THAPAR INSTITUTE OF ENGINEERING & TECHNOLOGY
PATIALA
(DEEMED TO BE A UNIVERSITY)
DEPARTMENT OF MECHANICAL & INDUSTRIAL ENGINEERING

The Indian Sugar and General Engineering Corp.
Yamunanagar

WORK TERM–I REPORT

Prepared by :
AMIT GUPTA
Roll No 135/85

Mr.S.K.SATSANGI,
Head: Placement and Co-ordination Deptt.,
Thapar Institute of Engineering & Technology,
Patiala-147001.

Dear Sir,

This report entitled," Report on Work-Term I" was prepared as my work report for the "Training and Development Deptt" of ISGEC LTD.,Yamuna Nagar. This is my First Work-Term Report.

M/S ISGEC LTD. are the manufacturers of different types of presses(Mechanical,Hydraulic, Hot Platon, Briqueting) steel plant equipment, Pressure Vessels, Boilers, etc.

The co-ordinating departments of the Company were headed by:-

Mr. S.K.Jain - In-charge Planning Department (PVD)

Mr. P.K.Manchanda - In-charge Industrial Engg.Deptt.(MBSD).

This report has been prepared and written by me and has not received any previous academic credit at this or any other institute.

Sincerely,

Amit Gupta.

Dated: 01.8.88.

(AMIT GUPTA)
Roll No. 135/85

ACKNOWLEDGEMENTS

In the beginning, I would like to thank the following personnel for helping and guiding me at every necessary step, during my training:-

(i) Dr.S.M.HAIDER - Training and Development Supdt.

(ii) Mr.S.K.JAIN - In-charge Planning D eptt.(PVD)

(iii) Mr.P.K.MANCHANDA - In-charge Industrial Engg.Deptt.(MBSD)

(iv) Mr.A.P.SINGH - Assistant Stores Officer.

I would also like to thank all the employees of M/S ISGEC LTD., Yamuna Nagar for co-operating and helping me in completing my training for Work Term I successfully.

Amit Gupta.

Dated: 01.08.88

(AMIT GUPTA)

ABSTRACT

This is a report of the training under Work Term I undergone by me at M/s ISGEC LTD., Yamuna Nagar. This report contains the observations, analysis, conclusions and recommendations made thereof for the following assignments that were carried out during the training :-

(i) ABC Analysis.

(ii) Inventory control for Welding Stores.

(iii) Study of Utilisation of Machines in the Machine-shop, using Work Sampling Technique.

(iv) Study of Utilisation of CNC Gas Cutting Machine, using Production Study Technique.

(v) Study the existing system of booking of welding consumables on jobs in Structure Shop and propose a better system.

LIST OF CONTENTS

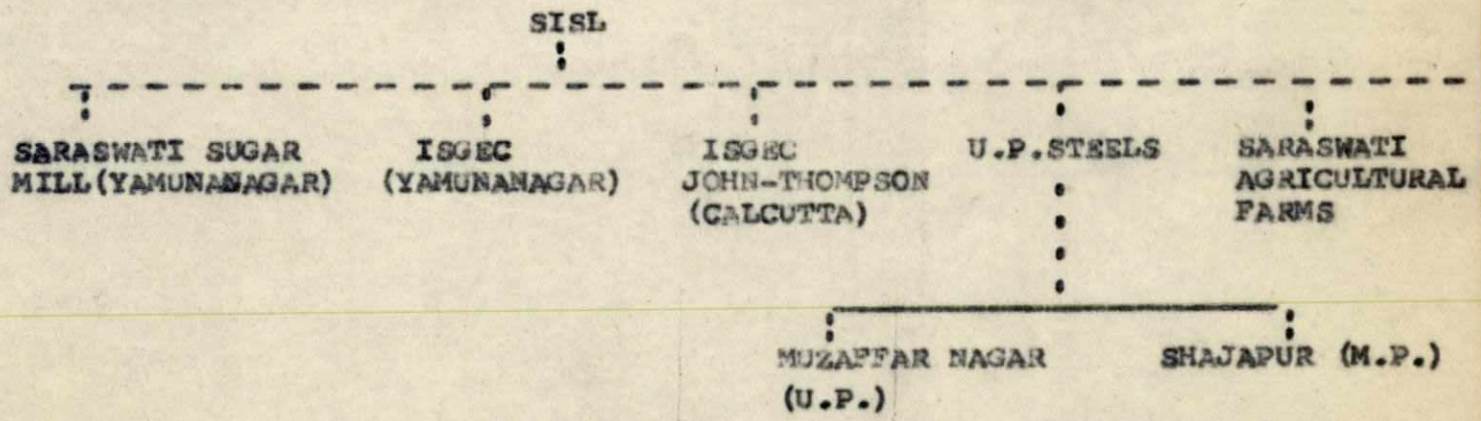
CONTENTS PAGE

CHAPTER - I.

1.1 Indian Sugar and General Engineering Corpn. (ISGEC) is the flagship company of the 'Saraswati Industrial Syndicate Ltd'. The syndicate was established on January 23, 1933, with two Sugar Mills of four hundred tonnes per day cane crushing capacity at Yamuna Nagar and Neoli(UP). A subsidiary in the name of "THE INDIAN SUGAR AND GENERAL ENGINEERING CORPORATION " was incorporated on January 19,1946. The main object of the subsidiary was Machinery manufacturing. in the year 1962 SARSWATI SUGAR MILL AND ISGEC" were amalgmated to form "THE SARASWATI INDUSTRIAL SYNDICATE LIMITED".

Another subsidiary named "ISGEC JOHN -THOMPSON LTD." was formed in 1965 for design ,Engineering and sale of different types of boilers and pressure - vessels and the same has been amalgmated with"The SISL", w.e.f. July 1,1973. IJT was originally ~~knee~~ in collaboration with John - Thompson of U. K. (now Clarke- Chayman).

The Orginisational structure of SIBL is as shown below :-



Branch Offices at :- Bombay, Delhi, Madras and Calcutta.

1.2 HISTORICAL BACKGROUND OF ISGEC.

ISGEC was conceived during Second World War, when shipping difficulties made it impossable for sugar industry in India to obtain replacement and spares. The company stared its manufacturing activities in a very modest faction in 1950. There were just 20 workers and the first order received

was for the manufacture of Brass Screws. Since then ISGEC has leaped and jumped to become the leading fabrication unit of Northern India.

Initially the company's activities were confined to sugar machinery manufacturing. There are several sugar plants that have been supplied by ISGEC . Diversification of production was started in 1960, when an agreement was signed with John - Thompson of U.K. for manufacture of Industrial boilersand pressure- vessels. Others are :

1963 - Agreement with Kawasaki of Japan for the manufacture of cement machinery.

1964 - Agreement with Farrels of USA for the manufacture of sugar mills.

1966 - Agreement with John Shaw & sons of UK for the manufacture of Hydraulic Presses.

1967 - Agreement with John Thompson (new Clarke Chapman) of UK for the manufacture of Thermal power station boilers upto 200 MW.

1968 - Agreement with Brons of UK for manufacture of Blate - Bending and Levelling Rolls.

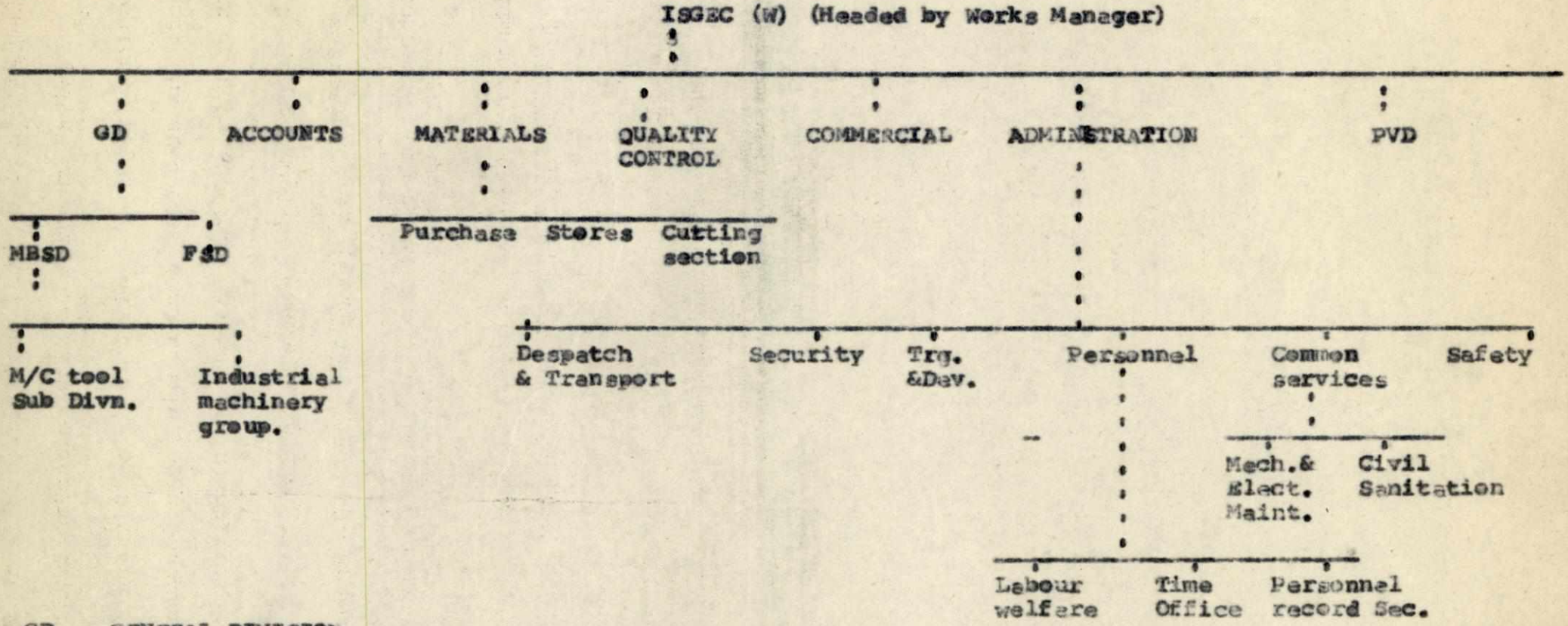
and 1986 - Agreement with M/S Rovetta of Italy for manufacture of MECHANICAL PRESSES.

To day the company is proud of having kept a close contact through the years of growth with many dynamic engineering and consulting organisations world-wide.

1.3 ORGANISATIONAL STRUCTURE OF ISGEC.

ISGEC has mainely two divisions , the GENERAL DIVISION & THE PRESSURE VESSEL DIVISION. Foundry division comes under the General Division .

(Chart on next page)



GD - GENERAL DIVISION

PVD - PRESSURE VESSEL DIVISION.

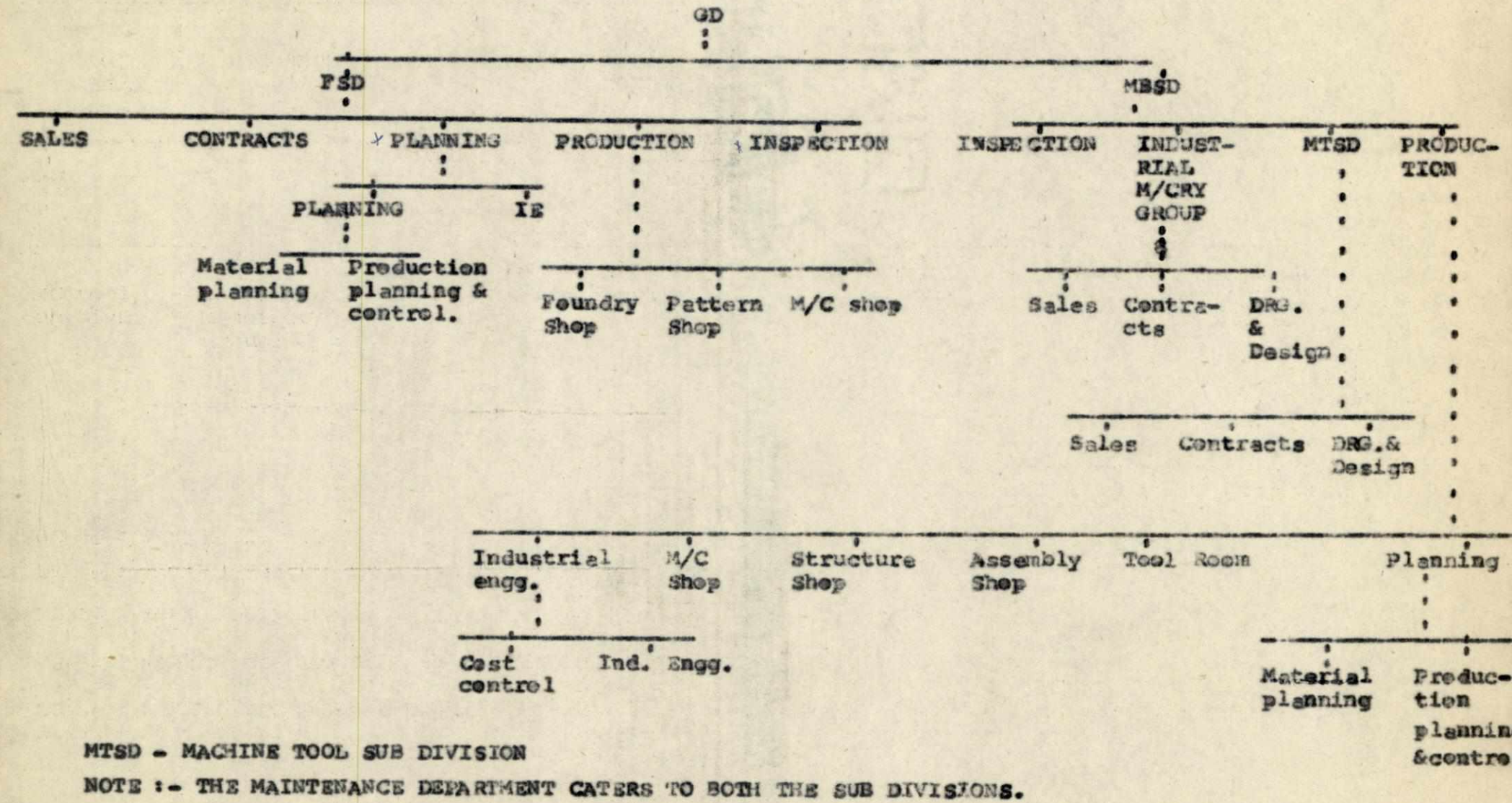
MBSD- MACHINE BUILDING SUB- DIVISION

FSD - FOUNDRY SUB DIVISION.

TRG.- TRAINING AND DEVELOPMENT.
&DEV.

1.3.1 ALL ABOUT GENERAL DIVISION

(a) ORGANISATION STRUCTURE



MTSD - MACHINE TOOL SUB DIVISION

NOTE :- THE MAINTENANCE DEPARTMENT CATERS TO BOTH THE SUB DIVISIONS.

(b) MAJOR PRODUCTS.

General Division has a wide range of products through its three sub divisons viz. Foundry Sub Division, Industrial Machinery Group, and Machine Tool Sub Division.

i)Fro Machine Tool Sub Bivision the major products are ;

- Hydraulic presses -
- Plate Bending and Levelling Rolls.
- Welding Rotators and Manipulators
- Press Brakes
- Briqueting Presses
- Mechanical presses (being produced for the first time in India)

ii)For Industrial Machinery Group ;

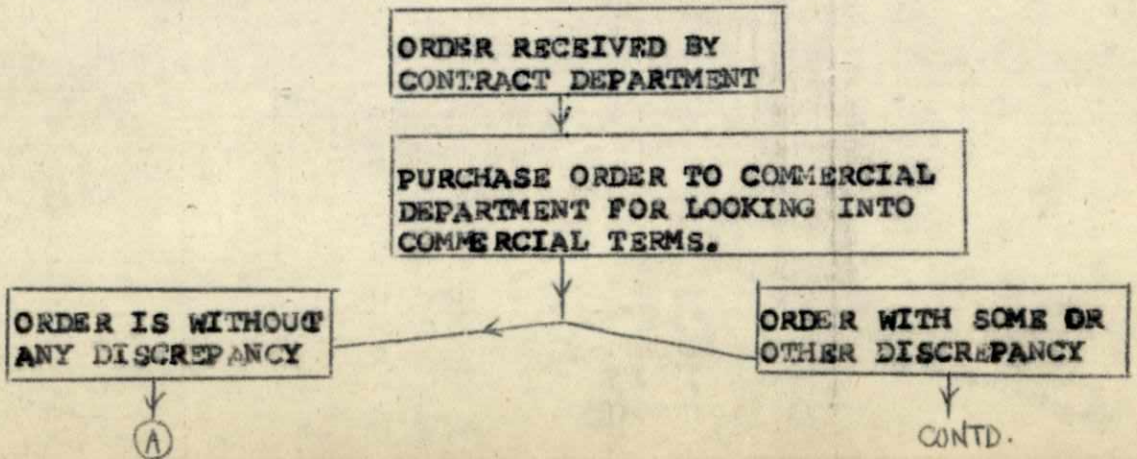
- Steel plant equipment
- Cement plant equipment
- Sugar plant equipment
- Wood working machinery - Log ,Peeling Lathes, Hot-Platten Presses
- Vernier Callipers
- Stockers , etc.

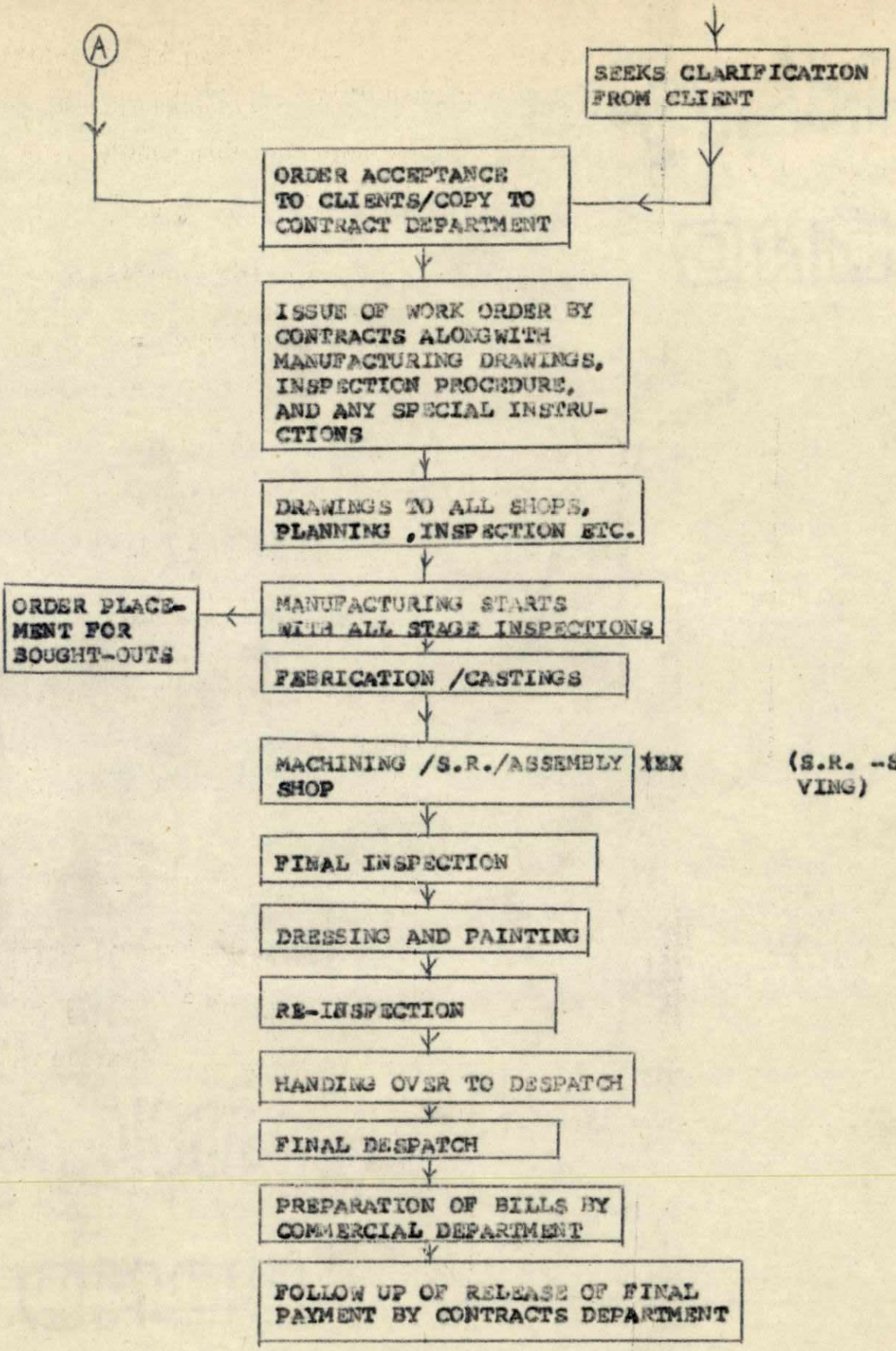
iii)For Foundry Sub Division.

- Grey and Alloy Iron castings , Copper and Brass castings.

