drawings: Based on the discussion with the Consultants, and inspection of working control panels at Jos, necessary modifications were recommended for achieving better operational controls besides safety of operating personnel.

0.4.4. Clubbing Check Dams & Water Reservoir with the Overall Drainage Plan:

0.4.4.1. Construction of the drainages using either hollow bricks or granite blocks is recommended.

0.4.4.2. To save costs, the drainage plan is modified to include three earthen check dams and a ground water reservoir for storage of storm water, recirculation water from settling tanks and drying pad, and prevention of water pollution.

0.4.5. Bore Well : Drilling of a bore well for meeting the fresh water requirements of MBPP is strongly recommended.

0.5. <u>Progress of Construction Activities:</u>

0.5.1. Scope of Consultant's Supervision: It comprises of effective coordination with and offer of advice and assistance to the local Consultants and Building Contractors and includes the following:

- Scrutiny of structural drawings and offer advice on necessary modifications for better effectiveness and achieving savings.
- Independent supervision of construction activities carried out by building Contractors to ensure execution of works as per the design drawings / written instructions involving modifications based on site inspection issued exclusively by the Structural Engineers (M.D.D.C) and Overall Supervisors (M.D.C.L) just to prevent / minimise the mistakes.
- Attending site meetings.

0.5.2. **Progress of Construction Activities as on 03.04.94.**

a) Substructure of Primary Crusher Building is completed.

b) Substructure of Secondary Crusher building completed.

c) 85% of fencing wall construction is completed .

d) Though construction of substructure for Beneficiation Plant is 3 months behind schedule, considerable progress has been achieved as result of remedial/strict measures taken by the Centre .

0.5.3 **Award of Construction of Super Structures:-**

Based on the good work done, the work orders for construction of super structures for the Primary and Secondary Crushers were placed with the same contractors who completed the substructures of Primary and Secondary Crushers. The contractors are expected to start the work soon after the completion of fabrication works with steel sections. This aspect of work has just been awarded by NMDC Management.

0.6. **Activities Deferred:-**

The following activities shall be taken up after completion of the pilot plant buildings:

0.6.1. Commissioning the pilot plant.

0.6.2. Rectification of the operational defects.

0.6.3. Training NMDC personnel in operation of the pilot plant.

0.6.3.1 **Preparatory Training:-** NMDC personnel were trained suitably in undertaking the preliminary tasks connected with the pilot plant operation.

0.6.4 **Preparation of Technoeconomic Feasibility Report (TEFR):** As a prerequisite for commercialization of any successful R & D results/knowhow, selection of an optimum process flowsheet, based on pilot plant testing of any ore by alternate routes, is necessary. As the pilot plant testing facilities are yet to be ready, the components of TEFR were indicated. The salient information of TEFR of Itakpe Mine of NIOMP, prepared by M/S Sofra Mines, were included, by way of an example so as to serve as a guide, for future preparations of TEFR.

0.7. Publicizing the facilities of NMDC

0.7.1 **Uniqueness of NMDC.**

(a) Has highly qualified personnel quite a few of whom are trained abroad/exposed to latest technological developments

(b) Availability of standard equipment capable of yielding reproducible results.

(c) Availability of divergent testing facilities together such as:

(1) Coke oven Pilot Plant

(2) Mineral Beneficiation Pilot Plant (under construction).

(3) Refractory and foundry materials

(4) Metals' testing facilities.

(5) Conventional and Instrumental methods of chemical analysis.

0.7.2 Utilisation of NMDC for achieving Regional Industrialization

These facilities need to be publicized widely for regional development of all African countries besides Nigeria for achieving rapid industrialization. No sample from Nigeria should be allowed to be tested abroad without obtaining confirmation regarding non availability of facilities at NMDC. Financial assistance for developing duplicate facilities elsewhere in Africa should not favourably be considered.

0.7.3 Publicity Material

Publicity material in the form of a leaflet "what NMDC can offer you" and a brochure listing out testing facilities offered by each Department was prepared for circulation to AISA/all Geological/Mining and Metallurgical Institutions in Africa/Producers/Importers/Exporters of ores/minerals/metals.

0.7.4 International Recognition of NMDC

For achieving recognition of NMDC as a centre of excellence in Africa,it is necessary to carry out assignments in a professional manner,keep up to time schedule, ensure

reliability of results through hard work, dedication, sincerity and knowledge of latest developments by all its personnel.

0.8.0 NMDC Operating on Commercial Basis

0.8.1 Generation of Revenue

For achieving rapid industrialization, NMDC should work on commercial basis and offer its facilities to all its users through collection of testing charges for meeting its revenue expenditure.

0.8.2 Testing Charges: The charges should be worked out on adhoc basis/approved rates of FGN/as per the prevailing market rate/actuals. No work should be undertaken without prior receipt of advance payment.

0.8.3 Departments Responsibility

Each Department should scout for work and earn 25% minimum of its revenue expenditure for becoming ultimately self sustaining/profit making unit .

0.8.4 MOU

To let each Departmental Head realise his responsibilities for earning its revenue expenditure, each should submit progress report for the previous month, program of work for the month ahead and the same should be reviewed periodically by D/CE.

Each Department Head should sign a memorandum of understanding with D/CE indicating targets set by himself at the begining of the year and a performance Appraisal Report (PAR) at the year end indicating

what has actually been achieved by Department. The gaps below the MOU and PAR should be critically reviewed by D/CE of NMDC for taking remedial action.

0.9 Technical Assistance:

0.9.1. Technical meeting: The following technical meetings were attended along with the Project Engineers of NMDC.

S.No	Dates	Meeting place	Meeting Objectives
1	16.1.94 to 21.1.34	Itakpe Iron Ore Mine of NIOMP	How to meet quality specifications of DSC
2	9.2.94 to 11.2.94	DSC, Warri	Review of test results for meeting specifications of DSC

0.9.2. **Measures for meeting DSC Specifications:**

The specifications of DSC can be met, out of the existing processing plant of NIOMP, by use of the following measures:

a) Proper mine planning for removal of waste prior to ore mining

b) Quality control for supplying more or less uniform ROM

c) Ore blending prior to processing

d) Using autogenous mill as semi autogenous mill for achieving finer grinding, and recirculating products containing locked particles for achieving liberation

e) Recirculation of middling products for minimising dilution of final concentrate grade through mechanical carriage

f) Rejection of ultrafine particles rich in gangue through primary cycloning

g) Increasing pulp density of spiral tails prior to magnetic separation for increasing their retention time

h) Sacrificing one or two percent iron recovery for meeting grade requirements of DSC.

A tentative process flowsheet / material balance flowsheets are included as a basis for finalization after discussion and testing.

0.9.3 **Suggestions:** Following suggestions are included for consideration:

- DSC to treat Itakpe as its captive mine and adjust its operating parameters suitably
- Offer incentives / higher price to offset additional cost for finer grinding / slightly reduction in iron recovery for meeting DSC specifications.
- NIOMP must try to improve its quality to the maximum extent possible in one out of three lines of the existing plant for meeting DSC specifications.
- NIOMP to improve its quality to the maximum extent possible in the existing plant for meeting ASCL specifications
- NIOMP to increase its production to the maximum extent possible without worrying itself about its offtake, producing both sinter quality fines that meet ASCL specifications and pellet quality fines meeting specifications of DSC to the extent possible for meeting the following demands:
- Total requirements of DSC
- Finding International market and export both sinter quality / pellet quality fines
- Using stockpile capacity of ASCL for storage of fines for their ultimate usage as and when ASCL is commissioned
- DSC to consider utilizing the available surplus capacity of

its various Divisions/Sections to the maximum possible extent to earn foreign exchange for meeting its requirement of super grade iron ore fines, graphite electrodes, refractories, spare parts for electric arc furnaces etc. through undertaking:

a) Export of pellets

b) Export of sponge / iron briquetts

c) Supply pellets to ASCL for use in its blast furnaces along with sinter as and when ASCL is commissioned as is done by most of the Japanese steel mills

- DSC may review / modify its contract, after the expiry of the existing contract, with the ore suppliers and enhance the quality of its iron ore imports with inclusions of bonus / penalty clauses over a specified basic grade of say 67.5% Fe.

0.10 <u>Follow up actions:</u> The urgent follow up actions, to be persued, include:

- drilling bore well for tapping ground water.
- Construction of overall drainage/check dam s/water reservoir.
- Procurement of dewatering, drying and coal washing equipment out of project funds.
- Persuing/speeding up construction activities.
- Fabrication of steel structures.
- Plantation of avenue trees, flower beds etc.
- Undertaking repairs/procurement of missing parts of equipment received prior to 1990.
- Obtaining extension of equipment warranty/performance

garantees from the suppliers.

- Ensuring flow of funds from FGN.
- Procurement of armoured cables, sheeting, switch gears, etc. out of funds released by FGN.

CHAPTER I

1.1 Objectives of the Assignment:-

The main objectives of the UNIDO project DP/NIR/87/031 is strengthening of the National Metallurgical Development Centre, Jos, (NMDC), so as to boost up industrial development of Nigeria. On the long run, this will lead to improved productivity in the industry as a whole, substitution of imports, and also better use of presently unexploited natural resources, besides exploitation of the rich mineral wealth of Nigeria on scientific lines.

1.2 Job description:

The services of the Expert were engaged to design and associate with the construction supervision, installation, commissioning and operation of the Mineral Beneficiation Pilot Plant (MBPP). The duties assigned by the UNIDO for the fourteen weeks duration assignment are listed below:-

1. Inspection of the equipment at site for arranging free replacement of damaged/missing items or compensation from the insurance company.
2. Technical scrutiny of bids for supply of sampling, laboratory and other equipment meant for the Centre and making appropriate recommendations.
3. Supervision of construction of the pilot plant as per the designs (including integration of coal washing line and also

of dewatering and drying facilities.)

4. Scrutiny of the structural drawings for achieving savings in the infrastructural costs on a continuous basis.
5. Assisting in the erection of the pilot plant equipment.
6. Commissioning the pilot plant, section wise, and as an integrated plant.
7. Assisting in assessment of testing charges to be realized from the prospective clients utilizing the pilot plant equipment facilities available at the Centre.
8. Rectifying operational defects and teething problems, if any.
9. Assisting NMDC personnel in preparing the techno-economics for adopting the process know-how developed after pilot plant testing.
10. Training the NMDC personnel in operation of the pilot plant with at least four different ores, utilizing each of the four available processing lines.
11. Assisting the Director/Chief Executive to publicize facilities/services available at the Centre.
12. Rendering technical advice/assisting the Director/Chief Executive on whatever matters/issues specifically sought by him.

1.3 <u>Assignments actually completed:</u>

As construction of the various buildings for housing the MBPP equipment and creation of infrastructural facilities are in progress, the installation, commissioning and operation of

MBPP could not possibly be taken up during the period of the current assignment. Further, the technical scrutiny of bids for supply of sampling, laboratory and other equipment was completed earlier and the recommendations were already submitted to the Centre/UNIDO in December 93, vide phase II Report of the Consultant. The following assignments were, however, handled/completed during the present three and half months mission.

1) Inspection of equipment at site.
2) Scrutiny of structural and electrical engineering drawings for achieving savings in infrastructural costs.
3) Supervision in construction of the Pilot Plant as per the designs.
4) Guide lines for preparation of Techno - economic Feasibility Report.
5) Assisting NMDC to publicise its facilities.
6) Suggestions for operating NMDC on commercial basis through collection of testing charges.
7) Participation in external technical meetings and offering technical advice to NMDC personnel.
8) Training Mineral Processing personnel connected with plant operation.
9) Carrying out physical stock verification and preparation of MBPP stock inventory.
10) Preparation of salient features of erection, operation and maintenance of MBPP equipment.

This report covers the above assignments carried out during the three and half months mission period from 20/12/93 to 3/4/94.

1.4 Extension of assignment beyond 04/04/94:

In anticipation of release of additional funds required for this project by the Federal Government of Nigeria (FGN), NMDC Management made formal request to UNIDO for extension of the services of this Consultant for an additional fifteen weeks from 04/04/94 for effective co-ordination and supervision of the ongoing construction of the MBPP infrastructures vide copy of NMDC letter dated 28/03/94 placed at Annex 1.

Based on the advice of Director/Chief Executive of NMDC, and anticipated approval of UNDP/UNIDO, the consultant is continuing his duties as UNIDO consultant at NMDC, Jos, Nigeria beyond April 4th, 1994.

CHAPTER II

INSPECTION OF EQUIPMENT AT SITE:

2.1 Equipment Receipt

All the MBPP equipment ordered by UNIDO, including the eight belt conveyors, costing a total amount of US$660,000 was received at site, intact, in about 80 crates/boxes.

2.2 Preliminary Inspection:

Due to non availability of all purchase orders at the Centre and packing lists, preliminary inspection of the equipment was carried out so far, on receipt of each equipment, by opening the crates just to confirm receipt of equipment in good condition without any damage and closing them immediately, after inspection.

2.3 List of Equipment and Spares to be supplied as per the accepted bid/purchase order:

Based on the scrutiny of the accepted bids of the equipment suppliers and corresponding purchase orders, the list of all the equipment including its accessories, as well as the list of the spares required to be received by NMDC was prepared as shown in Annex 2.

2.4 Physical verification of the MBPP Equipment received at site as per the available packing lists or purchase order:

All the crates were opened, and checked for presence of any damages to the equipment, and receipt of the equipment along with the

stipulated number of accessories to the equipment (like motor, starter, belts, rectifier, gear boxes, tools etc) and spares as per the packing list or purchase orders in the absence of packing list. The list of missing items/spares/shortages and damages, which are of minor nature, observed based on the scrutiny of accepted bids, purchase orders and packing lists is presented in Table I.

2.5 Communication with equipment suppliers:

Copies of the communications with the equipment suppliers, asking for free replacement of damages/missing items at no additional cost, are placed at Annex 3. These shall be followed up until the discrepancies are sorted out satisfactorily.

2.6 List of physical inventory of MBPP equipment accessories and spares as on 31/03/94:

For inventory control of the equipment and stores and undertaking periodical stock verification, the list of all the MBPP equipment, accessories and spares (along with part numbers, if available) adequate enough for two years, actually received/physically available as on 31.03 1994 including the Pilot Plant equipment procured earlier to May 1990 was prepared as shown in Annex IV.

2.7 Inspection of MBPP Equipment received from USA, UK, Europe and Australia in running condition:

All the MBPP equipment, excepting those which were inspected in running condition earlier, and those which would be installed,

commissioned and offered operational training by the equipment suppliers as per UNIDO purchase orders were tested in running condition for two hours and found to be in good working condition without any abnormal vibrations/sounds, over heating etc. However, as the slurry pumps should not be operated dry (i.e without slurry or water), only the motors ie. disconnecting the pumps were operated and found to be in order.

2.8 Salient Features of Equipment Manuals Pertaining to the erection, operation and maintenanace of various MBPP equipment

Due to the limited number of equipment manuals received and their non-availability readily as and when required, the salient features of the various equipment manuals are listed out as shown in Annex 5, for easy accessability to all those who are connected with the operation, lubrication and maintenance of the equipment. However, equipment manuals should positively be referred to before undertaking installation, commissioning and proper lubrication of the equipment for smoother and trouble-free operation and prevent/reduce breakdowns.

Table 1. List of Discrepancies between purchase orders/ packing notes/actual receipt of equipment.

				Observed discrepancy				
Purchase Order No.	Supplier	Equipment name	Qty	Name of part/ accessory/ spare part number	Quantity to be supplied as per purchase order	As per packing note	Actually received	Other Deficiencies, if any
15-2-0532k	B G R I M M China	Belt ore feeders		Insert plate-	-	Three	Two	-
		Thickener	1	Electric cables	-	Two	One	-
				Rake parts	-	Three	One	-
		Conditioners	2	Discharge valve	-	Two	Nil	-
		Flotation Cells	10	Impeller	-	One	Nil	-
				Shaft liners	-	One set	Nil	-
				Starters	-	Four	Nil	-
				Stators	-	Four	Nil	-
				Bearing	-	One	Nil	-
				Cover for joint	-	One	Nil	-
				Back up ring	-	One	Nil	-
				Starter	-	One	Nil	-
				Impellers (spare)	-	Two sets	Two pieces	-
		Water pumps	2	Shaft liners	-	Two sets	Nil	-

				Observed discrepancy				
Purchase Order No.	Supplier	Equipment name	Qty	Name of part/ aacessory/ spare part number	Quantity to be supplied as per purchase order	As per packing note	Actually received	Other Deficiencies, if any
15-20529k	KHD Humboldt Wedag, Germany	WHIMS	1	Rectifier unit	One	One	One	-
				Grease hand pump	-	One	Nil	-
				Wrench No. 4	-	One	Nil	-
				" No. 5	-	One	Nil	-
				" No. 6	-	One	Nil	-
				Double ring wrench 17-19	-	One	Nil	
15-3-0527k	STEEL-KAMET OY	BELT CONVEYORS.	8	BELT CONVEYOR 3B ASSEMBLY	-	1		Not located in Package No.
				SUPPORT BEAM	-	2		5
				SUPPORT	-	4		"
				SUPPORT	-	8		"
				GUIDE PLATE	-	4		"
				END PLATE	-	2		"
				BELT CONVEYOR ASSEMBLY	-	-	1	Located in package No. 5
				SUPPORTS	-	-	2	"
				SUPPORTS	-	-	2	Located in package No. 8
				SERVICE PLATFORM	-	-	2	Located in package No. 15

				Observed discrepancy				
Purchase Order No.	Supplier	Equipment name	Qty	Name of part/ aacessory/ spare part number	Quantity to be supplied as per purchase order	As per packing note	Actually received	Other Deficiencies if any
15-2-0530k	Mineral Deposites, Australia	Hydrocyclone Test rig.	1	ZG94A		Three	One	-
				ZJ94B		Two	Nil	-
				ZJ94C		Two	Nil	-
				ZJ94D		Two	Nil	-
15-2-5031k	Richard Mozley, UK.	Hydrocyclone Test rig.	2	C754		Two	Nil	-
				C779		Two	Nil	-
				C781		Two	Nil	-
				Set pin caps		Two	Nil	-
				Pin cap washers		Two	Nil	-
15-2-0697k	SAYAJI, India	Scrubber	1	Equipment frame		-	-	-
				Shell liners		Two	Nil	-
15-2-0531k	Eriez, USA	Vibrating feeders	2	Castors (for mobility of equipment)		Eight	Nil	-

KEY:

FB - FOUNDRY BUILDING
S - STORES
OSIFF & AB - OUTSIDE IN FRONT OF FOUNDRY & ANALYTICAL LAB.
OSIFFB - OUTSIDE IN FRONT OF FOUNDRY BUILDING
OSIFF & AL - OUTSIDE IN FRONT OF FOUNDRY & ANALYTICAL LABORATORY
OSIFAL - OUTSIDE IN FRONT OF ANALYTICAL LABORATORY

CHAPTER III

SAVINGS IN INFRASTRUCTURAL COSTS

3.1 NEED FOR REVISION OF STRUCTURAL DRAWINGS:-

a) In order to achieve savings in infrastructural costs, besides other measures, two separate first floors, built on steel columns and using steel plates for platform bases were clubbed together into a single RCC slab of lesser area of 14m. long and 12m. wide built on RCC columns. Incorporation of this modification, sought by NMDC for achieving savings, necessitated modifications in the structural designs of the Beneficiation plant.

b) The site, meant for locating the Beneficiation Plant, was found to quite uneven. Topo survey of the area revealed the sloping nature of the ground by about 2.5 meters from S.E to N.W direction and 1.38 meters from east to west direction. In order to limit the construction costs to the budgeted amount, and as no provision was made for any basement floor on the western side , it was decided to cut and fill the area to the natural ground level of 102.66 m. RL. and the ground floor level to 103.11 m. RL.

c) As a part of the construction activity, the trench, opened around the perimeter of the Beneficiation plant, revealed the following site conditions that may affect adversely the structural soundness of the building:

i) Presence of easily friable rocks without any hard rocks/ boulders

ii) Presence of filled up soil containing a lot of foreign materials like plastic covers, cloth rags, black soil with vegetation and plant roots upto a depth of about one meter on the Western side.

iii) Presence of moist soil at about 1.5 meters depth on North western side (in the month of February).

These adverse site conditions revealed the need for augmenting the foundation of the Beneficiation plant necessitating revision of the structural drawings. These revisions lead to escalation in building costs, rather than achieving savings.

3.2 Scrutiny of Revised Structural Drawings:

M/S Model Design and Development Co Ltd. (MDDC) the Structural Engineers have submitted afresh 23 structural drawings incorporating following modifications (specifically in 6 drawings) to take care of adverse site conditions:

1) Scrapping off the top 150mm soil.

2) Cutting and rejecting the soil on the eastern side substantially.

3) Increasing the depth of the column foundations from 1.25 meters to about 1.85 meters or till a hard bottom (offering a minimum of 200 kg/cm2 resistance to penetration)

is encountered so as to take care of the prevailing adverse soil conditions. This includes 0.05m blinding, 0.6m column bases, 0.55m hard core and 0.2m groundfloor beam.

4) Filling up the low lying areas with hard soil brought from outside to the required level.

5) Making the column bases sturdier by increasing the height of the column bases from 350mm to 600mm and increasing the number of column bases to 58 from 52.

6) Construction of a retaining wall along and adjacent to the western side of the beneficiation plant (B.P)

7) Achieving compaction of the entire area using a dozer/road roller etc.

The revised drawings were scrutinised and got modified for better effectiveness. These vital modifications are expected to increase the building costs, rather than achieving savings, for ensuring the structural soundness of the 16 meters high building.

3.3 Review of 14 Electrical Engineering Drawings:-

Based on the critical review of the fourteen electrical engineering drawings submitted by M/S Sitah Engineering Co, the Electrical Engineers, the following changes in the electrical controls are recommended primarily for better operational controls, safety of operating personnel besides marginal savings in infrastructural costs:

3.3.1. System Operation

a) Crushing plant including primary, secondary crushers, inclined belt conveyors, and the three reversible horizontal belt conveyors over the four bins shall be operated as an integrated unit to crush, convey, fill any one of the four bins at any given time.

b) All the four circuits of the Beneficiation Plant shall be operated either simultaneously or one/two/three lines at a time.

3.3.2. Sequential starting/stopping of the equipment should be available along with a Mimic Panel besides emergency stopping all the equipment from the central control panel. Provision is to be made by the side of each equipment for emergency stopping/starting also.

