CHAPTER FOUR

Production : Quality Control

C H A P T E R - IV -

PRODUCTION : QUALITY CONTROL

4.1 INTRODUCTION:

When a customer considers the purchase of a product or a service, he weighs the value he will receive against the asking price, before making his decision. The purchases will be determined by the following variables.

1) The price of the product;
2) Any associated service rendered,
3) The quality of the product.

The value and quality of the product or service must be customer-oriented and quality standards must reflect the consumer's requirements. Any manufacturing process, therefore, is cautious about the quality control of its product.

4.2 MEANING OF QUALITY CONTROL:

Quality control stands for the systematic control of those variables which affect the excellence of the utimate product. Control of quality means the development and realisation of specifications necessary to produce, economically and in adequate degree, the appearance, efficiency, interchangeability and life which will ensure the products' present and future market.(1) Every manufacturing process introduces variables which affect the quality of the end product. These variables

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(1) Simmon Cavid A, 'Practical Quality Control,' Addison-Wesley Publishing Company, 1970, PP.3.

result from the application of materials, men, machines and manufacturing conditions.

The control of quality is said to exist when these variables are regulated to the extent that they do not detract the excellence of manufacturing process. Quality is never absolute. It is always relative to certain other considerations, (2) namely

i) End use of the product,

ii) Definable and measurable characteristics of the product,

iii) Economics of manufacturing quality that can be maintained under a designated manufacturing process i.e. the percentage of imperfect goods, if any , that is acceptable to the producer and/or to the customer.

iv) Manufacturing cost and selling price.

4.3.3. THE REASONS FOR QUALITY CONTROL

Quality control has been talked about as though it was something new, and useful to only large firms, that can afford a quality control department. But it is neither new nor restricted to only large firms. Every manufacturing unit must have a quality control programme of some kind, if it is to stay in a business. There are three main reasons for quality control in a foundry.

i) To make castings to the customer's specifications;

(a) Metallurgically- to ensure hardness, strength,chemistry,

(b) Dimensionally - Outer dimension and internal dimension,

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(2) Dr. Saksena S.C.,'Business Administration and Management,' Sahitya Bhavan, Agra, 1988, PP.204

(c) Appearance - Surface finish and cleanliness.

(d) Special procedures- painting or oiling etc.

(ii) Reduce the amount of scrap or rework,

(iii) To make castings economically.

4.3.4. SCOPE OF QUALITY CONTROL: (3)

Today, quality control is taking on the emphasis of quality assurance i.e. the means to achieving true product reliability. Reliability cannot be inspected into a product; it must be designed and built-in. Furthermore, quality control must be more than simply see that products meet specifications. It must follow that the product performs the expected service, and in some circumstances, that they perform in the end product of a customer (which is especially applicable to those foundries which have undertaken job works and which provide the castings as one of the components of the end product of the industrial customer).

When quality control adopts this system concept of reliability it becomes a factor in every decision in engineering, in manufacturing, and in application, from product development to shipment to end use.

Methodical quality control can be achieved by means of the following principal tools of control:

1) Standards and specifications;

2) Inspection,

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(3) Samuel Eilon, 'Elements of Production Planning and Control', Universal Book Corporation, Bombay, 1981, PP.525

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3) Statistical techniques;

4) Quality circle,

5) Measuring instruments.

The terms ' Inspection ' and quality control are frequently used (in the shop) interchangeably but inspection is only a tool of quality control. A programme of the qality control by bringing variables under control, enlarges the 'production pile'; inspection by its seperation of the good from bad, merely enlarges the "scrap pile".

(1) STANDARDS AND SPECIFICATIONS:

A standard is a criterion of measurements, quality, performance or practice, established by custom, consent or authority.

Perfection in manufacture is impossible to attain and costly to approach. The economic law of diminishing returns applies to quality control. As perfection is approached, costs rise disproportionately.

Tolerances:

To be salable, a product must be acceptable to customers as regards both quality and cost. Somewhere along the scales of quality and cost, there is a point of compromise at which the quality meets the customer's minimum requirements and the cost fits his pocket. At this point then is established the 'basic standard of quality'

In practice, however, there is no such thing as an exact standard. But the variations around the standard can be restricted. That is, there is a 'tolerance' or a permissible deviation from the basic standard.

(2) INSPECTION:

The administration of quality control in most manufacturing units, rates with the inspection department. In case of precision products, this department is directly responsible to the top manufacturing executives, usually the plant managers. For a manufacture, in which precision is not a major factor the inspection department may be subordinated to plant superintendent.

Subordination of inspection department to superintendent, who has to maintain the production schedules, is definitely risks, because, when rush orders arise or when the pressure is on quantity, the superintendent has a tendency to sacrifice quality iin favour of quantity.

The best practice would be setting the men responsible for quantity and quality on a par with each other and under important authority.

"Inspection is the art of comparing materials, product or performances with established standards."(4) Inspection serves two main purposes :-

i) Segragating defective goods and thus ensuring that customers get only good of adequate quality.

ii) Locating flaws in the raw material or in the processing of that material which will cause trouble at subsequent opeations.

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(4) Dr. Saksena S.C. op.cit, PP.214.

The following practices tend to maximise the effectiveness of inspection :-

i) Inspect raw materials and purchased parts,

ii) Effective in-process inspection, which prevents -

(a) A defect from being concealed in the end product.

(b) A defect from affecting subsequent operations and,

(c) An additional work from being performed on rejectable material.

iii) Checiking the quality of end product through one or more inspection operations, immediately prior to shipment.

iv) Planning the inspection operations, which necessiates:

(a) Establishiing the tasks of each inspector clearly in advance;

(b) Providing him with measuring instrument;

(c) applying the principles of good workplace layout.

(d) Applying the principles of work-simplification to increase the efficiency of inspectors.

v) Inspecting for defects immediately.

vi) Careful selection and training of inspectors, establishing standard rates of inspection for each inspection element or operation and bonus schemes based on percentages of defects located.

vii) Set up a procedure for handling border line material.

viii) Make use of inspection records:-

Inspection cards or tickets showing the quantity inspected, number rejected, individual reasons for the rejections.

(3) STATISTICAL TECHNIQUES (5)

Application of the statistical techniques to quality control is one of the leading advances in industrial technology in the present century. Originally introduced in the "Bell Telephone Laboratories" and "Western Electric Company" in the 1920's statistical quality control did not find general acceptance in the industry until 1940's. By that time, workable shop tables, eliminating most of the statistical calculations were published, and, as charting technique became popular, statistical quality control became popular in industry.

It has brought a startling reduction in inspection costs and permitted a more fundamental control of quality than was previously possible. Proper tolerance for a process can now be set scientifically. Needless inspections and production interruptions e.g. machine adjustments when the work is well within control, can be eliminated.

It results into reduction in scrap, and in material to be reworked. It also results into improving the plant's average quality level. It ensures a definite quality of both incoming material and outgoing product.

The tools of SQC include :

i) Sampling,

ii) Frequency distribution

iii) Quality control charts

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(5) Buffa Elwood, Sarin Rakesh,'Modern Production Operation/ Operation Management,' Joh Wiley and Sons, 8th edition, 1987, PP.394.

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iv) Standard deviation,

v) Range

vi) Theories of probability.

The technique which is most widely used is that of sampling which includes Acceptance sampling (A.Q.L.) and Largest Permissible Percentage of Defective.

Fundamentals of Statistical Quality Control :

Essentially, statistical quality control regulates the quality of materials, parts, products and processes by scientific techniques of sampling, inspection analysis of results and charting devices. It relies on the theories of probability.

In evaluating the quality of a lot, therefore, it is possible to select a sample of specified size, analyse its condition (usually determining the mean and standard deviation or the range) and predict from it with calculated assurance, the condition of the entire lot.

However, even 100 percent inspection cannot catch all the bad pieces. Such inspection, because it must relay at least partly on the human element and because it is a monotonous operation, breeding 'Inspection Fatigue', does not guarantee a 100% perfection.

In the standardised control of process quality is usually accomplished with the aid of control charts. These charts keep a running record right at the machine or workplace to indicate whether production is proceeding on the road of good quality, when it is wandering off into border-line quality and when it is definitely out of control.

The manufacturing organization must believe in SQC, if it is to be really successful. Operators may require proof that it does work. They must be convinced that statistical quality control helps them.

(4) QUALITY CIRCLE (6)

Quality circle technique can be applied in any manufacturing unit, irrespective of its size, technology, or operations included in the routine work.

The basic rationale behind the quality circle it to produce quality product as per the specifications of the customers with minimum possible price, so as to increase the demand for the product. It necessiates the active and enthusiastic participation of the workers.

In case of a foundry, the problems which are dealt in the quality circles are as follows :-

i) How to reduce the percentage of rejection,

ii) How to make proper utilisation of the available instruments such as cores, oils, grinding wheel ?.

iii) How to make optimum use of electricity and other fuels

iv) How to reduce misutilisation of time resulting from various obstacles ?.

v) Is it essential to improve the existing machinery ?

vi) How to improve work security ?

vii) Are some training facilities essential to improve dexterity and efficiency of the workers as well as the managers ?.

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(6) Buffa Elwood, Sarin Rakesh, op.cit, PP.443.

The Modus Operandi of the Quality Circle :

It is essential to form a circle of workers who are performing a definite job and who know this job thoroughly. These workers elect a Group Leader. It is the responsibility of the Group Leader to decide the timing of the meeting and to inform the members of the group beforehand.