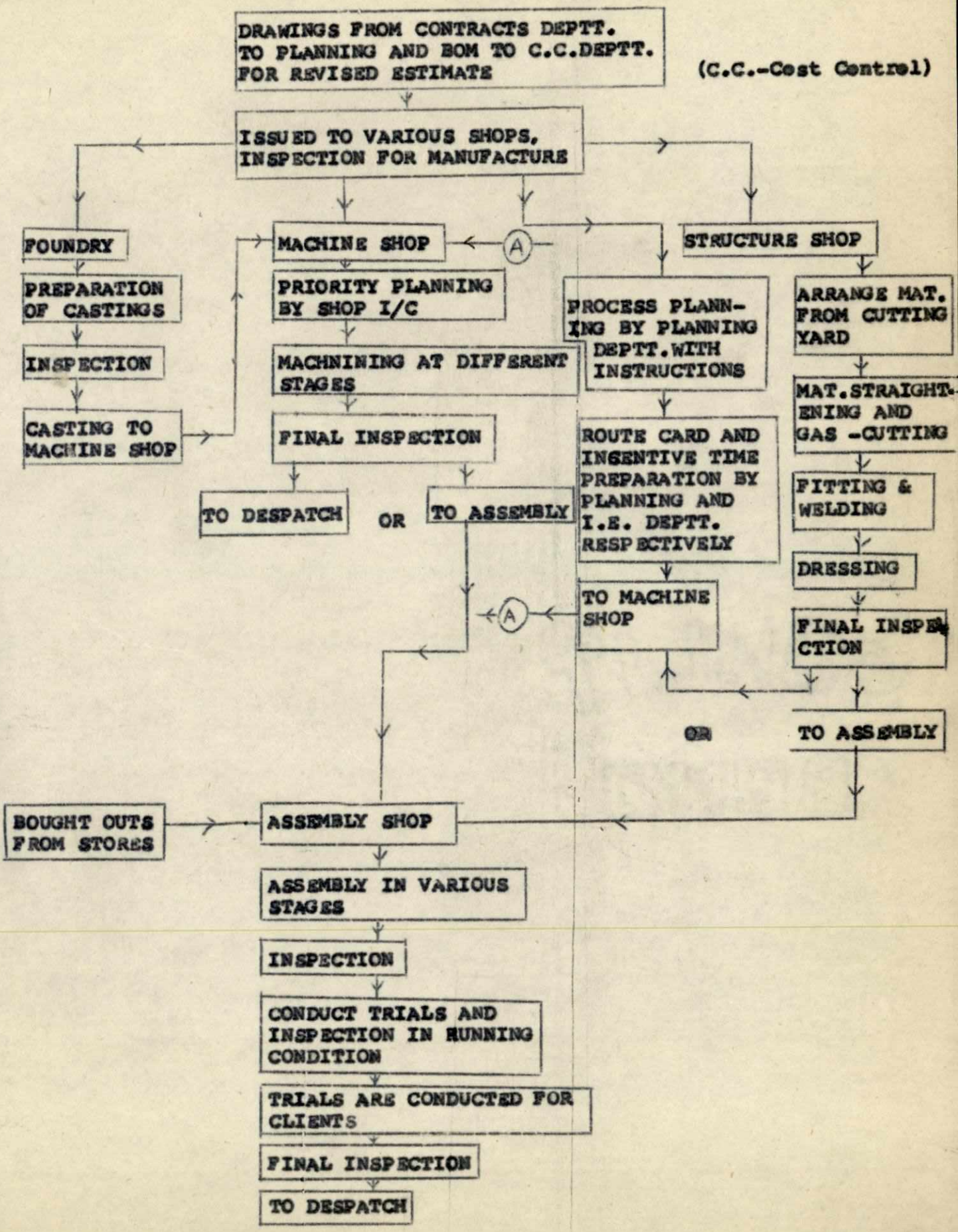
(c) PRODUCTION PROCESS FOR THE MBSD.

The production process is explained below in the flow chart.

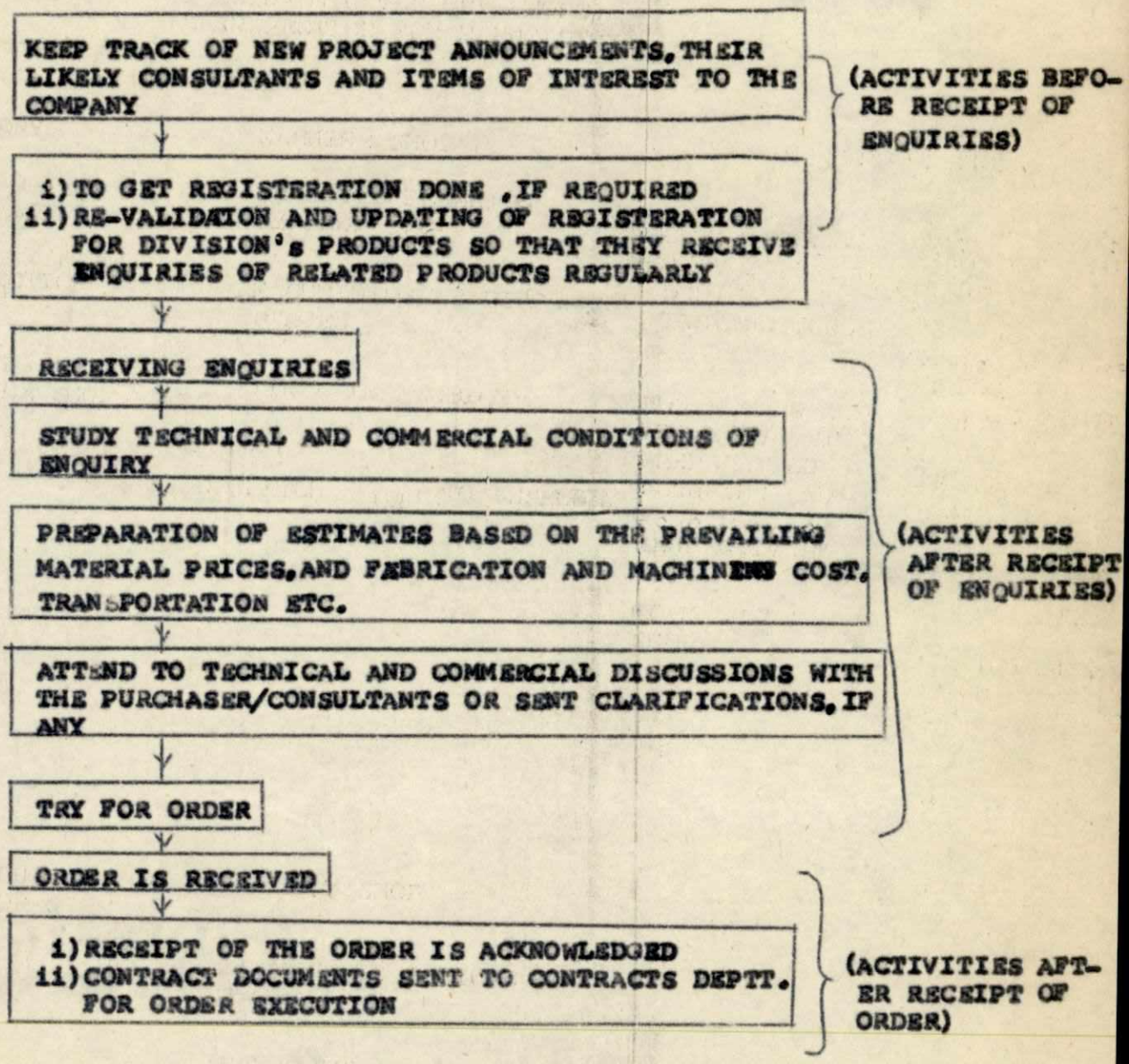



A
SEEKS CLARIFICATION FROM CLIENT
ORDER ACCEPTANCE TO CLIENTS/COPY TO CONTRACT DEPARTMENT
ISSUE OF WORK ORDER BY CONTRACTS ALONGWITH MANUFACTURING DRAWINGS, INSPECTION PROCEDURE, AND ANY SPECIAL INSTRUCTIONS
DRAWINGS TO ALL SHOPS, PLANNING ,INSPECTION ETC.
ORDER PLACEMENT FOR BOUGHT-OUTS
MANUFACTURING STARTS WITH ALL STAGE INSPECTIONS
FABRICATION /CASTINGS
MACHINING /S.R./ASSEMBLY SHOP
(S.R. -STRESS RELIEVING)
FINAL INSPECTION
DRESSING AND PAINTING
RE-INSPECTION
HANDING OVER TO DESPATCH
FINAL DESPATCH
PREPARATION OF BILLS BY COMMERCIAL DEPARTMENT
FOLLOW UP OF RELEASE OF FINAL PAYMENT BY CONTRACTS DEPARTMENT

MANUFACTURING PROCESS



The production process starts only after the contract has been allotted to the company as a result of efforts put in by the Sales Department. The line of action followed by the sales Department to bag as many contracts as possible is as shown below:-



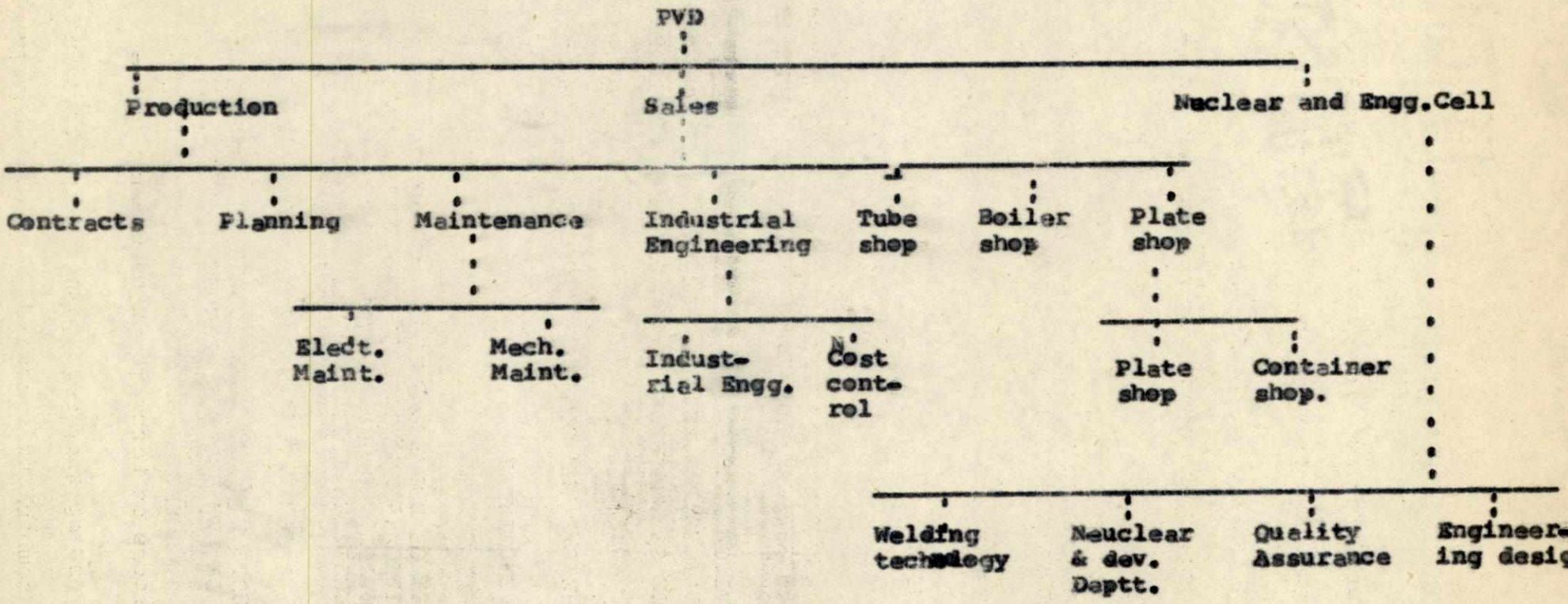
Besides, this there are other activities such as :-

i) To expedite first advance payment

ii) If there is any change in scope of work, settle revised price and delivery with the purchaser/consultants.

1.3.3 ALL ABOUT PRESSURE VESSEL DIVISION

(a) ORGANISATIONAL STRUCTURE



(b) MAJOR PRODUCTS OF THE DIVISION

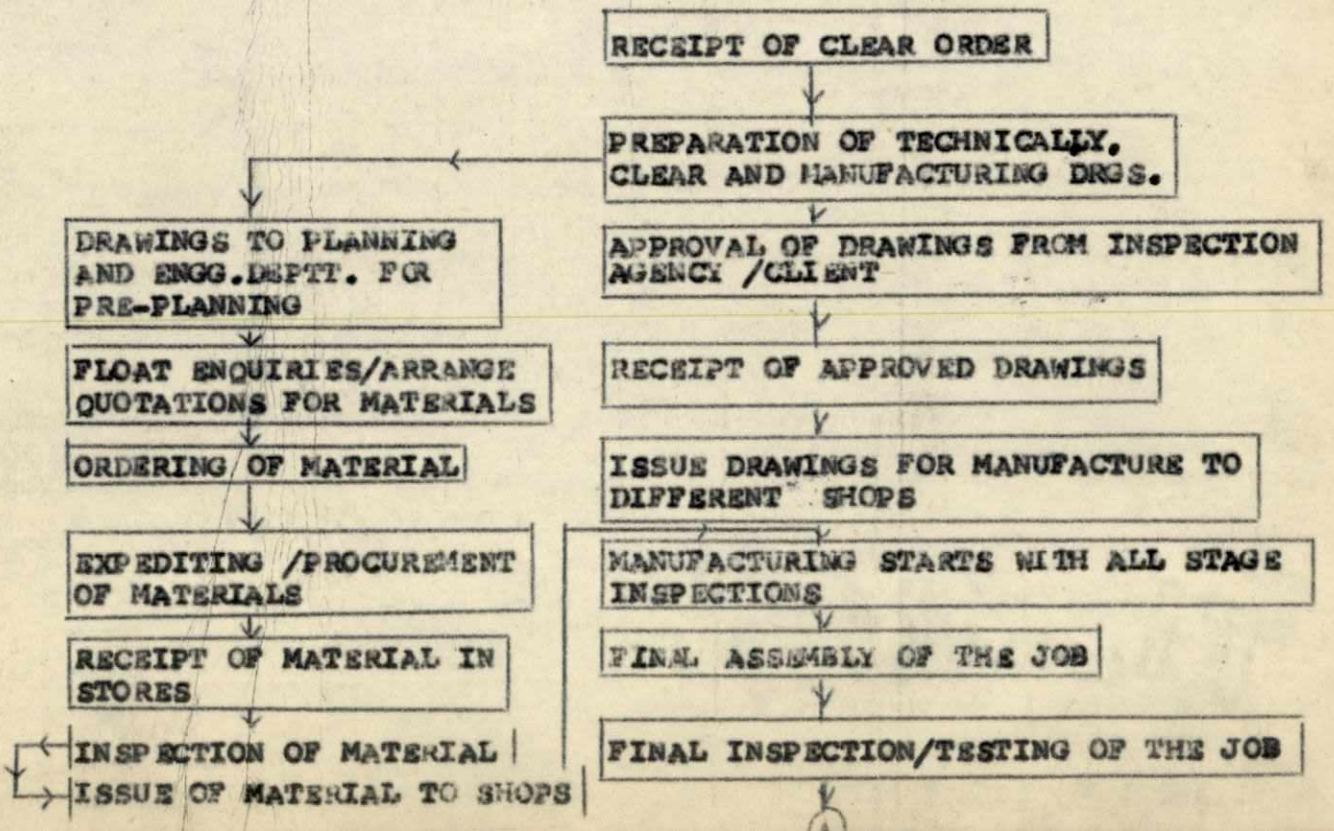
i) Pressure vessels

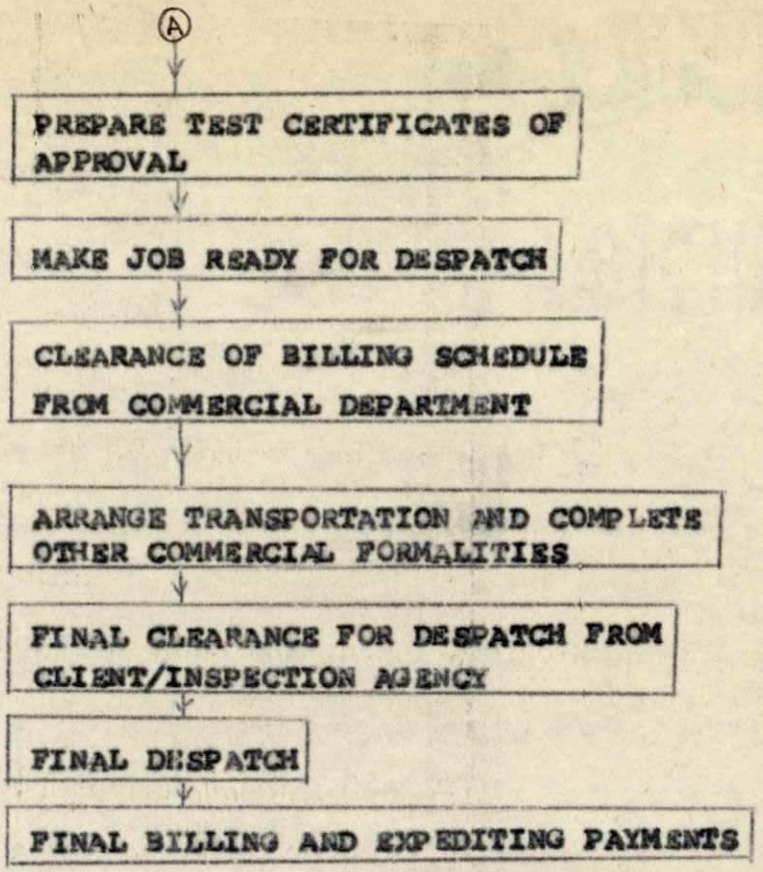
- Heat Exchangers
- Distillation columns and towers
- Autoclaves
- LPG /Ammonia and Liquified gas containers.
- LPG/Chlorine storage and transportation tanks and spheres
- Galvanasing baths
- Class I vessels in stainless steel ,Nickel and other special materials.

ii) - Boilers and Water Treatment Plants.:-

- Shell boilers for oil/coal/wood firing
- Water tube boilers for oil/coal/gas/Bagasse
- Waste heat recovery boilers
- Water treatment Plants for Industrial Applications.
- Deaerators.

(c) JOB ORDER EXECUTION SEQUENCE FOR PRESSURE VESSEL DIVISION.





(d) QUALITY CONTROL.

ISGEC proudly holds the 'A' Class welding certificate of Fedders Lloyd's Register of Shipping. This is because of the strict quality control exercised by the company for its pressure vessel division, through the Quality Control Deptt. which reports directly to the Works Manager.

Quality is maintained by carrying out various tests on the jobs at almost every step of manufacturing. There are mainely two type of tests that are carried out viz.

i) Destructive Tests

ii) Non-Destructive Tests.

Destrictive Tests includes a number of tests such as -

- Tensile Test
- Compressive Test
- Impact Test
- Torsion Test, etc.

- Non Destructive Tests include:-

- Hydro Test

- Magnetic particle Test

- X-Ray Test

- Dye Penetrant Test , etc.

CHAPTER TWO

2.1 OBJECTIVE

To conduct ABC Analysis for

(a) Welding Stores

(b) Boiler Stores

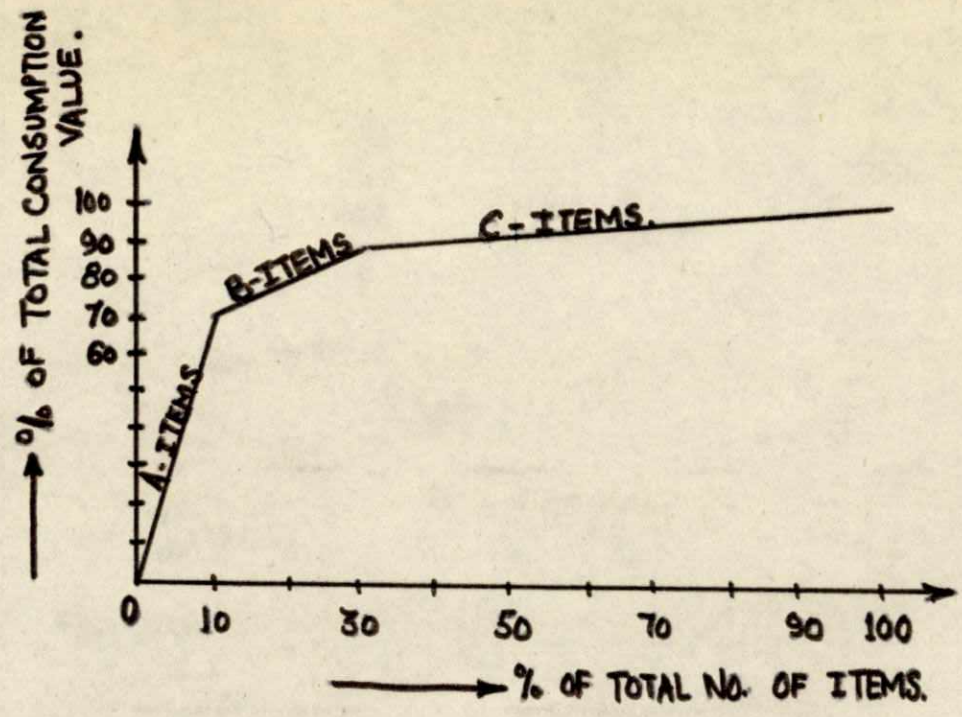
(C)Iron & Steel Stores.

2.2 THEORETICAL BACK GROUND.

ABC Analysis is a basic analytical management tool which enables top management to place the effort where results will be greatest. This technique popularly known as the " Always Better Control" has universal applications in many areas of human endeavour . In materials management this technique has been applied in areas needing selective control , such as inventory, criticality of items, obsolete stocks, purchasing orders, receipt of materials, inspection , store-keeping and verification of bills. The basis of the ABC approach to inventory control provides maximum overall protection against stockouts for a given investment in safety stocks. ABC Analysis is astudy of each item in terms of its price,usage, and lead time, as well as specific procurement or technical problem. Materials Manager finds a solid basis for allocation of deparmental effert and expense to tasks of Controlling thousands of inventory items.

The annual consumption analysis of any organisation would indicate that a handfdl of top high value items- less than 10% of the total number will account for substantial portion of about 75% of the total consumption value and these few vital items are called A items which need careful attention of the materials manager. Similarly a large Number of "Bottom" items -over 70% of the total number called the trivial many- account for about 10% of the consumption value, and are known as 'C' category items. The items that lie between top and bottom items are called the B -Category items.

ABC ANALYSIS.



2.3 THE BASIC PRINCIPLES OF ABC ANALYSIS

(i) The analysis does not depend upon the Unit cost of the items but only on its annual consumption value.

(ii) It does not depend upon the importance of item,

(iii) The limits for ABC categorisation are not uniform but will depend upon the size of the undertaking, its inventory as well as the number of items controlled.

2.4 MECHANICS OF ABC ANALYSIS.

The mechanics of classfying the items into 'A' ,'B' and 'C' categories is described in the following steps;

(i) Calculate the rupee annual issues for each item in inventory by multiplying the unit cost by the number of units issued ina year. It is assumed that the issues and consumption are same.

ii) Sort all items by rupee annual issues in descending order.

iii) Prepare a list from these ranked items showing item No, Unit cost, annual units issued and annual rupee value of units issued.

iv) Starting at the top of the list computs a running total item by item issue value and the rupee consumption value.

v) Compute and print for each item the cumulat

(v) Compute and print for each item the cumulative percentages for the item count and cumulative annual issue value.

(IMPORTANT NOTE:- All items which are basically the same but have different trade names should be clubbed together and considered as one item before carrying out the step ii)

The normal items in most organisations show the following pattern:-

(a) 5-10% of the top number of items account for about 70% of the total consumption value .These items are called the 'A' items.