3.3.3. All motors, starters for the equipment have been received at site. Specifications of these electrical equipment, particularly with regard to voltage, insulation ratings, power ratings, etc are to be taken into consideration to device the suitable electrical control panel.

3.3.4. An energy meter is required on each of the four parallel processing circuits in the Beneficiation Plant, and ammeter to know the extent of drawal of current for the rod mill, ball mill, and 2 classifiers. Provision should be made

to regulate the equipment speed from the central control room (for belt feeders, vibrating feeders). It is desirable to know the incoming supply voltage. Provision for sounding alarm from the central control room before starting any equipment circuit is to be made.

3.3.5. One simple circuit diagram, understandable to any layman explaining the various built in features of the control circuit is required.

3.3.6. Albeit the above provisions understandably involving additional costs, every effort should be made to achieve the savings to the maximum extent possible without sacrificing the safety of the personnel/ equipment/building. For example, locating the transformer near the central control room on the NE side of the Beneficiation Plant may result with savings in armoured cable costs.

3.3.7. Lightening arrestor is to be provided.

3.3.8. Coal washing, Dewatering and drying sections shall be included instead of the Reduction roast section, which is deferred.

3.3.9. The power factor should be improved only if necessary/ required by NEPA.

3.3.10. In case of interruption in NEPA power supply, provision for a Generator hook-up (which shall be provided in due course) automatically to the extents indicated below is recommended.

a) Stand-by Generator for keeping critical equipment in operation during interruptions of NEPA supply @ 12.5% of connected load of 120 KVA = 15KVA

b) Alternate power source to long interruptions in NEPA supply for uninterrupted production of saleable products/meeting urgent commitments @ 80% of connected load of 120 KVA. = 100 KVA.

3.3.11. Plant lighting should be limited to 10% of the connected load.

3.3.12. Provision for industrial power out lets at alternate Grid intervals (i.e 8.25 Meters), and the normal 13 amp. Power outlets at every grid interval(4.125 meters) is to be made.

3.3.13. Adequate lighting should be provided taking into consideration the change in the building heights and inclusion of transparent sheets in the beneficiation plant. Anti-mosquito lamp is recommended in the plant for having a better working environment.

3.3.14. A 2" raw water supply line be provided all around the Beneficiation Plant with 2"x2"x1" T joints and plugs for tapping water when ever required. A drinking water fountain (cold water free from bacteria and suspended solids preferably passing through activated carbon and ultraviolet light) be provided in the process plant.

3.3.15 The following provisions are recommended to be incorporated in the proposed rooms in the Beneficiation plant and bathrooms located in it.

- Easily accessible fire hydrants.
- Small water tank over each bathroom.
- Shower facilities.
- Push-button type taps for preventing water wastage.
- Adequate drainage outlets for floor washings, sewerage
- Airconditoners in the offices of D/CE & AD(MBPP)
- Exhaust fans.
- Attached W.C. tc the Offices of Director and Assistant Director (MBPP) besides separate W.C. for Gents and Ladies (i.e. total four).
- Non slippery flooring.

3.4 <u>Clubbing three check dams and ground water reservoir with the proposed overall drainage plan:-</u>

M/S Model Design and Development Co Ltd. has submitted an overall drainage plan for the Centre involving the following alternatives:

Alternate I. Drainage constructed of Rcc: N900,000

Alternate II. Drainage constructed out of hollow bricks N300,000.

As the proposed drainages are meant for discharging storm water, the proposal of constructing the drainage system with either hollow bricks or granite blocks is recommended.

Further, to achieve savings in infrastructural costs, conserve water and prevent water pollution to the extent possible, it is proposed to use the same system for collection of water from the following sources into a ground water reservoir for recirculation after allowing it flow through three earthe n check dams for allowing the solids to settle down:

a) Storm water/rain water;

b) Turbid water over flowing from the six settling tanks of the beneficiation plant;

c) turbid water over flowing from drying pad;

d) over flow water from thickeners;

e) filtrate water from filters;

f) muncipal water supply.

The modified drainage plan including the three earthen check dams built out of hard boulders with the natural soil flooring containing shrub type plants and water reservoir shown in Fig. 1 is expected to lead to substantial savings over what it would have costed when the following four works are undertaken separately:

1) Overall drainage plan

2) Three check dams to prevent water pollution

3) Ground water reservoir for meeting water requirements of MBPP during dry seasons.

4) Water outlets from settling tanks and drying pad.

3.5 Drilling Bore well for providing water required by MBPP.

The MBPP requires a minimum quality of 4m3/hour water (i.e at least 1 litre per second water). As the pilot plant would be otherwise idle without water, it is absolutely necessary to undertake drilling one or two bore wells in the MBPP premises utilising the available rigs without delay.

CHAPTER IV

PROGRESS OF PILOT PLANT CONSTRUCTION ACTIVITIES

4.1 Scope of Consultant's Supervision

It comprises of effective coordination with and offer of advice and assistance to the local consultants during the construction of the MBPP infrastructures and includes the following:

a) Study the structural drawings prepared by the local consultants and offer advice on necessary modifications for better effectiveness and achieving savings in costs.

b) Independent supervision of the construction activities with a view to prevent/minimise the mistakes committed, intentionally or unintentionally, by the contractors and bringing critical observations and the lapses, if any, to the immediate notice of the NMDC officers/Structural Engineering Consultants/overall consultants for prevention/rectification. This is done despite the responsibility of the Structural Engineers (M.D.D.C) and overall Consultants, M/S Mahalli Development Consortium Ltd, (M.D.C.L) to supervise so as to ensure the structural soundness of the buildings.

c) Attending site meetings along with the NMDC officers, representatives of M.D.D.C and M.D.C.L. to review and ensure progress of work as per the agreed time schedules/design drawings and overcome hurdles, if any.

4.2 Progress of Construction Activities:

The status/progress of construction activities as on 03/04/94 are briefly indicated.

4.2.1 Status of the Primary Crusher Substructure executed by M/S Alhaji Abdul Gafaru Yusufu and Co:

The work was executed and completed by the contractor in a professional manner, in time, strictly as per the design drawings, using quality materials under qualified Supervision. The work has been duly approved by the overall consultants (MDCL), Structural Engineers (M.D.D.C.) and NMDC Management. Construction of the storm water drainage, adjacent to the primary crusher, entrusted to the contractor is nearing completion. Based on the good/quality work done by the contractor, construction of the superstructure of the primary crusher is also awarded by the Centre to the same contractor who completed the substructure. The work is expected to be taken up by the contractor soon after erection of steel works by the relevant experts. Contract for this aspect of work has just been awarded by NMDC Management.

4.2.2 Status of construction of secondary crusher substructure executed by M/S Pakis Industrial Company Ltd, Lagos:-

This work was completed by the contractor in a professional manner and in time, meeting the design specifications and approval of Consultants (both M.D.C.L. and M.D.D.C) and NMDC. Based on the good work done by the contractor so far,

construction of the superstructure of the secondary crusher is also awarded to the same contractor who completed the substructure. Like the Primary crusher super structure, work on secondary crusher super structure will also have to await completion of steel works by the same contractor who was awarded the fabrication work of structural steel.

4.2.3 Fencing the premises of MBPP by Infrafam Nigeria Ltd:

The contractor has completed about 85% work. For tightening the security, the scope of work had to be enhanced substantially by the NMDC Management due to the following:

a) Height of the fencing wall on the eastern side (Zaria Road) had to be increased from 3.0m to 3.5m to prevent possibility of scaling up the wall. Likewise, the height of the inside fencing wall had to be increased from 2.5m to 3.0m to take care of topographical undulations. Infact, even this increase in height of the fencing wall is not adequate enough specifically between the Administration Building and Beneficiation Plant and needs to be increased to 3.5m.

b) To leave more space for the infrastructural facilities of MBPP (like Ore Bins etc), the length of the compound wall had to be increased on the eastern side from 250m to about 260m.

c) The excavation work done for a small length of trench had to be redone for avoiding reduction of area for MBPP.

The contractor is yet to fix the barded wire over the entire length of the fencing wall, besides construction of about 10m length hollow brick wall, casting the Rcc pillars for gates and undertaking the touch-ups of the Rcc columns, where ever required.

4.2.4 Status of Construction of Substructure of Beneficiation plant executed by M/S Al-Makura (Nig.) Ltd, Abuja.

4.2.4.1 Reasons for Work Delay:-

The work, though in progress, is behind schedule, by about three months, due to the following:-

a) The contractor came for taking charge of the site/execution of the contract by about 5 weeks after award of the work.

b) Ignoring the site conditions mentioned in para 3.2, and the need for undertaking the cutting and filling the site using any earth moving machine (like Caterpillar), and without any planning, the contractor excavated the trench all around the site perimeter and dug around 28 out of 58 column bases within the site and kept the excavated black/soft soil by the side of trench/column pits etc. When the contractor was advised by the Structural Engineers (M.D.D.C) to use the machinery, instead of manually, for cutting and filling the site to 102.66RL, the contractor withdraw his personnel from the site for 7 weeks. The NMDC had to intervene by hiring the caterpillar, on behalf of the contractor, to start the cutting

and filling the site, and ordered the contractor to speed up the work.

4.2.4.2 <u>The Upto date Progress of Construction Work achieved by the Contractor is rather slow as shown in Table II</u>

The construction work is slowed down considerably after 22/3, despite the Centre providing adequate lighting to facilitate the contractor undertaking construction work in the nights, probably due to financial constraints on the part of the contractor or his preoccupation with other pressing jobs, or lack of supervisors. Whatever the reason(s) may be, NMDC Management had directed the Consultants to follow-up more effectively and come up with a revised completion programme at a much higher rate of work. A meeting of all involved (NMDC Project Team, Consultants and Contractor) has been scheduled on this urgent issue.

Table II: Beneficiation Plant Construction Progress:

S/No.	Item of Work	Actual Progress Achieved	% Work Completed
1.	No of column bases dug to the required depth.	48/58	83
2.	No of column bases dug to the required depth and cleared for blinding.	48/58	83
3.	No of column bases blinded	38/58	66
4.	No of column footings between column bases.	11/28	39
5.	No of Rcc Column bases cast	25/58	43
6.	No of Steel reinforcement baskets in position awaiting casting.	25/58	43
7.	No of steel reinforcement column bases awaiting casting	1/33	3
8.	No of wooden frames ready for reinforcement baskets	14/58	24
9.	No of steel reinforcement frames ready awaiting pit deepening.	3/32	9

4.2.4.3 Assessment of the quality of work by the Beneficiation plant contractor:

i) Planning is poor.

ii) Due to the presence of only three persons which does not include competent structural/Civil Engineer on behalf of the contractor hardly any attention is paid for inspection to ensure the quality of work.

iii) Though intentionally or ignorantly, mistakes are committed by the contractor's personnel. For example, five out of 58 column bases were cast using steel less than the design specifications emphasizing the need for very close supervision.

iv) Quality and progress of work is adversely affected due to lack of adequate material at site like Steel, Vibrator, Water, etc. as is evident from the honey comb structure of a few of the column bases, exposure of steel rods in the cast steel bases etc.

CHAPTER V

ACTIVITIES DEFERRED TO A LATER PERIOD

5.1 Assisting in Erection of the Pilot Plant Equipment:

As the construction of the pilot plant substructure is in progress, the erection of the equipment shall be taken up subsequently after completion of the pilot plant buildings.

5.2 Commissioning the Pilot Plant, Section wise and as an integrated plant:

This assignment shall be taken up subsequently after completion of the pilot plant buildings and erection of the equipment. However, most of the equipment was operated in running condition, as a part of equipment inspection, and found to be in order.

5.3 Rectification of Operational defects, and teething problems, if any, in MBPP:

This assignment shall be taken up subsequently after completion of the pilot plant buildings, erection and commissioning of the equipment.

5.4 Training the NMDC personnel in operation of the pilot plant with at least four different ores, utilizing each of the four available processing lines:-

This assignment shall be taken up subsequently after completion of the pilot plant buildings, erection and

commissioning of the equipment, and rectification of the operational defects/teething problems if any.

5.5 Preparatory Training, Connected with the Pilot Plant Operation

NMDC Personnel were trained suitably in undertaking the following preliminary tasks connected with the pilot plant operation.

1) Collection of dry samples from stockpiles, conveyors, and samples of pulp using pulp density scale.
2) Preparation of samples for chemical analysis.
3) Undertaking dry/wet size and chemical analysis of test products.
4) Undertaking determination of moisture content, density, bulk density, specific gravity, angle of repose of test products.
5) Carrying out grinding studies.
6) Interpretation of design/engineering drawings and checking design calculations.
7) Determination of weight percentage, element recoveries, and grade of different/end products.
8) Preparation of process flowsheets and material balance flowsheets and checking their correctness.
9) Estimation of water requirements.
10) Operating equipment in running condition for inspection purposes etc.

Chapter VI

Preparation of Technoeconomic Feasibility Report For Exploitation of Any Promising Ore Body:

6.1 Information Required for TEFR:

The Techno-Economic Feasibility Report (TEFR) can naturally be taken up only after evolving the optimum process flowsheet based on pilot plant testing of any given ore by alternate routes in the pilot plant under construction. Broadly speaking, the TEFR should contain information regarding the following aspects :

6.1.1 Geology:

1. Contour plan
2. Geological plan along with location of bore holes, adits, shallow and deep pits etc.
3. Ore body dimensions
4. Mineralogy
5. Ore reserves (proved, indicated, inferred , total)
6. Average grade of ore body
7. Ore to waste ratio
8. Bench wise grades and reserves
9. Slice plans along with ore reserves and grade
10. Quality control.
11. Mine planning

12. Sample drawal locations for pilot plant tests

6.1.2 Mining:

1. Life of the mine
2. Type of mining proposed
3. Development of the mine
4. Methods of winning ore and proposed plan for rejection of waste.
5. Selection of bench heights
6. Selection of mining equipment
7. Development of mine roads, waste dumps, ore benches etc.
8. Ore haulage to blending yard/crushing plant/processing plant.

6.1.3 Ore Testing:

(1) Mineralogical composition of ore body

(2) Liberation size of ore minerals from gangue

(3) Batch scale tests to evolve optimum processing route.

(4) Pilot plant testing

(5) Recommended optimum process flowsheet

(6) Evolving design parameters including the following:
   (a) Assured quality of the concentrate
   (b) Minimum weight % of the concentrate
   (c) Recovery % of the desired element.
   (d) Determination of design parameters like filtration & settling rates, bulk

density, angle of repose, work index, grindability. etc.

(7) Material and water balance flowsheets

(8) Estimation of water requirements.

6.1.4 Detailed Specifications of equipment required for processing including the capacity,no. of equipment required, names of possible suppliers, and approximate cost.

6.1.5 Location Process plant Facilities.

(a) Primary crusher

(b) Secondary crusher

(c) Stock piles

(d) Processing plant

(e) Concentrate storage

(f) Tailings disposal.

(g) Concentrate loading yard

6.1.6 Electrical Plant

(i) Total KVA requirements

(ii) Electrical controls

(iii) Selection of cables

(iv) Estimation of electrification and instrumentation costs.

6.1.7 Estimation of civil costs including water supply, drainage, Township, plant etc.

6.1.8 Estimation of capital costs.

6.1.9 Estimation of operational costs.

6.1.10 Market demand and prices.

6.1.11 Construction schedule/Barchart.

6.1.12 Manpower Requirements (a) During construction period
(b) During Production stage.

6.1.13 Profitability Analysis - sensitivity analysis- Return on capital.

6.2 <u>Information collected from TEFR of Itakpe Iron Ore Mine:</u>

The salient information, collected by the NMDC Team including the Project Manager (MBPP), two Mineral Processing Engineers besides the consultant, from the project report of the Itakpe Iron Ore Deposit of National Iron ore Mining Project (NIOMP) as prepared by M/S Sofra Mines, France is given in Annex 6 to serve as a guide for the future preparation of TEFR for other investigations.

Since NIOMP is supposed to meet the iron ore requirements of Delta Steel Company, the information collected by the NMDC Team from the visit of DSC plant is also included in the Annex 7.

Chapter VII

Publicizing The Facilities Of NMDC, Jos

7.1: Uniqueness of NMDC Facilities: The excellent testing facilities, created by the Federal Government of Nigeria (FGN) with the financial assistance from UNDP / UNIDO at NMDC , Jos along with the highly qualified personnel, who are trained abroad and exposed to the latest technological developments, are comparable to those available in any other Institution located in the Developing Nations. NMDC has the following unique facilities together at one place whereas these facilities are not available in any single Institution / under one roof any where else:

a) Coke Oven pilot plant
b) Mineral Beneficiation Pilot Plant (under construction)
c) Refractories Testing Facilities
d) Foundry Testing facilities
e) Metals testing facilities
f) Conventional and Instrumental Methods of Chemical Analysis
g) Investigation & Consultancy Services.

These unique facilities available at the Centre should meet, not only the requirements of Nigeria but all other African Nations. Unless and untill NMDC is overloaded with the

assignments and cannot cope up with the regional requirements of all the African Nations, no financial assistance may be provided by UNDP/UNIDO/ other UN Agencies for creating duplicate facilities elsewhere in Africa.

7.2 Utilisation of NMDC for achieving Regional Industrialization: Adequate publicity of the facilities available at the Centre should be given so as to make their best use by the following Institutions located both in Nigeria and elsewhere:

1) Delta Steel Company
2) Ajaokuta Steel Company Ltd
3) Steel Rolling Mills under FGN
4) Steel Rolling Mills in other African Countries.
5) Geological Survey of Nigeria
6). Geological, Geophysical, and Geochemical Agencies of Neighboring African countries.
7) Bureau of Mines
8) Exploration Agencies
9) Producers of metals and Metallurgical Industries
10) Exporters of ores/ minerals/ metals
11) Importers of ores, minerals, and coal
12) Design & Consultancy Organizations/Foreign Consultants.

7.3 Clearance of NMDC before Samples could get Tested Abroad: As a matter of policy, the FGN should not permit any Government Agency to get its ores / samples tested abroad, unless NMDC

clears the proposal by confirming the nonavailability of testing facilities with it, based on which alone, the required foreign exchange could be released by FGN for meeting the testing charges.

7.4. Publicity Material: To facilitate wider publicity of the facilities available at the Centre, a brief leaflet, shown as Annex 8 and entitled **"What NMDC can offer you"** can be distributed to all the official visitors of the Centre. This leaflet includes the services that can be offered, its salient achievements and its major clients.

A detailed brochure, shown as Annex 9, listing out, Department wise, the major equipment and facilities available, its track record, and services offered was prepared for distribution to all the organisations in Nigeria and else where.

7.5 Publicity Media

To start with, both the leaflet and the brochures were distributed to all the Delegates of the African Iron and Steel Association. It is desirable to follow it up by sending copies of the same to all the Mining, Geological and Metallurgical Institutions located in the African continent. Brief advertisements of the NMDC facilities can be issued for publication in the Technical Journals, Newspapers etc besides distributing them at the seminars connected with the Geological, Mining and Metallurgical Industries.

7.6 **Need for Getting International Recognition of the Centre.**

The Centre should aspire for getting recognition, as a Research Centre of Excellence in Africa, by successfully undertaking the various assignments entrusted to it in a professional manner and keep up to the time schedule and ensure the reliability of results. This needs hardwork, dedication, sincerity and keeping abreast of the latest technological developments by all the members of NMDC.

CHAPTER VIII

NMDC OPERATING ON COMMERCIAL BASIS (Testing Charges)

8.1 **Generation of revenue through collection of testing charges:** NMDC should take lead for achieving rapid industrialization of Nigeria through offering its services and knowhow to promote iron and steel as well as other metallurgical industries. Having created the basic infrastructure and equipped itself with the necessary machinery / equipment/ instruments/ trained Personnel at huge cost,NMDC should make its services / facilities available to all its users on payment basis so that it could sustain itself through generation of internal revenue by way of collection of testing charges.

8.2 Testing charges: Though it may take quite a few years (may be even a decade) before it becomes a profit making Centre on commercial lines, testing charges to be realised from its Customers, should be worked out on a realistic basis appropriate to the Centre or its Users adopting any of the following alternatives.

8.2.1. **Alternate 1:** Adhoc basis as proposed by the Divisional Head and approved by D/CE.

8.2.2. **Alternate II:** At approved rates of the FGN , as proposed by NMDC on lines similar to the rates of payment approved for

the Designers, Structural Engineers, Quantity Surveyors etc. (Method followed by The Indian Bureau of Mines ,Nagpur, India)

8.2.3. **Alternate III:** At prevailing market rates in Nigeria , as charged by DSC, ASCL,NIOMP, or other FGN Institutions ie at par with other Institutions in the Country.

8.2.4 **Alternate IV:** This should be worked out on "actuals" basis as suggested below:

(1) Consumables like chemicals, reagents, glassware, power, water, fuel/lubricants on actuals.

(2) Interest on capital cost of equipment required to be used at Banks interest rate (say 15% p.a.)

(3) Depreciation of equipment on straight line basis assuming the life as per the following norms:

i) Sophisticated instruments like XRF; XRD; DTA; A.A S; Spectrometers; Electron Microscope: Five years.

ii) Normal equipment/machinery: 10 years

iii) Pilot Plant Buildings/sheds: 15 years

iv) Permanent Buildings: 28 years.

(4) Salaries and Wages (including all types of benefits), of all those associated and for the total duration of period associated by them with work.

(5) Overhead charges @ 10% of the sum of the above (1) to (4) items to take care of the salaries/wages of project

Management, Administration, Finance, Engineering Services, Stores, Security, Transport, Hospital and all other non productive Departments.

(6) Contingencies/escalation in input costs/fluctuation in exchange rate/profit @ 10% on sum of (1) to (5) items.

The total testing charges to be realised would be the sum of items (1) to (6).

8.2.5 **Charges for attending external meeting etc:**

For participation of Technical Meetings called by other Agencies of FGN/or Consultancy Assignments/Site visits, Investigations etc, the services may be charged on a daily basis as shown below for guidance:

Category of NMDC Personnel	Range of Charges in Naira/Day
Members of NMDC Management	1500 - 2000
Officers/Engineers/Scientists	1000 - 1500
Supervisory Staff	500 - 750
Assistants	100 - 200

No work should be undertaken without prior receipt of advance payment equal to 50% of total estimated testing charges.