The leader should inform the present members structure of the meeting and then start discussion on 'Only one subject at one time'. He should urge the members to participate in the discussions actively and should listen to all the suggestions carefully. He should never discard any suggestion without listening to it first.

Later on, he should delegate some members to gather inform -ation and statistical data about a certain determined problem and end up the meeting.

In the next meeting,the collected information and the statistical data should be discussed, which would lead him to decide a 'Cause and Effect' diagram. (See Fig No.4.1)

Explanation of the Cause and Effect Diagram:

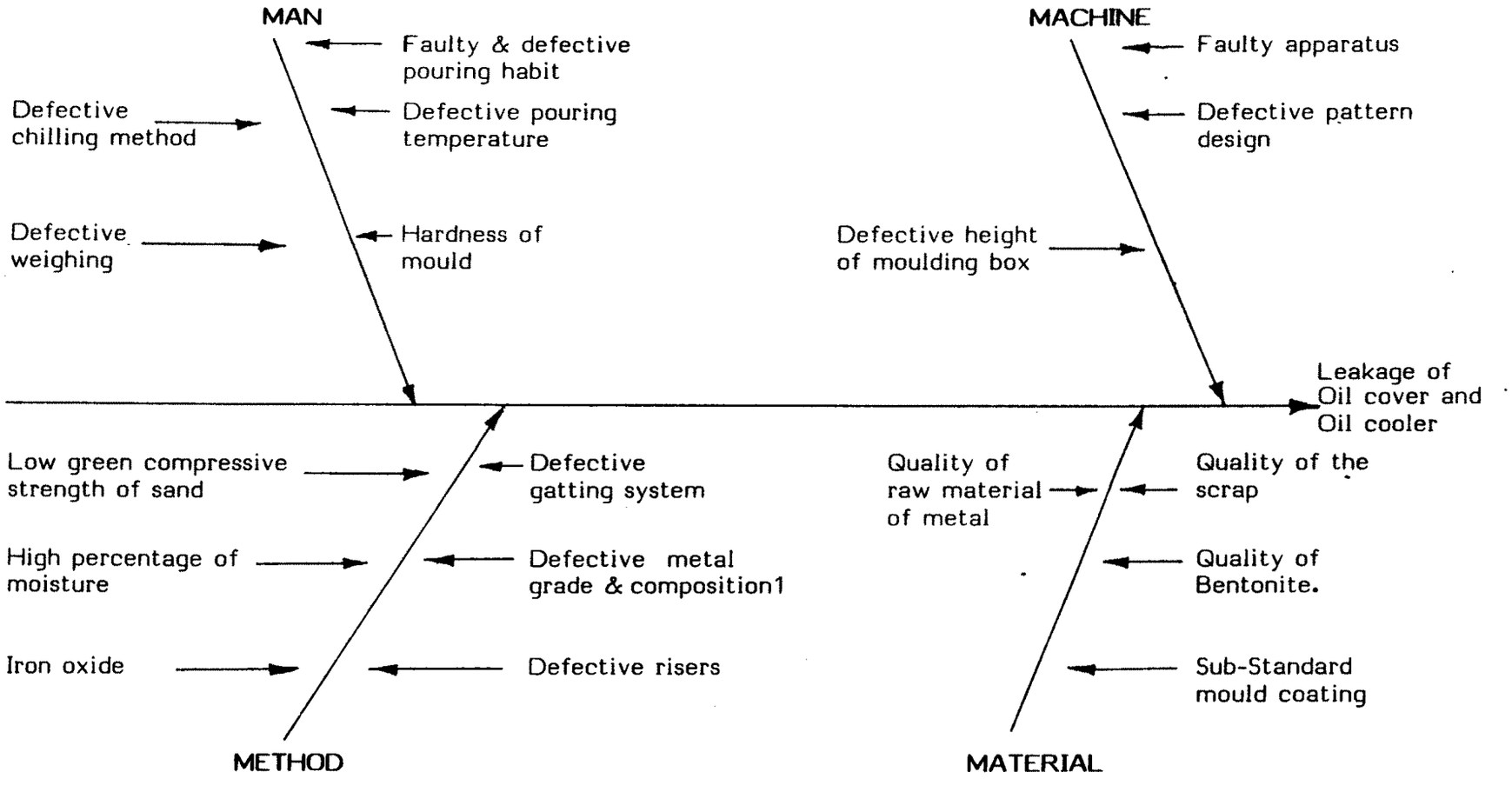
It is essential to note seriousness of any problem in order to find the effective solution for it. The main causes behind any problem are generally -

i) Man

ii) Machine

iii) Method

iv) Material.



CAUSE AND EFFECT DIAGRAM

Chart No. .1

The first step is to locate the defect.

The main horizontal line in the Figure No. 4.1 represents the main defect or the result.

The other lines represent the causes behind that result.

The second step is to trace back the reasons-man or machinery or method or material or all behind these causes.

The third step is to pinpoint the definite reasons or causes and to make a deep study.

The last step is to take a definite step to eliminate these causes.

A complete statistical data is very essential to pinpoint a particular cause behind a particular defect. If is essential to collect necessary information about the material, machine, worker, working time, batch shift of work and data.

If the firm is unable to undertake an elaborate method of implementing this concept, it can be implemented in a much simple way by discussing the matter with the concerning workers or foreman for 15 to 20 minutes every day. On-floor discussions are also helpful.

In short, Quality circle helps to reduce the percentage of rejection, thereby improving and maintaining a desired quality level.

(5) MEASURING INSTRUMENTS:

Measuring instruments furnish the means for performing delicate and exacting inspections, required in today's precision manufacturing. If one had to rely on human sense alone, precision would be a myth. Instruments supplement and in some cases supplant, the human elements.

Decision to utilise best measuring instrument is influenced by the degree of precision requirement, the volume, continuity and value of production, the amount of inspection, cost of alternative instruments and their rate of operations.

There are many types of measuring instruments i.e. gauges, electronic inspection devices, industrial radiographic instruments (X-ray) ultrasonic instruments and magnetic testing devices.

All the measuring devices must be under systematic inventory control and undergo periodic inspection.

4.6 PRODUCTION: QUALITY CONTROL OF THE FOUNDRIES

FOUNDRY 'A'

There is a definite and pre-planned programme and procedure for the quality control in this foundry. Foundry A monitors quality assurance very effectively mainly as follows:

1. At incoming material stage.
2. In-Process Inspection.
3. Inspection of the finished products
4. Preventive maintenance.

(1) **Incoming Material Stage:**

(a) Metals:- The most important raw material is the non ferrous metals. Foundry A purchases these metals from very reputed supplier from Bombay, Jaipur, and Madras. These suppliers always send the reports stating the chemical qualities of the lots delivered.

However, a Sample of each lot is sent for chemical test in the laboratory established in the same Industrial Estate.

b) Sand:- The second important raw material is sand. 100 to 120 mesh silica sand with about 98% purity is purchased. The supplier are from Vengurla. These suppliers have all the facilities to check the silica sand at their own end. Once the source of supply is established, all the properties-clay contents, chemical compositon, Grain shape, Grain finess, physical properties such as colour, sieve analysis are not checked each and every time. However, all these properties are checked once in every three months. Only following properties are checked before accepting every consignment namely. a) Colour b) Grain distribution c) Clay content d) Base permeability. Inspection of only these properties is considered as adequate by majority of foundries.

c) Binders: Coal-dust and sodium based Bentonite are used as binders. The sampling and inspection is done as per the methods given in IS-6186-1971 specifications for Bentonite. Bentonite is purchased from Madras and the IIT Madras has all facilities to check Benotonite. Hence, once the source of supply is established, all the properties are not checked. Only following properties are checked namely, a) Loss on Drying and b) Gelling time. However all the properties are checked once in three months at the nearby laboratory.

(2) **In - Process Inspection :**

(2) **(a)** Designing:- The most important part of the whole casting operation is the designing of the pattern. One of the partners himself is a designer and designs the patterns.

The following rules are observed while designing-

1) Critical portions of castings are to be positioned in

the bottom portion of a mould.

2) The number of cores is to be mainmised.

3) Proper ventiliation is to be given to the cores.

4) Provision of rises in case of masive portions of castings.

5) Machining allowances are included in the design.

If these rules are not observed, faulty pattern will be manufactured. A proper designing chart is made and all the rules are strictly observed.

(b) Pattern: The patterns are made in other pattern-making shop as the foundry does not have its own pattern shop. On-spot checking of the pattern in the pattern shop itself is undertaken by the designer (partner), each and every pattern is checked with the help of various measuring instruments, whether proper shrinkage allowance has been given before accepting (See Chart-4.2)

(c) Moulding:- Foundry A produces catings with the conventional Green Sand moulding. It has all the necessary equipment like sand mixers and other laboratory equipment.

The following rules are observed :

1) Foundry A has prepared a moulding method card.