(b) 15-20% of items account for the 20% of the total consumption value and are termed as 'B' Class items.

(c) The remaining number of the items account for the balance 10% of the total consumption value. These items are called the 'C' class items.

2.5 OBJECTIVES ~~AND~~ OF ABC ANALYSIS

As described earlier this analysis gives the materials Manager an idea about the selective control when he is confronted by a large number of items. Further;

(i)For the three categories of items different degree of control has to be exercised. For 'A' items the control should be as rigorous as possible and the least for the 'C' items.

(ii) This ~~xxx~~ analysis is also helpful to rationalise the number of orders and reduce the overall inventory. This can be done by increasing the number of orders to be placed for the 'A' items and corresponding degrease in the order for 'C' items so that the total number of orders remain the same.

2.6 OTHER CLASSIFICATIONS

For better control the ABC Analysis should be combined with one or more of the undermentioned classifications. Normally, it has been observed that ABC Analysis alone does not give a true picture of the items to be stored and the~~xxxxxxxxxx~~ nature of the control to beexercised on it.

(i) HML CLASSIFICATION

This method is similar to ABC classification but in this case instead of consumption value of items the unit value of the items is considered . The items are classified according their Unit value as High, Medium or Low value items. The focus in this classification is so directed to control the purchase prices.

(ii) XYZ CLASSIFICATION

In this classification the value of inventories stored is taken as the basis of differentiation. This is normally undertaken once in a year, during annual stock-taking. 'X' items are those items whose inventory value is high, 'Z' items are those items whose value is low and 'Y' items are those lying in between. This classification helps in identifying the items which are being extensivelystocked. The XYZ Classification is generally in conjunction with ABC classification to have better control.

(iii) VED CLASSIFICATION

This classification is used to determine the stock level of spare parts, since the consumptionpattern of spare parts is different from raw materials. Stock of spare parts will be based on strategy different from those for raw materials. Spare parts are classified as Vital , Essential, and Desirable. 'V' class of items are stocked adequately to ensure smooth operation of plant because their non-availability can cause serious set-back to the organisation. However risk can be taken in case of 'E' Class items. Stocking of 'D' type of items can be avoided if the lead-time for their procurement is low.

iv) SDE CLASSIFICATION

This classification is used for lead- time analysis and planning purchasing strategy. In this classification materials are classified as Secarce , Difficult, easy to obtain.

2.7 ASSUMPTIONS IN ABC ANALYSIS

By carrying out the ABC analysis following important assumptions were made.

i) The material or the units of an item issued from the store has been subsequently consumed.

ii) Price fluctuations did not occur i.e. the cost per unit of any item remained constant during the whole year.

2.8 MODE OF OPERATION

To carry out this analysis two types of informations were required viz. the annual consumption of any item, and its unit cost. The annual consumption was obtained from Welding stores ledgers. Cost of each unit of the item was obtained from the Accounts Department. Following the other mechanics of ABC Analysis as described earlier all the items were arranged in a descending order of their consumption value. Thus limits for 'A', 'B', and 'C' categories items were then fixed according to the theoratical limits. But the due modifications were made for these limits. ABC analysis for Boiler Stores and Iron and Steel Stores was also carried out in a similar fashion.

2.9 RESULTS

i) Welding Stores

(a) For Welding stores there were only 12 items in 'A' category forming about 5.33% of the total number of items and 71.38% of the total consumption value.

(b) For 'B' Category items there were 22 items - 10% of the total number of items and 19% of the total consumption value.

(c) The rest were in 'C' category i.e. 84.67% of the total number of items and 9.62% of the total consumption value.

ii) IRON AND STELL STORES

(a) 'A' category items were 19 in number i.e. 8.75% of the total number items , constituting about 72.5%of the total consumption value.

(b) 'B' Category items were 34 in number i.e. 15.6% of the total number items , constituting about 21.4%of the consumption value.

(c) Rest of the 6% consumption values was for the 'C' Category items which were 164 in number.

(iii) Boiler Stores

(a) There were 29 items under 'A' Category items i.e. about 7.25% constituting about 74.1% of the total consumption value.

(b) In 'B' Category there were 14.25 % of the items constituting about 20.7% of the consumption value.

(c) 'C' Category items had 78.5% items and 5.2%of the consumption value.

2.9.1 OBSERVATIONS

(i) WELDING STORES

(a) Oxygen and Acetylene were the two major gases sharing about 23.5 % of the total money invested in the Welding stores.

(b) About 30% of the items in Welding Stores are such that the Unit cost is less than Rs.10.

(c) In 'C' Category items, about 53.68 % items were such which were used either once or twice in one year i.e. were extremely slow moving.

(d) In 'C' Category items there were only 15 % items which could be called as Fast Moving Items.

(e) Cost of imported X-ray Films(AgfaMake) is less than the Indian Films (Indu make).

(f) For several items in the welding stores, shops issue individual indents i.e. every individual requiring items like hand-gloves, white glass etc. is issued on indent separately and this considerably increases the work load of the Welding Store personnel.

(g) Many items are lying dead in the store for quite a long period and nothing or very little , than required is being done to either use it or dispose it of.

ii) BOILER STORES.

(a) In this store, boiler tubes of different sizes shared the major chunk of investment.

(b) In many cases the boiler tubes of different categories like the ERW and SEAMLESS were being issued under the same heading, being classified only on the basis of their sizes.

(c) Most of the container items figured in the B - Catagory.

iii) IRON AND STEEL STORES.

(a) Imported BQ plates constitute the major items in 'A' and 'B' class.

(b) No categorisation is made for different grades of steel plates but accounting is based simply on the size of the sheet, angle, channel or plate.

(c) Accounting is being done on an average basis i.e. the average cost of the different items having same size in INDIGENOUS or IMPORTED category is taken. This results in numerous anomalies and quality analysis.

2.9.2 RECOMMENDATIONS.

i) X-Ray films, which are stored in the Quality Control Lab. , should be accounted for by the Quality Control Department i.e. they should maintain the record of its consumption. Recording of the consumption in welding stores could lead to SERIOUS ANOMALIES and incorrect recording of the consumption on either side.

ii) Indents for regular consumption items like the hand gloves , white glass, etc. which should be issued once in a week by the shop and stored with the shop incharge, rather than issuing indents for one or two pairs of gloves etc. This practice can save lot many man-hours which are lost because the workers take about 30 -45 Minutes to return to their work.

iii) Timings should be set in all the stores i.e. in a particular day, time for issue of material should be fixed. physical stock checking by respective Divisions should be undertaken by on specific dates of a month and during specified hours. This would result in smooth and efficient running of the stores.

iv) Stores pepple should report the dead items to the respective Divisions and the Divisions a re also requested to take prompt action either for their disposal or subsequent absorption in the shops.

v) In case of the container items which figure in the 'B' catagory of the boiler stores maximum control should be exercised which might result in further reduction in cost of production of containers.

CHAPTER THREE.

3.1 OBJECTIVE

Fixing up of Inventory levels of welding stores items.

3.2. THEORETICAL BACKGROUND

Fixing up the inventory levels of the items in a perticular store has become an important tool of Materials Management and more precisely the inventory control. Inventory problems are basically decision making problems. It is clearly observed that the basic decisions to be made in any inventory situation lie in the answers to the following , two questions, viz:

i) When do we buy?

ii) How much do we buy?

Answers to these two basic questions gives almost a total control over the inventory as far as raw materials are concerned.

Also the solution to the inventory problem is to find the appropriate levels for holding inventory and the ordering sequence and the quantity that had to be ordered so that the total cost incured is the minimum. The demand and supply conditions that act within and without impose constraints on the decision making process. The "Demand" remains either certain, risky or completely unsertain. On "Supply" side there are two different possibilities:

i) The supply being static if only a single supply is possible during the consumption period.

ii) Supply being dynamic if more than one supply is required during the consumption period.

These six conditions i.e. combinations of the supply and demand conditions gives rise to the two types of inventory control models viz:

i) Static Inventory Control Model.

ii) Dynamic Inventory Control Model.

Static Inventory Model is that in which the supply remains static, whereas in the second case the supply is in more than one order. Static Inventory Models although practical and of interest , are not so widely applicable as the Dynamic Model. They are of interest because they provide initial insight into the setting of the initial inventories of new items and into many problems of Dynamic inventory model.

Dynamic Inventory Control Model has the easiest approach in the fixing the Economic Ordering Quantity (EOQ) as the quantity to be ordered and fixing a Re-order Point (ROP) on basis of certain methematical formulae.

Now,

$$EOQ = \sqrt{\frac{2XAXC_o}{C_u x C_c}}$$

Where, A = annual demand of the item,

C_o = Ordering cost

C_c = Carrying cost

C_u = Cost/unit of the item.

& ROP = $\frac{Ax}{12}$ average lead - time (in months) + Safety stock + Buffer Stock

3.2 TERMS INVOLVED IN EOQ AND ROP

3.2.1 ORDERING COST

Every time an order is placed for stock replenishment or against a fresh re-quirement certain costs are involved and for all practical purposes, it can be assumed that the cost per order is constant. The ordering cost includes :-

(a) Paper work costs , typing and despatching an order.

(b) Follow-up costs , the follow-up required to ensure timely supplies, includes travel cost for purchase follow-up , telephone, telex and postal bills etc.

(c) Costs involved in receiving the order, checking, inspection and handing to the stores.

(d) The salaries and wages paid to the purchase Department.

3.2.2 INVENTORY CARRYING COSTS

This cost 'C' is measured as a percentage of the unit cost of the item. This measure, therefore, gives a basis for estimating what it actually costs a firm to carry a stock. This cost mainly includes:

i) Interest on capital.

ii) Insurances and Tax charges.

iii) Storage cost - any labour including handling of receipts of new orders, costs of provision of storage area and facilities like bins etc.

iv) Allowance for spoilage or deterioration.

v) Salaries of stores staff.

vi) Obsoleseence.

A major portion of this cost is constituted by the interest on the capital which depends upon the fiscal policies of the Govt.

3.2.3 SAFETY STOCK

While formulating a system for the purchase of raw materials and their subsequent replenishment , two factors play a pivotal role, viz.

(a) The consumption pattern never remains the same and is at best distributed over a set of probable values.

(b) The lead - time is never fixed but always has a probability of variation.

A precaution in the form of keeping an extra stock of the item must be taken to take care of these two variations, which quite often results in stock out and thus in loss in production. Stock required to check the first factor viz. the variation in the consumption pattern is called the "SAFETY STOCK". Safety stock depends upon the standard deviation in the consumption pattern.

SAFETY STOCK = S. D. x 2 (For 95% confidence level).

3.2.4 BUFFER STOCK

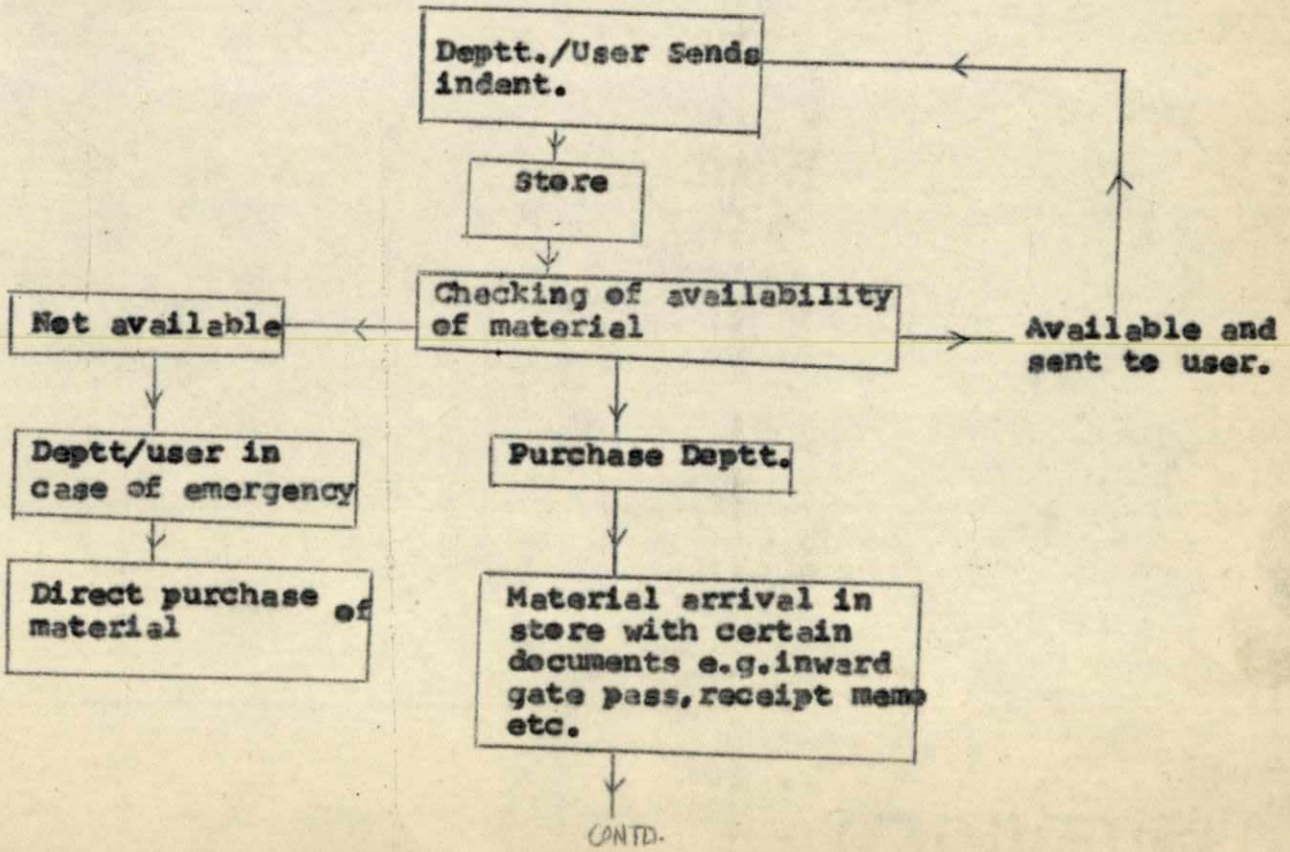
As mentioned earlier there are two factors besiding the development of a replenishment system. To take care of the second factor a "BUFFERS STOCK" is kept. Thus , Buffer sotck accounts for the variation in the lead time. Buffer stock depends on the maximum lead time and the the prbability of the material being supplied in that maximum lead time.

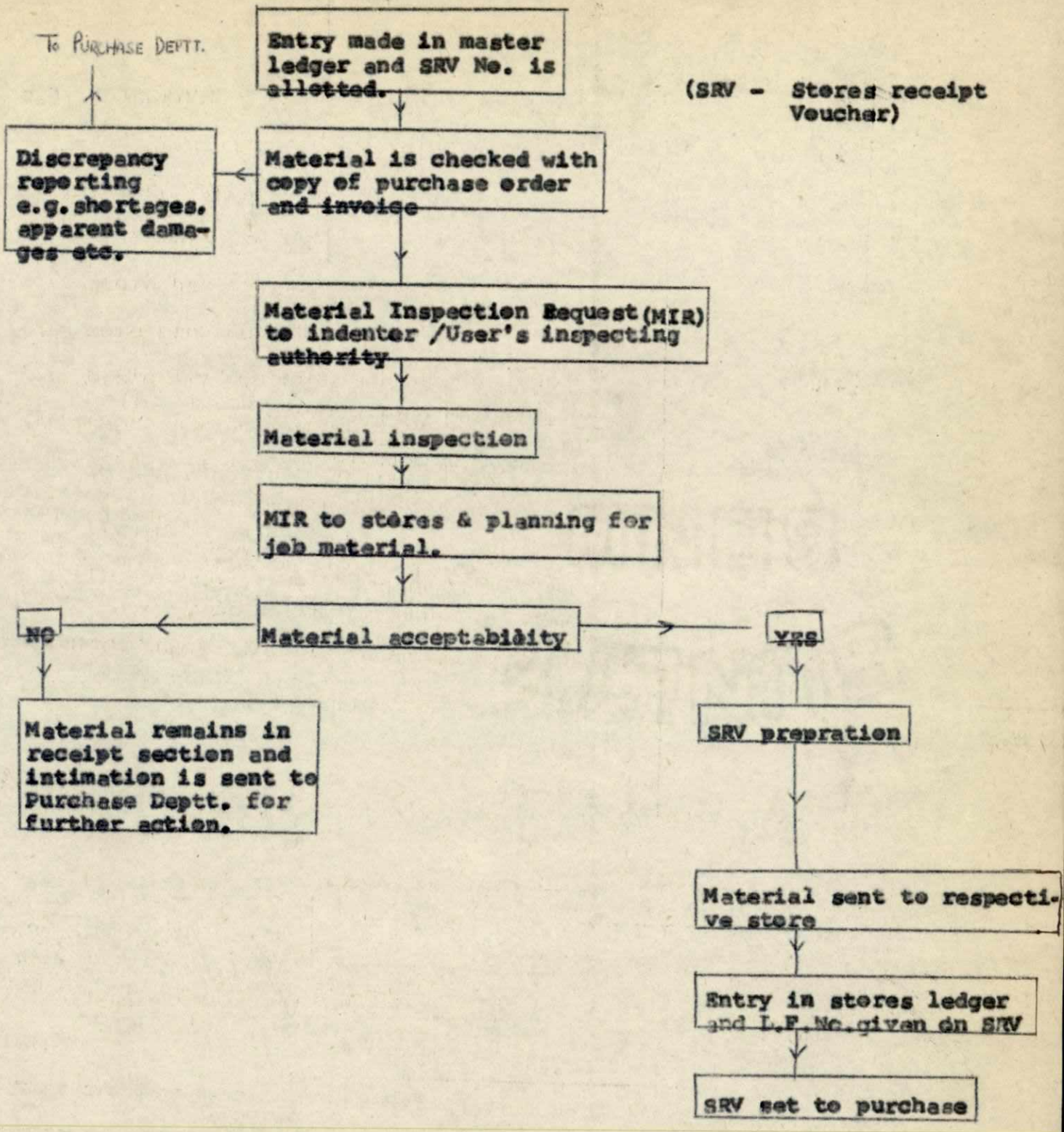
BUFFER - STOCK = P x Max. Lead - Time x Average Consumption (Per Month)

P = Pobability of item being delivered in the max. lead time.

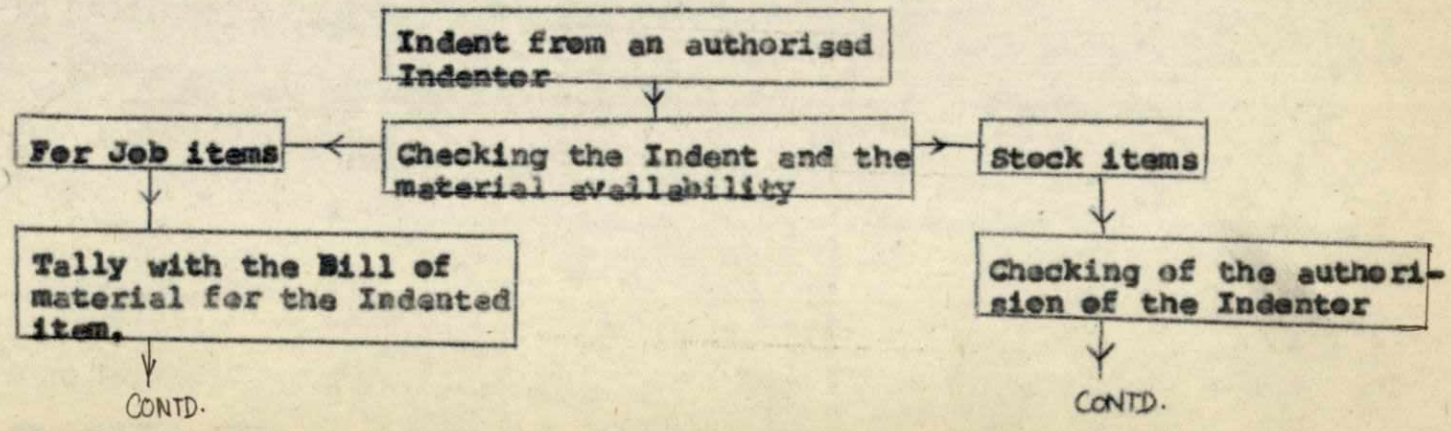
3.3 INTRODUCTION TO WELDING STORES AND PURCHASE DEPARTMENT.

As the name suggests, welding stores constitutes of the items which are called the "Welding consumables" and the "Welding equipment". Welding consumable constitutes the electrodes , fluxes , welding wires, filler wires , gases viz. acetylene, oxygen , Carbon-di-oxide. etc. and the welding equipments like cutting torches, Electrode-holder, etc. Consumption these items in the division was such that it necessitated the use of Dynamic Model of Inventory Control. Stores basically worked in the patternshown in the following flow diagram .