8.3 Revenue Earnings:- Each Department should scout for work and earn revenue for meeting at least 25% of its total expenditure (to start with, let it be one percent) including salaries/wages without

its dependance totally on the Centre/FGN. It is desirable to provide each Departmental Head with the information regarding the monthly/quarterly/half yearly expenditure incurred by the Department and its earnings. The object of this exercise is to make each Department of the Centre feel its responsibility to earn its revenue/salaries and wages and help NMDC becoming self sustaining and profit making unit.

8.4 Credit for Commercial-oriented research work:

The production of any saleable product by any Department like refractory bricks, enamel frits, saleable ore concentrates, etc should get credit for its produce at national/international market rate.

Similarly, for development work, or commercial/production oriented research work, or scientific breakthroughs which can be commercialised, or services offered, the concerned Department should get notional credit for revenue earnings commensurate to the value of work done by it..

8.5 Revenue Expenditure: The above ideas are presented as a basis for discussion so that system best suited to the Centre/Country, as it deems fit, is adopted by it for making it less dependent for funds for meeting revenue expenditure on FGN on a continuous basis.

8.6 Capital Expenditure: For meeting the Capital Expenditure, the Centre has to naturally depend on FGN for grant-in-aid.

8.7 Memorandum of Understanding (M.O.U.): To achieve NMDC operating on a commercial basis, on the pattern similar to other Research Institutions like Warren Springs Laboratory, UK;IRCID Laboratory, France; AMDEL, Australia; LKAB, Sweden; National Metallurgical Laboratory, Jamshedpur; Indian Bureau of Mines,Nagpur etc, it is desirable to expose the Management staff of NMDC to the latest management techniques for achieving/surpassing the targets set by themselves. It is desirable to consider feasibility of implementing the following suggestions, after modifications, if any:

8.7.1 Submission of monthly progress report, by each Divisional Head, listing out fresh jobs received, status/progress of the various ongoing assignments and earnings made during the previous month.

8.7.2 Submission of programme of work for the following month covering the same topic heads as in 8.7.1.

8.7.3 Critical review of the shortfall between what has been planned and actually achieved ,to be undertaken by the Director/Chief Executive at least once in two months.

8.7.4. Execution of Memorandum of Understanding (M.O.U) by each Divisional Head with the Director at the beginning of the year listing out targets set by the Divisional Head himself

including the jobs he proposes to get, the assignments he is going to complete and his Division's earnings as a percentage of his Department's revenue expenditure.

8.7.5 At the end of each quarter and end of the year, each Divisional Head has to submit a Performance Appraisal Report of his Department.(P.A.R.)

8.7.6 Critical review of the gaps between MOU and PAR of each Department is to be undertaken by the Director/ Chief Executive of NMDC to assess its performance with regard to achieving the targets set by itself and for taking remedial measures, if necessary..

CHAPTER IX

TECHNICAL ASSISTANCE THROUGH

Participation in Meetings connected with Boosting up Commercial Production of saleable Products

9.1 Background:- The existing processing plant of NIOMP at Itakpe produced around 100,000 tonnes of sinter quality iron ore fines containing less than 63% iron, meeting the specifications of Ajaokuta Steel Company, which is yet to be commissioned/not yet ready to accept iron ore fines produced by NIOMP (date of commissioning is not yet certain). As D.S.C. requires pellet quality fines containing over 67% iron, for direct reduction, after pelletization, in the vertical shaft furnaces by Midrex Process followed by smelting in the electric arc furnaces producing steel, D.S.C desires improving the quality of iron ore fines offered by NIOMP to the extent possible . For reasons of its own, NIOMP desires DSC lifting the available sinter quality fines as it is, with an assurance that it will improve its quality of fines in due course of time.

9.2: List of External Meetings Attended:

At the instance of Director / Chief Executive of NMDC, the following technical meetings listed in Table III were attended along with the members of NMDC, including Project Manager (MBPP) and other Officers of NMDC.

Table III

List of external technical meetings attended

Period of visit	Host Organization	Other Participants	Meeting objective
16.1.94 to 21.1.94	NIOMP	NMDC,Jos	How to improve available sinter quality iron ore fines for meeting specifications of DSC for use as pellet quality iron ore fines.
9.2.94 to 11.2.94	DSC	NIOMP; Koch; Sofra Mines; NMDC, Jos	To study test results obtained by DSC & suggest ways of using NIOMP iron ore concentrate by DSC for steel making.

9.2.1 **Tour Reports:**

The tour reports of the visits are presented in Annex 10 and 11 which are self explanatory.

9.3: **Technical feasibility of meeting ore specifications of DSC by NIOMP from Itakpe Mine:**

Based on his own personal experience, gained as the Project Head of an Exploration / Investigation Project of an iron ore deposit containing 3000 million tonnes of iron ore reserves (Bababudan Iron Ore Investigation of the National Mineral Development Corporation, Chickmagalur, Karnataka, India) as well as his knowledge and close association with development of the processing flowsheet for Kudremukh Iron Ore Company Ltd, Kudremukh, Karnataka, India, having 750 million tons of iron ore in a banded magnetite hematite quartzite deposit, the Consultant strongly believes that it should be possible to produce iron ore concentrate meeting specifications of DSC out of the existing processing plant of NIOMP, provided NIOMP is really committed for meeting specifications of D.S.C.

9.4: **Specific Measures to improve grade**:-

The following measures are recommended for consideration to achieve the desired grade.

(i) To enforce the quality control, during mining, so as to produce consistent quality of ore as per its D.P.R within acceptable range so as to maintain:-

a) Average grade of ROM : 36 ± 1% Fe

b) Hematite to magnetite : 60:40 or MAG Fe to total Fe ratio = 0.13

c) Soft ore to hard ore : 4:1

d) Removal of waste band before mining the intercalated ore

(ii) Ensure proper blending of the ore mined from different benches/pits for achieving homogenity in the existing blending yard prior to feeding it to processing plant.

(iii) As liberation of iron bearing minerals from the associated gangue is not taking place at -6 mesh size, grinding the ore to -28 mesh or finer using grinding balls in the existing autogenous mill. (i.e using the mill as semi autogenous grinding mill).

(iv) Using primary cyclones to reject -325 mesh/ -400 mesh gangue minerals and secondary cyclones to dewater the rougher spiral tailings before processing them through the available low intensity magnetic separators.

(v) The + 28 mesh fraction coming out of screens, cleaner spiral tails and cleaner non magnetic tails to be recirculated to semiautogenous mills for regrinding / achieving liberation.

(vi) Recirculation of reclaimer spiral tails to rougher spirals and reclaimer non magnetic tails to rougher magnetic separators to minimise mechanical carriage of gangue into concentrate.

(vii) Operating the plant in such a way as to achieve the highest possible grade concentrate even at the sacrifice of 1-2 percent iron recovery.

9.5 **Modified Process Flowsheet:-**

The process flowsheet incorporating the above modifications and presented in Annex 12, can definitely be carried out in the existing plant without addition of any equipment in one out of three lines.

9.6 **Material Balance Flowsheet:-**

Based on the available data from the existing plant of NIOMP, the material balance flowsheet, presented in Annex 13, is prepared as a basis for discussion.

NIOMP should try not only the above flowsheet but other alternate flowsheets recommended by its own Consultants/Engineers to evolve the best suitable for the existing plant for meeting the ore specifications of D.S.C.

9.7 **Other suggestions for generation of revenue/foreign exchange**

(i) Till A.S.C is in a position to accept the sinter quality iron ore fines produced out of Itakpe deposit, NIOMP should try to produce the maximum possible quantity from the two out of three existing lines (the third line being reserved for meeting the requirements of DSC) and export the ore fines to any of the Arab (Saudi Arabia,

Iran)/East European countries (Rumania) / Japan as is done by other iron ore producers of the world.(like India, Australia, Brazil.)

(ii) To make the best use of the available capacity of the pellet plant, DSC may consider accepting more quantity of pellet quality iron ore concentrate, meeting its own specifications/suitable for direct reduction, and export the pellets, after agglomerating the fines in its own pelletization plant having surplus capacity of 0.5 million tonnes/annum over its own present requirements. (like Chile, India etc.). This helps DSC earning foreign exchange for meeting, at least partially, cost of its own imports of high grade iron ore concentrate from Brazil etc. These pellets can also be utilised by A.S.P. along with sinter for smelting by Blast Furnace route as is done by Japan.

iii) Since DSC is hardly utilising 50% of its own installed capacity for undertaking direct reduction of iron ore pellets, DSC may also consider exporting the sponge iron, after pelletization and direct reduction of pellets out of iron ore concentrate, meeting specifications of DSC, produced by N.I.O.M.P. (like Indonesia).

iv) Since grinding the ROM at Itakpe definitely improves the grade of the Concentrate so as to meet the requirements of direct reduction and also saves considerable energy to DSC for grinding the same to pelletization size of about

60 % -325 mesh, DSC may offer a better / enhanced price to NIOMP commensurate to import cost of concentrate from abroad.

(v) DSC may consider improving the quality of the imported iron ore fines through offer of bonus/penalty for richer/poorer grade fines over a higher stipulated basic grade to the foreign suppliers of iron ore so that the super grade imported fines could be blended in suitable proportions with the Itakpe concentrate for use in DSC in the over all interests of Nigeria resulting with the utilization of the indigenous mineral wealth and achieving savings in foreign exchange, through reduction in quantity of iron ore fines imported.

(vi) DSC should consider Itakpe as its own captive mine and try to adjust its operating parameters to suit Itakpe iron ore.

Chapter X

FOLLOW UP ACTIONS

10.0 The following actions/jobs/works are recommended to be taken up at the earliest:

10.1. Construction Works:

10.1.1. - Drilling bore wells for tapping underground water.

10.1.2. - Construction of overall drainage along with Check dams and ground water reservoir.

10.1.3. - Approach road to MBPP for shifting of equipment and stores to the site.

10.1.4. - Fabrication of steel trusses/structures.

10.1.5. - Invitation of bids for construction of RCC foundation bases for installation of equipment.

10.1.6. - Taking required urgent measures for speeding up the construction activities.

10.2 Procurement Actions:

10.2.1. - Procurement of the following out of the Project Funds (UNDP/UNIDO):

10.2.1.1. Dewatering and drying equipment comprising of:

- Thickener
- Filter
- Dryer using effluent coke oven gases as a means of energy conservation.

10.2.1.2. Coal Washery Equipment including:

- Rinse screens

- Heavy Media Cyclone

10.2.1.3. Grinding Balls/Rods.

10.2.1.4. 15M long Belt Conveyor (surface conveyor).

10.2.2. Procurement of the following out of the funds of FGN;:

10.2.2.1. Procurement of steel sections, sheeting, chequered plates, seasoned wood for staircases etc.

10.2.2.2. Procurement of electrical armoured cables, switch gears etc.

10.2.2.3. Ordering electrical control panels/distribution boards.

10.2.2.4. To procure lubricants, oils, tools, testing instruments, etc.

10.3 Release of Funds: Steady release of funds by FGN has to be continued till the completion of MBPP buildings/its infrastructures/installation of equipment to take care of the following:

- Completion of the Pilot Plant as per the agreed time schedule between FGN and UNDP/UNIDO.
- Reducing cost escalation due to prevailing negative inflationary trends.
- Preventing damage of imported equipment due to rains.
- Preventing thefts/pilferages of component parts like motors/accessories, starters and belts.
- Preventing lapses of equipment warranty/performance gua rantee of the imported equipment from the suppliers.

10.4 Other Miscellaneous Jobs/Items:

10.4.1 Requesting UNIDO for obtaining extension of performance guarantees/equipment warranty from the equipment suppliers validated for 6 months more.

10.4.2. Giving advance information to the equipment suppliers about the likely date/period of installation of equipment to be undertaken by them as per UNIDO Purchase Orders.

10.4.3. Seeking additional power supply to the required extent of 300KVA, if not sanctioned so far.

10.4.4. Seeking diversion of overhead telephone lines.

10.4.5. Desirable to take up tree plantations and lawns during the present rainy season without delay.

10.4.6. Arranging to get the available equipment imported prior to the year 1992 against Project Funds (UNDP/UNIDO) repaired, if necessary, besides procuring the missing components/accessories like motors, starters etc.

10.4.7. Sub-delegating suitable administrative and financial powers to Project Head of MBPP/Management staff/Divisional Heads for NMDC becoming a Successful Commercial Organisation.

ACKNOWLEDGEMENTS:

I owe my sincere gratitude to the Federal Government of Nigeria, the United Nations Industrial Development Organization, and the United Nations Development Programme for associating me with their assistance to the National Metallurgical Development Centre, Jos, Nigeria.

I am grateful to Dr. J.V. KROUZEK, DR. C. Beinhoff & Mr. A. Dallalah of UNIDO, and Mr. A. Fre-Hiwet of UNDP for reposing their confidence in me to handle this assignment. I am indeed grateful to Dr. Usman M. Turaki, Director and Chief Executive of the NMDC for associating me with the construction of MBPP besides extending me help, guidance, and technical assistance.

I owe my sincere thanks to Mr. A.A. Odunaike, Project Manager (MPBB) for his valuable advice, help, and his colleagues for technical support. My sincere thanks are also due to Alhaji A.M . Tukur, Deputy Director, for his assistance.

I also acknowledge the unsolicited help received from Mr. J.D. Adebayo in preparation of drawings, typing, and inspection of equipment; Mr. Gargadi and his colleagues, and Miss Toyin Iseghohimen for their help in preparation of this Project Report and overall cooperation received from Mr. O.J. Nwosu, Engr. B.Y. Gbefwi, Mr. C.I.C. Nwankwo and Dr. G.G.O.O. Uwadiale of NMDC.

I received excellent cooperation, encouragement, and understanding from my wife, Mrs. G. Radhadevi, and Mr. N. Uday Sagar, Dr. (Mrs.) N. Sandhya Devi and Mr. N.V. Ramana leading to successful completion of this assignment.

ANNEX I

NMDC/ADM/102/2A/37 28th March, 1994

UNDP

Resident Representative,

11, Oyinkan Abayomi Drive,

P.O. Box 2975, Ikoyi - Lagos.

RE; AMMENDMENT OF MR. G.S. RAMAKRISHNARAO'S CONTRACT DP/NIR/87/031/.1-66/J13207

1. The telex message of 3rd March, 1994 from the Backstopping Officer on the above subject refers. Please be advised that there is an absolute need for another extension of Mr. Ramakrishnarao's contract.

2. The extension is informed by the fact that the construction work of the Mineral Beneficiation Pilot Plant (MBPP) is at the critical stage and the Federal Government of Nigeria is committed to funding the sub-project to completion. The Honourable Minister of Power and Steel personally reiterated this while on a visit to our Centre on Monday, 21st March, 1994. In fact, part of the funds for construction of the MBPP has actually been released.

3. We therefore, recommend that Mr. Ramakrishnarao's contract be extended by fifteen (15) weeks from 3rd April, 1994.

Thank you very much.

DR. USMAN M. TURAKI

DIRECTOR/CHIEF EXECUTIVE

cc: Dr. C. Beinhoff,

Metallurgical & Engineering Industries Branch

Industrial Sectors and Environment Division,

UNIDO - VIC,

P.O. Box 300,

A-1400 - Vienna,

AUSTRIA.

Please proceed with the necessary arrangements.

DR. USMAN M. TURAKI.

ANNEX : 2

NATIONAL METALLURGICAL DEVELOPMENT CENTRE, JOS, NIGERIA

MINERAL BENEFICIATION PILOT PLANT(MBPP)

LIST OF EQUIPMENT, ACCESSORIES & SPARES

TO BE SUPPLIED AGAINST UNDP/UNIDO INPUTS (PROJECT ACCOUNT).

S/No	EQUIPMENT WITH (SERIAL NO. & MODEL NO)	PURCHASE ORDER	DATE RECIEVED	QTY.	SUPPLIER	ACCESSORIES/SPARE PARTS	PRICE	LOCATION	LEDGER/ PAGE No
1	17. JONES WHIMS TYPE P.40 ;Cap:0.4 tph; 1 set of grooved plates 8R, 12 k,& 4R each; one rectifier unit of self ventilating design	15-2-0529K	OCT. '92	1	KHD HUMDOLDT WEDAG AG GERMANY	 - Complete rectifier unit. - Bearing assembly for upper and lower bearings. - Set of spares for rectifier unit consisting of: - Set of fuses - Thermal overcurrent relay. - Potentiometer lamp. - Installation & demonstration for one week Ocean freight Total Cost : US $ 115,361	DM 159,650 DM 16,000 DM 13,950 DM 1,900 DM 191,500	FB	
2	2B. JAW CRUSHER 1-3 tph 6 inch lumps; 12 "x 7" 5.5 KW motor,415/440 V;3 Ph,50 Hz;DOL starter MDL/JAQUES 12" X 7"	15-2-0530K	OCT. '92	1	MINERAL DEPOSIT AUSTRALIA	 - One tougle unit - Two sets of manganese steel jaw faces.	 US$ 20,000 US$ 1,500	FB	

3	10B. HYDROC YCLONE TEST RIG;MDL/AKW; CYCLONES	15-2-0530K	NOV. '92	1 3	MINERAL DEPOSIT, AUSTRALIA	- 25 Litre slurry sump - Mono Merlin pump type CAC12W-1R4 - Diaphragm protected pressure gauge - Sanders bypass/control valves - Galvanised and painted mild steel pipework - 440 volt 3 phase/5 cycle 6 pole (950RPM) direct coupled 2.2 KW drive motor. - Cyclone overflow receiver and outlet hose. - One 40mm hydrocyclone type RKW 810 configuration II as in appended literature. - One alternate 45mm hydrocyclone type KRS 98 configuration II for higher capacity operation. - One alternate overflow stopper (vortex finder) and 3 alternative underflow stoppers (spigots) for each of the two hydrocyclones. Additional three cyclones of 3/4", 1 1/2" and 3" size. freight Total	US$ 12,000 US$ 1,500 US $ 1,000 US $ 36,000	FB	

4	1B,1C VIBRATING FEEDER MODEL D58B with feeder , control & 6 cft hopper along with Firmex liners	15-2-0531K	NOV. '92	2	ERIEZ MAGNETICS PENNSYLVANIA, USA.	- With spares for feeder and hopper Quantity 1. - With 6 cubic foot mild steer hopper mounted in steel frame. -Packing, freight - Total	US$ 5,724 US$ 624 US$ 1,112 US $ 1380 US $ 8,840	FB	
5	1D-1G. HOPPER BELT ORE FEEDER 500x1,800 mm 500x4,000 mm 500x5,500 mm 500x9,500 mm roller dia: 400mm spacing of belt roller :1800 mm Speed:0.1;0.3;0.0.5 m/s.;cap:19 m3/hr;power:3 KW	15-2-0532K	10/5/93	1 1 1 1	B G R I M M, CHINA	- Additional spares - 4 V - belts - 8 idler pulleys.	US$ 4,700 US$ 5,210 US$ 5,465 US$ 6,145	OSIFF&AL	
6	9A,9B SPIRAL CLASSIFIER dia:300mm; length: 3,000mm speed: 10, 18 rpm;double pitch;circulating load:0.5-2 tph OF cap:0.5-1.5 tph; with manual lifting for shaft(seamless) OF cap:0.5-2 tph;	15-2-0532K	10/5/93	2	B G R I M M, CHINA		US$ 11,620.00	OSIFF&AL	

7	20B. THICKENER dia:1800 mm depth:1,800 mm cap:1.3-5.6 t/24 hr;1.1 Kw;with motor driven lifting device, overload alarm,motors for rotating & lifting spiral arm & steel tank	15-2-0532K	10/5/93	1	B G R I M M, CHINA		US$ 9,470.00	OSIFAL	
8	23B,23C. CONDITIONER size :750x1000mm vol:0.5 m3 Power: 1.5 KW with motor,stater & V belts	15-2-0532K	10/5/93	2	B G R I M M, CHINA		US$ 5,720.00	OSIFFB	
9	24B,24C. FLOTATION CELLS cell vol:0.13 m3 dia of impeller: 200mm;air suction:0.9-1 m3/m2,min;power: 2.2Kw;output:0.06-0.18 m/min	15-2-0532K	10/5/93	2	B G R I M M, CHINA		US$ 17,000.00	OSIFFB	
10	30A,30B. DRY REAGENT dia:170mm; speed:0.5, 0.8, 1.16 rpm;feed size:0.2 mm; power:0.25 KW	15-2-0532K	10/5/93	2	FEEDER, BGRIMM, CHINA	- Quantity 2	US$ 3,000.00	OSIFFB	
11	26A,26B. WATER PUMP type:IS 50-32-200 J;Discharge: 6.3 m3/hr;head:12.5m power: 1.5 KW	15-2-0532K	10/5/93	2	B G R I M M, CHINA	- Quantity 2 Total equipment cost (BGRIMM) -Ocean freight Total cif cost (BGRIMM)	US$ 1,800.00 US$ 70,130 US$ 4,500 US$ 74,630	OSIFFB	

12	4B,4C. J57L DOUBLE DECK SCREEN 24"x48" with motor,starter, 5sets of S.C panels, spray nozzles,water flow meter, feed chute, disc.chute	15-2-0698K	27/4/93	2	TATA-ROBINS FRASER LTD INDIA	(a) Screen accessories - V. Belt guard Quantity 2 - Spring pad Quantity 8 - Coil spring Quantity 24 - V Belt " 2 - Dol Starter " 2 (b) Water spraying arrangement - Pipe with flange and nozzle Qty. 6 - Bend pipe with valve " 2 - Valve wrench " 2 - Blind flange " 2 - U-bolt with nut and rubber pad " 8 - Nozzle " 2 - Flexible pipe with clips " 4 - Water flowmeter for 40 NB pipes" 2 (c) SPARES - Bearing closure " 1 - BRG closure gasket " 3 - Sleeve freed end " 2 - " fixed end " 2 - Springs " 8 -total equipment cost -freight	US$ 10,800 US$ 1,433 US$ 100.00 30.00 220.00 220.00 480.00 US$ 13,283 US$ 550 US$ 13,833	S	