2) Sample of every batch of the conditioned sand is collected and tested for its various desired properties and the results of each and every batch prepared for every day, are recorded on the chart. The following characteritics are checked - (a) Green compressive strength, b) moisture, c) permeability. The Line - graph of sand properties is depicted on Chart 4.3

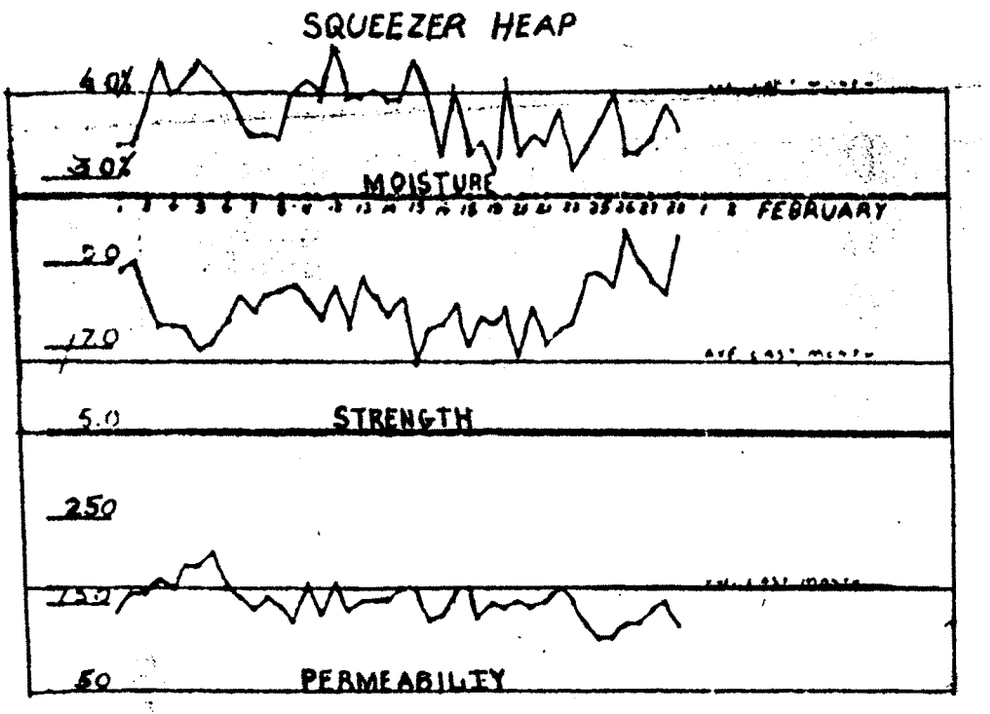
FOUNDRY - A -

SHRINKAGE - ALLOWANCE GIVEN TO THE PATTERN

CHART - 4.2

Metal	Characteristics of Casting-dimension	Weight group of Castings	Linear Shrinkage in in percentage
CAST IRON	1. Small size	upto 100 Kgs.	0.75 - 1.0
	2. Medium size	101 Kgs. to 1000 Kgs.	0.5 - 1.0
	3. Large and very Large size.	1001 Kgs to 5000 Kgs.	0.5 - 0.75

FOUNDRY - A -



— Line graph of sand properties.

CHART- 4·3

The straight horizontal lines representing 150 (of Permeability), 70 (of Strength) and 30% (of Moisture) are the Mean - lines of the relative properties of sand which are checked and improved (if necessary) with Quality Control.

3) Moulding boxes and pins are frequently used and handled heavily. So frequent inspection of boxes and templates is undertaken, necessary repairs are done, and the damaged units are discarded.

Core - Making :

1. Prepared cores are checked for hardness just like mould sand (See Chart 4.4)
2. Core-preparing card has been prepared. Dimensional inspection is undertaken which should match the specifications of core-preparation card.

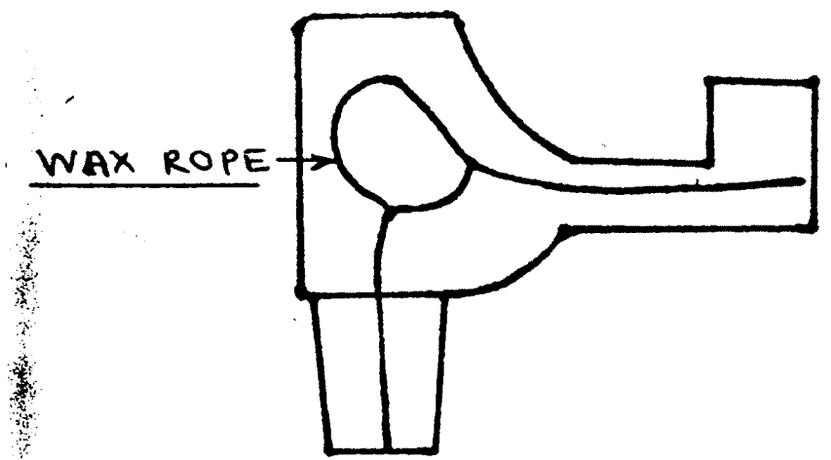
(d) **Melting :-**

1. A Charg composition is decided and inspected.(See Chart 4.5)
2. Each and every lot of metal to be charged is accurately and properly weighed on scales and due charts are kept.
3. Necessary fluxes are added at different times.
4. The furnace is a Rotary furnace and has indirect method of melting. The outer wall of furnance is constructed with refractory bricks, and coated with silica. The refractory bricks and the coating of silica is checked every time before the furnace is used. Visual inspection is used in this context, which is considered to be adequate.
5. The temperature of each and every charg of the molten metal is tested by an Immersion Parameter. Temperature of molten metal of tapping from furnance is 1150°C, and 1100°C. for pouring into mould.
6. The laddles are pre-heated every time.
7. Detailed record of each and every charge is maintained.

CHART 4·4

500 - 550 gm/cm^2

F. CORE PRACTICE :-



1) Oil Sand Core

2) Propertise required

a) Properly baked with nut brown colour.

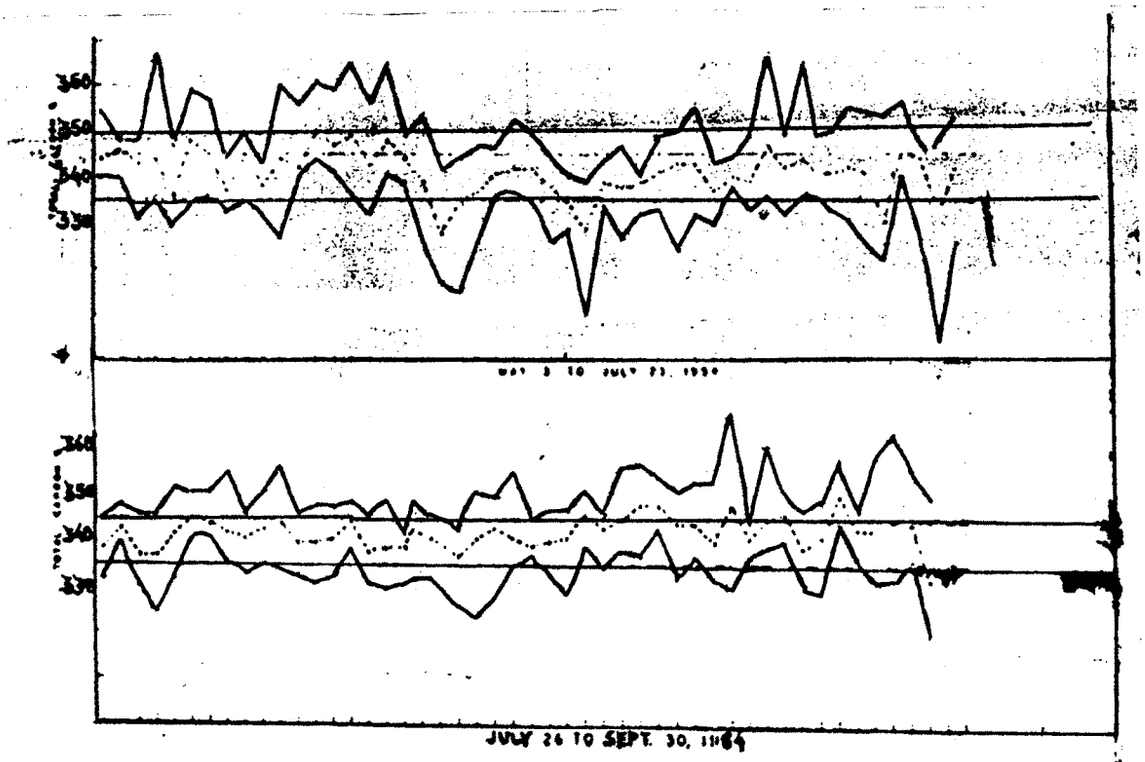
b) Good scrach hardness.

c) Muffler Core - Double baked

Venting to be done as shown in sketch.

Water base zircon to be applied.

F O U N D R Y - A -



– Line graph of a study of control of charge material.

CHART 4·5

The numerical numbers 330 and 360 indicate the minimum and maximum Liquidous points, respectively. The horizontal lines at 335 to 345 indicates the respective means of minimum and maximum liquidous points . It iindicates how the percentage of silicon is controlled in the charge material.

3) **Inspection of finished products :**

After the casting is lifted out of the mould box, the processes of cleaning, fettling, rumbling are undertaken. Then three kinds of inspections, are necessary, namely 1) Visual 2) Physical and 3) Chemical. The trained supervisor undertakes both visual and physical inspection of each and every casting, which includes-

(1) Visual observation of surface finish of casting.

(2) Inspection of removal of cores and such other foreign articles from castings.

(3) Examining outer and internal dimensions of casting with help of calipers, ruler and dividers.

Chemical analysis necessitates microscopic test which is essential for micro-porosity analysis. Foundry A does not undertake this type of analysis because the chemical analysis is essential only for manufacturing of high value, critical castings. Foundry A does not manufacture such castings.

(4) The casting are also checked for foundry defects such as warpage, hot and cold cracks, blowholes, surface oxidation.