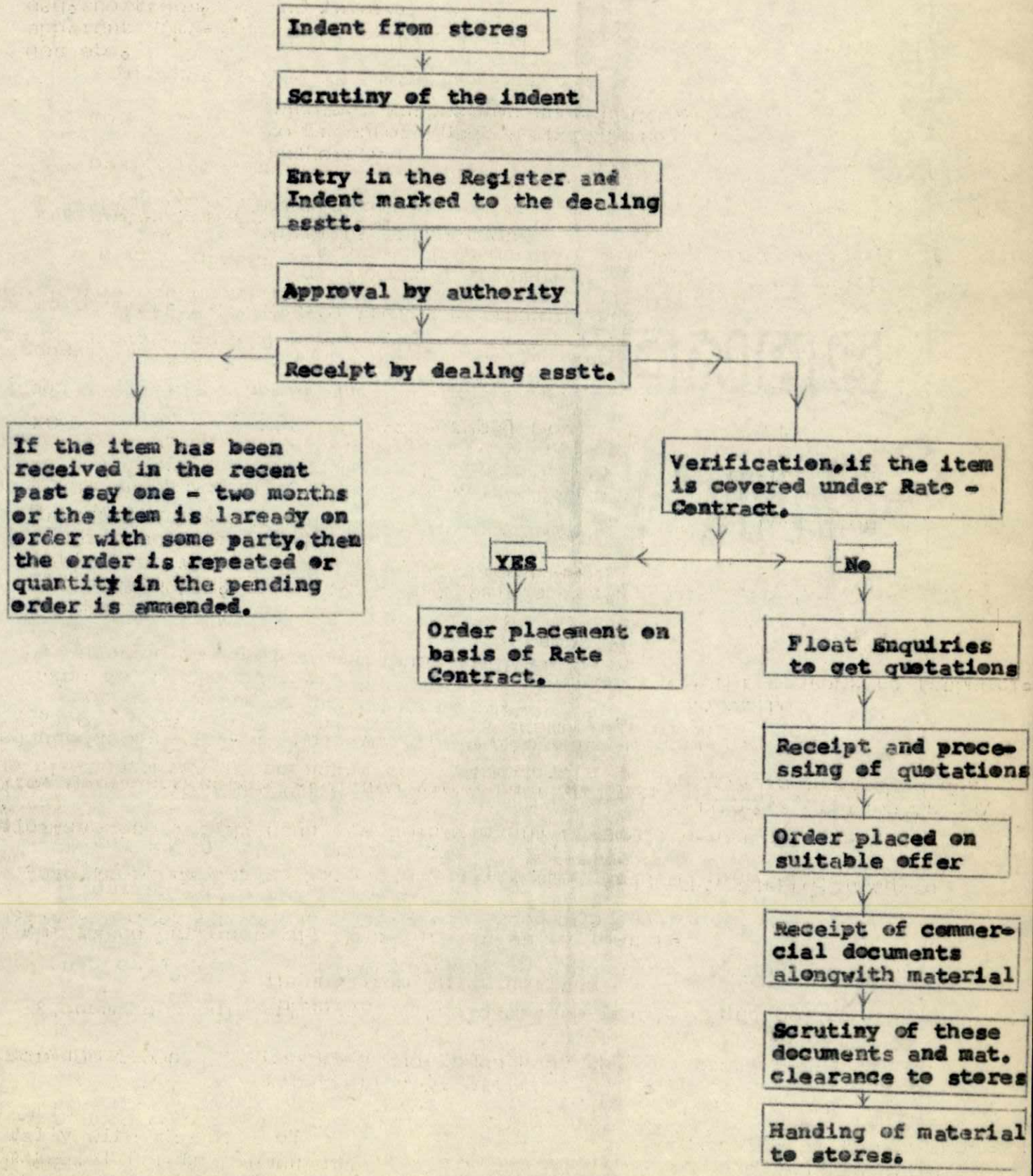
For issue purposes the procedure is as follows :-



In case the item is not in BOM or has been issued once the items is not issued

Issue of material and posting in ledgers

The working of Purchase Department is as shown in the following diagram:



3.4 ASSUMPTIONS

3.4.1 FOR CALCULATION OF EOQ AND ROP.

(a) Demand remains constant and is known for calculation of EOQ.

(b) For calculating ROP the "Veriable Demand Rate and /or Veriable Lead - Time" model has been assumed.

(c) Replenishment is instantaneous at the expiry of lead time.

(d) Cost/Unit of the item does not vary with the quantity.

(e) Ordering and carrying cost expressions include all relevant costs and these are constants.

3.4.2 FOR CALCULATION OF ORDERING COST.

(a) Only two types of items existed for the purchansing purposes ie.

i) Items purchased under an annual Rate - Contract with the suppliers, called the "Rate -Contract Items".

ii) Items purchased as and when required, called the "Non Rate Contract items."

(b) All the different types of costs constituting the ordering costs are taken care of by the Purchase Deptts Annual Budget.

(c) That 30% of the total time, spent on the prepration and execution of welding stores orders, goes for Rate Contract Items and 70% for non Rate Contract items.

3.4.3 SAFETY STOCK

(a) The consumption during lead time over a period one year is never fixed and is at best distributed over a set of propable values.

3.4.4 BUFFER STOCK

(a) There is always some probability of variation in lead time.

3.5 DATA COLLECTION.

3.5.1 ORDERING COST.

Annual Budget of Purchase Department = Rs. 5,95,200.00
Total number of orders placed by the Purchase Department = Rs. 4,255

No of orders placed for welding stores = 263

No of orders placed for Rate contract = 117

3.5.2 CARRYING COST.

Interest on capital = 16.5%

Salaries of the stores personnel = 1.0%

Storage costs = 1.0%

Other Misc. costs = 1.0%

3.5.3 ANNUAL CONSUMPTION.

The annual consumption of the items was taken as an average of the last 2.5 years as was available in the stores record.

3.5.4 COST /UNIT.

All the EOQ's were calculated on the basis of the cost/unit as per on 30.6.87 figures available with the accounts deptt.

(A factor was later incorporated to calculate the EOQ's on the current prices based on the escalation).

3.5.5 SAFETY STOCK

For calculating the safety stock, standard deviation over a period of 31 Months was taken. For 95% confidence level a multiplying factor of 2 was taken. The S.D. occuring in each item is shown against the same in Appendix ' ' .

3.5.6 BUFFER STOCK.

Calculation of Buffer stock constituted three major parameters viz. average consumption (Per Month) , max. lead time and probability of the max. delay.

Max. lead time was calculated on the basis of the deliveries made by the suppliers in the past. This record was available in "Master Ledger" maintained by the stores.

Based on the suppliers' rating and their past performances , probability of the maximum delay was supplied by the Planning Deptt.

Which is mainely associated with the suppliers.

Average consumption per month was already available.

The data was mainely collected from stores, accounts , and purchase Deptts. with the Purchase Deptt. supplying data for ordering cost, Accounts Deptt. the cost/unit of different items , carrying cost figures, while the rest of the data was collected from stores.

3.6 CALCULATIONS.

3.6.1 ORDERING COST

Based on the number of orders placed by the welding stores the ordering cost for the welding store items was calculated in the following manner:-

Total expenditure incurred on welding stores orders = $\frac{263}{4255} \times 595200000$

= Rs. 36,789.09

Expenditure incured on Rate Contract Orders =0.3 x 36,789.09

= Rs. 11,036.72

(Based on the time spent for preparation and final execution of Rate Contract Orders).

Expenditure incured on Non Rate Contract Orders = 0.7 x36,789.09

= Rs.25,752.36

∴ Ordering cost for Rate Contract Orders = Rs.94.33

and Ordering Cost for Non Rate Contract Order = Rs.176.38

For all practical purposes, Ordering Cost for,

i) Rate Contract Orders = Rs. 100.00

ii) Non Rate Contract Orders = Rs. 175.00

3.6.2 INVENTORY CARRYING COST.

Adding all the various costs given in 3.5.2 ,

Inventory carrying cost = 19.5%

≅ 20%

3.6.3 SAMPLE CALCULATIONS FOR EOQ AND ROP.

(a) Name of item - Supratherme (4mm) electrode.

Average requirement $\bar{A}$ = 11,673 Nos.

C_o = Rs. 100.00

C_c = 20%

C_u = Rs. 1.84.

EOQ = 8725 Nos.

Average lead time $\bar{LT}$ = 1.75 Months

Max. lead time LT = 2.25 Months

Probability of max. lead time = 10%

Standard deviation σ = 3988

$ROP = \bar{A} \times \bar{LT} + 2 \times \sigma + P \times LT \times \bar{A}$

$= 11673 \times 1.75 + 2 \times 3988 + 0.10 \times 2.25 \times 11673$

$= 31020.$

(For detailed observations for different items and their EOQ and ROP , refer Appendix 'I').

3.7 ANALYSIS.

3.7.1 CRITERIA FOR AN ITEM TO BE INCLUDED IN THE INVENTORY LIST.

Welding stores, as explained earlier, consists ,mainely of the items which can be called "Welding Consumbables", and "WeldingEquipment". To determine whether an item should be included in the Inventory List or not , the first step in involved was the ABC Analysis. From the ABC Analysis carried out for welding stores, explained in the previous chapter it was found that 90.4% of the total consumption value was taken away 'A' and "B" catagory items. So, if a strict control is exercised on these 'A' and 'B' items, by determining their EOQ and ROP , lot of saving can be expected. For the rest 9.6% of the stock value items, a comperatively relaxed control can be exercised by dec reasing the number of orders for

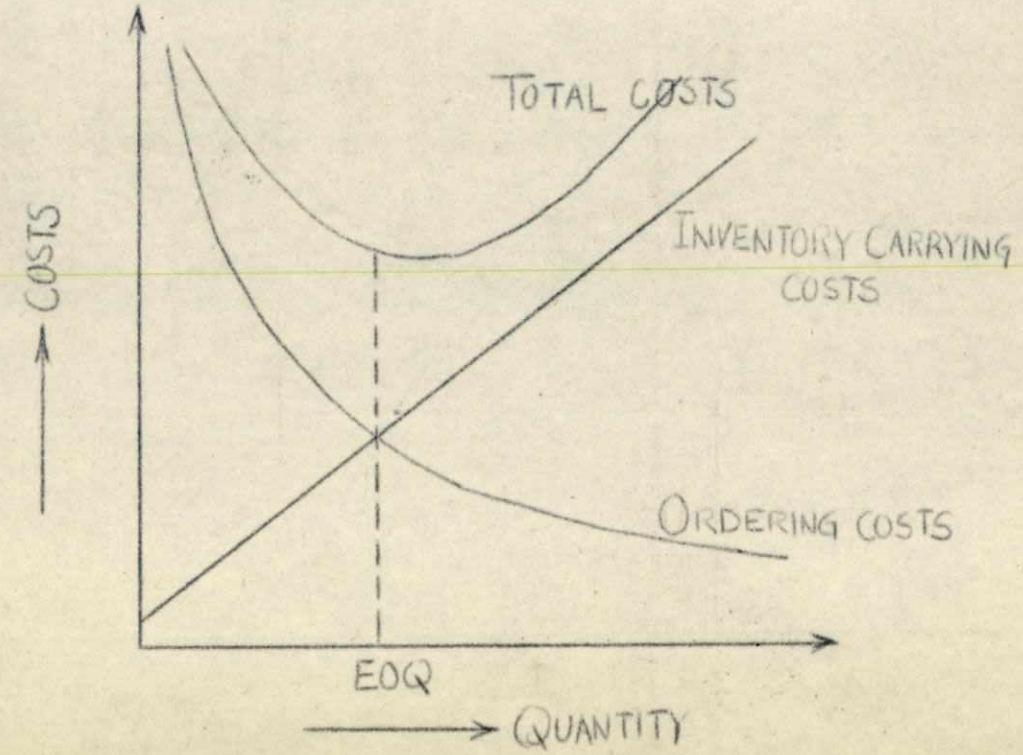
buying the total requirement of the Pressure Vessel Division.

For 'C' - Catagory items only, an FSN analysis was carried out. From this it was seen that only a few items were "Fast Moving" and the rest were quite "Slow" . These fast moving items were those which had been issued for more than Seven Times in a year. When this analysis was combind with the results of ABC Analysis , it was clearly observed that these fast moving C - catagory items were "high" C - class items i.e. these items were such ,that occupied the position very close to B catagory items. These items were also analysed for EOQ . depending upon the number of orders to be placed annually, their economics was calculated for one order and number of orders, which finally give the Inventory List. (Some of the items which were very slow moving and were put under this list earlier were retained without any change in the EOQ and ROP)

3.7.2 ANALYSIS OF THE MODEL

3.7.2.1 EOQ MODEL.

EOQ Model is is basically dependent on two factors i.e. ordering cost and Inventory carrying cost the veriation of the two with increasing quantity to be purchased is as shown :



16-3-89.

80074

Clearly with increasing ordering quantity the ordering cost decrease but there is an increase in the carrying cost. So an Optimum balance has to be struck where to two are equal and the total cost is minimum. And the quantity at that minima is the EOQ . After calculating the EOQ using the theoretical model , depending upon the packing available and further transportation in creats , an "Economic Batch" Quantity was calculated.

eg. EOQ = 4886

No of electrodes per packet = 100

No of packets per create = 10

Therefore , Economic Batch Quantity = 5000.

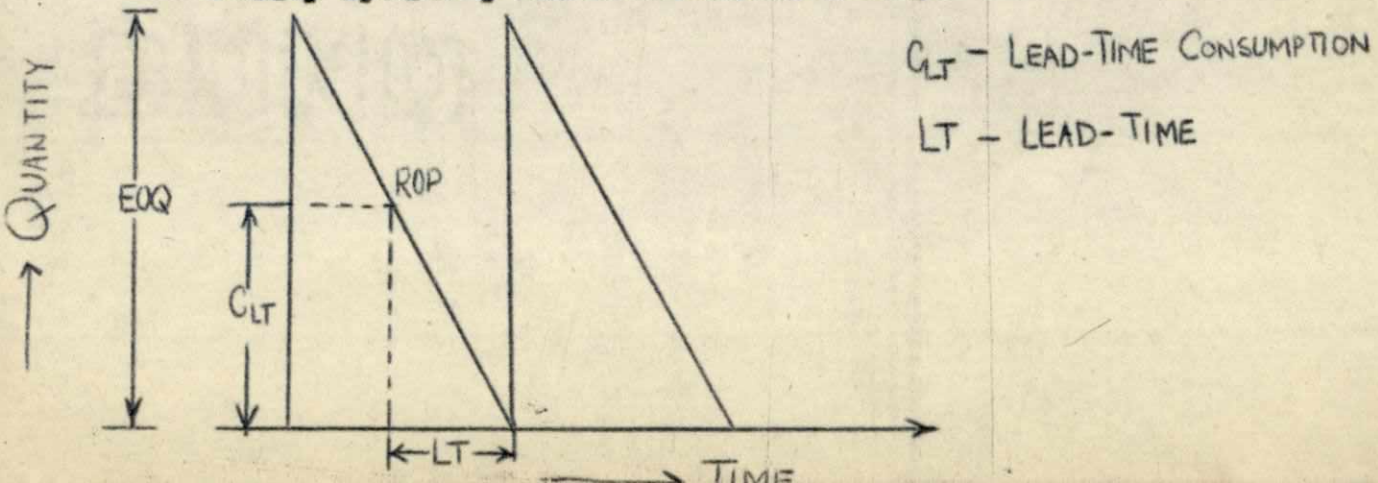
3.7.2.2 ROP MODEL.

The "Inventory Control Model" that has been adopted is probably the simplest of the different theoretical models available. The "Variable Demand and/or Variable Lead Time Model" for ROP was necessitated because of the two reasons :-

i) The demand of a particular item varied from month to month and the average consumption taken is at best distributed over a period of 2.5 years. Thus , there was a high possibility of variation in demand.

ii) The supply conditions in our country are such that there is always some probability of variation in the lead time.

Idealy speaking the model is as shown.



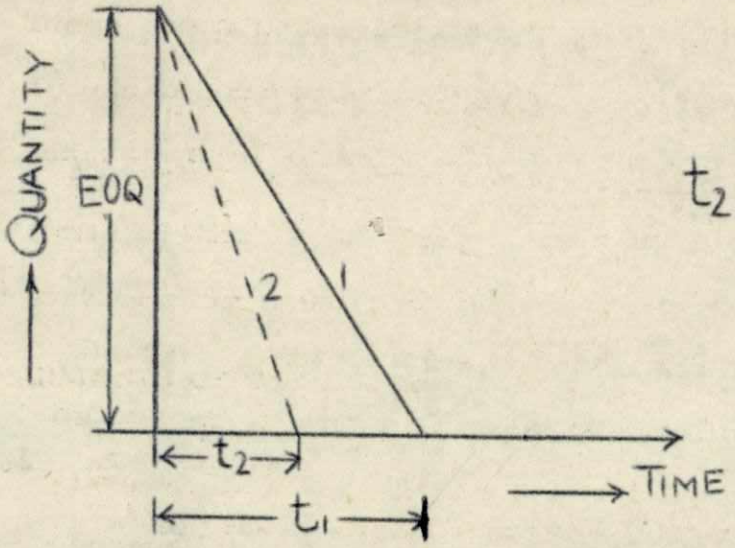
In an ideal system the replenishment is instantaneously at the expiry of lead time. Depending upon the lead time a Re-order Point is calculated as .

ROP = Lead time consumption

$= \bar{A} \times \overline{LT}$

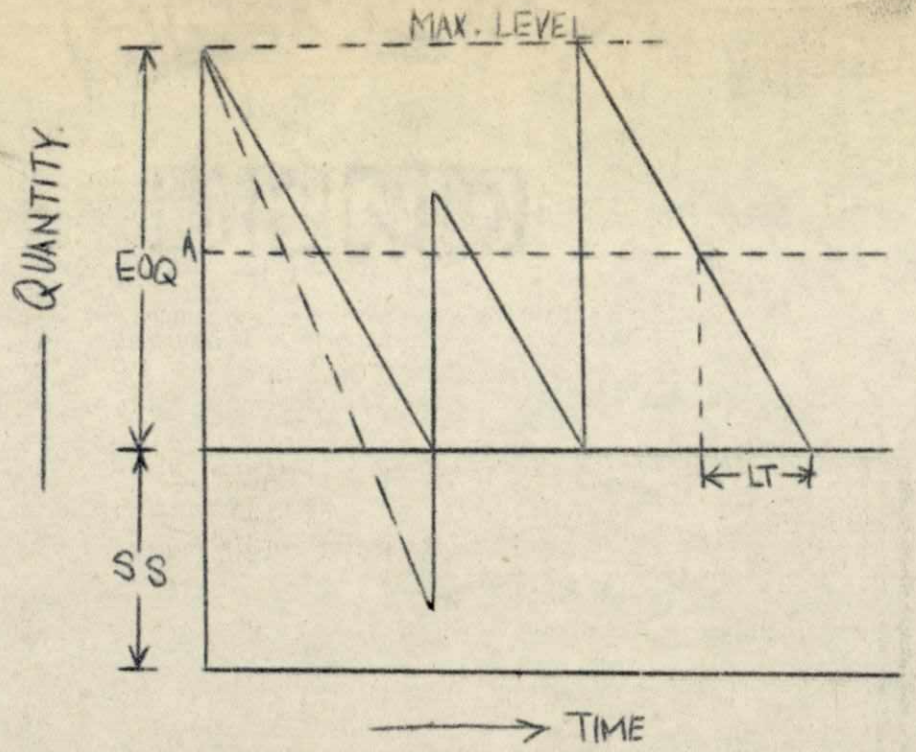
Thus when the ROP arrive we order a quantity equal to the EOQ.

Now considering the first variation,



$t_2 < t_1$

In an idial system,we always assume that the consumption will occurs at a constant rate starting from the maximum level to zero level at the expiry of the lead time. The rate of consumption is given by the slope of the line 1 . But, if the slope of the line increases to line 2, i.e. the stock that was earlier consumed in time 't_1' is now consumed in time 't_2' ($t_2 < t_1$) .it will result in a stock out for a time period of ($t_1 - t_2$) because the next delivery schedule at the end of time t_1. To avoid such situations a "Safety Stock" is kept. When there is safety stock available then the situation becomes as shown, on the next page.

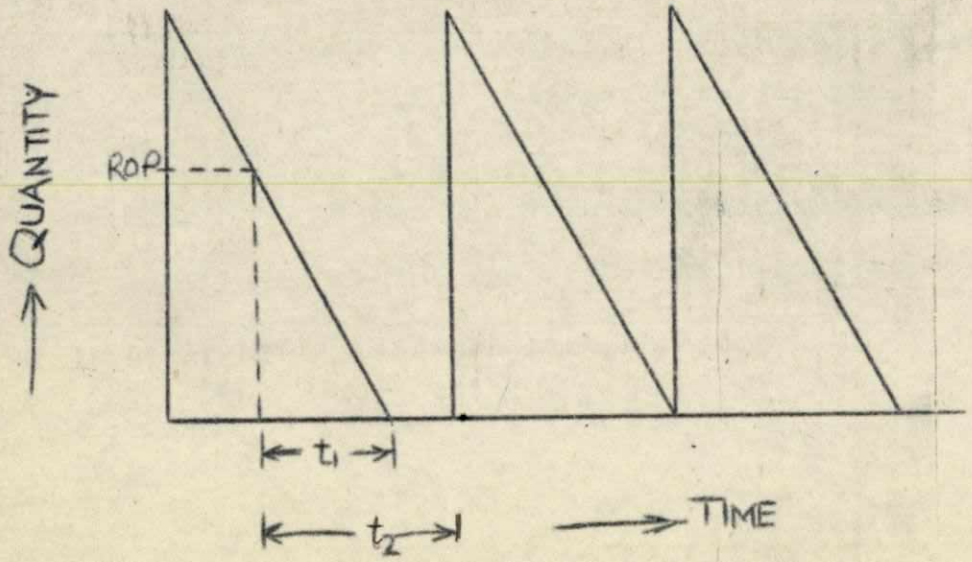


A - ROP

S.S. – SAFETY STOCK.

So, when the safety stock is available the user can use the safety stock for the time period t_1 - t_2. When the next supply comes the stock is replenished to level below the maximum level. But at the next ROP again the EOQ is ordered and assuming that it arrives in the scheduled time and the consumption remains constant according to the slope of line 1_2, the stock is again replenished to the initial maximum level.