13	8. ROTARY SCRUBBER with motor,starter, disch. chute,feed chute(both rubber lined), 500kg.cap. feed hopper & belt feeder 500x2000 mm;power 2 Hp,1440 rpm	15-2-0697K	27/4/93	1 1 1 1	SAYAJI IRON & ENG. CO. LTD INDIA	 b. 500kg capacity Feed hopper with 10mm thick resisting liner. c. Belt Feeder with drive arrangement (500 mmx 2000mm) for feeding scrubber. d. 25mm thick rubber lining wear resisting steel liner for feed chute. SPARES - Pins and Bushes for FC-5", FC-6" and FC-7" coupling Qty. 1 set each. - Thrust rollers " 2 - Support rollers " 4 - Drive pinion " 1 - Plummer blocks SN-509 with bearings No. 22209 + H.309 + 8/85.:5 sets - Locating rings Qty. 8 sets ??? - Taper roller bearings for thrust roller bearing No. 30209 Qty 4 set sets. - Plummer blocks SN-501 with bearings 22210 xK + 10/90:2 sets equipment & spares cost .- freight - Total CIF cost	a) US$ 21,033 b) 1,200 c) 2,000 600 US$ 24,833 US$ 567 US$ 25,400	FB	

14	21A,21B. SALA WET BALL MILLS TYPE SRR 1000 X 1500M Motor 11 KW,440v, 50 hz, 3 ph, with starter inc-luding contactor,therma l protection & fuses	15-20549 K	OCT. '92	2	SALA INTERNATIONAL AB SWEDEN	SPARES 2 SETS - Spout feeder Qty. 2 - Rubber sealing " 4 - Rubber sealing 50x70x8 " 1 - Rubber sealing 120x150x12 " 2 - Bearing 6309 " 1 " 6311 " 2 " 22211 " 1 " 6024 " 2 " 22218 " 4 - Sleere H 318 " 4 - Bearing NNF 5008 " 2 -Erection & Commissioning (14 days) - total FOB cost - ocean freight -CIF cost (US $ 166,170)	SEK 760,000 SEK 94,800 SEK 79,999 SEK 934,799 SEK 24,000 SEK 958,799	FB	
15	19. ELECTROSTATIC SEPARATOR MODEL HT 15,25,36) 111-15 Cap:125-200 Kg/hr Unit modified to run for 8 hours provided feed temp. less than 100 deg. C.	15-20539 K	OCT. '92	1	CARPCO INC. FLORIDA, USA	Spare parts for two years operation Qty. 1 set. Commisioning & training for 5 days	US $ 23,110 US $ 2,100 US$ 413 Us $ 2480 Us $ 897 Us $ 29,000	FB	

16	10A. MOZLEY HYDROCYCLONE TEST RIG, MODEL C700 with motor 240V/50/1 HZ Pump: 3.5 m3/hr at 3.5 bar;Pipe work: galvanised mild steel; saunders pinch type valves; diaphragm type pressure guage; C 1009 10 mm lab hydrocyclone C 155 1 inch lab hydrocyclone C124 2 " lab hydrocy-clone - all the cyclones complete with a range of outlets to allow variation of performance.	15-2-0503K		2 4 pce 4 pce 4 pce	RICHARDMOZLEY LTD CORNWALL, UK.	Additional spigots and votlex finders a) 10mm-spigot (body) 2mm, 1.5mm, 1mm. vortex finder 3.2mm, 2.6mm, 2mm. b) 1-inch spigot 3.2mm, 2.2mm, 1.5mm, vortex finder 7mm, 5.5mm, 3mm. c) 2-inch spigot, 9.4mm, 8mm, 6.4mm, vortex finder, 14mm, 4.5mm, 3.2mm, 11mm, 8ø - Mozley C155 1" laboratory hydrocyclone Qty. 2 pieces - Mozley C124 2" laboratory hydrocyclone Qty. 2 pieces. - Mozley C1009 10mm laboratory hydrocyclone Qty. 2 pieces. Spare parts for two years	£2,492.00 £21.00 x 3 £16.00 x 3 £15.00 x 3 £30.00 x 3 £ 9.00 x 5 £58.00 x 3 £480.00 £700.00 £350.00	FB	

						-FOB cost -Ocean freight -CIF cost of one complete set -CIF Cost of <u>two complete sets</u> (US $ 16,821)	£4641 £ 237 £ 4,878 £ 9,756 US$ 2,390 US$ 580	S	
17	35. CHAIN PULLEY BLOCK MODEL TRL 100	426K	9/6/93	1	BERTONI S.R.L BUILDING AND ROAD WORKS, ITALY.	-FOB cost -Air freight -CIF cost	US $ 2,970		
18.	29 Pulp density scale with 1 liter SS bucket	15-3-417K		2sets 2sets	Denver Process Equipment Ltd, Surrey, England	-FOB cost -Regd. parcel post CIF cost(US $ 225)	£ 150 £ 7.5 £ 157.5	FB	
19	36E1.36E2.Sala vertical slurry pumps, Type SPV 151-40 rubber lined wear parts; no requirement of seal water including V belt drive, motor 3KW/415V/50HZ/3 phase,Pump NOs: 200868,200867; wear parts quality: NR Cap: 3.5 M3/hr Total head:10M Pump speed:1524 rpm;Power consumption:1.2 KW (Water);Motor: 3KW/1430 rpm;415 V/50 HZ/IP:55 Motor sheave: 2 SPZ 140;Bushing: 1610 D 25; Pump sheave: 2 SPZ 132; Bushing: 1610 D 30; V belts: 2 SPZ 1080,service manuals :Six	15-3-422k			Trellex Allibsges HBH,Wein, Austria (Denver Sala)	Cost of two pumps Wear & spare parts for 2 pumps: 057394-M1 Inlet -3 pcs 057395-M1 Impeller - 3 pcs 057396- M1 Casing- 2 pcs 953120 - O ring 3 pcs 953314- V ring - 2 pcs 953908 - bearing -2 pcs 954116- lock washer- 2 pcs 954165- nut- 2 pcs 955848- V ring - 2 pcs 956327- bearing - 2 pcs 951111- Nut - 3 pcs 951127 - washer - 3 pcs Cost of spares FOB cost Freight cost CIF cost (US $ 14,202)	SEK 58,000 SEK 24,029 SEK 82,029 SEK 19,800 SEK 101,829		

20	3B Belt conveyor 40m x 400mm wide structural support walkway belt scraper steel plate hopper	5-3- 0527K	04/1 0/93	1pcc 1pce 1pce 1set 1set	KAMET-OY KALAJOKI, Finland		FIM 104,300 22,500. 36,100. 3,750	OSIFF&A B	
	3C Belt conveyor 60m x 400m wide structural supports walkway belt scrapper steel plate hopper			1pce 1pce 1set 1pce			3,500.- 133,600 31,200.	OSIFF&A B	
	3G,3I Reversible Horizontal Belt Conveyors Belt length 3m belt scrappers			2pcs 4set			49,900. 3,750. 3,500	OSIFAL	
	3E,3F,3H Reversible Horizontal Belt Conveyors Belt length 5m belt wide 400m belt srcappers			3pcs 6set			50,600.	OSIFAL	
	3D Reversible Horizontal Belt Conveyors Belt length 9m belt wide 400m belt srcappers			1pce 2set		Joki drum Motors : 2 pce	15,000. 95,000 22,500.	OSIFAL	
	Electric board with starters Safety switches			1set		Taildrum : 1pce Upperside rollers: 20pce Return rollers : 5pce	39,000. 7,500.	OSIFAL	
	Spare parts for two yrs			1set		Belt Scrapper blades : 3sets Emergency switches : 5pce Construction Planning Supervision/installation one filter for one month FOB Ocean freight CIF Cost in FIM CIF cost in US $ IUS $ = 5.1 FIM	11,700. 30,000. 85,500. 32,340. 781,240 85,000. 866,240 147,320		

KEY:
FB - FOUNDRY BUILDING
S - STORES
OSIFF&AB - OUTSIDE IN FRONT OF FOUNDRY & ANALYTICAL LAB.
OSIFFB - OUTSIDE IN FRONT OF FOUNDRY BUILDING
OSIFF&AL - OUTSIDE IN FRONT OF FOUNDRY & ANALYTICAL LABORATORY
OSIFAL - OUTSIDE IN FRONT OF ANALYTICAL LABORATORY

LOCATION CODE KEY

1st Letter Indicates name of plant	2nd letter Indicates Section	3rd Letter Indicates location in x axis	4th Letter Indicates Location in y axis	5th Letter Indicates location in Z axis (ie Floor level)
Primary Crusher: P		Grid 1 : 2 Grid 2 : 2 Grid 3 : 3	Grid A : A Grid B : B Grid C : C	Ground floor : G First floor : F Second floor : S
Secondary Crusher: S		Grid 1 : 1 Grid 2 : 2 Grid 3 : 3	Grid A : A Grid B : B Grid C : C	Ground floor : G First floor : F
Beneficiation Plant: B	Scrubber : S Flotation : F Magnetic Separation : M Gravity : G Electrostatic circuit : E Reduction - R Coal washing : C	Grid 1 : 1 Grid 2 : 2 Grid 3 : 3 Grid 4 : 4 Grid 5 : 5 Grid 6 : 6 Grid 7 : 7 Grid 8 : 8 Grid 9 : 9	Gird A : A Grid B : B Grid C : C Grid D : D Grid E : E Grid F : F Grid G : G	Ground floor : G 1st floor : F 2nd floor : S 3rd floor : T 4th floor : F 5th floor : 5

ANNEX 3

FAX

From: Jos

4/4/94

G.S. Ramakrishnarao,

UNIDO Consultant,

NMDC., P.M.B. 2116, Jos, Nigeria.

Fax: 0234 - 73 - 53266.

To:

Ms Rao Qilin, Rpt. Chief, Purchase Div.

BGRIMM, Beijing, CHINA. UNIDO, Vienna, Austria

Fax: 00861 - 832 - 1362 Fax: 0043-1-232156

Ref: Equipment Supplied to NMDC, Jos against UNIDO Purchase Order No.15 - 2- 0532K in 23 Crates during 1993

AAA. Dr. M.U.Turaki, Mr. A.A. Odunaike join me in conveying our greetings and best regards to you.

BBB. Happy to let you know that the Construction of the Mineral Beneficiation Pilot Plant has since been taken up and work is in progress.

CCC. As there was no external damage to the crates containing the equipment supllied by you, the crates were left in tact i.e not opened for security reasons till date for verification of the contents as per the packing notes. After undertaking physical verification of the equipment as per the packing notes now, the following very minor discrepancies were noticed.

Package No	Discrepancy			
	As per packing note		actual receipt	
	Item	Qty	Qty	Discrepancy
7/23	Insert plate	three	two	Missing one
15/23	Electric cables	two	one	one cable is not found
15/23	Rake parts	three	one	Remaining two are not available
16/23 and 17/23	Discharge valve	two	nil	Is it not a spare part?
20/23	Impeller	one	nil	Missing
	Shaft Liners (spare)	one set	nil	Is it a sparepart?
21/23	Starters (spare part)	four	nil	Not found
22/23	STATORS	four	nil	Not found in the Crates

	Joint	one	nil	"
	Bearing	one	nil	"
	Cover for Joint	one	nil	"
	Back-up Ring	one	nil	"
	Starter	one	nil	"
23/23	Impellors (spare)	two sets	two	Are they two sets or two pieces only?
	Starters (spare)	two sets	two	"
19/23	Shaft Liners	two sets	nil	Not found in the Crates

ANNEX 4

S/N	EQUIPMENT DESCRIPTION	QTY	S/N	MODEL/NO	STATUS (COND)	SOURCE	MANUFACTURER	YEAR OF MANUFACTURE	YEAR OF PURCHASE	PURCHASE ORDER NO	MANUAL	SPARE PARTS	COST	VERIFI-CATION	LEDGER NO
1	17. WHIMS Motor (1) V. Belt Starter/Switch (1) Infrared Bulbs (2) RECTIFIER (1) Electric Control Panel (1) Grooved Plates 5R (1 Set) Grooved Plates 12K (1 set) Grooved Plates 4R (1 set) Danger (High Voltage) (1) Lamp Holders (2) Thermal over current relay/Overload (3VA5/3UN 1) Potentiometer Lamp pilot light Bezel (2) WHIMS SPARES NTN Bearing 22218 BKF 1 - 91-04 SKF Half Circle Ring (FRB 5/140) 21312 EW Adopter for bearing Part No. 722516 Part No. 722518 FAG Cm 18 Fuse 2 A 500 V 25A - 500 V 16 A - 500 A 6A - 500 V V Belt SPZ x 1400 LW Installation & Demonstration Freight CIF Cost	1 1 1 1 1 1 1 2 2 4 4 1		P40	NEW	UNIDO	KHD HUMBOLDT WEDAG AG, GERMANY		Oct.'92	15-2-0529K (1992)	1+	--	153,650 16,000 13,950 1900 191,500		
2	28 12" x 7" Jaw Crusher with Motor (1), Starter (1), V. V. Belts (2. Product Receiver	1		127 ST	NEW	UNIDO	MDL/Jaques, Australia	Rs 84	October 1992	15-2-0530K (1992)	1			20,000	3/3

	TOGGLE UNIT (J J 12AB 481	1										Yes	1500		
	Moving Jaws 12AA 306 Fixed Jaws J12AA 307 Spanner J121	2 2 1										Yes			
	Freight												555		
													22.055		
3	10B: Hydrocyclone	1	Pump	RIG:MDL/RK W 810-II	NEW	UNIDO	Mineral Deposits, Australia		Nov. '92	15-2-0530K (1992)	Yes		12,000		
	TEST RIG, SUMP (1) with Motor (1), direct coupled to Slurry Sump MONOMERLIN PUMP (1), PRESSURE GAUGE (1), CONTROL VALVES (1), Pipe work, Cyclone overfloiw receiver, startor (1), Plastic sample buckets (10), Plastic sample receivers (5)			PUMP:CAB 12 G-TB4-K-1											
	Hydrocyclone 40mm RKW 810	1													
	Hydrocyclone 45mm KRS90														
	Component accessories Part ZJ 3 (a)	2 over-flow nozzles													
	Part 25 BC/ZH1 AB	1													
	Part No ZG (A)	2													
	Part No ZG 2	1													
	Part No ZE 91	1													
	Part No ZG 94B	3													
	Part No ZG 94A	1													
	Part No ZG 94C	3													
	Part No ZG 94A	2													
	Rubber Gasket	2													
	Bolts, nuts, washers	9													
	Vortex Finders	7													
	Accessories. Cyclone 3/4" size	1											500		
	Cyclone 1-1/2" size	1											50[illegible]		
	Cyclone 3" size	1											500		

4	Vibrating Feeder with Hopper (mounted in steel frame), Vibration control switch	2	MM09 938 MM09 939	D 58B	NEW	UNIDO	EREZ MAGNE-TICS, U.S.A.		Nov. '92	I5-2-0531K (1992)		5724 + 1112 = 6836			
	Spares: FIRMEX LINERS: For Feeder	11									Yes	624			
	For Hopper	4									Yes				
5	10 Hopper Belt Ore Feeder with Motor Starter, Belting V. Belt (4), Gear Box 500 x 1800 mm 500 x 4000 mm 500 x 5500 mm 500 x 9500 mm Starters (4) Belt Pulleys Triangle Belt A 2000 A 2184 A 1800 A 1600 Flat Idlers Troughing Idlers	 1 1 1 1 4 12 16 16 16 2	 1D 1E 1F 1G		 New New New New	UNIDO	BGRIMM, China	1992	10.5.93	I5-2-0532 K (1992)	yes 3+1 (Four	-	 US $ 4700 5210 5465 6145 Includ-ded		
6	9A, 9 B Spiral classifiers with motor, V belts, gear box, starter Support of classifiers (4) Bearing (for oil seal) Bearing (Decelarator) Special tool Motor Lower support Oil seals Drive pulley	2 4 2 1 1 2 4 2	-	-	New New	UNIDO	BGRIMM China	1992	10.5.93	I5-2-0532 K (1992)	yes 1+1	 yes yes yes yes yes yes yes	11,620 In-cluded		
7	1800dia x 1800 mm depth Thickener with motor for spiral rotation, motor driven lifting device, overload alarm, steel tank (ie 2 motors);Gear boxes (2 No) along with control panel (2 starters), electric cable, rake arm. **Spares**	1	-	TNZ-1.8	New	UNIDO	BGRIMM China	1992	10.5.93	I5-2-0532K (1992)	Yes One	-	US$ 9470 IN-cluded		

	Discharge valve and tubes for thickener Wrench Make parts * Two more parts to be located	1 1 1*													
8	750mmx1000mm ht conditioners with motors,starters, V Belts (2 each drain plug Impeller * To confirm fixation of discharge valve to the equipment.	2 2	-	-	New	UNIDO	BGRIMM China	1992	16.5.93	15-2-0532 E (1992)	Yes 1+1 Two	- Yes	US $ 5720 Inclu-ded		
9	0.11m³ Volume FLOTATION CELLS with Motors (5 Nos) Starters (5 Nos), V. Belts (3nos x 5) and Motors (2 nos) For FROTH REMOVAL Triangle V. Belts (2) Control Panel Reduction Gear Belt Guard Gear Box Motor Belt Pulley V. Belt Stator Belt Guard **Spare parts:** Impellers Stators	en 10 1 1+1 1 1 2set1 10?? 10??											yes	nil		
10	30A & 30B DRY REAGENT FEEDERS with Motor (1) Starter (1) and V. Belt (1) **ACCESSORIES:** Adjusting Ring (1) **SPARES:**	Two sets - -	-	-	New	UNIDO	BGRIMM, China	1992	10/5/93	15-2-0532E (1992)	Yes 1+1=Two)	1500x2 =3000			

11	WATER PUMP with Motor Anchor Bolts (4nos) **ACCESSORY:** Flange 1 each **SPARE PART:** Bearings 1 each Impeller	2	-	IS 50-32-2257	New	UNIDO	BGRIMM, China	1991	13.5.93	IS-2-3532K (1992)	Yes 1+1 Two	- Yes Yes	1200		
12	DOUBLE DECK VIBRATING SCREEN with motor (1), V. Belts (3), Starter (1), V. Belt Guard (1), Spring Pad (4). WOVEN WIRE SCREEN 30, 25, 18, 10 and 6mm. CLOTHS (2), COIL SPRINGS (12), Discharge Chute (1), FEED CHUTE (1) **ACCESSORIES:** Screen Panels (2) WATER FLOW METER (1) Spray Nozzle (1) Pipe with Flange & Nozzles (3) FLEXIBLE PIPE (2) V. Belt with nut & rubber pad (4) BEND PIPE with VALVE (1) BLIND FLANGE (1) VALVE WRENCH (1) MANUAL (1) Wovenwire Screen Cloth (1)	2 sets	.100 5181	TEF J 7L			TATA ROBINS-FRASER Ltd.. INDIA.	1993	27.4.93	IS-2-3069K 25 5.92	1+1 Two	5.490x2 = 10.830 1433			

13	Rotary Scrubber with discharge chute. feed chute. feed hopper. belt feeder; Motor (2 ;Starter (2); Belting (1) Gear boxes (2 Tronnel (1) Supports (2) Angle irons (8)	One set	-	-	New	UNIDO	Sayaji Iron & Eng.Co. India	1992	27.4.93	15-2-0697 E (1992)	222	-	US $ 21,0 33 3,000 1,20 0			
	Spares		1776													
	Pins & bushes for couplings (13)		22(5 NO)													
	Fc 5"												600			
	Fc 6"															
	Fc ""															
	Thrust rollers															
	Supprt rollers	1set														
	Drive pinion	1set														
	Plummer blocks	1set 2														
	SN 509 with Nachi bearings No.	4														
	611024 C (3 No);611025 C (5 No)	1														
	Locating rings	8 sets														
	Tapper roller bearings Nc															
	SKF No. 30209 for support rollers.															
	Plummer blocks SN-511 with bearings No.	5														
	NSK-22210 KE	8setse														
	Ball bearing sleeves	ts														
	Bolts & nuts															
	Adoter & withdrawal sockets	2 sets														
		3														
		one set														
		2														

I4	2I A, 2I B Sala wet ball mills Frame with rolls & motor (1) starter(1) V belts (12) Ball mill supports(2) Spout feeder (1) Discharge screen(1) Ball Mill shell (1) **Spare Parts:** Sprout feeder Rubber sealing Rubber sealing -50x70x8 Rubber sealing --120x150x12 Bearing 6309 Bearing 6311 Bearing 22211 Bearing 6024 Bearing 22218 Sleeve E 318 Bearing NNf 5008 Screen cloth V rope Erection & Commisioning Ocean freight CIF cost SEK CIF in US $	Two sets 4 4 1 2 1 2 1 2 4 4 2 6 24	-	SEK SALA	New	UNIDO	Sala International, Sweden		oct.92	15-2-0549 K (1992)	yes Four	-	SEK 380,000 x 2= 760000 94,500 79,999 24,000 958,799 166170		

15	Electrostatic Separator(Continu-ous type) SS Hopper & Support Stand(1) Product hopper (1) SS tray type chutes (3) 12" dia SS Roll (1); 18" dia. SS Roll (1); SS Plate type gates (3); Trays (3); DC Power /V belt A 85 (1) 4" x 8" SS Roll (1) Tranformer **Spare Parts** Drive belt motor / Roll Tachometer A 85 V belt Generator drive belt : Sp 3099 Heat lamp 250 W DC Electrode style 3239VWi Jumper cable style 3239 VWI Electrode wire Roll Brush Brush-Auto Transformer Panel Switch lamp SP 3104 (SPB 120) Fuse set Breather SS Pedal Vibratory drive unit Part SP 295513 Part Sp 3105 A Part SP 3106 A Commissioning & training Ocean freight CIF in US $	one 1 1 2 2 1 two recd 1 (10 ?) 2 1 3 1 2 1 **recd** 1 1 2 2	274-92	HT (15-25-36) III -15 R40 PNG	New	UNIDO	Carpco, Florida, USA	1992	Oct 92	15-2-0539 E (1992)	222	-	US$ 23, 110 + 2,100= 25,210 413 2480 397 29,000		

16	10A Mozley Hydrocyclone Test Rig Model C700 with Motor, Starter, Pump (1), V, Belt (1), Pressure Guage (1), Valves, Piping etc (1) Spigots Vorlex Finder **Accessories:** Cylindrical Tubes Nipples Plugs **Spares** C776-40 Gland Packing C754-R STATOR C779-40 Coupling Rod C781-40 SEAL RING C782-40 Coupling Rod Pins Set Pin Caps Pin Cap Washers V. Belts (2 per set) (BSL & Goodyear) Barrel Gasket Gland Gasket Box Spanners Ocean Freight CIF	2 SETS 24 17 10 11 4 2 sets 2 2 2sets 2sets 2sets 2sets 2sets 2 2 4	181 182	C700	New	UNIDO	RICHARD MOZLEY LTD, UK	1992	1993	15-2-0503K (1992)	Yes 2 (1+1)	2492x2 = 4984		10.00x2=20.00 27.20=54.40 45.00x2=90.00 6.80x2=13.60 7.20x2=14.40 27.2x2=54.40 13.6x2=27.20 8.8x2=17.60 4x2=8.00 4x2=8.00 474 9756	
17	Chain Pulley Block Freight CIF			TRL100	NEW	UNIDO	BERTONI S.R.L. BUILDING AND ROAD WORKS, ITALY	-	9/6/93	15-3-426K (1993) ???	-	-	2390 5202910		
18	29 PULP DENSITY SCALE WITH 1 Litre S.S. Bucket	1	-	-	New	UNIDO	DENVER PROCESS EQUIP-MENT LTD., ENGLAND	-	23/4/93	15-3-417K	Yes	-	150		
	Freight CIF												7.5 157.5		

19	36B1, 36B2 VERTICAL SLURRY PUMPS with Motor (1) Pumps (1) Starter (1), V. Belt (2), Belt Guard (1) **Spares:** 057394-MI-INLET 057395-MI IMPELLER 057396-MI Casing 953120-'O' Ring 953314-'r' Ring 95 3908-Bearing 954116-Lock Washer 954165-Nut 955348-V.Ring 956327-Bearing 951111-Nut 951127-Washer	2sets 2 2 3 3 2 2 2 2 2 2 2 2 2 3	SPV-181-40	NEW	UNIDO	DENVER SALA-TRELLE I ALLIBS GES. EBE, WEIN. AUSTRI A		1992	15-3-422E (1992)	six 727 three avai-lable	-	58,000 24,029			

Annex 5

Salient Features of Equipment Manuals

B500 SERIES BELT FEEDERS

Item	Unit	Specifications and Technical Performances
Belt width	mm	500
Distance between head and tail pulleys	mm	1800,4000,5,500, 9500
Type		Feeder with 1800mm distance can be moved as whole.The others are detachable
Belt speed & corresponding Dia.of driven pulley Dia of driving pulley	m/s	0.1; 0.3; 0.5 440 ; 148; 148 100 ; 100; 168
dia of driven pulley	mm	440 148 148
dia of driving pulley	mm	100 100 168
Feed Rate (without insert plate	m^3/h	0-19
Electric Model Motor Power Speed Power supply	 KW rpm	YU100L48 3.0 1430 415v,50H, 3-phase AC
Water pressure of the Sprayer	kg/cm^2	2
Overal Dimensions		Refer to drawing 1-3
Application. Nature of feed		ore, coal,building materials
Bulk density	T/m	0.5 - 2.5
Particle size	mm	minus 10
Working temperature	O	-10 + 40
Capacity of feed hopper	m^3	0.2

Means for adjustment of feed rate

(i) adjusting hopper outlet width

(ii) changing insert plates with different openings

(iii) changing belt speed

Installation, Test Runs and Operation:

1) (a) The feeders should be mounted on the base securly by bolts

(b) The detachable feeders with lengths of 4000,5500, 9500mm need to be assembled and the belt should be cold spliced after placing it in the position.