(5) A testing machine is used for inspection and checking of each and every casting. Each rate of tolerance is checked by the machine. It requires about 8 hours to set the machine for inspection.

(6) Permeability of casting is tested on a test sand. A liquid (water or kerosene) is poured into the cavity of casting to a specified level. Leaks (if any) are detected visually. Extensive charts have been prepared for all these operations.

(4) **Panting of the Castings :**

As foundry manufactures non-ferrous castomg, which do not have any corrosive action, there is no need of painting the castings.

(5) **Preventive Maintenance :**

Foundry A very much believes in this aspect of quality control. Hence, every Monday in a week is a Preventive Maintenance Day. Each and every piece of machinery is checked and oiled. Every patten, core, lining of moulding box and laddle, refractory bricks walls etc. are checked. The defective pieces are corrected. Some of the defective pieces which cannot be corrected, are replaced.

A quick daily inspection of all machinery equipment is undertaken before the actual process of manufacturing. If a certain defect is noted during in-process operation, efforts are taken to correct the defect (e.g. mal-functioning of a machine). If it is found that defect cannot be corrected on spot, the operation are stopped, This has increased the rate of work security.

The firm has also introduced the programme of quality control but the results are yet to be verified, because of its recent introduction.

(6) **Instruments:**

Foundry A possesses:

1) Hardness tester = for testing hardness of wet moulds.
2) Rammors, wood mallets, sleekers and slides, spoons, hooks for preparing moulds and cores.

3) Immersion Parameter for checking the temperature of molten metal.

4) Tumbling barrel- for decoring and cleaning of small and medium-sized castings. Apart from these instruments, other common instruments like weighing scale, gauges etc. are also there.

FOUNDRY 'B'

As previously stated, foundry B is a ferrous casting foundry and melts Pig Iron.

The unit observes a definite plan of quality control programme in the following steps :

1) In - coming material stage.
2) In - process Inspection.
3) Inspection of the finished castings.
4) Painting of the castings.
5) Preventive maintenance.
6) Instruments.

(1) **In - Coming Material Stage :**

(a) Metals:- The main supplier of this vitally important raw material is MSSIDC and Foundry B has to accept the material as it is. The report of the grade of Iron is attached to the lot received. Still foundry B makes a sample test of each and every consignment, for its chemical properties from the laboratory based in Sangli.

The unit has to rely to a large extent on scrap, which is purchased from the following dealers 1) Scrap centre, Kolhapur 2) Ambica Scrap Traders, Kolhapur 3) Prakash Scrap Trader Kolhapur. Laboratory testing of the scrap

is undertaken in Quality Marking centre, Shivaji Udyam Nagar, Kolhapur.

(b) Sand: Foundry B uses 800 mesh sand from Vengurla Sand is checked for clay content, silica percentage, colour, grain shape, grain fineness etc. The suppliers have all laboratory equipment to analyse these properties. So once the source of supply is established, foundry B undertakes a full check in every three months, at the laboratory in Sangli.

c) Binders : Foundry B uses moulding clay - Hydromica clay and Furitol 107 and Bentonite as Binders. The foundry undertakes following tests before accepting the consignment from the suppliers in every three months. (a) Binding Capacity (b) Plasticity (c) Refractoriness and (d) Chemical composition

In both the cases of sand and Binders full check of properties, in every three months is considered as adequate and is an approved custom followed by majority of foundry units.

(2) **In Process Inspection :**

a) Designing : As Foundry B is a wholly jobbing unit, the designs have been provided by its industrial customers. Hence, there is no ispection as far as designing is concerned.

b) Patterns : Foundry B purchases the patterns from the other pattern shop established Industrial Estate. On-spot checking in the pattern shop as per the design, is carried out by one of the partners.

Proper Shrinkage Allowances are given. Dimesional accuracy of patterns is also observed. (See chart 4·6). The patterns are checked as per the chart, before accepting the consignment.

FOUNDRY - B -

DIMENSIONAL ACCURACY OF WOODEN PATTERN SETS

CHART 4.6

Measured Dimension mm	Accuracy Class		
	Up to 100 Kgs.	101 Kgs.to 1000 Kgs.	1001 Kgs. to 5000Kgs.
	allowable deviations, mm		
51 - 120	± 0.1	± 0.5	± 0.6
120 - 260	± 0.3	± 0.6	± 0.7
261 - 500	± 0.4	± 0.7	± 0.8
501 - 800	± 0.4	± 0.9	± 1.0
801 - 1250	± 0.5	± 1.0	± 1.2
1251 - 2000	± 0.6	± 1.2	± 1.6

c) Moulding and Core making:

1) The unit has prepared a proper moulding card and all the properties are tested accordingly in the unit internally because it has necessary testing equipment (see chart 4.7

.Up - to - date records are kept of each and every moulding batch.

2) Moulding boxes and pins are inspected frequently to avoid further damages. The damaged units are corrected.

Core-Making:

) Core preparing card is prepared and prepared cores are inspected for hardness.

d) Melting :-

1) Foundry B works on a Rotary furnance which has an indirect method of melting. The refractory bricks are inspected visually every time. Also coating of silica is checked. Visual inspection is considered to be adequate by majority of foundry units.

2) A charge composition is decided and the charg composition card is also prepared. Record of each charg is kept and filed on. Foundry B uses the following charging formula-

Charging Formula

The componets of charge are found from the formula -

$$C_{ch} = \frac{Cm}{100 - y} \quad 100$$

C_{ch} = calculated contents of a component in the charge,%.

F O U N D R Y - B -

UNIFIED MOULDING MIXTURES FOR PIG IRON CASTINGS.

CHART 4·7

	SAND							PROPERTIES		
Castings	Quartz Sand, Small grain	Quartz Sand, Medium grain	Semi fat Sand Very small grain	Reclaimed Sand	Bentonite	Moulding clay	Ground Coal	Gas permeability in wet state	Moisture content %	Compresive strength in wet state
Small Castings	4.5		1.5	92 - 93		0.5-0.75	0.8	70	4.0-4.5	40 - 50

C_m = Specified content of that component in the molten metal, %.

y = the oxidation loss of the component during melting.

(3) Ingredients of the charge are properly weighed on the scale, Necessary amount of fluxes - ferro mangenese - are added to the charge at decided time-interval.

(4) The temperature is inspected with the Immersion Parameter.

(5) The ladles are pre-heated every time.

3. **Inspection of Finished Products :-**

(1) Foundry B uses a Knock-out machine for removing the castings from the moulds and a Vibrator for decoring of small castings.

(2) Foundry B undertakes following inspections :

i) Visual inspection of surface finish and

ii) Physical inspection for inspecting the outer and internal dimensions with help of rulers, calipers, and dividers.

(3) The castings are also checked for various foundry defects such as burnt on sand, washes, shrinkage, blow-holes etc.

(4) A testing machine is used for inspecting each and every piece of casting. The machine is set according to rate of tolerance. It requires 6 hours to set the machine.

(5) Foundry B has prepared detailed charts of all these operations.

4. **Painting of the Castings :**

The castings are prime-painted so as to avoid the surface against corrosion. Bituminous varnish is used by brush. Visual inspection is undertaken for checking the painting which is considered to be adequate.

5. **Preventive Maintenance :**

(5) **Preventive Maintenance :**

Foundry B undertakes preventive maintenance every Saturday which includes a thorough inspection of machinery and equipment. Foundry B has been able to avoid a major breakdown owing to the detection of minor faults and early correction of them and with a periodic overhauling.

All machinery, every mould and core box, every pattern, templates etc. are checked thoroughly. Defective pieces are replaced. Machinery is oiled. Apart from it, a customery routin check of every machine is undertaken before starting the activities.

(6) **Instruments:**

It owns all the usual necessary equipment like measuring tables, scales, gauges, calipers, weighing balances and so on. Apart from it, Foundry B possesses optical lences and Immersion Parameter for testing the temperature of the metal.

It also posses a Knock-out machine and a Vibrator, Sand-mixer and Oven. Foundry B is equipped with its own generator to avoid any sudden power-cuts.

(7) It has not yet implemented Quality Circle but a detailed plan in regards of quality circle has been prepared which will be implemented in a very recent future.

Foundry B has also installed a Computer.

The rejection is 8% at the foundry level. The quality at the firm's end is monitored by the percentage of castings rejected to castings produced. And with the help of Quality Circle, the firm hopes to reduce rejection percentage to 4% to 5%.

FOUNDRY 'C'

Foundry C manufactures both ferrous and non-ferrous castings. The quality is maintained in the following way.

1) Incoming-material stage.

2) In-process Inspection.

3) Inspection of Finished Castings.

4) Painting of the Castings.

(1) **Incoming-material stage :**

(a) Metals : Foundry C melts Pig - Iron in a cupola and Gun-metal in a Pit-furnance. It has to purchase Pig-Iron from MSSIDC and has to accept the consignment of Pig-Iron as it is. Foundry C does not undertake any kind of chemical analysis test.

In case of non-ferrous metals of bronze and gun-metal also, chemical analysis test is not undertaken.

(b) BPH Coke: It is essential for melting Pig-Iron in cupola. It is to be purchased from MSSIDC. In case of coke as well, only visual inspection is undertaken.

(c) Sand: A High percentage sand is pruchased from suppliers from Vengurla. This sand contains low carbon percentage. The suppliers send the report stating the properties of sand which are not verified by the partners.

(d) Binders: Foundry does not use Special Bentonite or specific binders. Ordinary moulding clays are used as binders. Properties of moulding clays are not checked. Only visual inspection is undertaken.