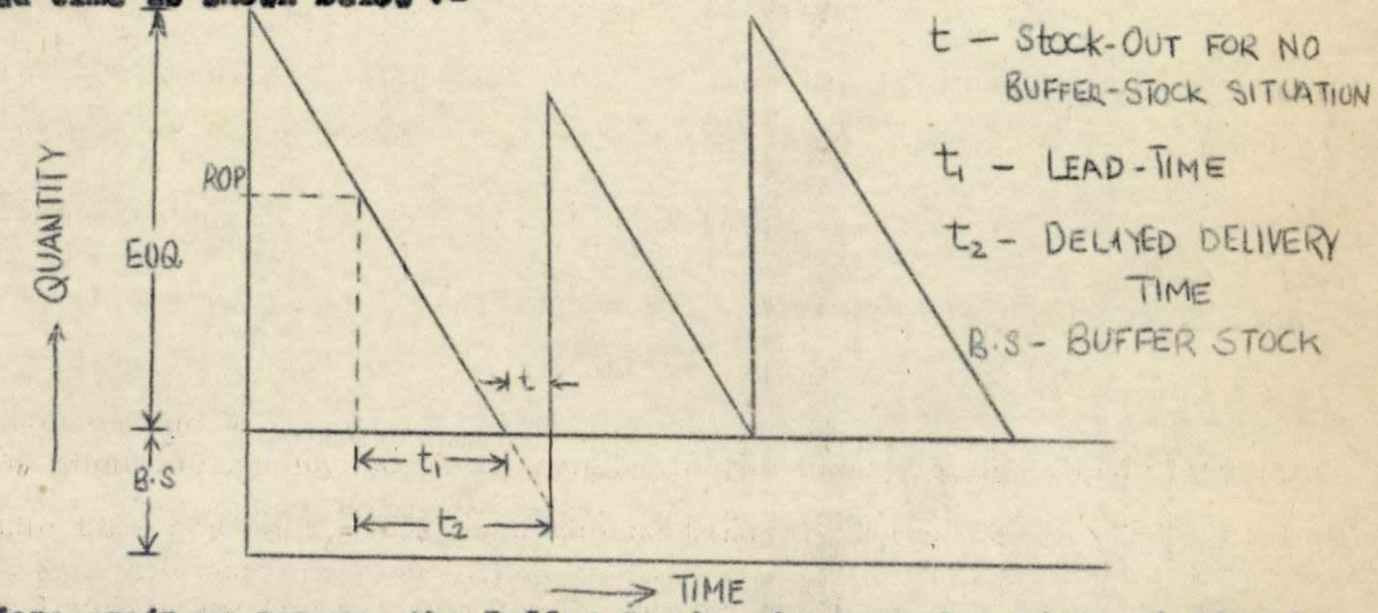
Further considering the second factor, we have variation in lea-d time. Then we have a situation,



$t_2 > t_1$

t_1 = LEAD-TIME

We have a situation where the stock has not arrived at the expiry of lead time and arrives at the end of time 't_2' ($t_2 > t_1$, where t_1 = lead time) Therefore, a "Buffer Stock" has been kept for checking the variation in the lead time as shown below :-

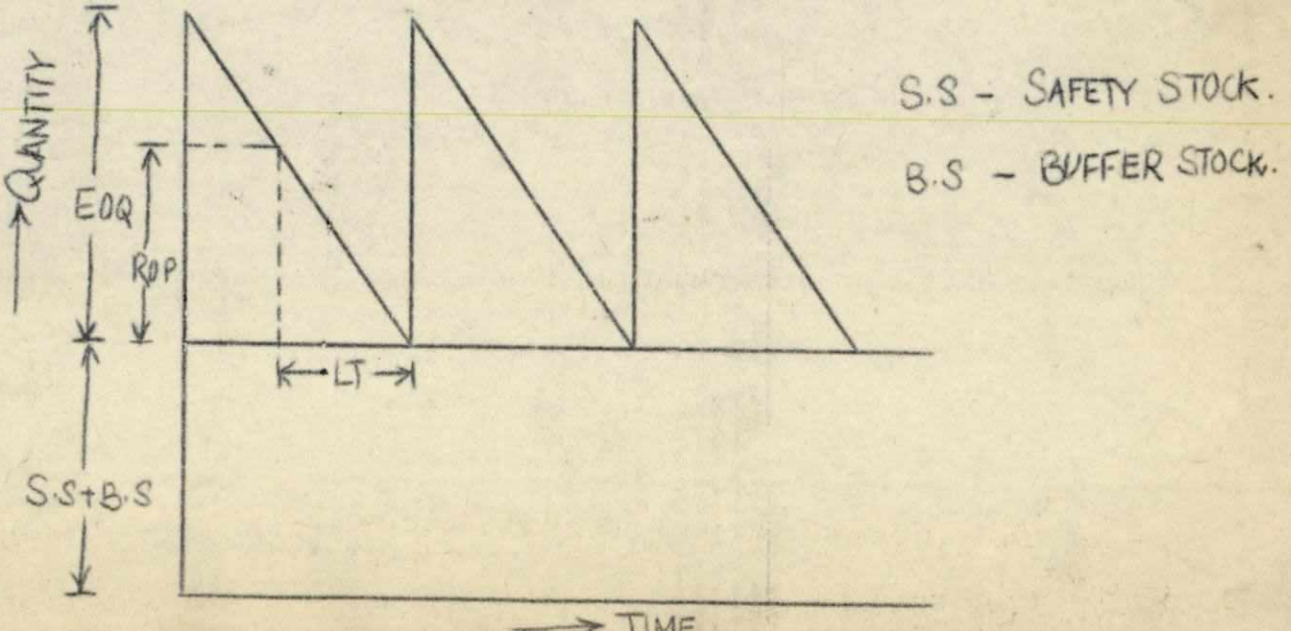


Here again we can use the Buffer Stock , in case there is variation in the lead time. Again the stock reaches its maximum level at the delivery of next order.

Following these two patterns , the ROP formula that was finally arrived at is ,

ROP = $\bar{A} \times \bar{LT}$ + Safety Stock + Buffer Stock.

So now we have the following pattern,



We order EOQ at ROP and hence we have,

Maximum level = EOQ + SAFETY STOCK + BUFFER STOCK , and

Minimum level = SAFETY STOCK + BUFFER STOCK.

But ,

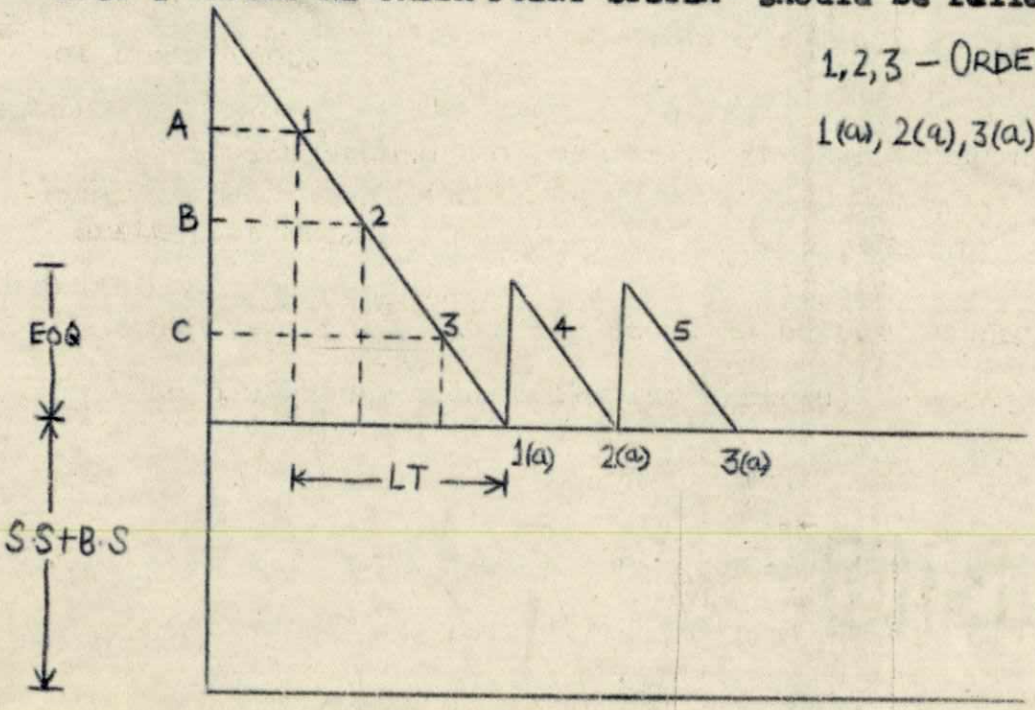
A MAJOR LIMITATION OF THIS EOQ - ROP MODEL IS THAT IT IS APPLICABLE ONLY WHEN ,

EOQ IS GREATER THAN LEAD TIME CONSUMPTION.

When an analysis of the various EOQ's and lead time consumption it was found that in most cases ,

EOQ is less than the lead time consumption.

So to make this model more adaptable to this condition it was proposed that a "MULTI RE-ORDER POINT SYSTEM" should be followed. Graphically.



A = First ROP (ROP_1)

= A x LT + Safety stock + Buffer stock

B = Second ROP (ROP_2)

= ROP_1 - EOQ

C = Third ROP (ROP_3)

= ROP_2 - EOQ

and hence subsequent Re-order Points can be calculated. Therefore,

Final ROP = ROP_1 - N (EOQ)

Where $N = \frac{\bar{A} \times L\bar{T}}{EOQ}$ (rounded off to lower value)

eg. If $\frac{\bar{A} \times L\bar{T}}{EOQ} = 2.8$

Then N = 2.

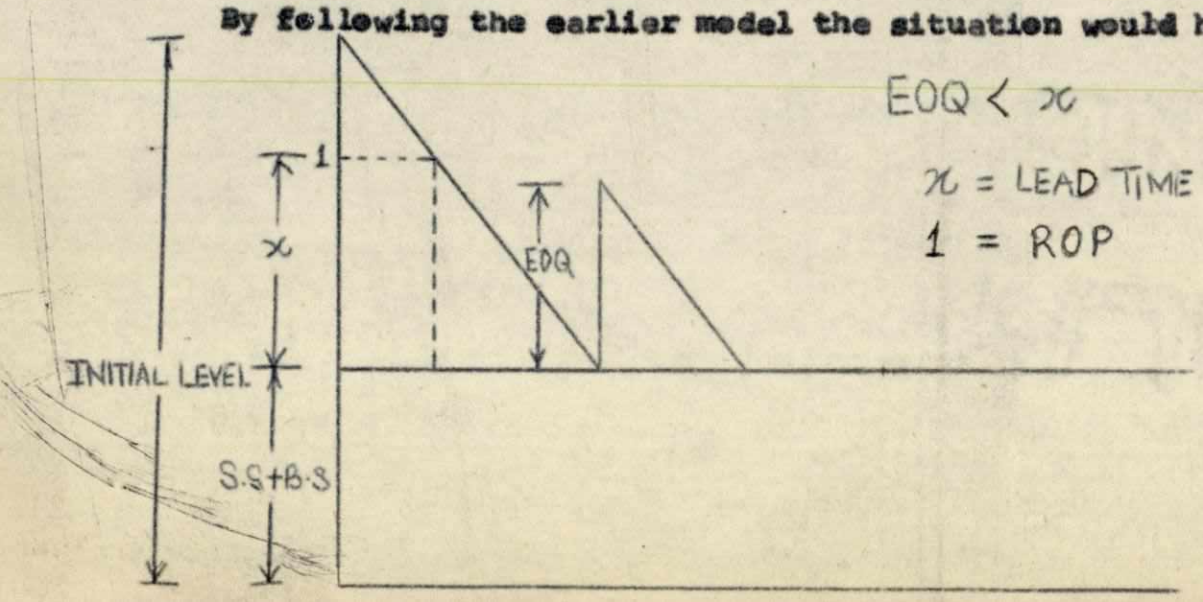
In this system the initial level is either greater than the previously calculated ROP or equal to it and the first order is placed at the ROP_1, which is the calculated ROP with earlier model. Second order is placed at ROP_2 and then the subsequent orders can be placed at different ROP's till the first supply reaches the store. Subsequently the order should be placed at Final ROP.

The advantage of this model over the previous one is that, by the time first supply comes in, two orders have already been placed and thus the system gives . ~~maxi~~

Maximum level = Safety Stock + Buffer Stock + EOQ

and Minimum level = Safety Stock + Buffer Stock.

By following the earlier model the situation would have been as shown:-



THEREFORE, AT THE SUPPLY OF THE FIRST ORDER, ROP IS NEVER REACHED AND HENCE A MULTIPLE RE-ORDER POINT SYSTEM HAS TO BE FOLLOWED.

3.8 CONCLUSIONS

(a) Most of the items in the existing list were being ordered uneconomically

(b) Safety and Buffer stock were either totally missing or inadequate.

(c) Both PVD and GD have given their seperate EOQ's and ROP's resulting in high expenditure and greater number of orders for the same item. This conclusion is based on the following analysis :-

S/No.	Name of item	Average requirement		EOQ		Proposed EOQ	Total cost	
		GD	PVD	GD	PVD		Existing	Proposed
1.	Supratherme (4mm)	2300	11,673	1800	13750	9500	5413.26	3512.96
2.	Supratherme (5mm)	5500	12,488	2400	8050	9100	7318.11	4728.91
3.	Supratherme (6.3mm)	900	4,417	2000	6000	4055	4527.40	3146.90
4.	Grinding wheels (6"x1")	180	208	150	250	440	5945.60	3698.05
5.	Flux Tapadia Gr-80	170 Kg	969 Kg	400 Kg	4500Kg	1565Kg	4844.20	3055.81
						TOTAL - Rs.	28048.57	18142.6

Therefore, savings in five items = Rs. 9905.94

Percentage savings = 35.31%

Further, seperate orders are placed for GD and PVD .

Total number of orders is .

S/No.	Name of item	Total No of orders (PVD + GD)			
		Existing	Proposed	TOTAL Existing	TOTAL Proposed
1.	Supratherme (4mm)	25	17		
2.	Supratherme (5mm)	47	24		
3.	Supratherme (6.3mm)	14	16		
4.	Grinding wheels (6"x1")	24	11	118	75
5.	Flux Tapadia Gr-80	8	9		

Therefore, % Reduction in number of orders = 36.4 %

(d) There are many items lying dead in the stores and majority of them have not been used for the last 10 years. The Company has been bearing a lot of carrying cost on these items.

(e) The Purchase Department , while making purchases for the items, for which the EOQ and ROP levels have been fixed, at a discount never calculated the relative merits and demerits of availing the discount. On one hand , savings might result by availing the discount, but it might also result in increased carrying costs.

(f) Many of 'C' category items i.e. 58 % were such, as were issued only once or twice during the year. Many of them are being maintained in the "Inventory List" , whereas these can be conveniently purchased in one order or by following a "DEFERRED ORDERING SYSTEM".

3.9 RECOMMENDATIONS.

i) Dead stock items should identified and should be either disposed of or consumed. It is also possible to change their book value and these items declared as "Scrap".

ii) GD and PVD should order the items of commun use to-gether i.e. single EOQ and ROP should be maintained. This can result in lot of savings.

iii) It is proposed that the Purchase Department be given a list of the EOQ's of various items. The Purchase Department shpuld make use of the following formulae while making purchase at a discount to compairethe savings and the extra inventory carrying cost.

$$\text{Savings} = \%\ \text{discount} \times \text{Annual demand} \times \text{cost/unit} + \left(O_n - \frac{\text{Annual demand}}{\text{Discount order}}\right) \times \ldots * 100$$

Where O_n = No of orders to be placed annually with no discount.

$$= \frac{\text{Annual Demand}}{\text{Calculated EOQ}} .$$

Discount order = Quantity being ordered for which the discount is available.

Extra Inventory Carrying Costs = (Discount order - Actual EOQ) x $\frac{1}{2} x C_u x C_c$

So, a comparison should be made and in case the savings come out to be greater than extra Inventory carrying cost , the discount offer should be accepted.

iv) For all purchased to be made by the Division , requisitions should be enrouted through Planning Department or Industrial Engineering Department, which should check that whether the requisitioned item is required in that quantity. Any modifications should be duly incorporated and then only the Indent should be forwarded to the Purchase Department.

3.10 FURTHER SCOPE OF STUDY

i) Detailed study of dead items lying the welding stores and the approx. carrying cost that the Company has borne . Further , identification of items which can be economically re-used and which should be disposed of.

ii) Evolving a system of booking of cost on the two Divisions if the two Divisions made a common purchase for the items of use in both Divisions.

iii) Conducting and ABC Analysis for the figures available for 1987-88 and combining it with the analysis for 1986-87 . and further analysis of the results.

iv) Carrying out of VED Analysis for the welding stores and combining it with the ABC Analysis, and revision of Inventory List on the basis of the results of the combined Analysis.

v) Identification of items which can be bought under "DEFERRED ORDERING SYSTEM".

CHAPTER FOUR

4.1 OBJECTIVE

To study the idleness of machines in the Machine shop for various reasons and to propose measure to control the same.

4.2 THEORETICAL BACKGROUND

Machines remain idle for a considerable period during a shift due to various reasons, like the job mounted on the machine is being unloaded or a new job is being mounted on the machine, etc. This idleness of machine is a direct loss and attempts and efforts should be made in this direction to reduce this loss.

From a number of machines in the Machine Shop a few representative machines were selected and a study was conducted. These machines comprised of .

i) Lathes - 4 Nos
ii) Horizontal Boring Machines - 4 Nos
iii) Planars - 2 Nos
iv) Shaper - 1 No
v) Horizontal Drilling Machine - 1 No.

Since, this study called for the study of a group of machines, it was decided that the WORK SAMPLING TECHNIQUE of Work Measurement should be adopted . Work Sampling Technique is a measurement technique which provides information on a quantitative basis for the effective utilisation of resources. The information is provided on the basis of the samples of work done in any place. The princple of work work sampling may be stated as follows :-

If a large number of snap readings are taken at random points of of time (also called Random Time Sampling) on a machine, and a record is kept of the status of the machine at each point of the time as working or idel the percentage of obversation recording the machine in a

given state (working or idel) is the measure of the time the machine is in that state. For example, if 180 readings are taken, and the machine is found to be idel on 18 occasions , the %age of the observations in 'Idle' state is .

$$\frac{18 \times 100}{180} = 10\%$$

and thus the machine working in an 8-hours shift remains idle for .

$$\frac{480 \times 10}{100} = 48 \text{ Minutes}$$

Work Sampling Technique is based on the following three aspects :-

i) Samples of work,

ii) That sufficiently large number of observations are to be made,

iii) That observations are to be made at random points of time.

All these three aspects of work sampling are statistical based and hence the whole technique is based on the statistical approach.

Few terms used in the technique :-

i) Accuracy

By 'accuracy', we mean that the closeness of the sample estimate is to the true value. The closer the estimate to the true value, the more accurate the estimate will be. To have the results to be of some practical use the estimates must be known and reasonable accuracy.

The range of accuracy required is normally specified in advance as $\pm$ 2% . $\pm$ 3% etc. The required accuracy level has a bearing on the number of observations. Greater the accuracy required i.e. smaller the range, larger the number of observations to be taken. The accuracy of work sampling results can be specified in two ways, viz. the 'absolute' and 'relative' accuracy.

Difference between the two can be explained in the following example:-

Let , the desired accuracy = 5%

Estimate of the activity under study = 22% (Say)

Then, the absoulute accuracy = 22% ± 5% i.e. between 17% and 27%

And , relative accuracy = 22% ± 5% of 22% i.e. between 21.9%

and 23.1 % or it can be expressed as 22% ± 1.1%

ii) Confidence Level

Confidence level or confidence means, that if one were to repeat such a study under similar condition, the results would lie between those limits. For example, assuming that estimates were expected to lie between P ± 2σ where "P" is the estimated occurance of the event , then the confidence level is 95% .

This means that if such a study was repeated under similar conditions 95% chances are that the results would be similar.

iii) Number of Observations

The numbers of observations required to have a desired confidence level at a specified accuracy vary and can be calculated by using the following formulae:

(a) Absolute Accuracy $= A = K \sqrt{\frac{P\ (1-\ p)}{N}}$

where K = multiple of depending upon the required confidence level.

A = Absolute accuracy

P = %age occurance of the activity under study

N = Number of observations

(b) Relative Accuracy $= R = K \sqrt{\frac{(1-\ p\ )}{P.N.}}$

.3 DATA COLLECTION

Before conducting the actual study, a pilot study was conducted to find out the various elements that will be involved in the study. After conducting the pilot study , following elements, with their definitions were observed. Proper numerical codes were allotted to each element for effective data collection (numbers shown in brackets represent the codes of the elements):-

i) MACHINE WORKING (ONE) : Activity marked (1) was that the machine was found to be inworking condition.

ii) TOOL SETTING/UNCLAMPING (2) : Operator was found to change the tool-setting or unclamping the tool.

iii) JOB SETTING /UNCLAMPING (3) : Job was being set on the machine or was being unclamped .

iv) MANIPULATIONS (4) : When the operator was found to be moving the carriage of the lathe, or the ram of boring machine, bringing the tool to the exact starting point etc. the activity was marked as (4)

(v) GAUGING (5) : Any measurement being taken.

(vi) ROUTE CARD /DRAWING READING (6): Self explanatory.

(vii) INSPECTION (7) : Self explanatory.

(viii) AWAY FROM WORK PLACE (8) : When the operator was not found at his work place.

(ix) OPERATOR IDLE (9): When the machine was idle because the operator was idle.

(x) MACHINE UNDER MAINTENANCE (10): Self explanatory.

(xi)CRANE-WAIT ((11) : Self explanatory.

(xii)PERSONAL NEEDS OF OPERATOR (12) : Self explanatory.

(xiii)TOOL ROOM /TOOL GRINDING (13) : Operator has gone for a change of tool to tool room , or is grinding the tool.

(xiv)OPERATOR RECEIVING INSTRUCTIONS (14): Receiving instructions from Supvr. , shop incharge , or any other senior staff.

(xv)HANDING/TAKING OF CHARGE (15): Self explanatory.

(xvi)MACHINE CLEANING (16) : Self explanatory.

The data was collected in the tabular form as shown below :-

M/C No. / Time	P-3	HB-2	L-22	L-18	S-1	HB-3	HD-1	L-21	HB-1	L-14	P-4	HB-5
7.38	13	10	5	14	12	1	12	14	6	2	13	4
7.54	16	10	14	14	1	1	9	4	1	8	6	9
8.06	8	10	1	8	1	3(3)	3	1	1	5	6	7
8.14	4	10	1	16	1	1	9	1	1	1	10	10

The alphabets used in M/C No. represents :-

P - Planar

HB -Horizontal boring

HD-Horizontal drilling

L -Lathe

S- Shaper

4.4 CALCULATIONS

After conducting a pilot study for three days the following observations were noted and the Required number of observations was calculated :-

Date	No of M/Cs working	Shift	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7.4.88	12	A	141	21	62	13	10	4	4	15	27	3	2	18	16	9	-	3
8.4.88	11	A	139	10	29	13	16	7	3	26	30	8	5	13	17	17	1	7
9.4.88	12	C	124	10	28	20	19	3	1	18	32	-	2	17	14	4	1	7
Total			404	41	119	46	45	14	8	59	89	11	9	48	47	30	2	17

Total number of observations taken = 988.

From the formula used for absolute accuracy .

$$A = K\sqrt{\frac{P(1-P)}{N}}$$

We observe . $A \propto P$.

That is with increasing P, A increases and hence the number of observations.