(c) The water pressure to the inlet antidust water sprays should not be less than 2 kg/cm^2

Commissioning

(a) A quick power on/off to ensure an abnormal noise

(b) No load operation for 1-2 hours

(c) Operation with load for 1-3 hours

3. Periodic Maintenance;-

a) Lubricate all bearings and time oil into the gear reducer periodically.

b) Strip and clean the pulley and idler bearings and change grease periodically.

c) Change the lubricant oil in gera reducer periodically

d) Repair or change worn out parts and the damaged conveying belt .

e) Eliminate the lateral misallignment of the belt without delay.

f) Check up the conveying belt joints and take immediate remedial steps to eliminate

WHIMS 17

Power: 5kw

Weight: 2700 kg (static load) No dynamic load

Motor RPM: 1410

Rotor Speed 3.71/min

Model N>. P.40kg (single rotor)

Cap. 500kg/Hr for continuous operation

50kg/hr for batch operation

In addition to metric load, no dynamic load.

- 1 meter gap all around

Desirable to instal with a mobile crane of 3.0+

Imput to rectifier = 2x380/440v-50/60

Max. Power = 1.6 kw

for magnet (DC supply)

AC supply to drive motor =

AC supply for drive

P = 2.2 kw 50/60 1-12

RPM = 1410 r/min

voltage = 380v 3 phase AC

Detail of Gear Unit: FLENDER CAVEX GEAR UNIT

Type: 160; Transmission 1 to 250

Oil filling : 7.5l

Oil quality : High duty transmission lubricant with a Kinematical viscosity at 40 C; DIN: 51550, from 612 t0 748mm^2/s

Grease quality for hollow shaft: Antifriction bearing lubricant, littium soaped (5x: SHELL ALVANIA GREASE R2)

Rotation direction of the rotor: Clockwise when viewed from top

Caution: Worm gearing: supplied in working order but without oil filling (oil is to be filled in before commissioning gearing case should be filled with transmission lubricant.

The entire casing of the upper bearing of the tubular shaft should be filled with grease.

Wash water requirement

For middlings : 50-100l/100 kg feed (solids)

for magnetics : 100 l/100 kg feed (solids)

Pressure of wash water = 3-4 bar

Success of magnetic washing depends on water pressure more than on water quantity. Magnetics wash water must be fresh water, Middlings wash water can be recycled water.

Maintance/Lubrication:

1) Maintenance intervals should not exceed 3 months under any conditions.

2) Both the main bearings should be grease with a hand pump at least once a weak. The grease issuing from the labyrinth appertures should be removed during the inspections.

3) The oil filling of the gearing should be checked on the oil level indicator and if necessary,renewed.

4) correct tensioning of the gearing 'V' belts should be checked

5) Grooved plates: Grooved plates should be controlled regularly regarding cleanliness and corrosion. Corroded grooved plates can falsify the metallurgical results. If P40 is not operated for long periods, wet the groove plates with anti corrosion fluid like kerosene. (Pour kerosene over the grooved plates) after thorough cleaning).

6) Rectifier:- It is equipped with thyristor set and as such, is not subject to mechanical wear, nevertheless,inspection is recommended

7) Dust and dirt should be removed from the control, cabinet, not by waterbut by dry hand cleaning or suction.

8) Water rinsing :- clean nozzles.

Exchange if necessary.

9) Repair & maintanance : P40 should be disconnected from the electrical power supply.

1. Applications: For separation of feebly magnetic minerals from the non magnetic minerals

   a) Making magnetic concentrate

   b) Removal of feebly magnetic minerals from non-magnetics like

clay, talc silica sand.

c) For pre concentration

d) Useful for batch/continuous; tab/pilot plant.

2. i) P40 : Proven highest efficiency

ii) Test results obtained from P.40 can be used for up scaling of large production units.

3. Installation

i) To be installed horizontally

ii) Must allow free product discharge during continuous tests.

iii) Free access around the machine=one meter

iv) The P40 works on a closed magnetic system. The magnetic field has one effect on steel mass of the supporting structures/ sorrounding structures

Caution: (v) Wrist watches should not be worn in the immediate vicinity of P 40.

4. Machine:

The P40 has two feed points. Alternately, one feed point can be used fro inlet of fresh feed and the second feed pour for cleaning the product of the first pass. (ie two pass operation). Better to coonnect a water meter and pressure gangue to the water feed line.

Desirable to use a vertical, monoblock or flexible tube pump

for feeding is the two feed points of P40.

Prior to slopping the P40 every day after the testing, run the P40 for atleast 3 minutes with water inflow to clean the flow way, especially the grooved plates.

5. Operation:

a) Do not change more than one parameter at the same time.

b) Recording & documentation of each test including machine and operation data is necessary for upscaling to production size Units.

c) During testing, density and feed rate should be checked regularly and held constant.

d) P 40 is sensitive to oversize grains and it is necessary to remove the oversize grains from the feed and coarse rust particles from the sample drum. Keep out the particles coarser than 1/4th the gap width of the grooved plates.

e) Rotor bearing temperature and gear temperature have to be checked regularly (to be maintained at less than 60 degrees C.)

f) All parts coming in contact with the feed flow should be inspected for wear and corrosion.

g) It is desirable to ensure uniform distribution of the pulp over all the open grooved plates/boxes

h) For feed sizes 100 to 1000 microns, use 8 R grooved plates.Use 12 R grooved plates for feeds finer than 100 micron sizes.

i) Correct sampling of the feed and the test products is required

for acieving optimum test results and evaluation of test data. Simultaneous testing of the feed and the products is required/ desirable.

Mono Merlin Pump

Specifications:

1. Body Material :
2. Pump design
3. Pump maximum capacity: M^3/Hr at 1450 Rev/min
4. No. of pump stages:
5. Drive arrangement:
6. Stator type including end cover
7. Mark No.
8. Stator materials
9. Rotating part materials:
   Rotor/shaft/coupling rod
10. Oblique symbol
11. Body size.

Pumps are normally arranged for anti clockwise rotation when viewed from the driven end which results in the branch nearer to the driven end being the suction (5.09)

Easy to maintain and rugged reliability.

i) As with other items of process plant, a pump which is in correctly installed, wrongly operated or poorly maintained will present a potential hazard includig the safety of personnel.

ii) Use a listing tackle for all compoenents weighing over 20kg

iii) Ensure the ccrrect alignment of the pump to its prime mover.

iv) Install the pump for direct on line starting.

PUMPS (Model 1S50 - 32 - 250J)

Model	Feed 'n' r/min	Flow rate Q		Head H m	Efficiency in %	Power (KW)		(NPSH)r	Bearing Type
		m^3/h	I/s			Shaf Rat-	Motor		
IS50-32-250 (J)	1450	6.3	1.74	20	32	1.07	1.5	2.0	307

Overall dimensions: 665 x 320 x 405

Inlet flange = 165 - 125mm

Outlet flange = 140 x 100mm

Pump requires primming. The direction of pump rotation is clockwise as viewed from the coupling. Suction life = 10m - NPSH = 10 - 2 = 8 meters. When the pump reaches its rated speed, open the gate valve on the discharge pipeline until the required operating condition is attained. The pump should not run for more than 3 minutes if the gate valve is closed. Never run the pump in dry condition.

Type: JS pumps are single stage, single suction centrifugal pumps with overhung impeller designed for delivering clean water without any solids (liquid temperature should be less than 80 degree centigrade.

The back cover is connected to the casing at back of impeller (called back pull out construction). The back pull out feature simplifies maintenance and reduces costs accordingly - pipelines as driver remain undisturbed during routine service and maintenance procedures.

INSTALLATION: There should be proper clearance between the coupling faces of the pump and the motor (maximum and minimum clearance should not exceed 0.3mm). The non alignment of the shaft axis should not exceed 0.1mm. Check whether the centre lines of the pump and the motor are properly in alignment. Adjust them with metal sheets if necessary.

OPERATING THE PUMP:

1. Frequently, notice whether the read number of the gauge, temperature of bearings, amount of leakage from the packing, increase of fluid temperature, vibration and moise are normal or not. If abnormal, stop the pump at once, and find out the cause of the fault, and solve the problems promptly.
2. The maximum temperature of the bearings should be less than 80 degrees centigrade and it should not exceed the room temperature by about 40 degree centigrade.
3. Under normal packing condition, the amount of leakage of water from the packing box should be less drop by drop.
4. **The pump should keep a proper oil level, not too high or too low.**
5. The clearance between the impeller and the wearing ring should be always within the permissible limit. Otherwise the wearing ring should be replaced because of the excessive wear due to great friction.

(6) Please earth all the equipment.

(7) Never run the pump in a dry condition even for a few revelation or the stator will immediately be damaged. Never run the pump against closed inlet or outlet valve.

(8) Care must be taken to protect all electrical equipment from water/pulp splashing.

(9) Be sure to provide drive guards in compliance with the statutory requirements

(10) To monitor the performance of the pump, install either a

vacuum and pressure gauge or a vacuum gauge only on the pump inlet branch and a pressure gauge filled to the outlet branch.

(11) A pressure relief valve be installed at the discharge of the Mono pump.

(12) To prevent the damage of the pump due to dry running, provide a recirculating bypass connecting the lower portion of the discharge side of the pump to the suction passage (good for 10 minutes lubrication of the stator).

(13) Gland packings are meant to permit a controlled leakage of the pump medium, not to stop it altogether so as to minimise friction and dissipates the heat caused by the friction.

A packed gland must leak and leakage should take place, commencing soon after the stuffling box is pressurised. The use of grease is not recommended for fitting the seals.

Starting: 1. Never run the pump in a dry condition even for a few revelation or the stator will immediately be damaged. Pumps must be filled with water before starting, **not** for priming purposes but to provide the necessary lubrication of the stator until the pump primes itself.

Periodic Checking of Bearings: Bearings and their housings should be cleaned and inspected regularly. After cleaning and inspection, the bearings should be packed to not more than one third full with shell ALVANIA R3 or its equivalent. The normal period for renewal

of bearing grease is six months. Correct maintenance schedule, be established by periodic inspection.

Grease Specification:

1. Use any one of the following recommended greases for bearing assemblies:

a) SHELL ALVANIA R3

b) B.P. ENERGREASE L53

c) MOBILEPLEX 48

d) TEXACO REGAL STARFAX PREMIUM 3

e) CAST TOL SPHEEROL AP 3

2. For coupling roads and universal joints - SHELL RETINAX AM

Note: No other grease should be used without consulting Monopumps Ltd., for ascertaining its suitability.

Maintenance Problems:

Fault	Cause	Remedies
1. Overheating of bearings	a) Lack of lubricant in bearings. b) Pump shaft and motor shaft not in alignment. c) bearing trouble.	a) Feed new lubricant. b) align pump shaft and motor shaft. c) Inspect/replace bearings.
2. Pump vibrates	a) Pump shaft and motor shaft not in alignment.	a) Align pump shaft and motor shaft. b) Replace motor shaft
3. Abnormal noise, no suction	a) Excessive delivery. b) Suction lift too high. c) leakage of air into suction part. d) Temperature of liquid delivered too high.	a) Throttle discharge valve to reduce delivery. b) Reduce height of Suction pipe. Tighten all pipe threads and gauges. c) Reduce the temperature of the liquid or suction lift.
4. No Suction, indicating hands of pressure gauge and vaccuum gauge oscilliating vigorously.	a) Insufficient water for primming the pump. b) Air leakage into pipes and gauge.	a) Reprime the pump. b) Check up leakage and tighten.

IMPORTANT INSTRUCTIONS FOR VIBRATING SCREENS:

1 **Storage:** Even when equipment is not installed/idle, grease at least once a month. Manually, turn the equipment to distribute the lubricant.

2 **Structure:** Keep 75mm clearance minimum between the moving live frame and stationary parts. Drive motor is to be located so that the drive belts are in horizontal position.

3 **Chutes/Hoppers:** See that the feed falls on the screen as gently as possible in the direction of flow.

(b) Try feeding close to the feed end

(c) Change the screen cloths only (woven wire screen cloths) after bringing the screen to horizontal position.

(d) Use a piece of rubber belting on top of screen cloth at the feed point.

4. **V. Belt Drive:** Locate the motor so that the line between the pulley centres in within the range of 30 degrees above or below horizontal :- horizontal is ideal.

5. **Inclination:** To obtain maximum efficiency at the required capacity, adjust the angle of inclination during operation of the screen so that the material travels over the deck at a rate of 20 meters/minute and the rotation of live frame should be against the flow of material (counter flow)

Bolted Connection:- (a) Modern principle of high tension bolting is employed to a large extent. So all bolt replacements should be done within HT Bolts and carburised washers only.

Shaft Seals:- As the shaft seals off, the vibrating equipment are not designed intentionally to regain grease, the bearings should be purged at regular intervals with new, clean grease (at least 14 grams grease each 8 hours).

LUBRICATION DETAILS:

Grease Lubricant: Recommended Types of Grease:

S/No.	Type/Designation of Grease	Uptomaximum Temperature Degree & Centigrtade
1.	SERVOGEM HTXX	150
2.	SERVOGEM EP 2	100
3.	SERVOREX L - 1	80
4.	SERVOGEM - 2	80
5.	LANTHEX EP 2	80
6.	SHELL DARINA EP 1	100
7.	SHELL RETINAX A	80
8.	LIM POPLEX 2	80

The quantity of grease to be lubricated depends on the size (bore measurement) of the bearings. The frequency of lubrication should be governed by the type of o peration including the amount of dust, dirt or moisture present, and operating schedule of the machine.

24 B,C **FLOTATION CELLS**

Item		unit	value
Inside Dimensions of cell	Length	mm	500
	Width	mm	500
	Height	mm	600
Weight of a cell		kg	270
Effective volume		m_3	0.13
Through put (pulp)		m_3/min	0.06 - 0.18
Main motor	Model	-	YU112M6A
	Power	kw	2.2
	RPM	r/min	940
Power supply		-	415V 50H_z 3 phase AC
Impeller	Diameter	mm	200
	RPM	r/min	579
	Peripheral V.	m/sec.	
Rate of air suction		m123/m_3.min.	0.8 - 1.0
Froth paddle unit	model		YU90S6A
	power	k.w	0.75
	power supply		415V/50 hZ/3PH. AC.

Name and specification of wearing parts.

Name	Standard	Specification
Roller bearing	GB297 - 84	7310
Sealing	FJ145 - 63	Seal 48
V belt.	A type	L = 1825 mm
Bearing for paddles.	SF 0.13 - 03000002	
	SF 0.13 - 03000006	
Impellers	SF 0.13 - 04000015	
Stator	SF 0.13 - 04000014	

Important instructions for flotation cells

I **Preparation work before start:**

1. The holes of the lower part of central tube, which is not connect with few pipe or middling pipe, must be plugged with corks.
2. The rotating direction of main shaft is clock wish

II Peration:

Start flotation cells and drive unit of froth paddles before the entry of pulp.

III Maintenace:

Grease is to be infected into the bearings of the main shaft and froth paddles and engine oil is injected into the gear reducer of the drive unit of froth paddles.

The impeller and stator are main wear parts of the cells and (2 - 3 years service life) have to be replaced when in rate of air suction is too low to meet the need of flotation.

SINGLE SPIRAL CLASSIFIER

Item		Unit	Specifications
Diameter of Spiral		mm	300
Nominal Length of spiral		mm	3000
RPM of spiral		r/min	11.2, 16.6
Capacity	Overflow Rate	t/h	0.5 - 1.5
	Underflow Rate	t/h	0.5 - 2.0
Overflow size		mm	0.15 - 0.30 (48-100 mesh)
Tilt Angle of Tank			14^{0} - 18^{0}
Electric motor	Model		YU90L6A
	Power Supply		415V 50Hz three phase AC
	Power output	kw	1.1
	RPM	r/min	910
Worm Reducer	Model		WSJ-12-11
	Velocity Ratio		40
Lifting Device	Type		Manual
	Velocity Ratio		30
Overall Dimensions (LxWxH)		mm	3950x755x935
Non - load Weight		kg	668

IMPORTANT INSTRUCTION

I. **Installation:**

(1) Indination of the classified should be 14^{0} and the apiral speed should be 11.2r/min for 100 mean separation.

(2) Feed opening should be gas cut.

II **Test Run:**

(a) 2 - 4 hours no load test run should be carried out to ensure smooth operation, without collision rubbing, extra heat, and abnormal noise.

(b) Lifting device should run smoothly.

(c) Discharge value should open and close easily.

III **SPIRAL STOPAGE DUE TO OVER LOAD DURING OPERATIONS:-**

(1) Lift the spiral and cut off the power supply.

(2) For a long time shut down, drain the pulp from the tank.

IV **LUBRICATION:-**

(1) Ca - grease (GB492-65) and va-grease (GB191-65) are recommended.

(2) Check the lubricant oil level in reducer every shift. Of oil is not enough, it should be refilled. The lubricant oil should be replaced every six months.

V **MAINTENANCE:**

Check the linear and seal of the lower supporter regularly and repair the broken parts timely.

CONDITIONER(23A & 23B)

Main Dimensions and technical specifications 750X1000m

Item		Unit	Dimensions & Specifications
Inside diameter of tank		mm	750
Depth of Tank		mm	1000
Pulp Density(maximum)		%	lesinan 45
Motor	Model		YU90L4A
	Power	Kw	1.5
	RPM	r/min	1400
	Power Supply		415V,50Hz,-3 phase AC
	Outer Dimensions	mm	940X900X1540
	Weight	Kg	230

IMPORTANT INSTRUCTION

Start up:

(1) Move the triangle belt transmission mechanism by hand to confirm its smooth rotation.

(2) Run the equipment with no load for one hour, ensuring correct rotation of in peller to confirm its smooth operation without any unusual noise) and the rise in temperature is less than 35^0C.

(3) Run the equipment with load for 2 hours.

(4)Then the equipment is ready for opeartion.

Maintenance:

(1) Apply sodium base grease to lubr cate all bearings.

(2) Look over condition of the impeller and shaft as well as condition of other parts.

BALL MILL DETAILS 21A,21B

Type of discharge = Overflow

Inside shell disc = 1000mm

Length of shell = 1500mm

Operating speed = 34.8rpm

% of critical = 78%

Mill power corresponding to Bond = 9.3 Kw

Net weight including dining = 2.440 Ton

Heaviest part of Assembly = 1.100 Ton

Motor : SQ-Cage 11Kw, 1450 rpm 380V, 50Hz, IP 54.

Ball charge (Not included) = 37% volume

= 1450 kg.(Approx.)

Total mill weight including charge = 4750 kg.

C700 HYDROCYCLONE TEST RIG

Motor: 1.5 Kw

Weight: 100 kg or 950 kg

DRY REAGENT FEEDER

Item		Unit	Specification
Feed Disk Diameter		mm	170
Feed Size		mm	0-2
Feed Rate		kg/h	0-10
Feed Disc Speed		r/min	0.5,0.8,1.18
Decelerator	Model		sg 68
	Ratio		1:1369
Motor	Model		YC8014
	Power Supply		230V, 50Hz, AC single phase
	Power	W	180
	RPM	r/min	1400
Overall Dimensions		mm	575x472x750
Weight		kg	60

Application: For uniform and stable feeding various dry, fine particles or powders.

Means for adjustment of feed rate between 0-10Kg/Hr:

(a) Changing the position of the triangle belts to vary the speed to 0.5, 0.8 and 1.16 r/min.

(b) Changing the gap between the adjusting ring and the feed disc.

Maintenance:

The superior gear lubricating oil in the Sg 68 decelerator should be changed/replaced every half a year.