(2) **In-Process Inspection:**

(a) Designing: Foundry has appointed a trained and skilled draftsman. The design of pattern is drawn by the one of the

partners and draftsman assists him.

(b) Pattern - making: The alluminium patterns are purchased from pattern maker, working in the same Industrial Estate. On-spot checking of pattern is not undertaken. However, the patterns are checked for the accuracy before accepting the consignment.

(c) Moulding and Core-Preparation: Foundry uses high content silica sand, binders and water for mould and core preparation, However, definite and proper charts have not been prepared, either for the mixture of content or for testing of the desired properties afterwords. Foundry C does not possess any necessary equipment for checking these properties.

(d) Melting:

(1) The charge composition has not been determined because Foundry C does not follow any specific formula.

(2) The materials are weighed approximately.

(3) The heating and melting time is decided approximately. The necessary charts are not kept up-to-date. It has been decided that it takes approximately two to two and half hours to tap the first laddle of molten metal. The tapping-time is decided when the slag starts to come out from the back- vent of the cupola.

Then, a small quantity of metal is tapped which is inspected visually.

(4) The laddles are preheated.

In case of non-ferrous metals foundry C uses pit furnace, having a crucible capacity of 13 Kgs. It takes about 45 to 50 minutes to melt the metals weighing 13 Kgs. In case of melting of non-ferrous metals also, no proper charge composition is maintained or charging-tables are recorded.

(3) **Inspection of Finished Castings:**

Foundry C uses a Tumbling Barrel and Vibrator for lifting the castings out of moulds.

Visual inspection is undertaken on sample basis i.e. one casting out of every ten is inspected visually for detecting any foundry defects. The castings are also checked for internal and outer dimensional accuracies. Chemical analysis is not undertaken.

(4) **Painting of the Castings :**

The ferrous castings are prime painted with brush. Only visual inspection is undertaken for examining the accuracy of painting.

(5) **Preventive Maintenance:**

Foundry C does not undertake any specific preventive maintenance. Sometimes the machines are lubricated and the mould boxes, cores, etc. are checked. Defective pieces are discarded. On-spot inspection of machines when castings are being manufactured is not usually undertaken.

It has to be noted that this particular foundry unit has been declared as a sick unit.

FOUNDRY 'D'

Foundry D is the oldest established foundry-unit under the present survey. The third generation has been working in the unit. However, it has been observed that the unit depends mainly on visual inspection for its quality control programme.

1) In-coming Material State.
2) In - Process Inspection.
3) Inspection of Finished Castings.
4) Painting
5) Preventive Maintenance.

(1) **In - coming Material Stage:**

(a) Metals: Foundry D is a non ferrous unit and melts AD 5 Gun metal, Copper, and Bronze. The metals are purchased from various suppliers in Bombay, who send the reports of chemical properties. Foundry D does not undertake any laboratary sample-test of the supply before accepting the consignment.

(b) Coke: Two types of coke are used namely Nut Coke and BPH coke. Coke is purchased from MSSIDC. No test is undertaken before accepting the consignment.

(c) Sand: A fine mesh sand is used which is purchased from suppliers in Khanapur. No test is undertaken for veryfying any desired properties.

(d) Binders: Moulding Tar is used as binders. The suppliers are local private firms. No test is undertaken to check its quality.

(2) **In Process Inspection :**

(a) Designing : The designs are provided by the Industrial customers.Hence the designs are not inspected.

(b) Pattern : The patterns are manufactured as per the design. The patterns are manufactured by the foundry itself, and are checked with the design.

(c) Moulding and Core-Preparation : Moulds and cores are prepared by mixing the sand, moulding tar and water. No particular charts are kept describing the properties permeability, green sand strength and moisture. The inspection of the prepared sand and cores is visual and by hand.

(d) Melting: The charge contents are weighed accurately and it is not much cumbersome a job because the crucible capacity is only 13.5 Kgs. It requires about 50 minutes to melt the charge.

Only visual inspection is undertaken to inspect the temperature of the molten metal. No tables of charge composition or the yields from each charge are kept.

(3) **Inspection of Finished Castings :**

After the castings are lifted out of the moulds and decored, visual inspection is undertaken for checking the surface finish and detecting foundry defects like blow holes. Internal and external diameters are also checked. A 100% inspection is undertaken. But chemical test is not undertaken.

(4) **Painting:**

Finished castings are prime-painted with brush as per the instructions of the customers. Visual Inspection is undertaken to check whether painting has been done thorouhly.

(5) **Preventive Maintenance :**

Proper attention is not paid for preventive maintenance. Lubricating of machninery, inspection of mould boxes, cores etc. is undertaken sometimes. Once in 15 days, on-spot inspection of working machinery is undertaken.

It has to be noted that, at present foundry D has been suffering from severe decrease in its orders and seems to be on the verge of being declared as a sick unit. The percentage of rejection at the foundry level is as high as 12%. It seems that the management has only realised the cost of non-conformance-- i.e. inability to provide defect - free work for the customer.

FOUNDRY 'E'

It is a Private Limited Company. The foundry is engaged in manufacturing Cast Iron and Alloy Iron castings by conventional green sand moulding as well as shell moulding process. The complete operation is of jobbing nature. In most of the foundry operations, there is a heavy dependence on human element. There is very little automation.The major raw material sources are such where the foundry has no control on quality, reliability and price.

In spite of these adverse condition, the foundry tries to produce quality castings in order to achieve sound reputation in the market. The firm believes in -

1) Fully understanding technical requirements of customers,
2) Then devising appropriate manufacturing processes within the realm of available resources;
3) And attaining quality levels which will be closest to the expectations of the customers.

The foundry monitors quality assurance very effectively mainly in the following Four important are as -

1) At Incoming Material Stage,
2) In-Process Inspection.
3) Inspection of finished products.
4) Quality Circle.

(1) **Incoming Material Stage :**

The firm has made extensive specifications for each and every item of raw materials which goes into the manufacturing of castings. Laboratory checks are undertaken e.g.

i) Sand is tested for M.B. Clay percentage, Total clay percentage, Sieve analysis, Volatile substance etc.

The Quality of Sand is checked and controlled in the following way:

(1) **Scope:**

This standard covers Medium high silica sand of high Refractoriness and angular to rounded grain shape for use in Foundry.

(2) **Typical Applications:**

This grade is used for making cores by linseed oil sand process and for blending with screened Medium river sand to improve the refractoriness of the moulds and cores. This grade is also used for the green moulding sand facing.

(3) **Clay Content:**

The clay content of this grade of high silica sand shall not exceed 0.50%.

(4) **Chemical Composition :**

After washing off clay matter, the material when analysed shall conform to the requirements given in the following Table 4.1

Loss of ignition	.. ..	1.0% Maximum
Silica	.. ..	98.0% Minimum
Alumina	.. ..	0.50% Maximum
Iron Oxide	.. ..	0.50% Maximum
Calcium and Magnesium Oxide	.. ..	0.50% Maximum
Alkalies	.. ..	0.50% Maximum

(5) **Grain Shape :**

Washed sand grains shall be mostly of sub angular to rounded shape.

(6) **Grain Fineness:**

The grain distribution of medium high silica sand shall be given in the following table. 4·2

I.S.SIEVE	ASTM SIEVE	% RETAINED
425 Micron & above	40 and above	2.0% maximum
300 micron	50	15%
212 Micron	70	80% minimum
150 Micron	100	80.0% minimum
106 Micron	140	80.0% minimum
75 Micron	200 and below	1.0% maximum

(7) **Physical Properties:**

Colour - White

Base permeability : 160-170

Sintering point : 1685 - 1710°C.

(8) **Methods of Test and Samplings**

Sampling Inspection as per IS 1811-1961 Method of sampling Foundry sands.

Chemical analysis shall be carried out in accordance with IS:1917-1962 method of chemical analysis of quartzite and high silica sand.

(9) **Quality Control Procedure:**

All the above chemical and physical properties must be checked before establishing the source of supply. All the facilities are available to check high silica sand at IIT Madras and NIFFT Ranchi. Once the source of supply is established, all the properties may not be checked and only following properties will be checked

for the acceptance of every consignment.

PROPERTIESM		REQUIREMENT
Colour	:	White
Grain Distribution	:	Retained on IS Sieve 425 micron and above passing through IS sieve 106 Micron - 1.0%
Clay Content	:	0.50% Maximum.
Base Permeability	:	160 to 170

Note: All the properties are to be checked once in three months.

ii) Sand additives are also tested. Bentonite and ferro silicon is checked for Gelling index, Swelling index, PH value, etc. Coal dust is checked for its Ash percentage. Fixed carbon etc.

iii) Metallics like Pig Iron, Steel Scrap and Cast Iron scrap are checked for the percentage of carbon silicon etc.

iv) Acceptance and non acceptance levels have been specified.

v) For the items of high value incoming materials, 100% inspection of lots received is observed but for low value items quality checks are carried on sampling basis.