Considering activity number (3) which is occuring for most of the time, (From all the various reasons of idleness).

$$N = \frac{K^2}{A^2}(1-P)\,P$$

For K = 2 i.e. 95% confedence level,

& A = 4%,

$$N = \frac{(2)^2}{(0.04)^2}\,P\,(1-P)$$

$$P = \frac{119}{988} = 0.12$$

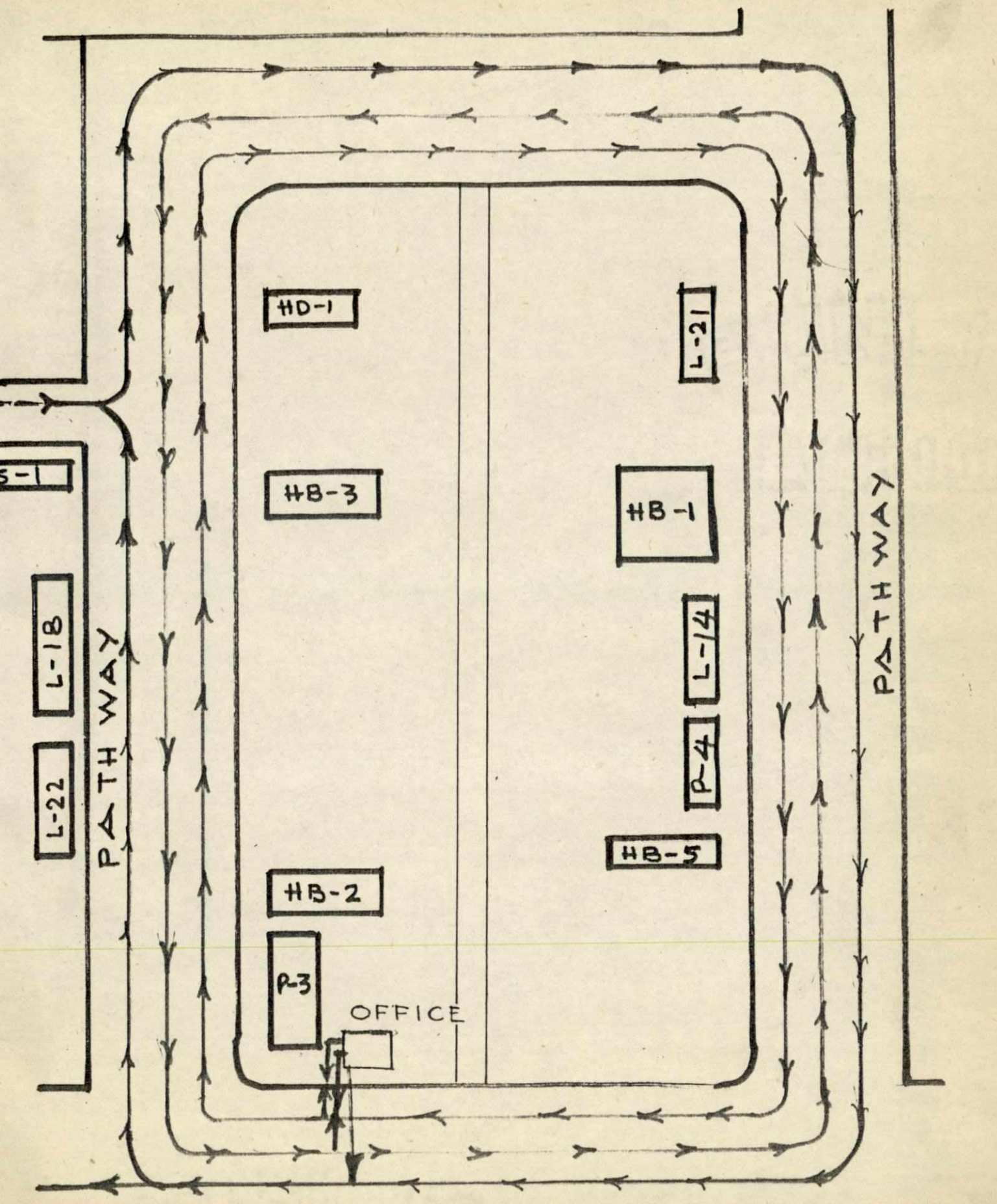
$$N = 265.$$

i.e. for each machine a minimum of 265 observations are required. After taking about 400 observations for each machine back calculations were done and 'A' was calculated.

S/No.	Machine No.	No of observations	$P_{max.}$ (%)	A
1	P-3	450	14.5	3.3
2	HB-2	463	22.7	3.9
3.	L-22	433	18.2	3.7
4.	L-18	436	11.2	3.0
5.	S-1	462	13.6	3.2
6.	HB-3	325	18.8	4.3
7.	HD-1	437	17.6	3.6
8.	L-21	463	10.4	2.8
9.	HB-1	461	9.5	2.7
10.	L-14	461	9.8	2.8
11.	P-4	449	14.0	3.3
12.	HB-5	463	10.8	2.9

Therefore, the number of observations taken was sufficient.

LAYOUT OF MACHINES



PRINCIPAL PATHS FOLLOWED FOR OBSERVATIONS

4.5 ANALYSIS

The analysis of the study is reflected in the following two tables :-

TABLE No. 1 (Results with machines under maintenance)

M/C No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
P- 3	33.4	6.0	14.4	7.8	2.9	-	2.5	9.3	4.5	3.3	-	3.3	5.1	2.0	-	4.5
HB-2	32.6	5.2	11.9	3.2	1.7	-	-	6.3	2.6	22.7	-	3.7	4.1	2.8	-	-
L-22	35.8	3.9	18.2	2.5	4.4.	1.6	-	10.2	5.5	-	-	4.6	5.8	4.2	-	2.3
L-18	33.0	-	3.7	10.8	11.2	-	1.4	8.7	9.9	2.1	-	5.3	5.7	5.7	-	-
HB-3	29.5	5.5	18.8	5.6	2.1	-	-	6.8	8.3	8.9	1.5	4.3	3.1	3.4	-	1.5
S-1	47.4	4.1	13.6	2.4	2.8	-	-	9.5	4.8	-	1.1	4.9	5.2	2.2	-	-
HD-1	20.4	5.7	17.6	2.7	-	1.6	-	13.0	16.0	-	1.4	6.2	10.1	2.3	-	1.1
L-21	49.6	4.5	3. 7	3.7	6.0	1.7	2.8	10.4	4.8	-	1.9	3.5	3.0	3.5	-	-
HB-1	34.3	9.5	7.6	6.9	8.9	2.2	5.4	1.9	2.4	9.5	-	2.6	3.5	3.7	-	-
L-14	51.8	5.2	9.8	3.5	6.5	-	1.1	6.1	3.9	-	-	1.9	2.4	1.7	-	3.9
P-4	42.5	2.9	14.0	11.1	2.9	2.0	1.1	2.2	2.2	6.2	1.1	3.6	2.0	3.3	-	2.0
HB-5	41.7	3.9	10.8	6.9	6.5	1.3	5.2	5.8	4.9	1.1	-	4.5	3.2	3.2	-	-
Average	37.6	4.7	12.0	5.6	4.7	1.0	1.6	7.5	5.8	4.5	0.6	4.1	4.4	3.3	-	1.3

TABLE No. 2 (Results with machine ,not considered, under maintenance)

M/C No.	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16
P-3	34.7	6.2	14.9	8.1	3.0	-	2.5	9.7	4.6	-	3.4	5.3	2.1	-	4.6
HB-2	42.2	6.7	15.4	4.2	2.2	-	1.4	8.1	3.4	1.1	4.7	5.3	3.6	-	-
L-22	35.8	3.9	18.2	2.5	4.4	1.6	-	10.2	5.5	-	4.6	5.8	4.2	-	2.3
L-18	33.7	-	3.7	11.0	11.5	-	1.4	8.9	10.1	-	5.4	5.9	5.9	-	-
HB-3	32.4	6.1	20.6	6.1	2.4	-	-	7.4	9.1	1.7	4.7	3.4	3.7	-	1.7
S-1	47.4	4.1	13.6	2.4	2.8	-	-	9.5	4.8	1.1	4.9	5.2	2.2	-	-
HD-1	20.4	5.7	17.6	2.7	-	1.6	-	13.0	16.0	1.4	6.2	10.1	2.3	-	1.2
L-21	49.6	4.5	3.7	3.7	6.0	1.7	2.8	10.4	4.8	1.9	3.5	3.0	3.5	-	-
HB-1	37.9	10.6	8.4	7.7	9.8	2.4	5.9	2.2	2.6	-	2.9	3.8	4.1	-	-
L-14	52.2	5.2	9.8	3.5	6.6	-	1.1	6.1	3.9	-	1.9	2.4	1.7	-	3.9
P-4	45.4	3.1.	14.9	11.9	3.1	2.1	1.2	2.4	2.4	1.2	3.8	2.1	3.6	-	2.1
BH-5	42.1	3.9	10.9	6.9	6.6	1.3	5.2	5.9	5.0	-	4.6	3.3	3.3	-	-
Average	39.5	5.0	12.5	7.8	4.7	0.8	1.8	7.4	6.1	0.7	4.2	4.6	3.4	-	1.3

NOTE : The figures in the tables representx the %age occurance of each activity.

For detailed observations taken on each machine, refer Appendix.

From the analysis in the two tables following observations were also made:

i) From the study conducted it was clearly observed that the job -setting time for a majority of machines is very high. Various reasons for this are :

(a) Operators do not have adequate and proper fixtures to hold the job. They run from here to there to arrange for these fixtures.

(b) Operators are not informed of their next job to be mounted on the machine, in time.

(c) Some times the operators also have to run around to locate the Supervisor and inquire about the next job and then further locate the job - piece and then start the job- setting. This leads to increasing job - setting time.

(d) Operators tend to leave the job -setting part to the "Trainees" or "Apprentices" resulting in greater job -setting time.

ii) Tool - Setting time is also very high. If this time is combined with the tool - room and tool-grinding activity then the time increases further. This is so because bringing the tool from the tool room can be taken as a part of the tool setting. Reasons for this are

(a) No information to the operators regarding the next job.

(b) Every operator returning the tool at the end of the shift and next operator getting it re-issued.

(c) Im-proper selection of tool is also a major cause for this high percentage of tool - setting. The operators have to run time and again to the tool room for grinding the tool or get a new one.

(iii) The percentage occurance of the activitity (8) i.e. away from work place, is also very high. Various reasons are ;

(a) The operator has to go around to get the crane for job -setting/ unclamping.

(b) Has to run around to get a new job after finishing the first one. Sometimes time is lost due to the fact that the operator himself has to look for the particular job assigned to him and hence remains from his work place.

(c) For certain clarifications the operator has to run after the supervisor, who is normally available only after lot of search.

(d) The operator himself has to run to the Inspection deptt. with the inspection request.

(iv) Percentage occurence of the idleness of machines and the operators is also very high . This again is a result of few reasons explained above such as :

(a) Operators remain idle due to non-availability of the next job, once they unload a job after doing the required machining. This means that there is lot of time gap between the loading of job and unloading of the proceeding job.

(b) While seeking clarifications from their Supervisors the operators remain idle. This is due to:

i) Non-availability of the Supervisors because he is busy somewhere else.

ii) Supervisors take long time to take decisions on small matters.

(c) Non-availability of crane. Although "Crane Wait" was taken as one of the reasons of idleness in the study , it did not occure with good frequency. This is because whenever the operator require , Crane, either they leave their work place or tend to sit idle.

SOME GENERAL OBSERVATIONS ABOUNT MACHINE SHOP.

(a) Material handling equipment is inadequate. For what-so-ever loading or unloading of jobs of about 30 kg and above, overhead crane is required. Hence the overhead - cranes are quite busy.

(b) General maintenance of machines is very poor. Except for two or three machines which were under preventive maintenace the percentage occurance of "machine under maintenance" does not figure much.

(c) Charge is not handed over to the next operator. This results in lot of time wastage because when the next oper ator comes in at the next shift he has to spent time to check work already done and the rest to be done on the job.

(d) Particularly in the B-Shift the supervisors are not available to the operators for clarifications.

(e) The Supervisors, in general, seem to be more busy in getting extra time from the Industrial Engineering Department rather than consentrating on how to finish the job in time.

(f) Incentive Cards , in the Time Booth, are not started on an finished off without any verification and is done only on the word of the operators or Supervisiors.

(g) Operators are dependant on their Supervisors for even for smallest of the decisions. And Supervisiors are further dependent on pepple like the Shop Incharge, Industrial Engineering Depa rtment, Inspectors etc. In short , the decision making of a minor problem becomes a lengthy issue.

5.7 RECOMMENDATIONS

i) Job setting time is quite high. To reduce it the operators should be provided with proper clamps and fixtures. Regular check should be made for these clamps and fixtures at the machines.

ii) In case of machines, HB-5, P-4, HB-1, HB-2, P-3, where to jobs can be set due to available space on table, the second job should be set while is being completed.

iii) To have the suggestion (ii) to be effective the operators should be informed of their next job quite in advance so that he can make the necessary tool, clamps etc. arrangements while working on a job already mounted on the machine. Supervisors should check that a particular job will be ready for dismounting and hence informed the operator of the next job, rather than taking action only when the operator informs them that they require the next job after dismounting the first one.

iv) Once a job has been worked on for two or more shifts continously the Operator need not go to the tool room to return the tool to be re-issued to the next operator. The tool should be passed on to the next shift operator. This can result in saving of about 30 minutes per shift.

v) Charge, too is not handed over to the next operator. The should be instructed to do so and and Supervisors should see to it that they pass on the running charge during the last ten -twelve miutes during which the operators are either idle or changing cloths.

vi) Material handlingequipment should be improved in the shop. Atleast

handling of jobs upto a maximum weight of 100 kgs should be done by means other than the overhead crane. For this purpose, it is suggested that a consultancy firm should be engaged and material handling equipment improved in the shop.

CHAPTER FIVE

5.1 OBJECTIVE

To study the existing utilisation of the CNC Gas Cutting Machine and propose measures for better utilisation of the machine.

Material for the fabrication of structures , etc. is receive d in the form of steel plates. These steel palates are cut to size and shape in the cutting yard, manually and of late with the help of the CNC Gas Cutting Machine. It was proposed to conduct a study involved of utilisation of the machine. Since this study involved only one machine it was deemed fit to carry out the "PRODUCTION STUDY".

5.2 THEORETICAL BACKGROUND

Production study is normally conducted where it is found that the time standards set , after conducting time and motion study , are not working properly. This production study is of longer duration and is covered over the whole shift.

Sometimes it happens that it become necessary to assess the reasons for low utilisation of the machines or operators are not performing at standard. In as much as production studies are continouly observed, intensive sample,the exact events may be examined and the reasons for sub standard performance determined. Indeed ,they are more effective for this latter purpose than for determining delays ,and should be taken over longer periods than can be economically studied by means of production studies. The sutdy was conducted with the help of a stop watch.

5.3 DATA COLLECTION

The study was conducted with the help of a stop watch , and the following steps were followed in the recording of the data:

(a) The basic information, like the name of operator, date, shift, were recorded prior to the start of the shift.

(b) The stop watch was started at the instant the operator entered the cutting machine shed, and recorded the time of beginging of each element.

(c) The watch was allowed to run throughout the shift and all events were recorded.

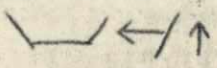
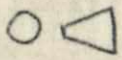
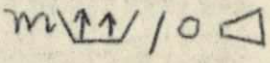
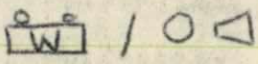
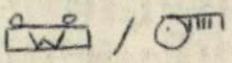
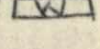
(d) The information was recorded with the help of certain symbols (given in 5.5) devised by the observer after conducting a pilot study.

(e) The actual production or the time for each element was obtained subsequently by subtraction and values for different elemental time was computed.

The data was collected in the following pattern :

DATE: _____ OPERATOR'S NAME: _____

SHIFT: _____

STOP WATCH TIME	ACTIVITY
7:44:30	
45:00	Inspecting the cut plates.
47:24	
51:12	
51:40	
53:24	
57:37	
8:02:08	Mains 
02:20	m/c 
02:50	m/c 

In this fashion , activities for the whole shift were recorded. Activities on the left of slash mark the activities of the machine and to the right are that of operator. No slash-Represents combined activity

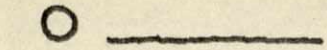
5.4 LIST OF ACTIVITIES

The following activities were recorded with the help of symbols given in 5.5.

1. M/C Working
2. Trolley loading/unloading.
3. Ganging.
4. Receiving Instructions.
5. Manipulations
   (a) M/C
   (b) Nozzle/Flaure
   (c) Gas Cylinder
6. Operator Idle.
7. Personal Needs.
8. Copy/Programme reading.
9. Crane Wait.
10. Cleaning.
    (a) M/C
    (b) Nozzle
    (c) Plate.
11. Inspection
12. Marking
13. Power failure
14. Plate setting in Trolley.
15. Late start/Early leaving.
16. Crane/Trolley under maintenance.
17. Away from work place.
18. Decision wait.
19. Avoidable Delay.

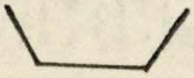
5.5 Symbols used in study :

Various ~~symbols~~ symbols used in conducting the study are as :-

i)  Operator

ii)  (arrow pointing towards left) going out of the shed.

iii)  (arrow pointing towards right) Coming inside the shed.

iv)  Trolley.

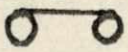
v) PN Personal Needs of Operator

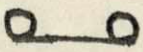
vi) M/C Machine Via G.C. - Gas Cylinder.

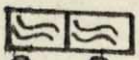
vii) N Nozzle

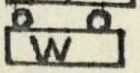
viii) Y Flame

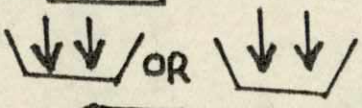
ix)  Crane under maintenance.

x)  ON/Start

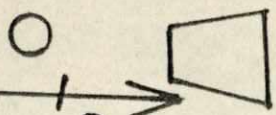
xi)  OFF/Stop

xii)  Copy/programme reading

xiii)  Crane wait

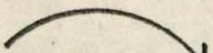
xiv)  Trolley unloading or loading respectibely.

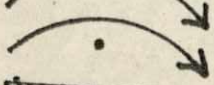
xv)  Gauging

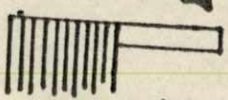
xvi)  Operator receiving instructions

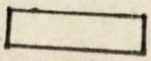
xvii) M/C working i.e cutting of plate in progress.

xviii)  Operator Idle.

xix)  Manipulations.

xx)  Setting

xxi)  Cleaning

xxii)  Plate.

xxiii)  Inspection

These symbols was either used individually or in combination with other symbols.

5.6 ANALYSIS

Based on the pilot study conducted on the machine it was observed that all activities can be comfortably put under 19 basic activities. These activities are listed in 5.4.Following are the day-to-day results of different activities :

Activity No. / Date	1	2	3	4	5A	5B	5C	6	7	8	9	10A	10B	10C	11	12	13	14	15	16	17	18	19
11.5.88	32.1	13.1	1.6	0.4	5.8	4.1	0.9	0.6	2.7	0.9	2.4	0.9	0.8	-	1.1	4	-	0.4	2.7	29.5 (C)	-	-	-
12.5.88	42.9	13.4	-	0.9	6.4	2.9	-	-	5.7	0.3	14.9	-	-	-	0.5	1.9	0.9	-	3.9	-	3.5	0.9	-
13.5.88	38.9	30.1	0.3	-	6.5	1.3	1.2	6.9	2.3	0.3	-	-	1.3	-	-	-	0.4	0.6	8.3	-	-	1.4	-
14.5.88	34.5	21.4	1.9	0.5	5.3	1.2	-	2.1	6.8	-	1.6	-	-	-	-	-	0.5	1.2	7.9	14.5 (C)	-	-	-
19.5.88	33.8	9.4	-	1.8	10.0	2.2	-	1.4	1.2	0.4	2.2	-	2.2	0.5	-	-	-	-	7.4	23.3 (C)	3.1	0.5	-
21.5.88	24.6	13.0	0.6	0.9	5.1	1.7	1.3	3.2	7.8	-	3.7	-	-	-	-	2.4	-	0.4	11.7	9.3 (T)	2.5	1.4	-
30.5.88	29.1	15.7	2.4	2.4	9.2	1.6	1.4	2.7	8.0	1.9	8.9	-	1.5	0.5	-	2.9	-	-	6.7	-	1.1	0.3	3.6
01.6.88	40.9	5.6	-	0.9	11.8	1.9	1.3	3.7	6.2	0.7	4.8	-	2.2	-	-	5.2	-	-	6.9	-	4.0	3.4	-
Average	35.9	15.2	0.9	1.0	7.5	2.1	0.8	2.6	5.1	0.6	4.8	0.1	1.0	0.8	0.2	1.6	0.3	0.3	6.9	9.6	1.8	1.0	0.5

('C' and 'T' represent crane and trolley.)

Another analysis was carried out by not taking the crane breakdown and trolley breakdown into consideratio

This is shown in the following table :

Activity No. / Date	1	2	3	4	5A	5B	5C	6	7	8	9	10A	10B	10C	13	18	15	14	15	17	18	19
11.5.88	45.1	18.5	2.3	0.6	8.2	5.8	1.2	0.9	3.9	1.3	3.3	1.2	1.1	-	1.5	-	-	0.5	3.9	-	-	-
12.5.88	42.9	13.4	-	0.9	6.4	2.9	-	-	5.7	0.3	14.9	-	-	-	0.5	1.9	0.9	-	3.9	3.5	0.9	-
13.5.88	38.9	30.1	0.3	-	6.5	1.3	1.2	6.9	2.2	0.3	-	-	1.3	-	-	-	0.4	0.6	8.3	-	1.4	0.
14.5.88	40.5	25.1	2.3	0.6	6.2	1.4	0.3	2.4	8.0	-	1.9	-	-	-	-	-	0.5	1.3	9.2	-	-	-
19.5.88	44.1	12.3	-	2.4	13.1	2.9	-	1.8	1.6	0.5	2.8	-	2.8	0.6	-	-	-	-	9.6	4.1	0.7	-
21.5.88	38.2	14.4	0.7	1.0	5.6	1.9	1.5	3.5	8.6	-	4.1	-	-	-	-	2.6	-	0.5	12.9	2.7	1.5	-
30.5.88	29.1	15.7	2.4	2.4	9.2	1.6	1.4	2.7	8.0	1.9	8.9	-	1.5	0.5	-	2.9	-	-	6.7	1.1	0.3	3.
01.6.88	40.9	5.6	-	0.9	11.8	1.9	1.3	3.7	6.2	0.7	4.8	-	2.2	-	-	5.2	-	-	6.9	4.0	3.4	-
Average	40.0	16.9	1.0	1.1	8.4	2.5	0.9	2.7	5.5	0.6	5.1	0.2	1.1	0.2	0.3	1.6	0.2	0.4	7.7	1.9	1.0	0.5

Figures represent the percentage occurance.