SALIENT FEATURES OF EQUIPMENT MANUALS

THICKENER

Item			Unit	Value
Model				TX2-1.8
Type				Centrally driven with electric rake-lifting
Inside Tank Diameter			mm	1800
Tank Depth			mm	1800
Rake Speed			min/r	2
Lifted Height of Rake			mm	200
Settling Area			m^2	2.55
Capacity (Solid)			t/d	1.3-5.6
Host Driving mechanism	Motor	Model		YU90L6A
		Power	Kw	1.1
		RPM	r/min	910
	Reducer	Model		WxJ120-31-11
		Reduction Ratio		31
	Reduction Ratio of special Worm Reducer			40
Lifting mechnism		Model		YU9056A
	Motor	Power	kw	0.75
		RPM	r/min	930
	Reduction Ratio of Special Worm Reducer			50
Overall Dimensions			mm	200x1960x3430
Total Weight			Kg	1300

ANNEX: 6

DESIGN FEATURES OF ITAKPE IRON ORE DEPOSIT OF NIOMP AS PER TEFR/DPR:

I. **GEOLOGY:**

1. **Reserves:**

Proved ore: 93.2 M.T = 25.2 am

Inferred ore 11.1 M.T = 3.0 cu.m

104.3 M.T = 28.2 cu.m.

2. Classification of Ore types:-

Ore Type	Tonnage (MT)	Overall %	Variation with Depth
Coarse + Mediumn Ore =	81.4	87	91.6 - 78.8
Fine Grain Ore =	11.8	13	8.4 - 21.2
Total =	93.2	100	

3. Bulk Density:

Ore in sit u = 3.7 Tonnes/cu.m

Waste in sit u = 2.8 Tonnes/cu.m

4. Nature of Occurance:

Ore is found in fairly thin seams

5. Average Grade of Deposit = 36% Fe

Grade of waste for rejection = less than 28% Fe

6. Mineralogical Composition o f Iron Bearing Minerals

% Hematite : 60%

% Magnetite : 40%

7. Chemical Composition of R.O.M.

II MINE

1) Planned excavation of Ore = 5MT/Year.

2) ∴ Mine life = $\frac{90\ MT}{5\ MT/year}$ = **18 years**

Deposit peak height = 400 M

Extent of ore reserves between 400m to 150 m depth= 90 MT or 18 years mine life.

Extent of ore reserves between 400m to 125 m depth= 105 MT = 21 years mine life.

Ore extends up to T5M depth level.

3) Nature of mining: Open pit

Bench height = 10 meters for first five years.

= 12.5 meters after five years.

4) General guidelines:-

a) Waste should be mined sufficiently in advance of the ore i.e overburden should be removed ahead of ore excavation.

b) As the process plant is designed to accept up to 12% by volume contamination of waste with ore, contamination of ore with waste should be avoided to the extent possible.

c) Optimum quality of extraction is to be endured through working in different benches for obtaining different grain sizes and different grades.

Mine workings: East pit and West pit.

Mine design: To work 275 days / year;2 shifts/day or 550 shifts/year 6.5 hours/ shift.

∴ No. of hours of mine working = 550x6.0 = 3300 hours/year

∴ Quantity of ROM to be mined/hour = $\frac{5.46 \text{ MT/year}}{3300 \text{ hours /year.}}$ = 1654 tons/hour

Processing Plant.

1) Crushing Plant: To work 275 days/year; 2 shifts /day = 550 shifts /day 6.0 hours/shift = 3300 hours/year.

∴ Average capacity of crushing plant

$$\frac{546{,}000}{330} = 1654 \text{ tons/hour}$$

% Design cushion = 2%

Peak capacity of crushing plant = 1654x1.2=2000 tons/hour

max. product size = 0-200 mm.(98% - 200 mm).

Bulk density of ore= 2.3 Tons/cu.m.

2) Blending yard: -2 weeks production for blending(i.e. 273,000 tones) for evening out irregularities in the characteristics is the incoming ore where as mine planning is done to supply ore of different properties present in the ore body.

Reclamation stock pit has 2 weeks production (i.e. 273,000 tones) for feeding uniform quality ore to Beneficiation Plant.

3) Processing Plant

To work 22 hours/day (3 shifts/day)

300days/year

= 300x22 = 6600 hours/year.

Average R.O.M. to be treated = $\frac{5.46 \text{ MT/year}}{6600 \text{ hrs/year}}$ =827 tph

Rated capacity = 827TPH+11 % design = tph

No. of lines : Three

∴ capacity of each line = $\frac{909}{3}$ = 303 TPh/line

4) Concentrate production capacity:-

wt % of concetrate = 41% of R.O.M.

= 0.41x909=342 tph(avg)

= 342x110 % design = 377tph(max)

∴ quantity of concentrate production/year 342x6600 =2260125epy

wt % tails with 5% moisture tails production = 59% of ROM

= 0.59x909 = 567tph(average)

= 567x110% desigbn = 619 tph(max.)

% moisture in the find concentrate production/year = 2257200x2,260,125 tpy.

5) Tailings Dam Design:

Tailings and disposal = 536 TPHx6600 Ha)year = 3,537,600TPY

= 590x6600 = 3,894,000 TPY(max.)

% Moisture in dewatered(filtered) tailings = 5%

∴ Density of tailings = 2.11

∴ Quantity of wet tailings to be handled ≠ stored = 4,099,000 TPY

6) Design capacity of loading station = 377 TPH=Loading capacity =1500-2000 TPH

Loading track = One for concentrate(Two on emergency)

average quantity of dry concetrate produced in a year= 909x0.41x6600 = 2,459,754 TPY

Average quantity of wet concentrate containing 5% moisture produced in a year =2,459,754 ÷ 95 = 2,589,000 TPY

7) Water Requirements: 7 million cum/year Fresh water consumption = 7/5.46=1.28m^3/ton ROM

Specifications & Quality of DRI Produced out of Itakpe super concentrate processed & supplied by NMDC, Jos to D.S.C.

Parameter	Other details	DSC/Middress Specifications	Itakpe concentrate
A) Chemical Properties of iron ore concentrate(pell el fine quality)			
% Fe			
% SiO_2 +%Al_2O_3	-	66-67	67.4
% CaO	-	2.7-3.5	2.45
% MgO	-	0.1	0.17
% S	-	0.1	0.03
% P	-	0.04 max	0.001
%LOI	-	0.05 max	0.04
	-	1.2 max	0.24
B) Size	-45microns	30.0 max	1.0
% moisture	-	10.0 max	0.17
Specific surface area of feed	cm^2/g	-	2033

C) Oxide pellet Quality			
%Fe	-	66-67	66.7
%SiO_2+%Al_2O_3	-	2.7-3.5	2.45
%CaO	-	1.6	1.65
%MgO	-	0.04-0.1	0.05
%S	-	0.03-0.055	0.001 max
%P	-	0.03-0.04	0.03
Basicity	$\frac{CaO+MgO}{SiO_2+Al_2O_3}$	0.6 min	0.75
D) Physical properties of pellets.			
Compression strenght	N/P	2000 Min	5000
% Pellet size	6.3-19 mm	93	97
% Tumbler Index	6.3-19 mm	93-97	95%
% Abrasion Index	-1 mm	5 max	3.5
% Porosity	-	20.0	21.0
Firing temperature	Degrees(C)	1300	1200

Parameter	Other details	DSC/Middress specification	Itakpe super concentrate
E) Linder Test Results	(Gaseous Reduction Disintegration Test Results)		
(i) Reduction Temperature	Degrees C	760-850	780
(ii) Chemical properties			
%Fe	-	90	90.5
%Degree of metallization	-	88-94	85.0
%C	-	1.1-2.0	1.89
%S		0.042	0.003
%P	-	0.042	0.04
(iii) Physical properties			
Compression strength	N/P	1000	1700
% grain size	-3 mm	6% max	3.1%

F) Reduction Test in shaft Furnace Reduction Temperature			
ii) Chemical Properties	Degree C	760-850	800
%Fe			
%Deg. Met.	-	90	92
%C	-	88-94	96
%S	-	1.1-2.0	1.27
%P	-	0.042	0.003
	-	0.042	0.04
iii) Physical Properties			
Compression Strength			
	N/P	1000	2766
%grain size(-3 mm)		6	4.5

ANNEX 7

BASIC DATA COLLECTED FROM D.S.C

1. Ore Storage & Handling:

   Iron ore stock yard = 900,000 tons

   No. of piles in stock yard = Three (Two for ore & one for pellets

2. Peller Plant

   Capacity = 1.5 MTPY

   Moisture content in pellet feed after drying = 1% max.

   Feed size = 0.045mm = -325 mesh

   Binder Used: Hydrated lime and water.

   Agglomeration Equipment: Pelletising disc

   Induration Temperature = 1300°c

   Size of oxide pellets produced = 5-25mm

3. Direct Reduction Plant:

   Process : Middrex

   Reductant : Natural Gas

   Flow : Counter current (Fed from i[illegible] of shaft furnace counter current to [illegible]ow of oxide pellets from the top.

   No of Modules : Two (Middrex)

   Capacity of each module = 510,000 TPY

Total Capacity = 1.02 MTPY

Advantage: Abundant availability of otherwise flared natural gas.

Degree of mettalization = 93%

Size range = 10 - 15mm

Method adopted for preventing reoxidation: Stored in large storage bins and protected with inert atmosphere of nitrogen or seal gas.

Plant requirement of natural gas: 75,000 Nm³/Hr.

Note: DRI is an alternative material to ferrous scrap in electric arc furnace steelmaking. The lower impurity content and homogenity of the material ensures faster melting time and higher quality steel than that produced from scrap alone. DSC produces both DRI and cold briquetted iron in excess of its internal requirement.

4. ELECTRIC ARC FURNACES:

Power supply to Arc furnaces: 33KV

Raw materials: Reduced sponge 80% with

Steel scrap 20%

Feeding system: Scrap is melted first before feeding DRI through vibrofeeder.

Average density of steel + 7.5 tons/cu.m

Equipment capacity = 4nos x 110T capacity/tapping

Number of furnace = four

Total capacity = 1.00 MTPY

capacity of continuous casting mill = 0.96 MTPY

Lime Plant:

Equipment: 70 meters long rotary kiln.

Capacity: = 66,000 tons/year burnt lime.

Uses of burnt lime: = 1) Used as a binder in the pelletisation plant.

2) Used as deslagging agent in steelmaking.

Overall power requirement: = 230 million watts/year

Nature of supply: = 330 KV supply.

Lime Products:

Element	Burnt lime	Hydrated Lime
Cao	92 Min	71%
$Ca(oH)_2$	-	93.8%
Mgo	1.5 Max.	0.5
SiO_2	1.7 Max.	1.0
Al_2O_3	1.2 Max	1.5
H_2O	1.5% (Moisture)	22%
Reactivity	350ml/4NHCL/10mm	
Lol	0.5 - 1.5%	26%
Bulk density	$0.85t/m^3$	$0.5t/m^3$
Color	off white	off white
Grain size	70 - 80% < 1mm	92.5%< 45microns

Product Characteristics

	DRI Steel %	Cold Bonded Iron %
A) chemical Properties Fe	88	78min
Fe (Metallic)	85min	-
FeO	11.7	-
Degree of Metallization	93.0min	89min
C Carbon	1.5 + 0.3	3.5max
S	0.01	0.004 max
P	0.06	0.07
SiO_2	4.0 max	3.5 max
MgO	0.06 max	0.03 max
Al_2O_3	0.8 max	0.7 max
CaO	2.5 max	3.5 max
B) Physical Properties		
Bulk Density	1.7 tons/m^3	2.1 tons/m^3
Compression Strength	500-1400 (N/pellet)	2500 N/briquette
C) Size	92% > 6mm	97.8% > 10mn

COMPARISON OF QUALITY OF IRON ORE FINES IMPORTED BY DSC WITH ITAKPE CONCENTRATE

	FEIJAO	CVRD	LAMCO	ITAKPE
% Fe_2O_3	95.41	95.72	95.64	91.1*
% Fe	66.66	67.02	66.88	63.77+
% SiO_2	2.36	2.62	2.49	8.13+
% Al_2O_3	0.80	0.40	0.35	0.62+
% CaO	0.038	0.37	0.46	0.17=
% MgO	0.034	0.031	0.03	0.03=

* Calculated from % Fe
+ Calculated from Size analysis, date provided by NIOMP/Sotra mines (BGRIMM Analysis)
= Date of Itakpe Super concentrate produced by NMDC.

RESULTS OF SIZE AND CHEMICAL ANALYSIS OF ITAKPE CONCENTRATE REPORTED BY M/S SOFRA MINES (BGRIMM)

Size (mm)	Vol-%	ASSAY PERCENT			
		% Fe	% SiO_2	% Al_2O_3	% P
+ 1.0	4.2	64.8	4.85	0.83	n.a.
-1+0.63	9.1	67.6	3.35	0.75	0.02
-0.63+0.315	26.1	67.3	4.7	0.6	0.04
-0.315+0.16	36.6	60.7	11.45	0.55	n.a.
-0.16+0.08	18.5	61.7	10.95	0.70	n.a.
-0.08	5.5	67.3	3.25	0.62	n.a.
Total	100	63.77	8.13	0.62	n.a.

* n.a Not Available

SPECIFICATIONS OF IRON ORE ORES FOR DIRECT REDUCTION IRON PROCESS (DRI.)

PARAMETER	DETAILS	MIDDREX PROCESS	COREX PROCESS
1. Chemistry % Fe	-	67.0min	60 - 67
% SiO_2 + % Al_2O_3	-	2.0max	7.0 max
% P	-	0.02max	0.02 max
% S	-	0.015max	0.015 max
% Ca	-	0.01max	0.01 max
% TiO_2	-	0.15max	0.5 max
% SiO_2	-	1.0max	5.0 max
% Moisture	-	2.0max	2.0 max
Basicity	$\frac{CaO + MgO}{SiO_2+Al_2O_3}$	0.5-0.8	Minor relevance
2. Physical Properties			
9 - 16mm	-	90.0 min	90 min
-6 + 3mm	-	4.0 max	4 max
Compression Strength	kg	250 min	150 min
% Tumbler Index	% +6.3mm % -1.0mm	94 3.0	95 5
% Porosity	-	20 - 30	20 - 30
Bulk Density		2000 min	2000approx
Linder Test Results: Reduction Temperature	Degree C	750	750
% Metallization	-	92.0 min	90.0 min
% Sulphur Liberation	-	30.0 max	Not relevant
Wt %	- 3.3mm	3.0 max	3.0 max
Compression	Kg	50 min	50 min
Static Bed Reduction: Reduction Temperature	Degrees 'C'	815	815
% Tumbler index	% + 6.3mm	90 min	90 min
Clustering Tendency		zero	Not Desirable

ANNEX 8

Publicity Leaflet

What NMDC, Jos can offer you/AISA:

1) *Laboratory scale and continuous Pilot Plant scale Mineral Beneficiation investigations.*

2) *Mineralogical studies*

3) *Characterisation studies on coal and coke.*

4) *Produce coke on a pilot scale, from coal blends.*

5) *Assess suitability of available clays/ores for production of refractory bricks, ceramics, potteries, etc.*

6) *Offers knowhow to produce good foundry castings.*

7) *Offers knowhow for commmercial exploitation of enamel frits and wire drawing lubricant.*

8) *Evolving optimum process know-how/flowsheet/expertise for utilization of available ores/clays.*

9) *Undertaking technoeconomic feasibility studies.*

10) Can assist you in undertaking design and engineering for setting up commercial plants.

11) Can assist you in preparing equipment specifications, selection and inspection of equipment.

12) Troubleshooting jobs in iron & steel industries and offer consultancy services.

13) Offer training facilities.

14) Agglomeration studies.

15) Chemical and instrumental methods of analysis for ores, metals, and steel sections.

16) Assists in undertaking failure analysis of industrial components.

17) Mechanical testing of metals.

18) Microstructural investigations/analysis.

19) Can assist you to adopt pollution control measures.

20) Technical services on heat treatment.

OUR SALIENT ACHIEVEMENTS

(1) Characterization of all known iron ore deposits of Nigeria based on its beneficiation characteristics.

(2) Development of process know how for iron ore super concentrate production from Itakpe iron ore for meeting stringent specification of Delta Steel Project via direct reduction route.

(3) Production of iron ore sinter.

(4) Availability of data bank and know how for production of refractories out of available clay deposits.

(5) Production of coke out of foreign coal.

(6) Establishment of optimum blend for utilization of indigineously available poor coking coals with imported coals for production of metallurgical coke meeting specification of Ajaokuta Steel Plant.

(7) Results of studies with available foundry sands useful for production of castings.

(8) Development and production of dry powder wire drawing lubricant.

(9) Production of Enamel Frits.

(10) Development of expertise/knowhow and offer of consultancy services by foreign trained personnel of NMDC.

OUR MAJOR CLIENTS

(1) Peugeot Automobile Nigeria Ltd., Kaduna.

(2) Ningi Mining Company Ltd., Jos.

(3) Jakura Marbles Ltd.

(4) Ajaokuta Steel Plant, Ajaokuta.

(5) Delta Steel Plant, Warri.

(6) National Iron Ore Mining Project.

Please Contact:

Director/Chief Executive

Or

Project Manager

M.B.P.P.

National Metallurgical Development Centre,

PMB 2116, Jos, Plateau State, Nigeria.

Phone: 0234-73-53264, 53271, 53763

Fax No: 010 234 73 53266

ANNEX 9

Publicity Brochure

The National Metallurgical Development Centre
Jos, Nigeria
Federal Ministry of Power & Steel
Welcomes
Distinguished Guests & Delegates of AISA

To make use of its

1 (i) Excellent facilities created by FGN with assistance from UNDP/UNIDO.

(ii) Expertise to test and undertake technoeconomic feasibility studies.

(iii) Personnel, trained abroad, to assist you in solving production oriented problems in iron and steel industry.

(iv) Consultancy services.

2. BENEFITS

(a) Saves foreign exchange, and time in getting your samples tested over here rather than in USA/Europe etc.

(b) You can be associated with during testing just to be sure of the reliability of results.

(c) Builds up your own confidence for commercialising the proven process.

(d) Enhances your own expertise.

(e) As members of AISA, the available facilities in Africa

can be used to mutual advantage without duplicating them at huge costs.

The facilities available at NMDC, Jos, are briefly outlined and can be utilised on a No profit - No loss basis.

Motto: Advancement through Technology.

MINERALS LABORATORY

A) Equipped to undertake.

a) petrological studies
b) Ore microscopic studies
c) liberation studies
d) beneficiation studies on a batch scale
e) determination of work index, grindability studies, settling and filtration rates and other design parameters.

B) **Major equipment:**

i) Petrological, ore and stereo microscopes
ii) Crushing & grinding equipment
iii) Sizing, classification and sub-sieve sizing equipment
iv) Flotation, Jigs, tables, magnetic separators etc.
v) Hydro sizing, thickening and filtration equipment.
vi) Agglomeration equipment. (Sintering & Pelletising disc.,
vii) Sample preparation.

C) **Significant Achievements:**

i) Tested indigenously available low grade iron ores by various processing techniques and characterization of iron ore deposits.
ii) Processing low grade iron ore from Itakpe for meeting stringent ore specification of DSC for direct reduction route.
iii) Flotation studies to upgrade available Nigerian coals.
iv) Oil agglomeration studies with fine grained iron ores and coals.
v) Mineral Beneficiation of other nonferrous/nonmetallic ores.
vi) Agglomeration of iron ore by sintering.

MINERAL BENEFICIATION PILOT PLANT

(under construction)

1. **Equipped to:**
   a) Process any low grade ore required by the iron and steel industry at 250 Kg/Hr (with provision to increase it to 500 Kg/Hr) on a continuous scale.
   b) Produce adequate quantities of concentrate for assessing its market acceptability.
   c) Evolve optimum processing flowsheet and assess the technoeconomics for its commercial exploitation.
   d) To determine design parameters based on which commercial plant could be designed/set up.
   e) Capable of offering training facilities

2. **Suitable for processing low grade ores of**
   i) Iron ores
   ii) Limestone, dolomite
   iii) Magnesite
   iv) Sulphide ores of copper, lead, Zinc
   v) Coal (proposed to be added)
   vi) Ilmenite garnet, zircon, rutile, monazite, casseterite etc.
   vii) Manganese, chromite etc.

3 MAJOR SECTIONS/EQUIPMENT	CAPACITY/Kg/Hr
Crushing & Screening (Primary, secondary)	1000
Classification/cycloning	500
Grinding, Classification, Flotation	500
Jigging, Tabling, Spiral Concentration	250
Magnetic Separation	250
Electro Static Separation	250

4 POSSIBLE AREAS OF COOPERATION

(i) Assist iron ore miners to produce either the sinter quality or Pellet quality iron ore fines required by iron and steel producers.

(ii) Assist small mining entrepreneurs to improve recovery of their values.

(iii) Assist steel producers to meet their ore requirements for achieving industrial growth.

COKE OVEN PILOT PLANT

1) To undertake characterization studies on Coal and Coke samples.

2) To produce Coke on a pilot scale, from coal blends.

3) To establish the optimum blend for mixing indigenously available poor coking coals with imported coking coals for producing metallurgical coke acceptable to steel industry.

4) To assess suitability of a given coal/coke for steel making.

Major Equipment:

1) Coke Oven Pilot Plant

- 250kg capacity pilot coke oven
- Coal/coke screening facility
- Mixer preheater
- Impact crusher
- Briquetting machine
- Stamp charge facility.

2) Coke testing facilities for:

a) Micum Drum Test (Mechanical M_{40} and Abrasive M_{10} values)

b) Shatter test

c) Coke reactivity test

d) Post reaction strength test.

3) To analyse coal samples for:

- Proximate analysis
- Coking and caking capacities (free swelling index, Gray-King Coke Type, Dilatometric and Plastometric properties.
- Macerals counting and Reflectance of vitrinite determination.

REFRACTORIES LABORATORY DIVISION

Services offered:-

(1) Testing/undertaking characterization studies of indiginously available deposits of clay, limestone, dolomite, magnesite etc. to assess their suitability for refractories production.

(2) To produce refractory bricks, on pilot scale, with suitable materials for assessing their acceptability by the end users, say iron and steel producers.

(3) Testing/evaluation of limestone for lime production;

(4) Offering consultancy services for production of Ceramics, refractory bricks, Potteries etc.