(2) **In Process Implementation Stage:-**

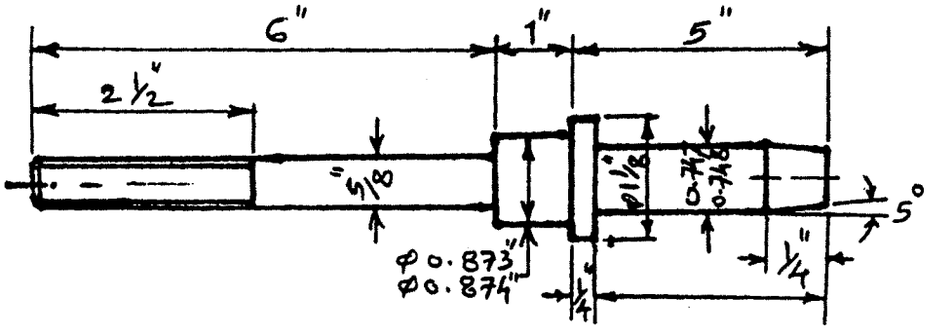
(a) Pattern Equipment: (See the chart No. 4·8)

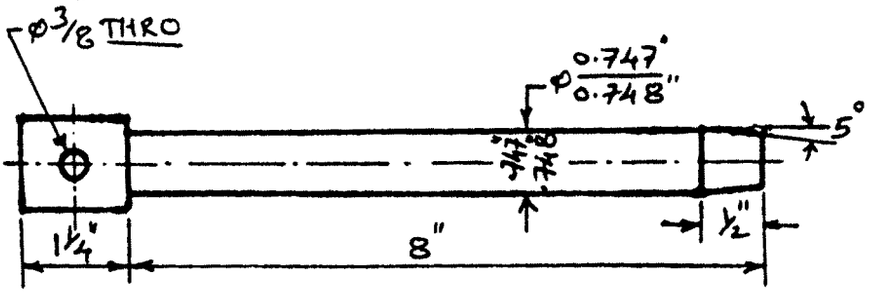
i) Maximum care is taken to maintain dimentional accuracy to providing correct contraction allowances and with close tolerance.

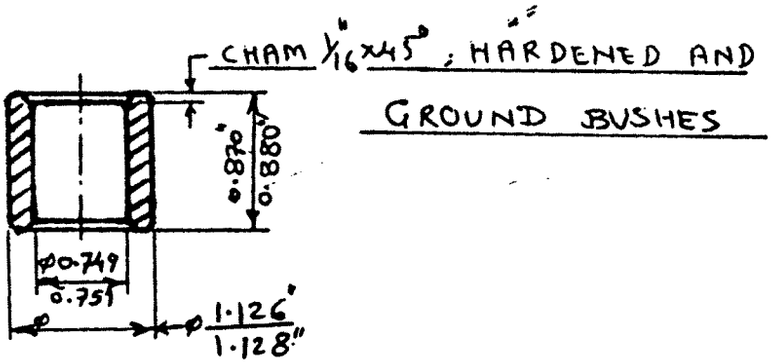
ii) At every specified interval, checking of its diamensions, fitment with match plates etc. is done and for each check,templates are made and preserved with correlating codification.

MOULDING BOX :- Size 400 mm x 400 mm x 200mm Fabricated with ovel and Round Bushes.

: PATTERN PIN AND CLOSING PIN AND BUSH SIZE :- Pattern Pin as per sketch
Pattern pin as per sketch
Bush sizes as per sketch.







(b) Moulding:

i. The firm has prepared Moulding Methods card (See (Chart No 4·9)

ii. The development engineer of the firm trains the workers by by demonstrating how they can produce the castings correctly by following instruction meticulously.

iii. As per process requirement, specifications of moulding sands are laid down and sample of every batch conditioned is collected and tested for various properties like green compessive strength, permeability, moisture, compactability, flowability etc. Results of every batch of every day are recorded on chart. (See charts 4·10, 4·11, 4·12·). And only batches conforming to the allowable mits are allowed to be used in moulding. Special care is taken to see that batch made for a particular job is used for that job only.

iv) iv) There is rendom checking on pprocesses like Zircon application, Mould spray quality etc.

v) Moulding boxes and pins are frequently used and handled heavily. So every week-end, batch of boxes and pins are thcroughly checked, repairables corrected and damaged ones are replaced.

(c) Core-Making:

i) Process finalisation is done, prepared cores are checked for hardness and dimensional inspection by templates.

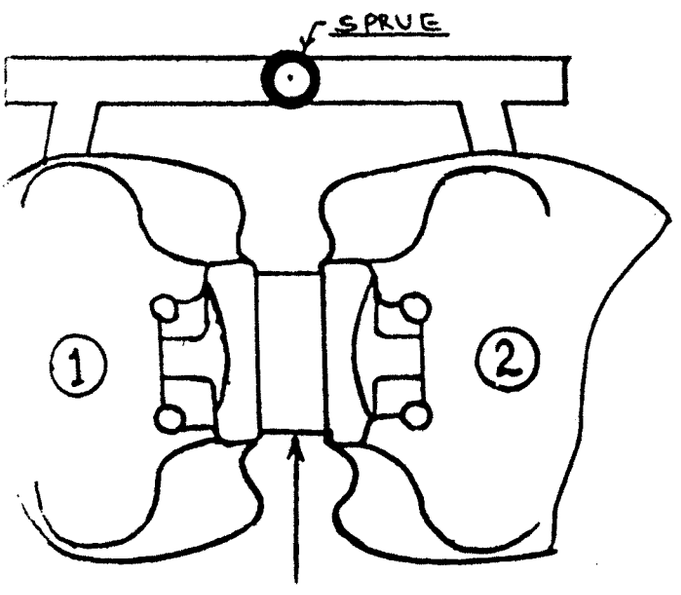
ii) All other manufacturing steps like knockout, shot fettling, painting etc. are monitored.

MOULDING METHODS CARD

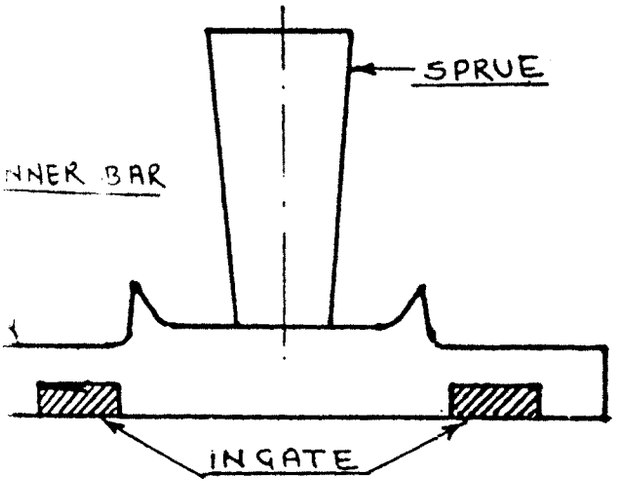
CHART 4·9

1. Part Name : Crank case
2. Drawing No : 20165
3. Customers name :
4. Casting weight : 7.39 kgs
5. Yield : 90.5%

PATTERN AND GATING SYSTEM :-



CYLINDER BORE CORE PRINT



1) Pattern Material:-

Cast Iron

2) Type of Pattern:-

Matchplate fitted in two halves.

3) No. of patterns:-

Two sets

4) Foundry Identification-

'K' Mark on unmachined surface

5) Gating system :-

Pressurised gating system as shown in the sketch.

6) Gating Ratio :-

1 : 1.8 : 1.4

Down Sprue size 21 mm dia at bottom. Sprue height 8"