5.7 CONCLUSIONS

i) From the analysis ,it was found that the loading of plates on the trolley and unloading of the trolley took away the major working time in the morning.

ii) Clearly the crane being used for the loading/unloading remains under maintenance for considerable period and hence the trolley can neither be loaded nor unloaded. Thus for loading and unloading the trolley, much depends upon the crane.

iii) It was found in the analysis that ,nozzele has to be manipulated time and again. This was due to fact that the plate on the trolley is placed on the channels of varying heights ,resulting in unevenness in the plate setting. Thus the nozzle has to be manipulated. Although the time taken for the nozzle manipulations is very small but the number of times it has to be done is very high.

iv) Similarly, the machine manipulations time is very high. The number of times, the machine has to be manipulated to bring to the starting point etc. is again very high. This is due to the following reasons :

a) The program fed into the machine is not properly designed.

b) The machine is being operated by untrained persons.

v) The late arrival / early leaving time of the operator is also very high. Although the study reflects only a percentage of ~~mix~~ 6.9% during a shift that is about 35 minutes , the actual time wasted in this activity is higher on the days when no study is being conducted.

(vi) Further the study reflects ,fix 5.1 percent as time for the personal needs of the operator this again is very high,because the operator goes to the shed, near the shearing machine, to have his tea and a lot of time is wasted in this.

5.8 OTHER OBSERVATIONS.

Apart from these conclusions from the analysis , there were other observations. These are :

i)The general maintenance of the machine is very poor.

ii)Only one nozzle is usually in working condition at a time.

iii)Handling of the machine by untrained persons has made a mess of the machine.

iv)The "EYE " which can be used to cut the plate to shape using a scaled drawing, is not in working condition.

v)Operator ueses only one nozzle while cutting a plate in longitudinal direction and when number of cuts in that direction have to be made.

vi) Despite being informed of the next day's programme in advance by the cutting yard incharge, the Iron Store people never left the plates near the shed before leaving, so that little time is lost in searching and bringing the plates to the trolley from a distance , while loading the next day.

vii) The crane's utilisation is very low and remains idle for lot of time but when it is required for loading /unloading trolley, the Iron store people start using it for their own work and the crane

wait is thus about 4.8% i.e. about 25 minutes when the trolley has has to be loaded and unloaded only once in a shift.

5.0 RECOMMENDATIONS

i) Since the loading/unloading time is very high, there should be another trolley so that when work is going on one trolley the second should be loaded, so that as soon as work finishes on first trolley second could be taken up.

ii) A thorough maintonance checkup should be carried out for the crane and efforts should be made by the PVD maintenance for its minimum breakdown. Moreover Jib crane should be provided, so that if the crane is not in work order, loading/unloading could be done with the help of the Jib crane.

iii) The plate should be placed on cast iron blocks machined to a uniform height so that the plate is levelled and the nozzle is not to be manipulated time and again.

iv) Proper training should be given to the operators and the person incharge of making the program for machine so that minimum number of machine manipulations have to be carried out.

v) Greater Supervisory control needs to be exercised on the operator by the Incharge to check the late arrival, early leaving, and time taken for the personal needs. Moreover, greater co-operation and harmony is desired in the working of cutting yard and Iron Store.

CHAPTER SIX.

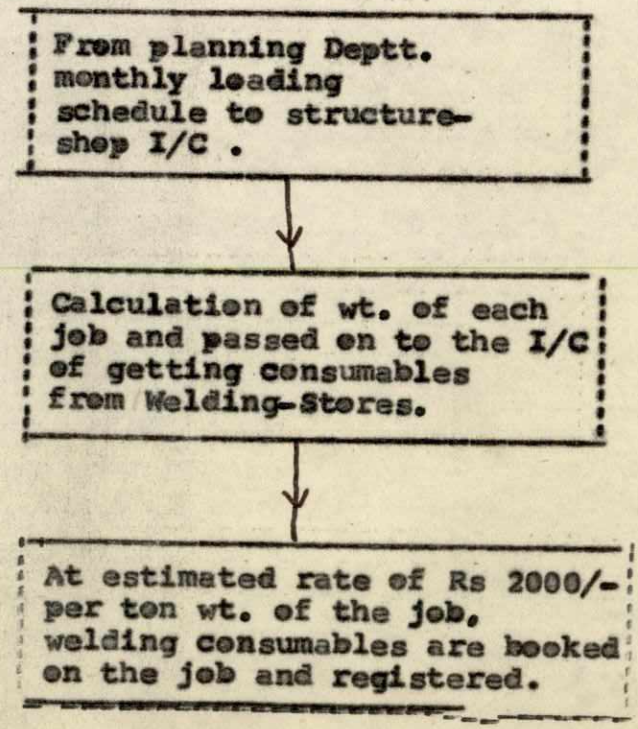
6.1 OBJECTIVE

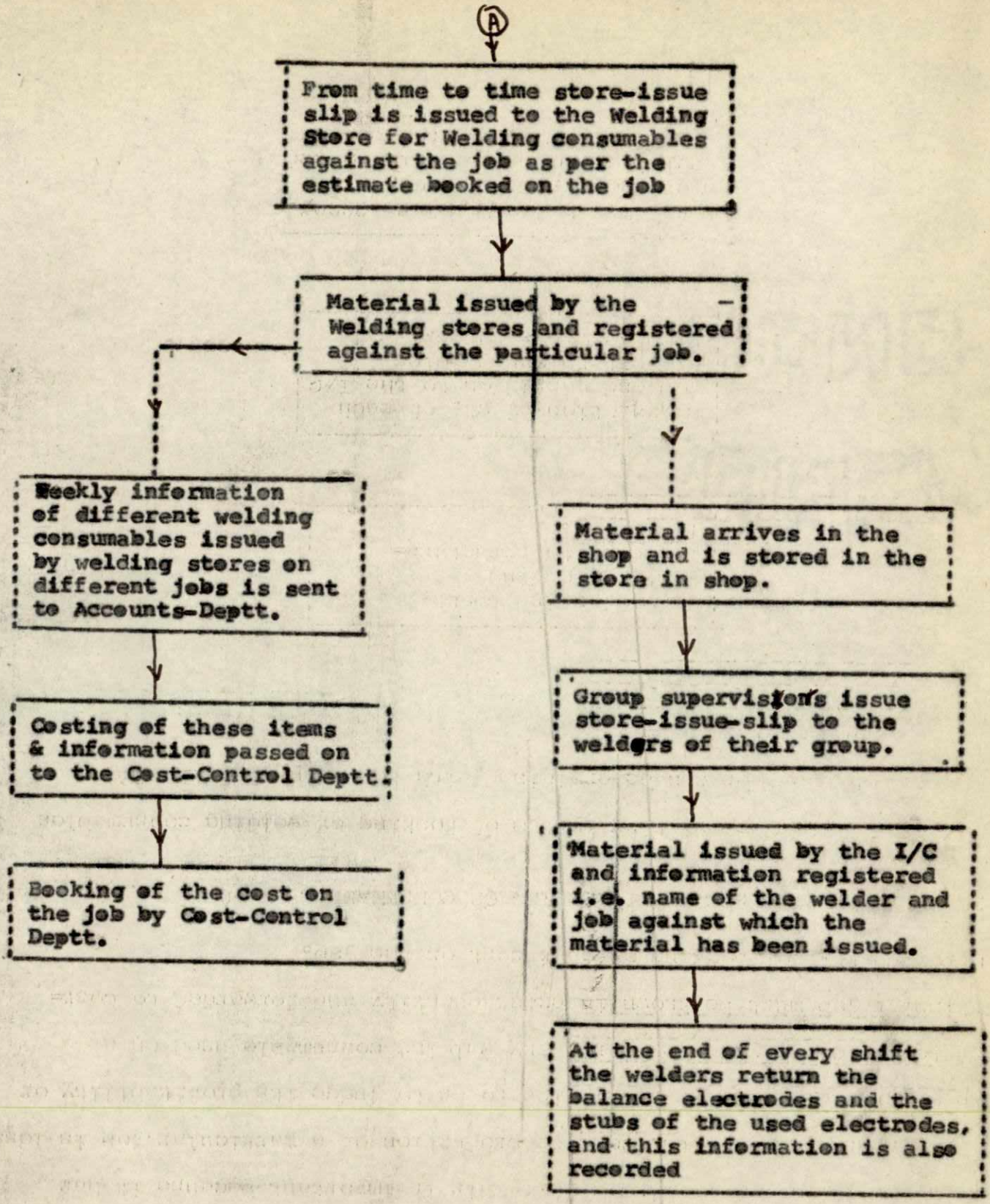
To study the present procedure of booking of welding consumables on jobs and propose an improved procedure.

Welding consumables are the electrodes, welding wire, flux and gases. Booking of welding consumables on jobs, means that the item used on a particular job must be known and its cost forwarded on the job as its manufacturing cost. This is important because it has to be assessed whether the cost of production of a particular job is less than or greater than its sale price so as to judge its profitability or loss to the company. Therefore, any welding consumable used on a particular job must be known in exact quantity and forwarded to Cost-Control Deptt. for booking of that cost on the job.

6.2 EXISTING SYSTEM OF BOOKING OF CONSUMABLES ON JOBS

The existing system of booking of welding consumables on the jobs can be explained with the help of following flow-chart




A
From time to time store-issue slip is issued to the Welding Store for Welding consumables against the job as per the estimate booked on the job
Material issued by the Welding stores and registered against the particular job.
Weekly information of different welding consumables issued by welding stores on different jobs is sent to Accounts-Deptt.
Costing of these items & information passed on to the Cost-Control Deptt.
Booking of the cost on the job by Cost-Control Deptt.
Material arrives in the shop and is stored in the store in shop.
Group supervisions issue store-issue-slip to the weldrs of their group.
Material issued by the I/C and information registered i.e. name of the welder and job against which the material has been issued.
At the end of every shift the welders return the balance electrodes and the stubs of the used electrodes, and this information is also recorded

6.3. DRAWBACKS IN EXISTING SYSTEM :

THE MAJOR DRAWBACK IN THIS SYSTEM WAS THAT WELDING CONSUMABLES WERE BOOKED AT THE RATE OF RS. 2000/- PER TONNE OF THE JOB WEIGHT, ON ALL JOBS. CONSUMABLES ACTUALLY USED ON THE JOB WAS NOT TAKEN INTO ACCOUNT RESULTING IN INACCURATE BOOKING OF CONSUMABLES ON JOBS.

Other drawbacks were :

(i) No recorded information was available as far as gasses are concerned.

(ii) No information regarding the exact consumption of the welding wire. Once the roll of the wire is issued it was not known that what quantity of wire is consumed on a particular job.

~~(iii)~~

It was also observed that in the structure-shop, where welding consumables were required, used only three types of welding consumables viz. Electrodes, Welding-Wire and gases.

For these three different consumables, different procedures proposed to give an accurate account of the consumables used on the job.

6.4 PROPOSED SYSTEM

6.4.1 For Electrodes. For calculating the exact No. of electrodes of a particular size and type the following procedure in steps should be adopted :

(i) The shop-store should be declared as the sub-store of the Welding-store.

(ii) The material to be brought in this store should be brought in the name of the shop and kept in this store.

(iii) As in the existing system, the welders should be issued electrodes against jobs and the information duly recorded. At the end of the shift the unused electrodes should be returned alongwith the stubs of the used electrodes. Information regarding the unused electrodes should be recorded.

(iv) A weekly report of the electrodes actually used on a particular job should be sent to stores, from where the further procedure of booking of the electrodes on jobs should be carried out.

(v) Fresh supplies of Out-of-stock electrodes should be, again, brought in the name of shop.

(vi) A monthly check should be carried out by the stores people to tally the actual No. of electrodes in the "Sub-store" and the No. of electrodes shown as "consumed" in the weekly statement.

Recording of information can be done in the following pattern :

JOB NO_____

Srl No	Date	Name of Welder	Electrode size & Brand Name	No of electrodes issued (1)	No of Electrodes returned (2)	No of Electrodes actually used. (1) - (2)

6.4.2 **Welding-Wire :**

In case of welding wire, the roll is issued and it becomes difficult to keep track of the amount of wire used on a particular job. For this it is suggested that a "COUNTER" be fixed with the shaft on which the roll moves. The "Counter" will give the No. of revolutions, which can be converted into length of wire and hence into weight. The following procedure should be adopted for recording consumption of wire.

(i) At the start of shift, the group supervisors should note-down the "Counter-Reading" and the job on which the wire is to be used.

(ii) At the end of the shift, again the " Counter-Reading " should be noted.

(iii) Refering to the chart supplied, the actual wire consumed should be registered. (For Charts, for 1.6 mm & 2.0 mm wire, please refer Appendix respectively).

6.4.3 GASES

For recording the consumption of gases the "Gas-pressure" should be noted against the job at the beginning and end of the shift. The difference in pressures, can be converted in terms of volume of the gas consumed and further in no. of cylinders. For this another chart can be prepared at different gas pressures and supplied to the shop.

APPENDIX 'I'

CONSUMPTION 1986-87	1987-88 (till Jan:88)	Average consumption (Per Month)	S.D. IN Consumption	Average lead time (Months)	Max. lead time (Months)	Probability (P%)	EOQ	Re-order Points.
4	5	6	7	8	9	10	11	12
27100	NIL	2188	2092	1.5	1.75	10	5000 Nos	7800 Nos
149400	74000	11722	3678	1.0	1.50	10	9750 "	20850, 11100"
149875	60720	11673	3988	1.75	2.25	10	8800 "	31020, 22220 13420"
157270	153955	12488	3325	1.0	2.00	10	7700 "	21630, 13930"
60250	28468	4417	3000	1.0	1.50	10	3840 "	11064, 7224 "
65100	32100	4788	2100	1.75	2.0	10	10500 "	13500, "
82660	6960	3340	3106	2.5	3.50	10	7200 "	15675, 8475"
5775	2200	420	560	2.5	4.5	30	1650 "	2750, "
7805	4060	625	765	1.5	2.5	30	1400 "	2940, "
8904	2160	583	733	2.5	4.0	30	1200 "	3624, 2424 "
43835	27725	3050	4945	4.0	4.5	20	5500 "	24750, 19250 13750"
8825	11950	755	745	1.0	1.25	25	2250 "	2475, "
8965	16118	960	919	2.0	3.0	25	2250 "	4478 "
24080	39420	2419	2040	2.5	3.5	25	3500 "	12250, 8750 "
14875	6600	1088	558	2.0	3.5	20	2650 "	4050 "
2328	1533	208	85	2.0	3.0	25	323 "	742, 419 "
451	256	33	13	2.0	3.0	25	100 "	117 "
235	152	17	12	2.0	2.5	25	77 "	69 "
338	389	31	20	1.75	2.0	25	185 "	110 "
590	141	20	25	2.0	2.5	25	134 "	103 "
17050	9650	1290	439	3.0	4.25	40	1250Kg	6941, 5691, 4441, 3191Kg
3635	760	156	212	3.0	4.25	40	350"	1157, 807 Kg
8210	8168	959	548	2.0	3.5	20	1450"	3700, 2250Kg
9956	6602	730	355	2.0	2.5	25	725"	2750, 2025, 1300Kg
3882	2292	326	137	2.5	3.5	25	475"	1375, 900 Kg
3000	3604	235	392	2.5	3.5	25	525"	1750, 1225Kg

4	5	6	7	8	9	10	11	12
11	5	8/Yr.	12/Yr.	2.25	4.25	25	5 Nos	4 Nos
7411	18889	1255	1157	2.5	3.5	25	960 "	6650, 5699, 4730, 3770 Nos
2080	5220	300	470	2.0	2.5	20	960 "	1680 Nos "
108	56	3	28	1.5	2.0	20	52 Kg	68 Kg
288	264	3	42	1.75	2.5	20	92 Kg	152 Kg
8100	4500	565	672	2.5	3.0	20	3200 Nos	3200 Nos
522	305	33	21	2.5	3.0	20	113 "	145 "
2909	1442	206	70	2.0	2.5	25	1000"	600 "
2890	3580	350	520	2.0	2.5	20	1000"	1800 "
L 800	3645	520	400	2.0	2.5	20	825"	1980, 1155 Nos
12	1	1	1	3.0	3.5	20	5"	6 Nos
							12 Nos	18 Nos
							12 Nos	18 Nos
							2 Nos	2 Nos
							5 Nos	3 Nos
							10 Nos	10 Nos
							5 Nos	2 Nos
							20 Nos	20 Nos
							20 Nos	20 Nos
							70 Nos	50 Nos
							50 Nos	30 Nos
							25 Nos	30 Nos
							5 Nos	3 Nos
							5 Nos	2 Nos
							25 Nos	15 Nos
							25 Nos	15 Nos
							25 Nos	15 Nos
							5 Nos	3 Nos
							5 Nos	3 Nos
							5 Nos	3 Nos

4	5	6	7	8	9	10	11	12
11	5	8/Yr.	12/Yr.	2.25	4.25	25	5 Nos	4 Nos
7411	18889	1255	1157	2.5	3.5	25	960 "	6650, 5699, 4730, 3770 Nos
2080	5220	300	470	2.0	2.5	20	960 "	1680 Nos "
108	56	3	28	1.5	2.0	20	52 Kg	68 Kg
288	264	3	42	1.75	2.5	20	92 Kg	152 Kg
8100	4500	565	672	2.5	3.0	20	3200 Nos	3200 Nos
522	305	33	21	2.5	3.0	20	113 "	145 "
2909	1442	206	70	2.0	2.5	25	1000"	600 "
2890	3580	350	520	2.0	2.5	20	1000"	1800 "
L 800	3645	520	400	2.0	2.5	20	825"	1980, 1155 Nos
12	1	1	1	3.0	3.5	20	5"	6 Nos
							12 Nos	18 Nos
							12 Nos	18 Nos
							2 Nos	2 Nos
							5 Nos	3 Nos
							10 Nos	10 Nos
							5 Nos	2 Nos
							20 Nos	20 Nos
							20 Nos	20 Nos
							70 Nos	50 Nos
							50 Nos	30 Nos
							25 Nos	30 Nos
							5 Nos	3 Nos
							5 Nos	2 Nos
							25 Nos	15 Nos
							25 Nos	15 Nos
							25 Nos	15 Nos
							5 Nos	3 Nos
							5 Nos	3 Nos
							5 Nos	3 Nos

APPENDIX 'II'

MACHINE NO. P- 3

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	-	3	18	-	-	-	-	2	-	3	-	2	-	-	-	1
2.	8.4.88	A	31	16	2	-	2	-	-	-	2	-	4	-	1	-	2	-	2
3.	9.4.88	C	26	15	1	-	3	-	-	-	-	4	-	-	1	-	-	-	2
4.	14.4.88	A	29	13	3	7	2	-	-	-	-	2	-	-	-	-	-	-	2
5.	15.4.88	A	30	7	-	8	3	1	1	-	2	4	-	-	2	-	1	-	1
6.	16.4.88	A	29	6	-	11	2	-	-	-	1	-	5	-	1	1	-	-	2
7.	18.4.88	A	29	9	-	1	-	3	-	3	6	1	1	-	1	2	1	-	1
8.	19.4.88	A	29	7	3	-	3	1	-	1	6	-	2	-	1	2	2	-	1
9.	20.4.88	A	29	9	3	1	-	-	-	-	5	2	-	-	2	3	1	1	2
10.	21.4.88	A	29	16	4	-	1	-	-	-	1	-	-	-	-	6	1	-	-
11.	23.4.88	A	30	15	1	2	2	2	-	2	-	1	-	-	-	4	-	-	1
12.	25.4.88	A	26	12	-	-	3	3	-	1	3	-	-	-	2	-	-	-	2
13.	26.4.88	B	28	9	2	4	3	-	-	2	3	2	-	-	-	1	-	-	2
14.	27.4.88	A	30	8	3	-	9	3	-	1	2	-	-	-	1	2	-	-	1
15.	28.4.88	B	30	3	2	13	1	-	-	-	5	1	-	2	1	1	1	-	-
16.	29.4.88	B	16	6	-	-	1	-	-	1	4	3	-	-	-	1	-	-	-
	TOTAL NO. OF OBSERVATIONS		450	151	27	65	35	13	1	11	42	20	15	2	15	23	9	1	20
	PERCENTAGE			33.4	6.0	14.5	7.8	2.9	-	2.5	9.3	4.5	3.3	-	3.3	5.1	2.0	-	4.5

MACHINE NO. HB-2

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	21	4	-	-	-	-	-	-	1	-	-	2	1	-	-	-
2.	8.4.88	A	31	16	2	3	3	2	-	-	-	1	-	-	1	1	2	-	-
3.	9.4.88	C	26	16	2	-	-	1	2	-	-	3	-	-	1	1	-	-	-
4.	14.4.88	A	29	11	3	1	1	1	-	-	5	2	-	-	1	1	2	-	1
5.	15.4.88	A	30	19	1	-	1	-	-	-	5	-	-	-	3	1	-	-	-
6.	16.4.88	A	29	20	2	1	3	1	-	-	2	-	-	-	-	-	-	-	-
7.	18.4.88	A	29	12	-	4	-	-	-	4	5	-	-	1	1	2	-	-	-
8.	19.4.88	A	29	5	1	10	1	1	-	-	4	1	-	1	3	-	2	-	-
9.	20.4.88	A	29	21	2	12	-	-	1	-	2	1	-	1	2	4	2	-	-
10.	21.4.88	A	29	6	1	10	-	1	-	-	4	1	-	-	1	4	1	-	-
11.	23.4.88	A	30	17	4	-	3	1	-	-	-	-	-	-	-	3	-	1	1
12.	25.4.88	A	26	3	2	8	2	-	-	1	1	1	1	1	1	1	4	-	-
13.	26.4.88	B	28	-	-	-	-	-	-	-	-	-	-	28	-	-	-	-	-
14.	27.4.88	A	30	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-
15.	28.4.88	B	30	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	-
16.	29.4.88	B	29	3	-	6	1	-	-	-	1	1	16	-	1	-	-	-	-
	TOTAL NO. OF OBSERVATIONS		~~464~~ 463	151	24	55	15	8	3	5	29	12	105	4	17	19	13	1	2
	PERCENTAGE			32.6	5.2	11.9	3.2	1.7	-	-	6.3	2.6	22.7	-	3.7	4.1	2.8	-	-