MAJOR EQUIPMENT AVAILABLE AT THE CENTRE

(1) D.T.A. for determination of mineralogical composition of refractory materials.

(2) 100 Ton Hydraulic press to facilitate production of refractory bricks.

(3) High temperature furnace (1700°C).

Metallography Laboratory

Services offered:

(1) To undertake metallographic analysis

(2) To certify the quality of various steel/metal products and castings.

(3) To undertake metal failure analysis and offer advice regarding quality control of micro structures.

Major equipment/Facilities

a) Polishing and grinding equipment

b) Optical microscope

FOUNDRIES

The offered services include:

(a) Moulding sand technology

(b) Development of foundry process

(c) Core process development

(d) Preparation of small casting

(e) Under taking feasibility studies

Major equipment available

(1) Sand testing equipment

(2) Universal testing machine

(3) Wet tensile strength testing apparatus

(4) Arkon gas determinator

(5) Manual strength testing machine

(6) Impact tester

(7) Graphite melting crucible furnace.

(8) Induction furnace.

(9) Shell mould apparatus.

(10) Optical pyrometer.

(11) Sand mixer, & other accessories.

SCIENTIFIC SERVICES

Services offered:

(1) Environmental pollution monitoring and control (Air, Water/Effluent and land) including solid waste management monitoring and disposal.

(2) Chemical analysis by classical method of ores/rock samples.

(3) Instrumental analysis of ores, ferrous and non ferrous cast materials.

Major equipments available:

(1) Atomic absorption spectrophotometer.(AAS)

(2) X - ray fluorescence Equipment (XRF)

(3) X - ray Diffractometer (XRD)

(4) Flame photometer.

(5) Colcrimeters:- Spectrophotometers

(6) Carbon/Sulphur Analyser.

(7) Electron Microscope.

Design & Engineering:

1) Can assist small entrepreneurs in undertaking design and engineering.

2) Preventive maintenance

3) Breakdown maintenance

4) Construction supervision

Data Processing

1) Electronic data processing.

2) Can assist you in preparation of your

   a) Payrolls

   b) Stores inventory and control

   c) Preparation of your projects reports/log sheets

   d) Computer training

Scientific Library

1) Sharing our Scientific books and Journals

2) Literature survey

3) Availability of reprints of technical articles published after 1991.

Other Facilities/Credits

1) Technical know-how for commercial production of wire drawing lubricant out of locally available raw materials.

2) Technical know-how for commercial production of enamel frits out of locally available raw materials as a means for import substitution.

Please Contact:

Director/Chief Executive

Or

Project Manager

M.B.P.P.

National Metallurgical Development Centre,

PMB 2116, Jos, Plateau State, Nigeria.

Phone: 0234-73-53264, 53271, 53763

Fax No: 010 234 73 53266

Annex 10

Tour Report of NMDC Team to Itakpe Iron Ore Mines & ASCL from 16:1:94 to 21:1:94 :-

The NMDC team visited NIOMP including its mine, plant, concentrate stock piles, tailing dumps, water dam, Express Laboratory besides the offices of Soframines. We attended the meeting of officials of NIOMP / Soframines / Koch and held discussions with them on 18th January 1994. Based on what we have actually seen and the reports, data, plans made available to us for our study, our observations and suggestions are given below for kind perusal.

1) During the year 1993, 300,000 tons ROM was processed producing 80,000 tons of sinter fines reportedly analysing between 63-66% Fe. The concentrate, produced in three out of four lines, is meant to be evacuated but could not be done by the A.S.C.L.

2) The IVth line, meant for meeting the DSC requirements, is neither available on the ground, nor seen in the plans. The reported receipt of equipment for the IVth line is not revealed. The test results are not made available. As such, NIOMP is not ready for meeting pellet fines requirement of DSC.

3) Mines development is far from satisfactory for excavation of 5.46 MT of ore and 22 MT of waste per annum (i.e. 27.46 MT / annum excavation) for producing 2.2 M>T./annum of sinter fines required by Ajaokuta Steel Company Limited.

4) The mine planning is not clear, if there is any, for controlling the quality of mill feed to the plant, particularly with regard to % Fe, the proportion of hematite to magnetite, the proportion of coarse/ medium grain size feed to fine grain size feed, as well as undesirable impurities like phosphorus.

5) In case Ajaokuta Steel Company Limited is commissioned before the end of the current year 1994, and is ready to lift / receive 2.2 MT sinter fines / annum, the Itakpe mine is not developed enough to meet this demand, even though the plant is ready to process the ore to produce sinter fines.

6) NIOMP needs assistance of NMDC to make Delta Steel agree to lift its 80,000 tonnes concentrates as it is, without any further processing.

7) They welcomed the resolution for asking Delta Steel to smelt its concentrate, as it is, on a trial basis.

8) Should there be genuine desire or will on part of the officials of NIOMP, for producing the pellet fines required by Delta Steel out of the existing plant designed for producing sinter fines meant for A.S.C.L., the possible way for achieving the desired goal through adjustment/fine tuning of the process variables could certainly be found, only after the availability of the data sought from NIOMP.

Remedial suggestions are as follows:

(1) Development of the mine, on war footing, for producing 2.2 m.t./annum of sinter fines required by A.S.C.L. through excavation of over 20 MT/annum of waste and 5.46MT/annum of ore from different benches/faces/pits.

(2) Supplying uniform quality of ore, as available in mine, through adoption of proper mine planning and quality control w.r.t. to % iron content, % hematite to magnetite, proportion of hard ore to soft ore and phosphorus content if it is non uniform or more than 0.03%

(3) Modifying one out of three lines of the process plant for meeting pellet fines requirement of Delta Steel Company and remaining two lines for meeting sinter fines requirements of A.S.C.L.

(4) Exporting sinter fines if A.S.C.L. is not ready to lift it in the overall interest of Nigeria.

For kind consideration.

(1) (Sd) PROJECT MANAGER (MBPP), NMDC, Jos.

(2) (Sd) UNIDO CONSULTANT, NMDC, Jos.

ANNEX 11

OUTCOME OF THE MEETING OF DSC, NIOMP & NMDC HELD AT WARRI ON 10/2/94.

1 Test results carried out by DSC on concentrate sample drawn by them in 12/93 from NIOMP showed the following:

	Itakpe Conc.	DSC Specifications
a) Chemical Analysis. %Fe	62.28	66-67
$\%SiO_2 + Al_2O_3$	11.10	2.7-3.5

b) Size and chemical analysis of sized fractions

Size (Microns)	wt %	%Fe	$\%SiO_2 + Al_2O_3$	%P
+ 500	17.95	65.26	5.19	not indicated
-500 + 200	37.91	63.47	8.82	0.063
-200	44.11	58.1	15.22	0.147
Total	100.00			

c) Properties of Fired Pellets

% Hydrated lime added = 1.3% (DSC Practice =2%)

Basicity = 0.2 (DSC Requirement = 0.6)

I) Chemical:

Parameter	Itakpe Pellets	DSC Requirement
%Fe	59.6	66-67
$\%SiO_2$+ $\%Al_2O_3$	10.27	2.7-3.5
Basicity	0.26	0.6
Physical Strength	1560N/Pellet	2000N/Pellet

II Based on these test results, DSC drew the following conclusions.

a) It is not advisable to use the concentrate in the present form.

b) + 500 Microns fraction comes closer to DSC specifications. -200 Microns fraction is not acceptable due to very low iron content and high gangue content. This is based on the following adverse effects of using concentrate containing high gangue content:

Pelletization Plant:

a) More hydrated lime (10%) is required to obtain 0.6 basicity. (There is no facility to add more than 3.0% lime at DSC).

DR Plant:

b) Low degree of metallization is achieved in DR Plant.

c) High generation of fines in DR Plant requiring briquetting of large proportion of - 3mm size reduced pellets.

d) Undesirable clustering of reduced pellets.

SMS Plant:

e) High wear of refractories (upto 4 times the current rates)

f) Increase in slag volume (3 to 4 times increase in slag volume)

- requirement of more ladles to carry slag requiring additional capital.
- more spillage of slag around surroundings.

g) Relatively low productivity of steel.

h) High energy consumption.

i) High phosphorous content not acceptable as it affects the smelting in the electric arc Furnace.

j) High consumption of imported graphite electrodes

III a) NIOMP indicated that the sample collected in 12/93 is not representative of the available 117,000 tons concentrate. Consequently, they desired drawal of a fresh sample, and undertaking the tests with the fresh sample.

b) They were of the opinion that the ESC's

specifications are too rigid and stringent.

c) They agreed to undertake modification in their (NIOMP's) processing plant to supply + 500 Microns fraction after say a month or two.

d) NIOMP seems eager to supply the available 117,000 tons concentrate to DSC as it is (??????????).

IV However, DSC agreed to test the .+500 Microns fraction on its own and also, blending with the imported concentrates in suitable proportions to be ascertained based on further tests to be carried out at DSC Jointly by NIOMP, NMDC & DSC.

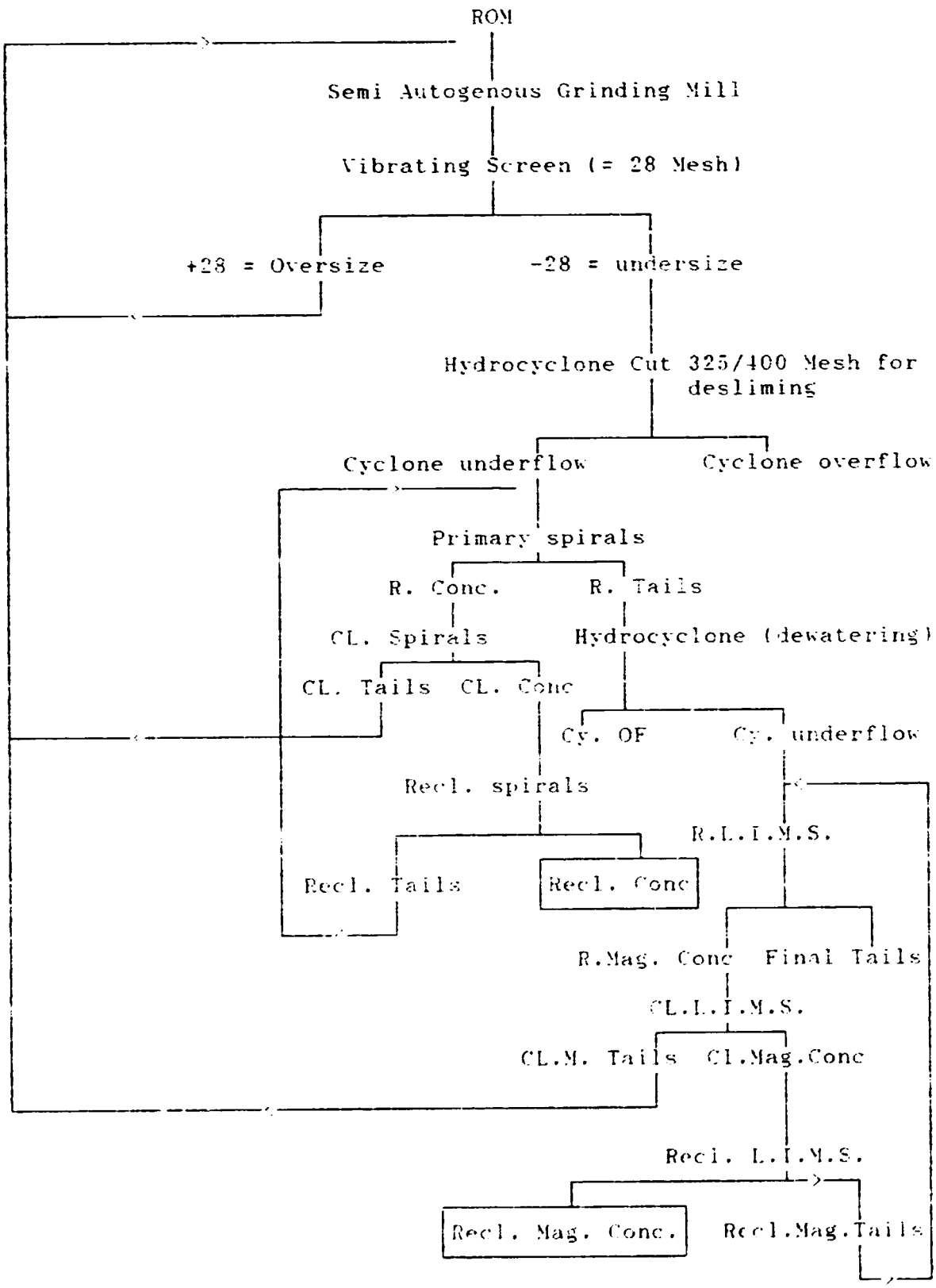
V As annual shot down for maintenance of the various sections of DSC is in progress and is expected to be completed by 28/2/91, DSC desired the association/presence of the representatives of NMDC, NIOMP, and DSC from 1/3/91 to 15/3/91 without waiting for any further confirmation.

For kind information please.

UNIDO Consultant **Project Manager(MBPP**

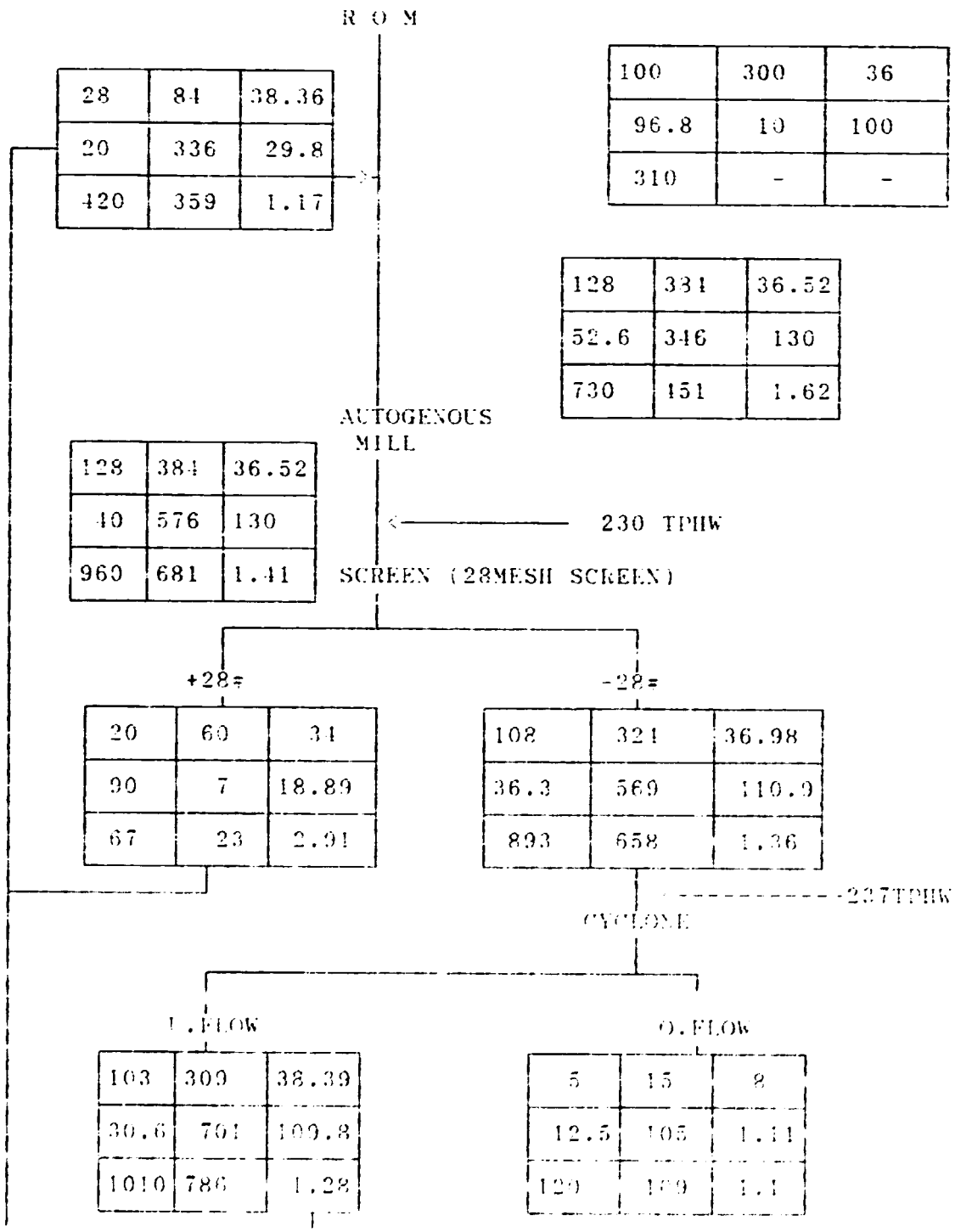
ANNEX 12

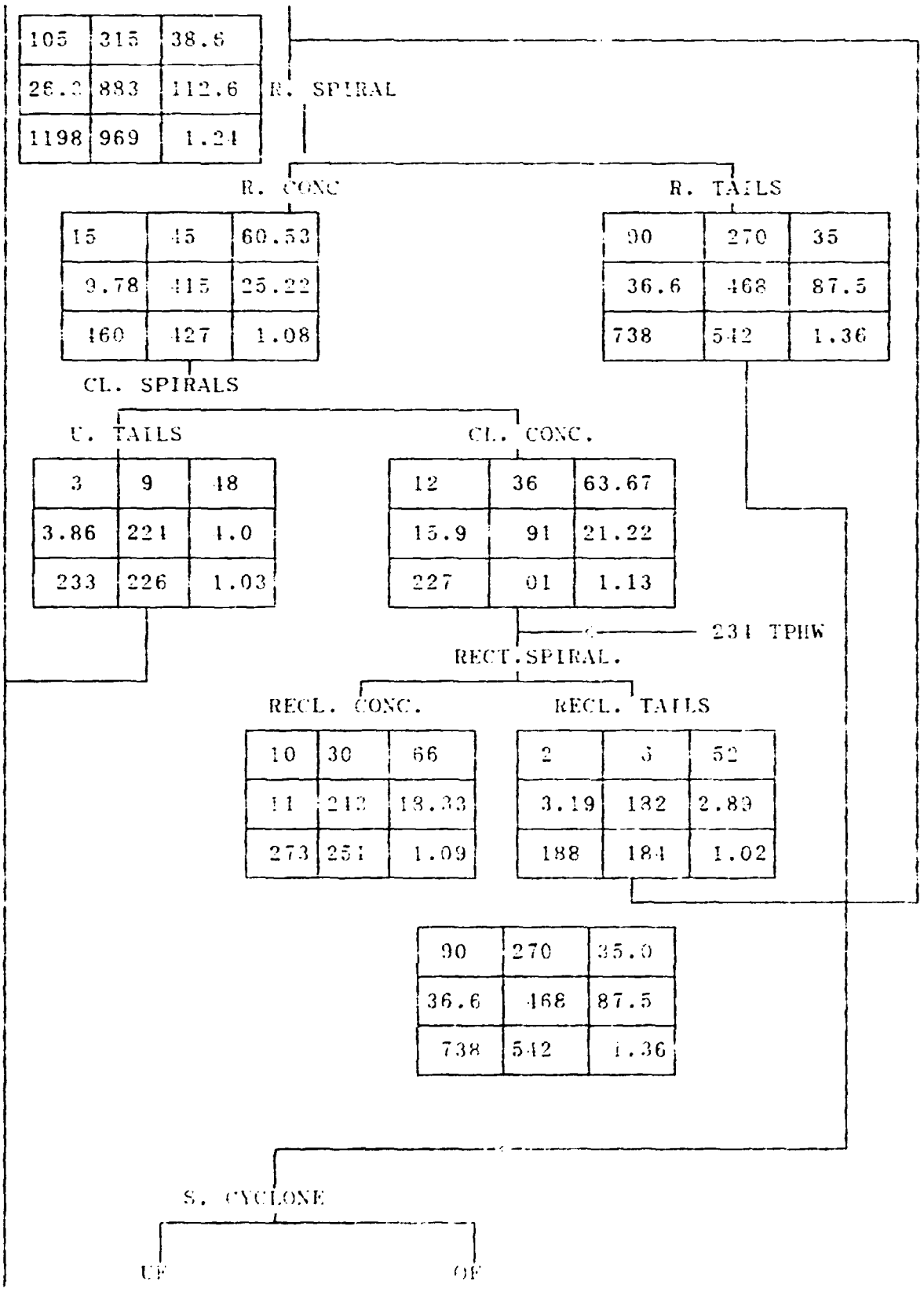
Recommended modified flowsheet for processing Itakpe Iron ore to produce, in the existing plant; pellet quality fines suitable for DSC instead of sinter quality fines meant for A.S.P.