... 2/

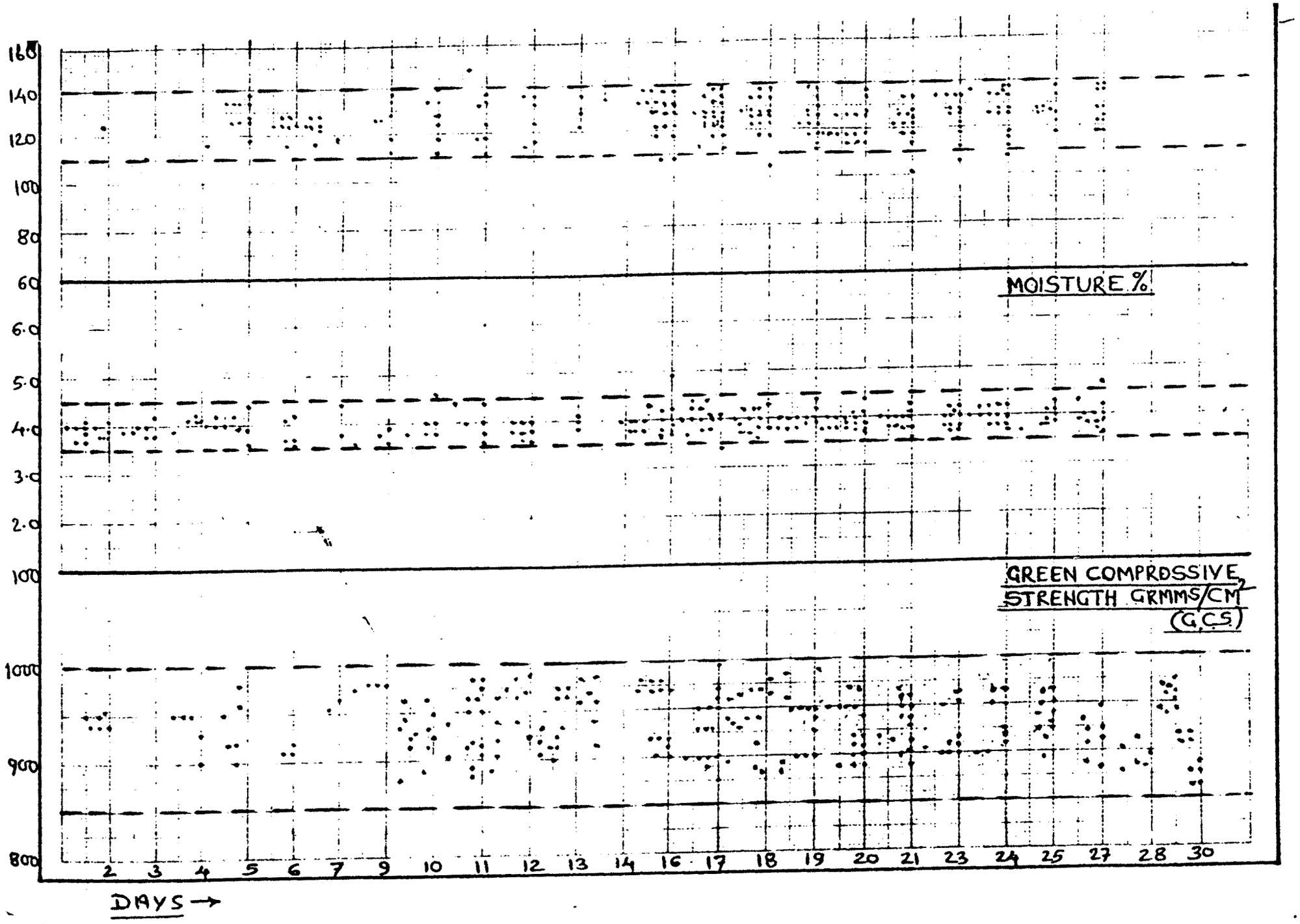

160
140
120
100
80
60
MOISTURE %
6.0
5.0
4.0
3.0
2.0
100
GREEN COMPRDSSIVE STRENGTH GRMMS/CM² (G.C.S)
1000
900
800
2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 19 20 21 23 24 25 27 28 30
DAYS →

CHART 4-12

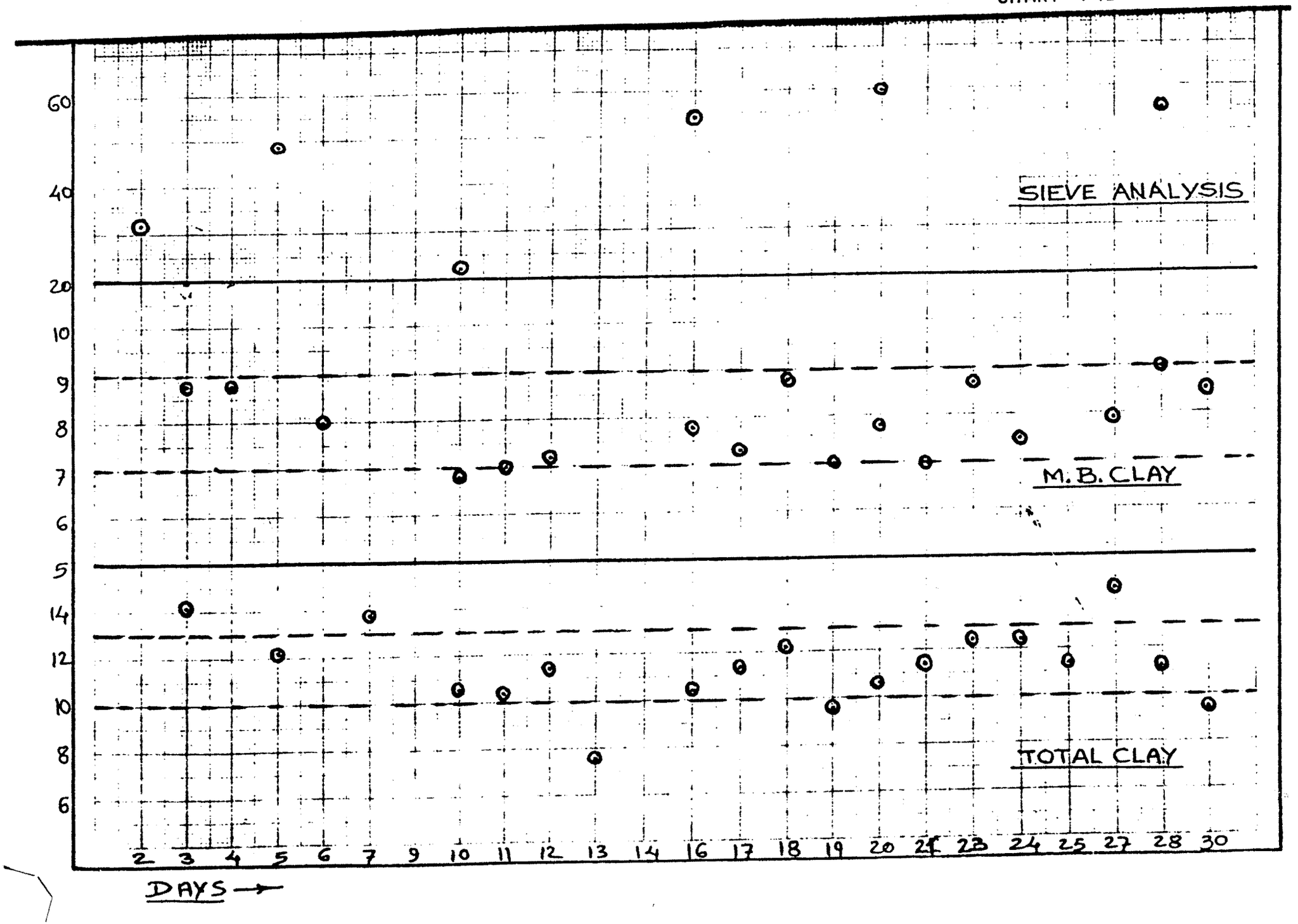
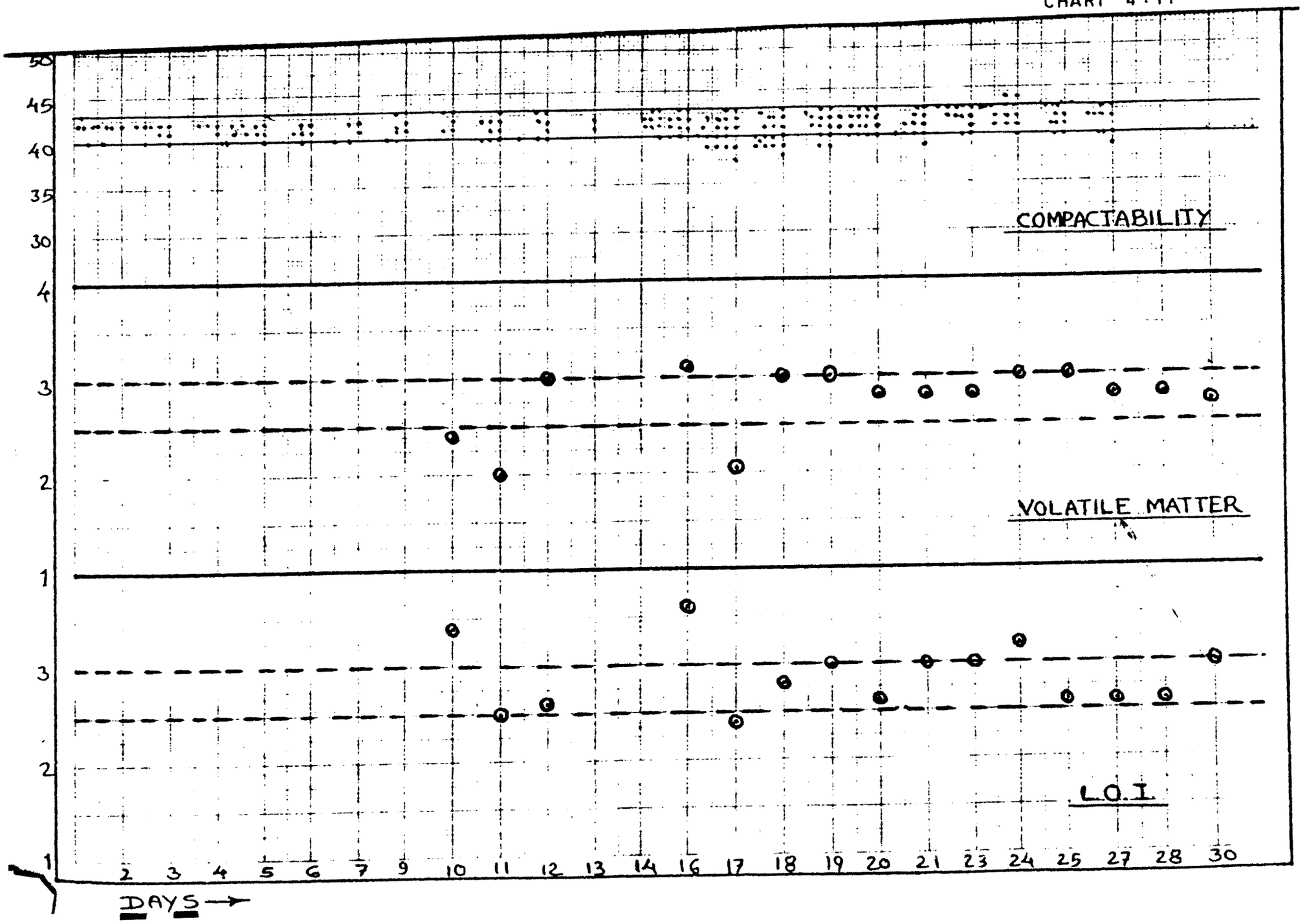

SIEVE ANALYSIS
M.B. CLAY
TOTAL CLAY
60
40
20
10
9
8
7
6
5
14
12
10
8
6
2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 19 20 21 23 24 25 27 28 30
DAYS →

CHART 4.11


50
45
40
35
30
COMPACTABILITY
4
3
2
VOLATILE MATTER
1
3
2
L.O.I
1
2 3 4 5 6 7 9 10 11 12 13 14 16 17 18 19 20 21 23 24 25 27 28 30
DAYS →

(d) Melting:

i) The foundry has tried to standardise their melting process in minimum number metal grades in three varities.

ii) Specification of every grade is decided to acheive chemical compcsition and physical strength required. To achieve this, charge composition is decided. Checked and known inputs only are allowed to be used.

iii) When metal is ready in the furnace, the sample is testec for carbon and silicon and the whole lot is corrected till required specification is acieved. Then only the metal is allowed to be used.

iv) Before dispatching the metal from furnance to laddles (which are preheated), other tests like wedge test, spiral test, final pouring temperature etc. are undertaken.