MACHINE NO. L- 22

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	12	1	3	2	-	-	-	1	2	-	-	1	4	1	-	2
2.	8.4.88	A	31	16	-	4	1	2	1	-	4	-	-	-	-	1	-	1	1
3.	9.4.88	C	26	10	1	1	2	3	-	-	2	1	-	-	2	3	-	-	1
4.	14.4.88	A	29	10	1	3	-	1	-	2	7	1	-	-	2	2	-	-	-
5.	15.4.88	A	30	14	2	6	1	-	2	-	1	2	-	-	1	-	1	-	-
6.	16.4.88	A	10	-	-	-	-	-	1	-	2	4	-	-	-	-	-	-	3
7.	18.4.88	A	29	12	1	7	-	-	-	-	2	-	-	-	-	3	4	-	-
8.	19.4.88	A	29	14	1	4	2	1	1	-	3	-	-	-	2	1	-	-	-
9.	20.4.88	A	29	6	3	12	-	2	1	-	1	2	-	-	-	1	-	-	1
10.	21.4.88	A	29	8	2	3	-	2	-	-	4	1	-	-	3	3	2	-	1
11.	23.4.88	A	29	8	-	6	-	2	-	-	3	1	-	-	2	2	5	-	-
12.	25.4.88	A	21	7	1	11	-	-	-	-	1	-	-	-	-	1	-	-	-
13.	26.4.88	B	23	5	-	*6	2	2	-	1	4	-	-	-	2	1	-	-	-
14.	27.4.88	A	30	12	2	4	-	2	1	-	1	3	-	-	-	2	3	-	-
15.	28.4.88	B	30	9	-	5	1	2	-	-	4	4	-	-	3	1	-	-	1
16.	29.4.88	B	29	12	2	4	-	-	-	-	4	3	-	-	2	-	2	-	-
	TOTAL NO. OF OBSERVATIONS		433	155	17	79	11	19	7	3	44	24	-	-	20	25	18	1	10
	PERCENTAGE			35.8	3.9	18.2	2.5	4.4	1.6	-	10.2	5.5	-	-	4.6	5.8	4.2	-	2.3

MACHINE NO. L- 18

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	5	-	-	4	4	-	-	2	8	-	-	3	2	1	-	-
2.	8.4.88	A	31	13	-	-	2	1	1	-	1	6	-	-	2	1	3	-	1
3.	9.4.88	C	26	11	-	-	5	1	-	-	4	3	-	-	-	2	-	-	-
4.	14.4.88	A	29	12	1	-	1	1	-	2	1	3	-	-	2	3	3	-	-
5.	15.4.88	A	30	17	-	-	-	1	-	-	-	1	6	-	2	-	3	-	-
6.	16.4.88	A	29	10	1	-	5	4	1	1	4	-	-	-	1	1	1	-	-
7.	18.4.88	A	29	4	-	2	-	7	-	-	6	4	-	-	2	3	1	-	-
8.	19.4.88	A	29	3	-	8	-	4	1	-	4	1	-	-	3	2	3	-	-
9.	20.4.88	A	29	9	-	-	4	5	-	2	4	3	-	-	-	1	1	-	-
10.	21.4.88	A	29	12	-	6	-	-	-	1	-	4	-	-	-	4	2	-	-
11.	23.4.88	A	30	13	1	-	4	1	-	-	2	1	-	-	3	1	2	-	2
12.	25.4.88	A	26	11	-	-	8	2	-	-	2	1	-	-	-	2	-	-	-
13.	26.4.88	B	15	3	-	-	7	-	-	-	1	1	1	-	-	2	-	-	-
14.	27.4.88	A	30	2	-	-	3	12	-	-	2	2	2	-	-	1	5	-	1
15.	28.4.88	B	30	14	-	-	4	3	1	-	2	2	-	-	4	-	-	-	-
16.	29.4.88	B	15	5	-	-	-	3	-	-	3	3	-	-	1	-	-	-	-
	TOTAL NO. OF OBSERVATIONS		436	144	3	16	47	49	4	6	38	43	9	-	23	25	25	-	4
	PERCENTAGE			33.0	-	3.7	10.8	11.2	-	1.4	8.7	9.9	2.1	-	5.3	5.7	5.7	-	-

MACHINE NO. S- 1

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	12	2	10	-	-	-	-	2	2	-	-	1	-	-	-	-
2.	8.4.88	A	31	14	1	3	-	1	-	-	4	2	-	1	4	-	-	-	1
3.	9.4.88	C	26	17	1	2	1	-	-	-	1	1	-	-	1	1	-	-	1
4.	14.4.88	A	29	18	1	3	-	2	-	1	1	1	-	-	1	-	1	-	-
5.	15.4.88	A	30	19	1	4	-	-	-	-	4	1	-	-	-	-	1	-	-
6.	16.4.88	A	29	16	2	3	-	1	1	-	2	-	-	-	2	1	1	-	-
7.	18.4.88	A	29	16	1	4	-	1	-	-	5	1	-	-	-	1	-	-	1
8.	19.4.88	A	29	10	2	3	-	-	-	-	5	1	-	-	4	3	1	-	-
9.	20.4.88	A	29	11	-	2	2	1	-	-	2	1	-	2	-	8	-	-	-
10.	21.4.88	A	29	10	1	3	-	1	-	-	6	1	-	1	1	1	3	-	1
11.	23.4.88	A	30	8	3	9	-	1	2	-	-	2	-	-	1	2	2	-	-
12.	25.4.88	A	26	11	1	3	1	1	-	-	2	3	-	1	1	2	-	-	-
13.	26.4.88	B	28	18	1	1	2	-	-	-	-	-	-	-	3	3	-	-	-
14.	27.4.88	A	29	11	1	8	2	-	-	-	2	3	-	-	1	-	-	-	1
15.	28.4.88	B	30	14	1	3	3	4	1	-	2	2	-	-	-	-	-	-	-
16.	29.4.88	B	29	14	-	2	-	-	-	-	6	1	-	-	3	2	1	-	-
	TOTAL NO. OF OBSERVATIONS		462	219	19	63	11	13	4	1	44	22	-	5	23	24	10	-	4
	PERCENTAGE			47.4	4.1.	13.6	2.4	2.8	-	-	9.5	4.8	-	1.1	4.9	5.2	2.2	-	-

MACHINE NO. HD- 1

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	11	3	4	1	-	-	1	2	2	-	-	2	2	1	-	-
2.	8.4.88	A	31	5	4	-	-	-	-	1	8	4	-	-	1	7	1	-	-
3.	9.4.88	C	26	5	-	7	2	-	-	-	-	7	-	-	2	3	-	-	-
4.	14.4.88	A	29	4	3	3	-	-	-	2	7	3	-	3	1	2	-	-	1
5.	15.4.88	A	30	5	2	12	1	-	1	-	4	2	-	1	2	-	-	-	-
6.	16.4.88	A	29	2	-	3	-	1	-	-	5	11	-	-	4	3	-	-	-
7.	18.4.88	A	29	5	-	5	-	-	2	-	7	3	-	-	1	5	1	-	-
8.	19.4.88	A	29	11	2	4	1	1	-	-	2	3	-	-	2	1	1	-	1
9.	20.4.88	A	29	9	1	10	-	-	1	-	1	3	-	-	2	2	-	-	-
10.	21.4.88	A	29	4	4	1	1	-	1	-	4	9	-	-	2	1	-	-	2
11.	23.4.88	A	30	7	2	6	-	-	1	-	5	7	-	-	-	1	1	-	-
12.	25.4.88	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.	26.4.88	B	28	3	2	4	2	1	1	-	5	3	-	-	2	3	2	-	-
14.	27.4.88	A	30	9	2	5	1	-	-	-	1	5	-	-	1	3	3	-	-
15.	28.4.88	B	30	6	-	10	2	-	-	-	2	1	-	-	3	5	-	-	1
16.	29.4.88	B	29	3	-	3	1	1	-	-	4	7	-	2	2	6	-	-	-
	TOTAL NO. OF OBSERVATIONS		437	89	25	77	12	4	7	4	57	70	-	6	27	44	10	-	5
	PERCENTAGE			20.4	5.7	17.6	2.7	-	1.6	-	13.0	16.0	-	1.4	6.2	10.1	2.3	-	1.1

MACHINE NO. HB- 3

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	10	2	4	-	3	1	-	2	1	-	-	1	4	1	-	-
2.	8.4.88	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3.	9.4.88	C	13	6	-	2	2	-	-	-	-	2	-	-	-	-	1	-	-
4.	14.4.88	A	29	9	3	5	1	2	-	-	3	1	-	-	1	-	2	-	2
5.	15.4.88	A	30	12	3	9	-	-	-	-	-	4	-	-	-	1	-	-	1
6.	16.4.88	A	28	9	-	5	2	-	-	-	2	7	-	-	1	-	2	-	-
7.	18.4.88	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	19.4.88	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.	20.4.88	A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	21.4.88	A	29	10	1	8	1	-	-	-	3	-	-	-	1	2	3	-	-
11.	23.4.88	A	30	7	1	4	1	1	-	-	1	8	-	2	3	1	1	-	-
12.	25.4.88	A	26	5	3	4	4	1	-	-	3	2	-	1	1	1	-	-	1
13.	26.4.88	B	28	12	-	7	1	-	-	-	-	1	-	2	4	-	1	-	-
14.	27.4.88	A	24	9	2	7	2	-	-	-	3	1	-	-	-	-	-	-	-
15.	28.4.88	B	30	7	3	6	4	-	-	1	5	-	-	-	2	1	-	-	1
16.	29.4.88	B	29	-	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-
	TOTAL NO. OF OBSERVATIONS		325	96	18	61	18	7	1	1	22	27	29	5	14	10	11	-	5
	PERCENTAGE			29.5	5.5	18.8	5.6	2.2	-	-	6.8	8.3	8.9	1.5	4.3	3.0	3.4	-	1.5

MACHINE NO. L- 21

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	10	1	1	1	-	1	3	-	6	-	22	2	-	2	-	-
2.	8.4.88	A	31	13	-	1	2	1	-	-	4	3	-	3	1	2	1	-	-
3.	9.4.88	C	26	7	-	5	-	-	-	-	4	6	-	1	3	-	-	-	-
4.	14.4.88	A	29	10	2	-	3	2	1	-	4	-	-	-	2	2	3	-	-
5.	15.4.88	A	30	18	-	1	1	3	1	-	5	-	-	-	-	-	-	-	1
6.	16.4.88	A	29	12	2	-	1	2	-	3	3	1	-	2	1	1	1	-	-
7.	18.4.88	A	20	20	-	-	1	1	1	-	3	-	-	-	1	1	-	-	1
8.	19.4.88	A	29	12	1	2	-	1	-	-	8	2	-	1	1	-	1	-	-
9.	20.4.88	A	29	24	1	-	-	1	-	-	-	-	-	-	-	1	-	-	1
10.	21.4.88	A	29	23	1	-	3	-	-	-	1	-	-	-	1	-	-	-	-
11.	23.4.88	A	30	24	1	-	-	2	1	-	1	-	-	-	1	-	-	-	-
12.	25.4.88	A	26	12	5	-	-	-	1	1	3	1	-	-	-	2	1	-	-
13.	26.4.88	B	28	21	-	-	-	5	-	-	-	1	-	-	-	-	1	-	-
14.	27.4.88	A	30	8	2	-	1	3	-	3	6	2	-	-	2	1	2	-	-
15.	28.4.88	B	30	11	2	6	2	1	-	2	1	-	-	-	1	1	3	-	-
16.	29.4.88	B	29	5	3	1	2	5	2	1	5	-	-	-	-	3	1	-	1
	TOTAL NO. OF OBSERVATIONS		463	230	21	17	17	28	8	13	48	22	-	9	16	14	16	-	4
	PERCENTAGE			49.6	4.5	3.7	3.7	6.0	1.7	2.8	10.4	4.7	-	1.9	3.5	3.0	3.5	-	-

MACHINE NO. HB- 1

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	13	1	2	2	2	1	-	1	3	-	-	1	2	1	-	-
2.	8.4.88	A	31	8	-	3	1	5	2	2	-	1	1	1	2	2	3	-	-
3.	9.4.88	C	26	7	2	1	1	8	-	1	-	1	-	-	2	-	1	-	1
4.	14.4.88	A	29	5	3	8	4	2	-	2	-	-	3	2	-	-	-	-	-
5.	15.4.88	A	30	13	4	1	2	5	-	1	1	-	-	-	-	2	1	-	-
6.	16.4.88	A	29	-	-	8	1	3	2	6	-	3	-	-	2	1	1	1	1
7.	18.4.88	A	29	18	1	-	1	-	1	2	6	-	-	-	-	-	-	-	-
8.	19.4.88	A	29	10	4	2	4	4	1	1	1	-	-	-	1	-	1	-	-
9.	20.4.88	A	29	12	2	4	4	1	1	-	-	-	-	-	2	1	2	-	-
10.	21.4.88	A	29	8	5	1	4	3	-	-	-	-	7	-	-	-	1	-	-
11.	23.4.88	A	30	7	4	-	4	4	-	8	-	-	3	-	-	-	-	-	-
12.	25.4.88	A	26	10	2	-	1	1	-	-	-	-	12	-	-	1	-	-	-
13.	26.4.88	B	28	6	2	2	-	-	1	-	-	2	12	-	±(1)	1	1	-	-
14.	27.4.88	A	30	20	5	-	1	-	1	-	-	1	-	-	-	2	-	-	-
15.	28.4.88	B	30	14	3	1	2	2	-	1	-	-	1	-	1	4	-	-	1
16.	29.4.88	B	27	7	6	1	-	2	-	1	-	-	5	-	-	-	5	-	-
	TOTAL NO. OF OBSERVATIONS		461	158	44	35	32	41	10	25	9	11	44	3	12	16	17	1	3
	PERCENTAGE			34.3	9.5	7.6	6.9	8.9	2.2	5.4	1.9	2.4	9.5	-	2.6	3.5	3.7	-	-

MACHINE NO. L- 14

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	27	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	8.4.88	A	31	11	-	1	1	2	-	-	-	9	3	-	-	-	3	-	1
3.	9.4.88	C	26	6	-	6	2	2	-	-	2	4	-	-	2	2	-	-	-
4.	14.4.88	A	29	3	-	8	1	1	1	-	7	-	-	3	1	-	-	-	4
5.	15.4.88	A	30	22	4	-	-	-	-	-	2	-	-	-	1	-	1	-	-
6.	16.4.88	A	29	15	5	-	1	4	-	2	1	-	-	-	1	-	-	-	-
7.	18.4.88	A	29	15	3	4	-	-	-	-	2	-	-	-	1	3	1	-	-
8.	19.4.88	A	29	9	1	2	2	3	-	-	2	-	-	-	1	1	-	-	8
9.	20.4.88	A	29	5	2	12	-	-	1	-	1	1	-	-	2	1	1	-	3
10.	21.4.88	A	29	25	-	-	-	-	-	-	1	-	-	-	-	2	-	-	1
11.	23.4.88	A	30	23	1	-	-	3	-	-	3	-	-	-	-	-	-	-	-
12.	25.4.88	A	24	17	-	1	-	2	-	-	3	-	-	-	-	-	1	-	-
13.	26.4.88	B	28	14	1	7	4	-	-	-	1	1	-	-	-	-	-	-	-
14.	27.4.88	A	30	18	1	1	2	5	-	-	2	1	-	-	-	-	-	-	1(1)
15.	28.4.88	B	30	13	2	3	1	4	-	2	1	3	-	-	-	1	-	-	-
16.	29.4.88	B	29	16	2	-	2	4	2	1	-	-	-	-	-	1	1(1)	-	-
	TOTAL NO. OF OBSERVATIONS		461	239	24	45	16	30	4	5	28	18	3	3	9	11	8	-	16
	PERCENTAGE			51.8	5.2	9.7	3.5	6.5	-	1.1	6.1	3.9	-	-	1.9	2.4	1.7	-	3.9

MACHINE NO. 1 - 4

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	9	1	13	-	1	1	-	1	1	-	-	-	1	1	-	-
2.	8.4.88	A	31	21	-	3	1	1	-	-	1	1	-	-	1	1(1)	-	-	1
3.	9.4.88	C	26	14	1	1	1	3	-	-	3	-	-	-	2	1	-	-	-
4.	14.4.88	A	29	17	1	-	2	-	2	-	2	1	-	-	1	-	2	-	1
5.	15.4.88	A	30	13	1	4	6	-	1	-	1	1	-	-	2	1	1	-	-
6.	16.4.88	A	29	22	1	-	4	1	-	-	-	-	-	-	-	1	-	-	-
7.	18.4.88	A	29	11	1	8	1	-	1	1	-	1	-	1	1	-	2	-	2
8.	19.4.88	A	29	6	-	5	8	4	2	-	-	-	-	-	1	-	2	-	1
9.	20.4.88	A	29	13	1	8	2	-	-	1	-	-	-	-	-	1	1(1)	1	1
10.	21.4.88	A	29	5	2	3	5	-	-	-	1	1	9	-	1	-	-	-	2
11.	23.4.88	A	30	10	1	6	6	-	-	-	-	2	-	-	1	-	3	1	-
12.	25.4.88	A	26	10	2	3	2	-	-	-	1	-	-	4	1	1	1	1	-
13.	26.4.88	B	28	10	-	6	5	2	-	3	-	-	-	-	1	-	-	-	1
14.	27.4.88	A	30	13	1	2	3	-	2	1	1	-	3	-	-	2	2	-	-
15.	28.4.88	B	30	6	-	1	4	-	-	-	-	2	16	-	1	-	-	-	-
16.	29.4.88	B	15	11	-	-	-	1	-	-	-	-	-	-	3	-	-	-	-
	TOTAL NO. OF OBSERVATIONS		449	191	13	63	50	13	9	5	10	10	28	5	16	9	15	3	9
	PERCENTAGE			42.5	2.9	14.0	11.1	2.9	2.0	1.1	2.2	2.2	6.2	1.1	3.6	2.0	3.3	-	2.0

MACHINE NO. HB- 5

S/No.	Date	Shift	No of obser.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	7.4.88	A	29	11	1	7	3	-	-	-	2	1	-	-	3	-	1	-	-
2.	8.4.88	A	31	6	1	11	-	1	3	-	2	3	-	-	-	2	2	-	-
3.	9.4.88	C	26	10	2	2	1	1	1	-	2	-	-	-	1	1	2	1	2
4.	14.4.88	A	29	11	2	-	3	7	-	-	-	4	-	-	1	-	1	-	-
5.	15.4.88	A	30	14	1	6	-	-	1	5	-	-	-	-	1	1(1)	1	-	-
6.	16.4.88	A	29	14	1	6	-	1	-	-	-	2	-	-	3	1	-	1	-
7.	18.4.88	A	29	18	2	-	1	4	-	-	1	1	-	-	1	-	1	-	-
8.	19.4.88	A	29	4	-	9	3	-	-	3	4	4	-	-	1	1	-	-	-
9.	20.4.88	A	29	22	-	-	-	1	-	-	1	-	-	-	1	3	1	-	-
10.	21.4.88	A	29	18	2	-	2	4	-	-	7	2	-	-	1	-	1	-	-
11.	23.4.88	A	30	16	1	-	2	2	-	3	-	1(1)	-	-	4	1	-	-	-
12.	25.4.88	A	26	13	-	-	3	2	-	2	1	1	-	-	2	2	-	-	-
13.	26.4.88	B	28	14	2	-	2	2	-	3	1	-	-	-	1	3	-	-	-
14.	27.4.88	A	30	6	1	-	8	1	-	6	3	2	3	-	-	-	-	-	-
15.	28.4.88	B	30	8	2	9	2	2	1	2	2	1	-	-	-	-	1	-	-
16.	29.4.88	B	29	16	-	-	2	2	-	-	1	1	2	-	1	-	4	-	-
	TOTAL NO. OF OBSERVATIONS		463	193	18	50	32	30	6	24	27	23	5	-	21	15	15	2	2
	PERCENTAGE			41.7	3.9	10.8	6.9	6.5	1.3	5.2	5.8	4.9	1.1	~~4.5~~	~~4.5~~	3.2	3.2	-	-

APPENDIX III

CHART FOR (1.6 mm Wire)

COUNTER READING	LENGTH OF WIRE(m)	WEIGHT OF (WIRE (Kg)	COMMULATIVE WT. (Kg)
0-42	31.00	0.490	0.490
43-96	39.18	0.614	1.104
97-150	38.92	0.610	1.714
151-204	38.64	0.605	2.319
205-258	38.37	0.601	2.920
259-312	38.10	0.597	3.517
313-366	37.83	0.593	4.110
367-420	37.56	0.589	4.699
421-474	37.28	0.584	5.283
475-528	37.01	0.580	5.863
529-582	36.74	0.576	6.439
583-636	36.47	0.571	7.010
637-692	36.20	0.568	7.578
693-744	35.93	0.563	8.141
745-798	35.66	0.559	8.700
799-852	35.38	0.554	9.254
853-906	35.11	0.550	9.804
907-960	34.84	0.546	10 .350
961-014	34.57	0.542	10 .892
015-068	34.30	0.539	11 .431
069-122	34.03	0.536	11 .967
123-176	33.76	0.533	12 .500

The above chart has been verified as explained

A semi-used roll of 1.6 mm wire was taken and weighted and its external diameter was measured

Wt. of the semi used wire roll	= 5.530 kg
Wt. of the empty wooden-roll on which wire is wound	= 1.400 kg
Wt. of wire on the roll	= 4.130 kg
Wt. of wire used	= 8.370 kg
Wt. of wire of 1m length	= 0.016 kg
Length of wire weighing 4.13 kg	= 258.13 m

Using Formula,

$$LN = 54 \left(ND + \frac{n(n-1)}{2} T\right)$$

Where Ln = length of wire for 'n' windings

N = No. of windings

D = Dia of the empty roll = 0.199 m

T = Thickness of wire

$$258.13 = 54 \left(n \times 0.199 + \frac{n(n-1)}{2} \times 1.6 \times 10^{-3}\right)$$

$$n = 7.54 \quad n \simeq 8.0$$

Total external dia. of the roll (calculated)

= 212 mm

Measured external dia. of the roll = 231 mm

The variation of 19mm is allowable because the external diameter of the new roll was measured as 260 mm whereas theoretically the external diameter was calculated to be 235 mm, ie. a variation of 25 mm. This variation is due to the fact that the theoretical calculation has been made on the assumption that there is no slackness in the winding of the wire on roll.

APPENDIX

CHART FOR 2 mm WIRE

COUNTER READING	LENGTH OF WIRE (m)	WEIGHT OF WIRE (kg)	COMMULATIVE WEIGHT (Kgs)
0-12	16.00	0.392	0.392
13-55	31.20	0.765	0.157
56-98	30.93	0.758	1.915
99-131	30.67	0.752	2.667
132-174	30.39	0.745	3.412
175-217	30.12	0.738	4.150
218-260	29.85	0.731	4.881
261-303	29.58	0.725	5.606
304-346	29.31	0.718	6.324
347-389	29.04	0.712	7.036
390-432	28.77	0.705	7.741
433-475	28.50	0.698	8.439
476-518	28.23	0.692	9.131
519-561	27.96	0.685	9.816
562-604	27.69	0.679	10.495
605-647	27.42	0.672	11.167
648-690	27.15	0.665	11.832
691-733	26.88	0.659	12.491