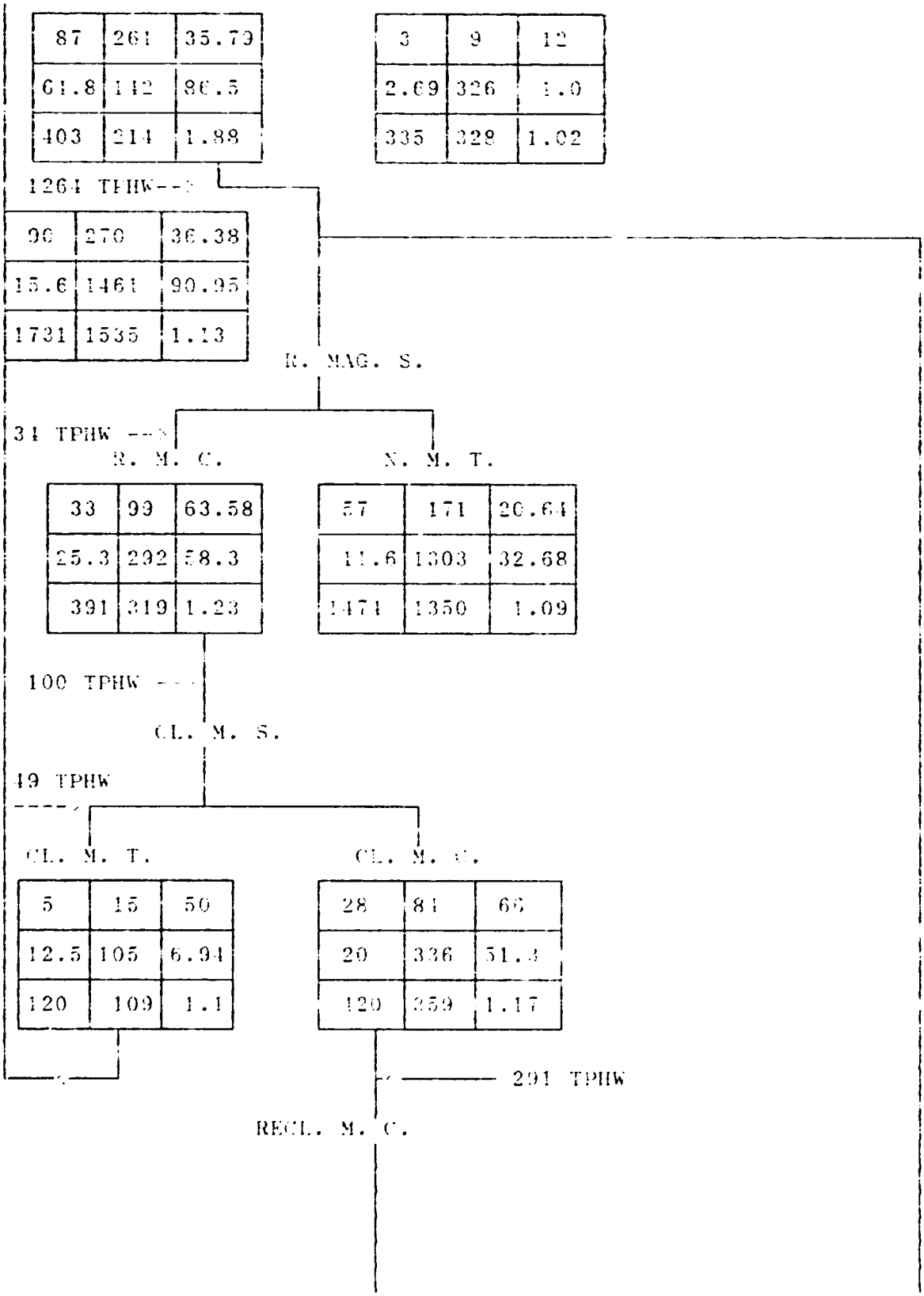

ROM
Semi Autogenous Grinding Mill
Vibrating Screen (= 28 Mesh)
+28 = Oversize
-28 = undersize
Hydrocyclone Cut 325/400 Mesh for desliming
Cyclone underflow
Cyclone overflow
Primary spirals
R. Conc.
R. Tails
CL. Spirals
Hydrocyclone (dewatering)
CL. Tails
CL. Conc
Cy. OF
Cy. underflow
Recl. spirals
R.L.I.M.S.
Recl. Tails
Recl. Conc
R.Mag. Conc
Final Tails
CL.L.I.M.S.
CL.M. Tails
Cl.Mag.Conc
Recl. L.I.M.S.
Recl. Mag. Conc.
Recl.Mag.Tails

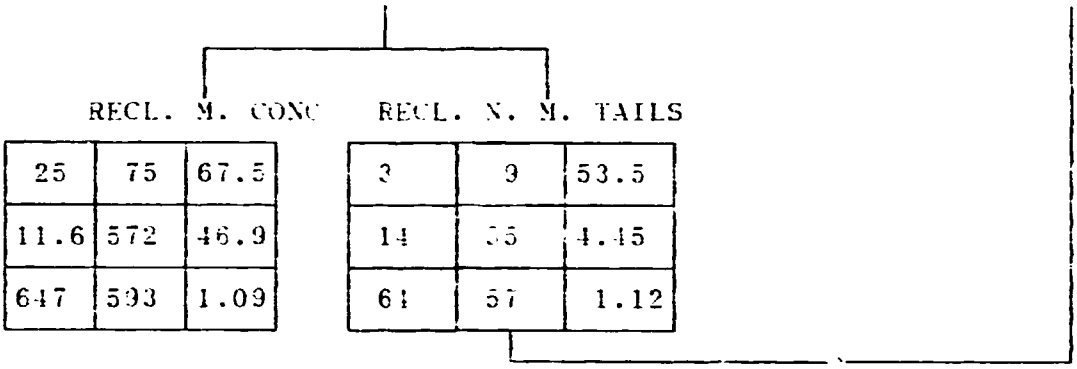
ANNEX 13

MODIFIED MATERIAL BALANCE FLOWSHEET For Processing ITAKPE IRON ORE To Meet DSC's Specifications




105 315 38.6
26.3 883 112.6
1198 969 1.24
R. SPIRAL
R. CONC
15 45 60.53
9.78 415 25.22
160 427 1.08
CL. SPIRALS
R. TAILS
90 270 35
36.6 468 87.5
738 542 1.36
C. TAILS
3 9 48
3.86 221 1.0
233 226 1.03
CL. CONC.
12 36 63.67
15.9 91 21.22
227 01 1.13
231 TPHW
RECT.SPIRAL.
RECL. CONC.
10 30 66
11 213 18.33
273 251 1.09
RECL. TAILS
2 3 52
3.19 182 2.89
188 184 1.02
90 270 35.0
36.6 468 87.5
738 542 1.36
S. CYCLONE
UF
OF


87 261 35.79
61.8 142 86.5
403 214 1.88
3 9 12
2.69 326 1.0
335 328 1.02
1264 TPHW
90 270 36.38
15.6 1461 90.95
1731 1535 1.13
R. MAG. S.
31 TPHW
R. M. C.
N. M. T.
33 99 63.58
25.3 292 58.3
391 319 1.23
57 171 20.64
11.6 1303 32.68
1471 1350 1.09
100 TPHW
CL. M. S.
49 TPHW
CL. M. T.
CL. M. C.
5 15 50
12.5 105 6.94
120 109 1.1
28 84 66
20 336 51.3
120 359 1.17
291 TPHW
RECL. M. C.



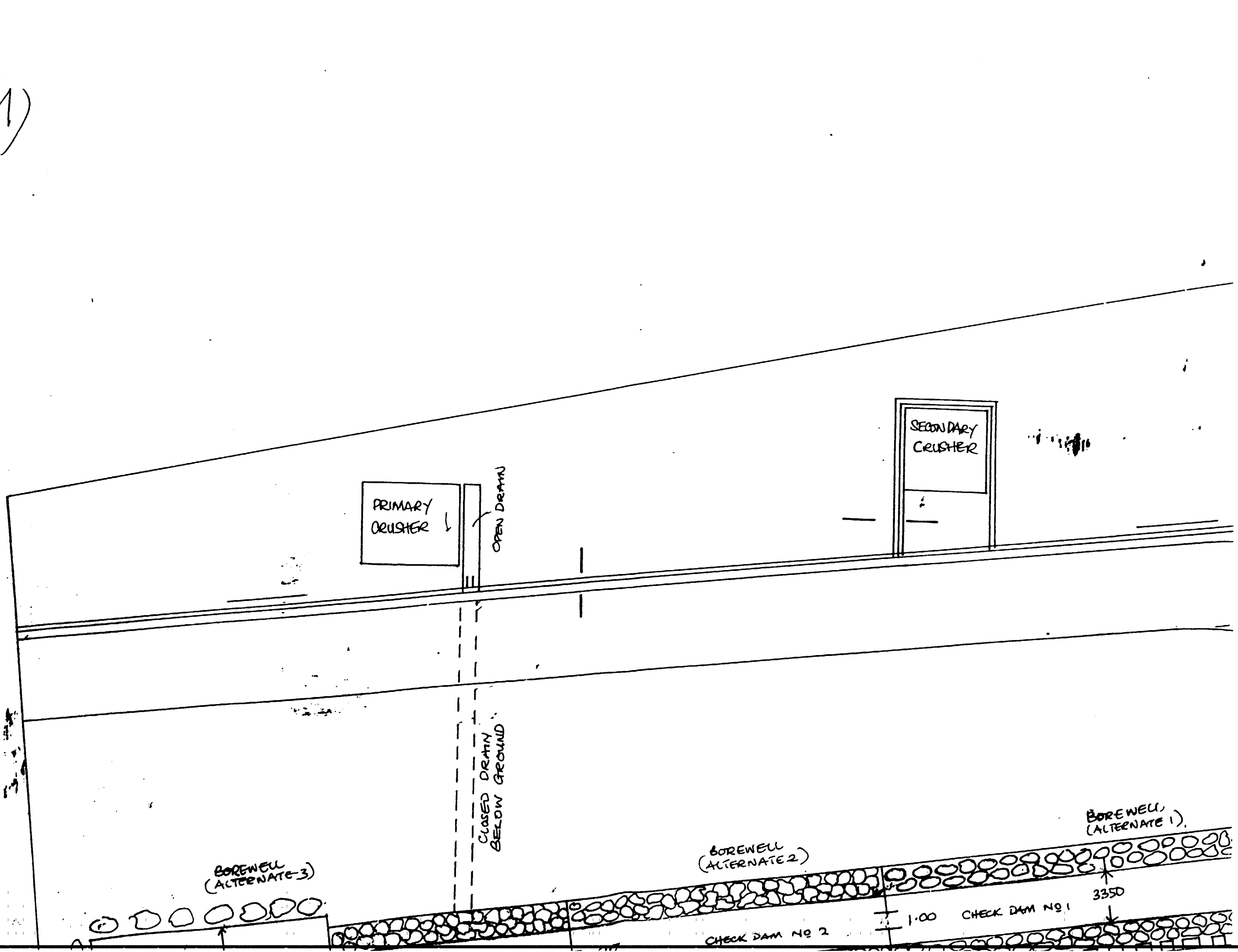
25	75	67.5
11.6	572	46.9
647	593	1.09

3	9	53.5
14	35	4.45
61	57	1.12

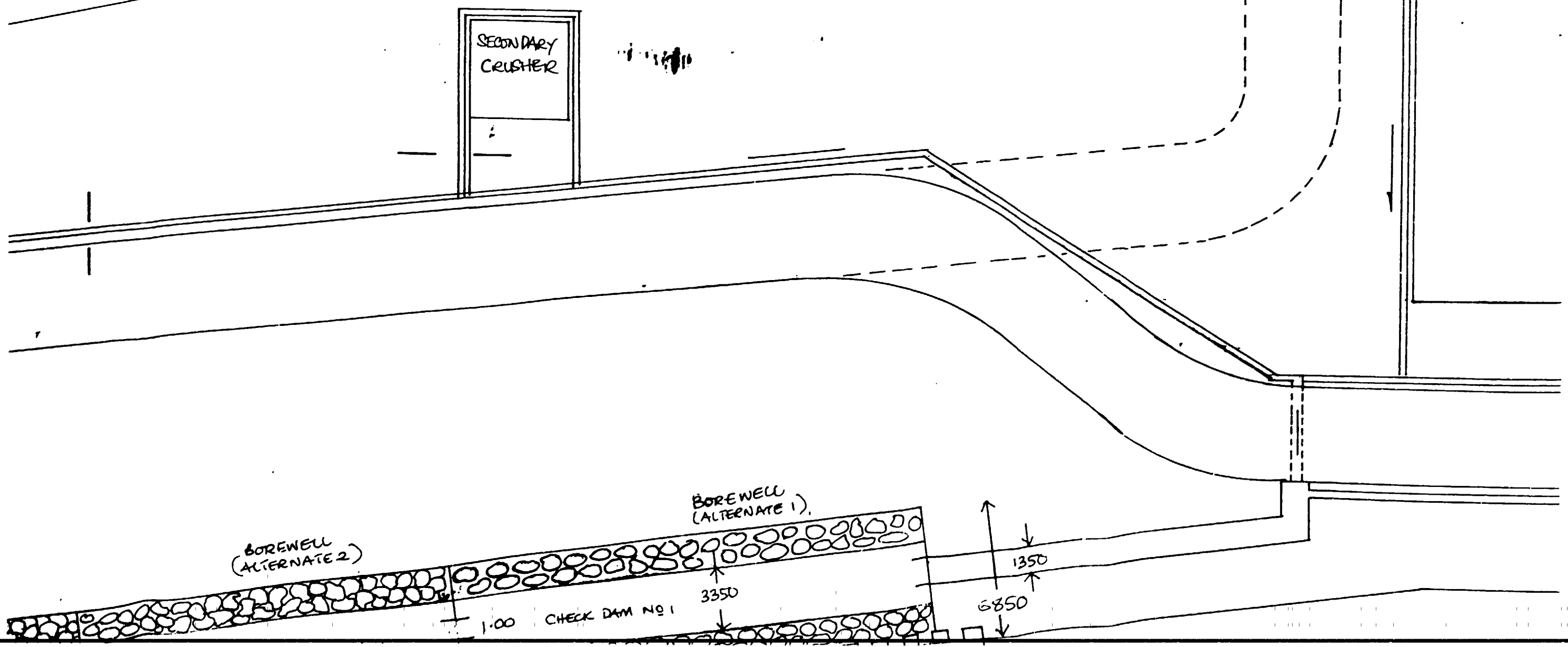
KEY

WT%	TPHS	% Fe
% S	TPHW	% Iron Dist.
TPHP	M³/Hr PULP	PULP Sp. Gr.

1)


SECONDARY CRUSHER
PRIMARY CRUSHER
OPEN DRAIN
CLOSED DRAIN BELOW GROUND
BOREWELL (ALTERNATE-3)
BOREWELL (ALTERNATE 2)
BOREWELL (ALTERNATE 1)
3350
1.00
CHECK DAM NO 1
CHECK DAM NO 2

2)


SECONDARY CRUSHER
BOREWELL (ALTERNATE 2)
BOREWELL (ALTERNATE 1).
1.00
CHECK DAM No 1
3350
1350
6850

3)

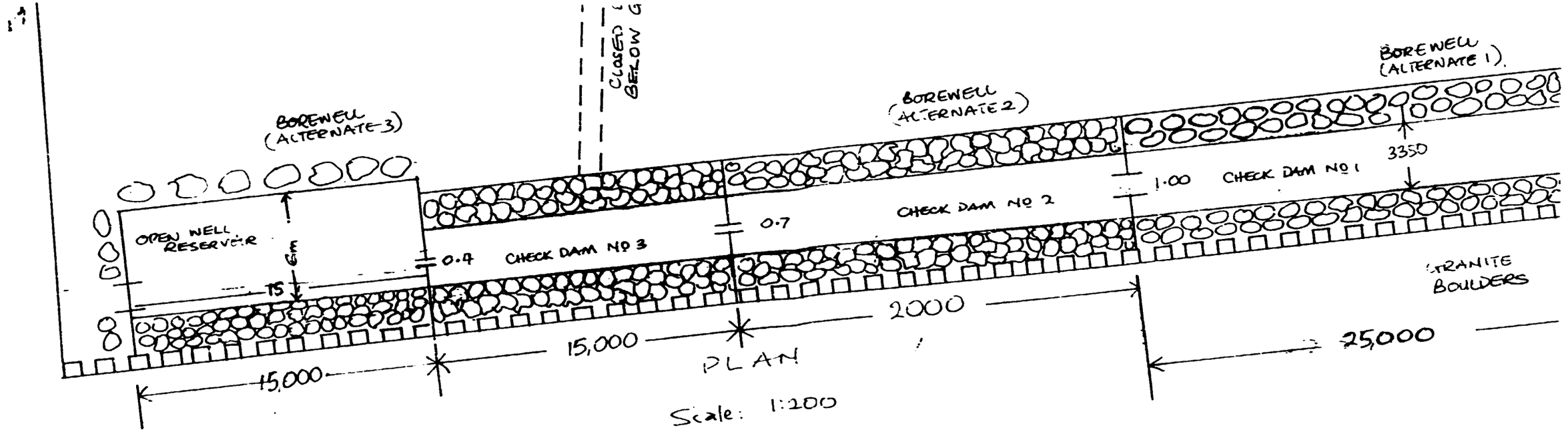
MINERAL BENEFICIATION

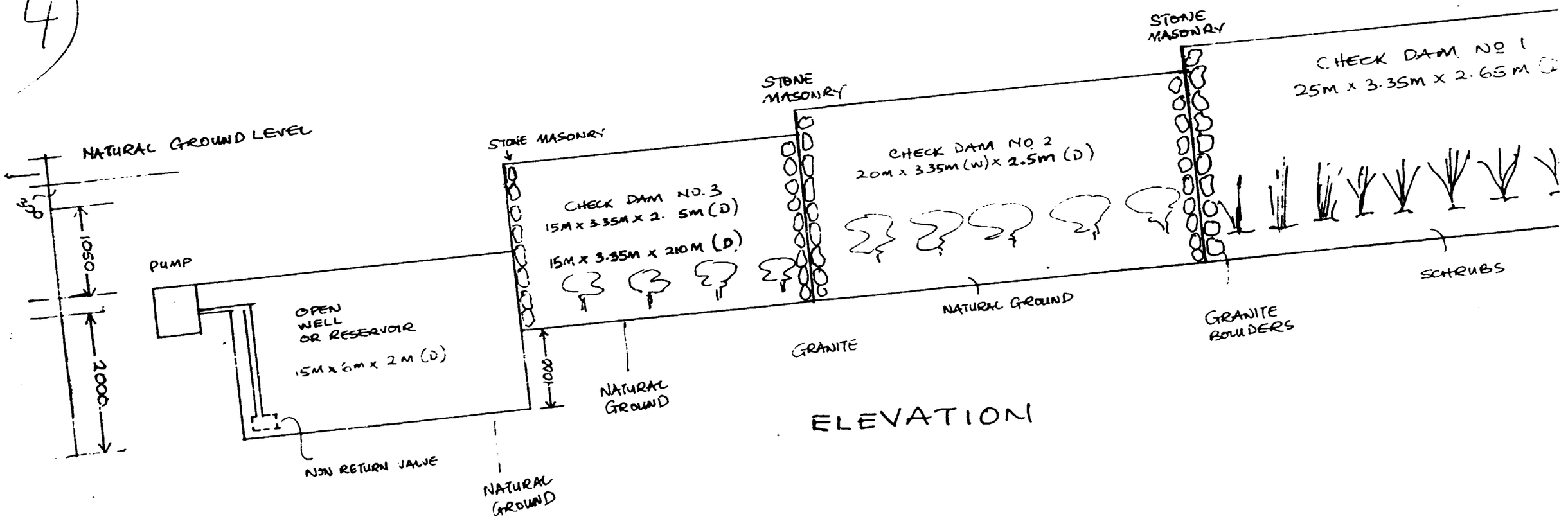
PILOT PLANT

SETTLING TANKS

DRYING PAD

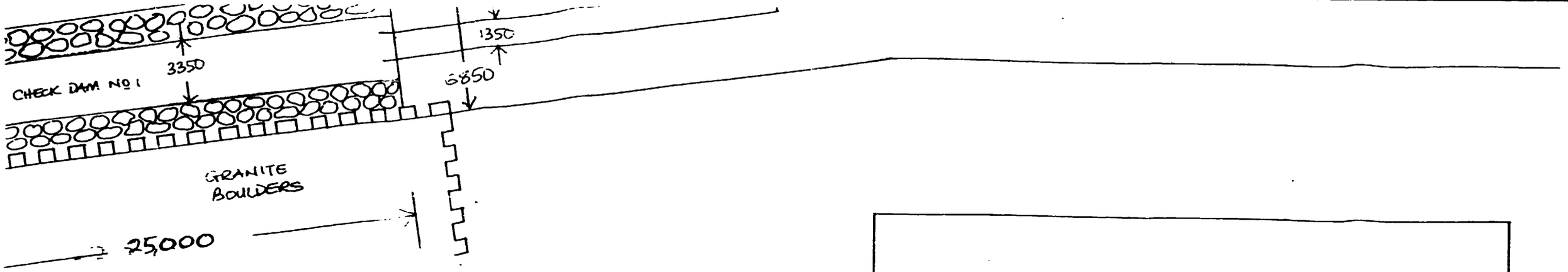
4)



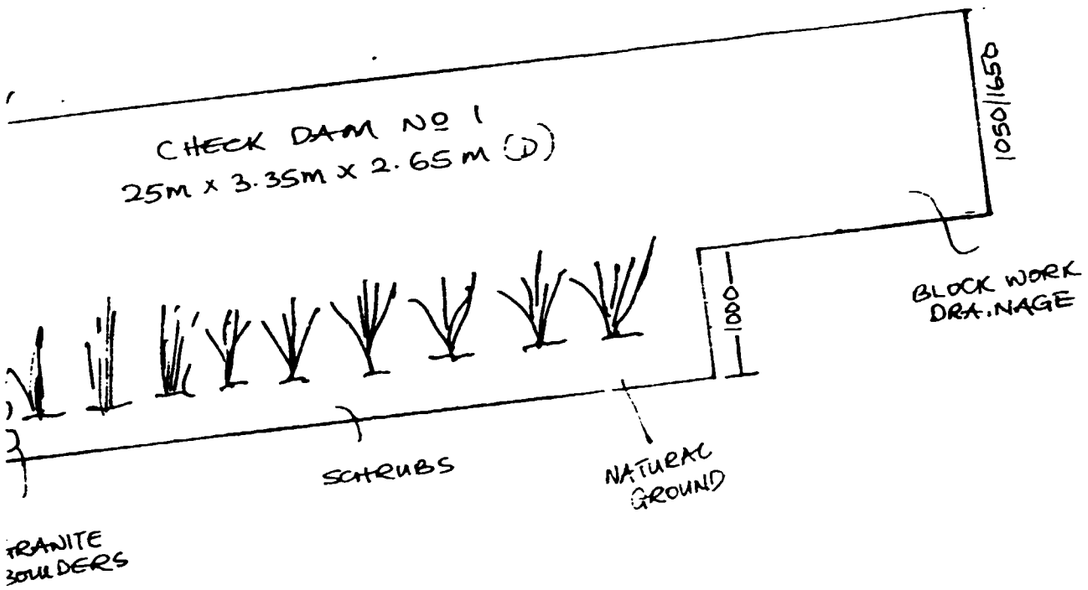


National Metallurgical Development Centre, Jos

DESIGNED BY:	Ramakrishnarao G. S.	G.S.Ramal
DRAWN BY:	Joseph D. Adebayo	
CHECKED BY:		



MAIN ADMINISTRATION BUILDING



5)

Ramakrishnarao G. S.	G.S. Ramakrishnarao	09.05.1994
Joseph D. Adebayo		5th May 1994
A.A. Odunaike	A.A. Odunaike	9/5/94.

DRAINAGE PLAN OF MBPP WITH CHECK I AND RESERVOIR

MAIN ADMINISTRATION BUILDING

6)

DRAINAGE PLAN OF MBPP WITH CHECK DAMS AND RESERVOIR

Scale 1:200; 1:50	Rev,
Drawing No. 71	