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D02824

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.100/9
27 September 1971

ORIGINAL: ENGLISH

Training Workshop in Quality Control

Cairo (Arab Republic of Egypt)
30 November to 9 December 1971

QUALITY CONTROL IN SELECTED FIELDS:
Building Materials - Textiles -
- Food Processing Industries - Engineering Industries[1/]

by

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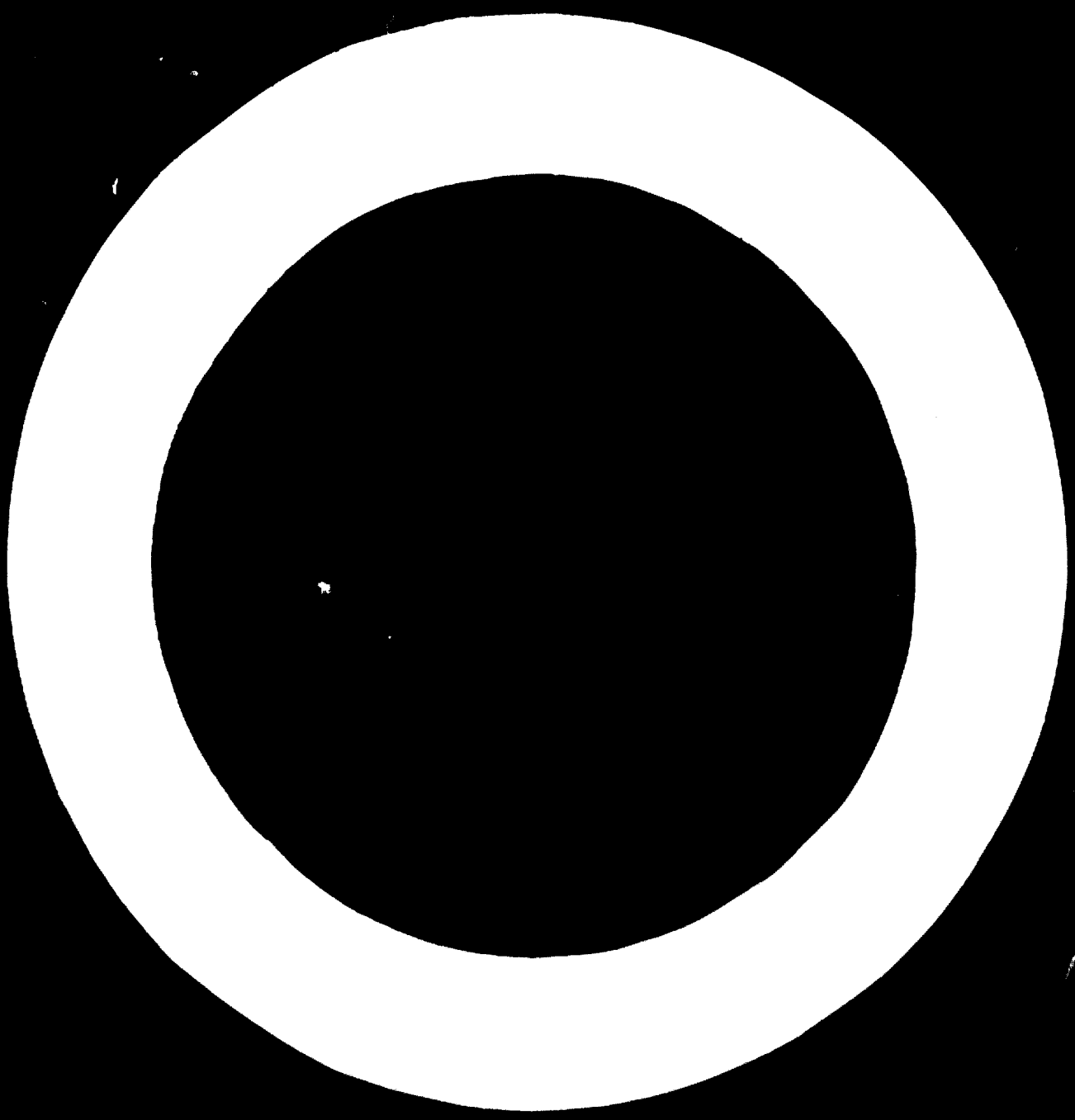
Building Materials

Quality Control Techniques Applied in the Production of Portland Cement



Building Materials

Portland Cement

I - Introduction :

Portland cement is an active combination of silicates, aluminates, and ferro aluminates of lime obtained by the preliminary grinding and mixing of the requisite quantities of lime (usually in the form of carbonate) , silica, iron oxide, and alumina . Then burning the mixture to incipient vitrification and grinding the resulting clinker to a fine powder with a small percentage of gypsum to adjust the setting time . There are small quantities of magnesia and alkalies present as impurities with the raw materials used in the portland cement manufacture .