(3) **Inspection of Finished Product :**

i) Chemical analysis of final casting for percentage of carbon, silicon, phosphorous etc. as per the stipulated specification is done. Foundry has all necessary laboratory equipments.

ii) Testing of microstructure of different castings. The firm has a microscope and other equipments for this test.

iii) Physical testing is also done. Every batch of casting has test-bars poured alongwith it. Tensile strength is carried out using common facility centre of the Industrial Estate. The foundry also supplies 'Test Bars Facility' to their customers for varification.

iv) Every day's 100% production is inspected for foundry defects.

(v) Few samples (10% of every batch) are checked for hardness from every batch of castings.

(vi) Most of the castings are checked for dimensions, warpage

(vii) Some castings from every batch are proof-machined and checked for microporosity.

viii) Pressure testing, if specified by the customer, is done for 100% for that type of castings.

ix) After the casting are painted as per the specification of the customer, they are checked with standard samples.

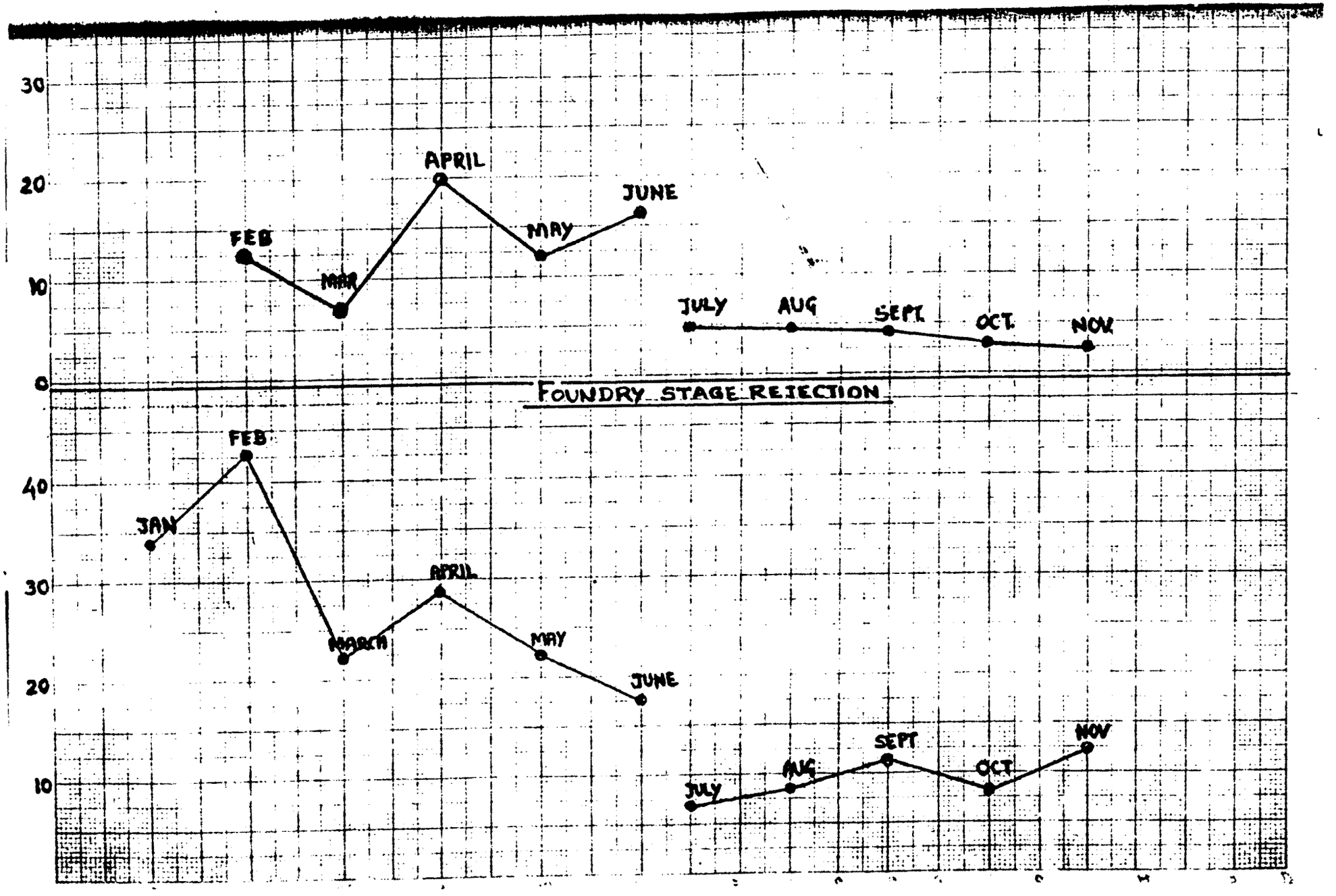
Record keeping at all the above the stages is kept up-to date which helps them build the history of each type of casting and it is always useful, if something goes wrong at the user's end.

The firm has studied the programme of Quality Circle in 1984 and has implemented it in an elaborate manner as discussed earlier in this chapter.The quality at the Foundry's end is monitored by the percentage of castings rejected to castings produced. (see chart 4.13) The quality at the customer's end is measured, by the components rejected against the components processed by the customers.

The firm takes into account the fact that they have to depend extensively upon human factor at various stages of production as well as inspedction. In spite of these odds, the firm has been doing export business in foreign countries, namely Japan and West Germany.

Foundry

CHART 4.13



FOUNDRY 'F'

Foundry F is in this business for more than 20 years and has experienced many ups and downs. But inspite of its long standing experience, it has not made any scientific and systematic plan of Quality Control. However, it has to be noted, that the senior most partner had evolved a reduimentary scheme of quality control as follows :

1) In-Coming Materials
2) In-Process Inspection
3) Inspection of Finished castings.
4) Painting of Casting
5) Preventive Maintenance.

(1) **Incoming Materials :**

(a) Metals :Foundry F melts Pig-Iron which is purchased from MSSIDC and has to be accepted as it is. Visual Inspection is undertaken to inspect the quality of consignment. A chip of metal is split and the properties are asserted after inspecting the cut of that split iron. Chemical analysis is not undertaken.

(b) Coke : BPH coke is purchased from the MSSIDC. Visual inspection is undertaken to inspect the carbon contents by breaking a piece of coke and inspecting the cut of the piece.

(c) Sand : Sand is purchased from the suppliers in Vengurla. No chemical analysis is undertaken. A visual inspection is considered to be adequate by the management.

(d) Binders: Coal dust is used as binders for which visual inspection is undertaken.

(e) Chemical :-Ferro-silicon is used infrequently which purchased from suppliers at Kolhapur.

(2) **In-Process Inspection:**

(a) Designs :- Designs are provided by the customer i.e. by the sister concern.

(b) Patterns:- Patterns are wooden - patterns and are purchased from the pattern makers established in the same Industrial Estate. Patterns are inspected visually and with help of various instruments like calipers, gauges etc.

(c) Moulding and Core-preparation: Moulds and cores are prepared by mixing sand, binders and water with pre-determined component composition. No testing equipment is used for inspecting the properties of prepared sand. A visual inspection is undertaken. Also some sand is picked up in hand and is moulded with fingures and its green-strength, moisture contents are inspected approximately.

(d) Melting :Foundry F has a cupola furnace, A charge compos tion is determined approximately. The metals, coke and chemicals are weighed. But charge sheets, yield records are not kept. Approximate time- about two to two and half hours - is determined as sufficient for the melting. Melting temperature is not inspected with parameter. However, the laddles are pre-heated.

(3) **Inspection of Finished Castings :**

After the castings are lifted out of the moulds and decored, foundry uses Vibrater to free them from any sand-particles.

Sample-testing- Every one piece out of ten, is undertaken to inspect.Visual inspection for detection of foundry defects, analysing surface finish is undertaken. Chemical analysis is not undertaken.

(4) **Painting of Casting :**

The castings are prime-painted with brush to avoid corrosive action and a visual inspection to determine the paint-work and its adequacy, is undertaken. Visual inspection is considered to adequate by most foundries.

(5) **Preventive Maintenance :**

Foundry F undertakes some preventive maintenance such as Lubricating machinery every day. Once in 15 days the moulds, cores, moulding pins etc. are checked and defective pieces are replaced.

From the above discussion, one thing is clear that foundry F has adopted rudimentary methods of quality control. Foundry F relies mainly on visual inspection for quality control.