UAR produces portland cement since 1928. There are four main producers of cement in the UAR. The Egyptian cement is well known in the international markets, it conforms to the required quality characteristics stated in the standards,even it exceeds this level due to the good quality of the raw materials found in the U.A.R. The results of the technical studies carried out by the Egyptian Organization for Standardization confirms this fact. It points out that during about two years of inspection control due to the quality mark system, no single Sample was found to be below the level of the Egyptian standards or any other international standards. On the contrary all the test results exceed the standard level. This is also due to the fact that the cement is considered as

a building material related to the safety of the consumers. Hence an efficient system of Q.C. is applied in all the producing cement units in the U.A.R.

However this project covers a comparative study for the production and Q.C. of portland cement in two main producing factories, namely factory I which produces about 1,400, 000 tons of cement (6 types) and factory II which produces about the same quantity of cement (7 types) .

II- Fundamentals of the Portland Cement manufacture :

The Cement manufacture has two pr ncipal objects in view i.e. to make good Cement at the least possible Cost. There are different means of attaining these ends. There is in fact, no straight and narrow road to the production of a cheap and good Cement . Nevertheless , it is not to be supposed that the quality of Portland Cement has reached its climax, nor has the cost of production reached its minimum, and the factors tending to high quality and law cost are kept continually in view by the manufacturer.

The process of Cement manufacture may be summerized under three headings :

(1) The grinding of the raw materials and mixing to the desired chemical composition .

(2) Burning in the kiln .

(3) Clinker grinding .

The fineness of the raw material is important in relation to the production of good clinker . If the raw mix is too coarse, incomplete combination of the lime, silica, alumina and iron occurs and instead of the desired compounds, other

compounds with quantities of free lime are produced and the Cement quality is poor. On the other hand the reduction of most raw material to excessive fineness is costly and it is therefore desirable to use first that degree of fineness which will allow of combination in the kiln. The most suitable degree of fineness varies with the physical and chemical charachterstic of the raw materials .

In the kiln using the wet process, which is the process applied in the two factories, drying the slurry, decarbonating the calcium carbonate, and burning at a high temp. to produce the requisite chemical compounds are all carried in the same unit. The burning is taken to what is described as incipient fusion i.e. part of the clinker is solid and part is liquid or molten glass. When the clinker is cooled, it is ground to a fine powder with a small quantity of gypsum to control the setting time. Generally the finer the Cement is found the stronger is the resulting concrete at early ages .

A simplified schematic diagram of the process is attached. Both plants use the wet process. But there are some differences in the techniques applied. For example, Factory I transforms the clay into a slurry before feeding into the mills . Where as factory II. produces the mix within the mill (i.e . clay , lime stone, etc are fed in dry). There appears no detectable difference in the quality of tha final product. It was said by factory I however that their process results in less wear within the mill and requires less electrical power per ton of processed material .

III - Q.C. of portland Cement :

The basic processes of the Cement manufacture can be summerized in the following :

1- Preparation of the raw materials by:

a- mining
b- grinding

2- Preparation of the slurry.

3- Burning in the kiln .

4- Preparation of the final product .

5- Packaging .

Hence, the Q.C. scheme of Cement must cover all these principal operations .

In the following there is a brief description of the Q.C. points and tests applied in each point :

1. The Raw materials: (control point I)

a) Samples of the mining Zone:

Samples, representing the mining Zone are taken once/month minimum in the usual conditions i.e. when the mining Zone is homogeneous.

The interval must be shorter as necessary when a difference between two successive samples is noticed, or when the mining zone is not homogeneous.

A complete chemical analysis is carried out for these samples.

The aim of this control is to have a general knowledge about the composition of the raw material .

The exact present composition is controlled at the 2^{ed} stage (b).

b) Samples of the ground raw materials :

Lime Stone :

Periodic samples from the crushers are taken every one hour to determine:

a. Calcium Carbonate content.

b. Water content.

Clay :

Periodic samples are withdrawn every one hour to determine the water content .

Gypsum :

Representing samples are withdrawn from each batch to determine the percentage of both $S O_3$ and $Ca SO_4 . 2 H_2O$.

It is evident that the object of control point I is to determine the main constituents of the raw materials so as to mix them in the proper ratios to prepare the required slurry. The SO_3 in Gypsum is estimated to determine the adequate percentage of gypsum added to the clinker without effecting its quality.

2- The slurry : (Control point II)

Periodic samples are drawn every one hour from the mills and the tanks ,also from the kilns where the following tests are carried out :

- Fineness .
- Determination of the percentage of calcium carbonate .
- Percentage of water .
- Viscosity .

However this point of control is very import, it decides to a great extent the properties of the clinker formed in the kiln. A corrective action takes place at once if any deviation from the standard specifications occurs by readjusting the composition before allowing the slurry to enter the kiln .

3. Burning : (Control point III)

Periodic samples are drawn every hour from the kiln where the litre weight is determined . Samples representing every 24 hours are collected and tested as portland cement according to the national standards .

Needless to say that the temprature measurements of every Zone of the kiln is a decisive factor in determining the properties of the cement and has a notable effect on the economy of the process .

Dealing first with cold end of the kiln, the following data is required :

- Temp. of the exit gas .
- Composition of the exit gas .
- Quantity of tha raw materials fed into the kiln .
- Percentage of moisture in the raw materials.
- Quantity of dry raw materials carried away with the exit gas.
- The draught in the back end .

At the hot end the following data is required :

- Temp. of the clinker in the Zone where incipient fusion takes place .
- Pressure of the air in the kiln hood and the firing pipe .
- Weight and rate of feed of fuel .
- Temp. of the clinker leaving the cooler .

- Temp. of the kiln cooler shells .
- Weight of the clinker produced .

After recording these data, the figures are analysed and a rapid corrective action is carried out by readjusting the conditions of the kiln if any deviation from the standard conditions is noticed .

4- Preparation of the finished product : (Control point IV)

Periodic samples are drawn every one hour from each mill to determine the specific surface and the setting time. Samples of 24 hours are collected and tested completely according to the standard specifications .

The control point indicates the properties of the final product and determines whether the cement can be accepted or rejected .

5- Packaging : (Control point V)

a- Periodic samples are taken every one hour during packaging. The samples are collected and tested according to the standard specifications .

b- From the samples collected, a sample weighting 5 Kg. is kept in a tight closed package where the date of packaging is indicated . The samples are reserved under suitable conditions for at least three months .

c- Samples representing the cement packages are weighted on a calibrated balance .

d- The craft paper of the cement packages is tested according to the national standards .

Moreover the number of the plys of the packages are checked .

This control point indicates the conditions of the cement which will be delivered directly to the consumer and it is the final check carried out by the producer .

However, in the conclusion, the manufacturer must bear in mind always that the cement production is a continuous process. The kiln can't be stopped at any moment to adjust the conditions . Any deviation from the standard condition means a direct loss. For this reason the control must be carried out continuously. All the corrective actions such as readjusting the conditions of the kiln or the composition of the slurry must be carried out directly. All results concerning the control of tempratures or the kiln are to be recorded. The quality control and the production sections must get the required information even minute by minute to be able to carry out any corrective action .

IV- Sampling and Testing of Cement :

The sampling of cement, so that a small quantity shall adequately represent the bulk is an important preliminary to the carrying out of the tests. If the sample is not represe-ntative the tests are valueless.

However in the best equipped laboratories it is impossible to ignore the most important element, the personal element. The Egyptian standard specification (ES/373/1965) lays down a prodedure for avoiding as far as possible the personal element in the following way : - It states that in sampling for testing, each sample shall consist of a mixture of approximately equal portions selected from at least tweleve different portions. If the cement is kept in tanks, samples must be drawn during packaging. If the cement is kept in bags or other packages, the

samples must be draw from six bags or packages at least. In case there is a less number than six pags a sample shall be taken from each bag, the samples are mixed together to form one sample. The final sample must weigh at least 10 Kg. for each 250 tons of cement. If the cement tested exceeds 250 tons a separate sample must be taken for each 250 tons .

The two producing factories carry out the tests according to the Egyptian standards. The Egyptian standard requires that the following tests must be carried out :

1- Chemical Composition
2- Fineness
3- Setting time
4- Soundness (le chatelier test)
5- Test for strength (compressive strength).
6- Tensile test in some cases .

Soundness is the most essential quality for a cement, and the le-chatelier test provides a means of measurment which has in practise proved reliable .

In the test for strength, which comes second in importance we have variations due to the personal equation in mixing, moulding, maturing and breaking, which make this test dependent upon knowledge and experience and not so susceptible of exactness as might be desired. In testing for setting time, too, these inaccuracies occur .

V- Conclusions of Comments :

1 - The Cement produced in the two producing factories comply with the Egyptian standards .

The E.O.S. gives both factories the right to put the quality mark. According to the technical studies and continuous inspection carried out by the E.O.S through withdrawing at

least monthly samples from all types of cement, and checking continously the Q.C. systems applied, we can state trustly that the Egyptian Cement is worth of awarding " The quality mark ".

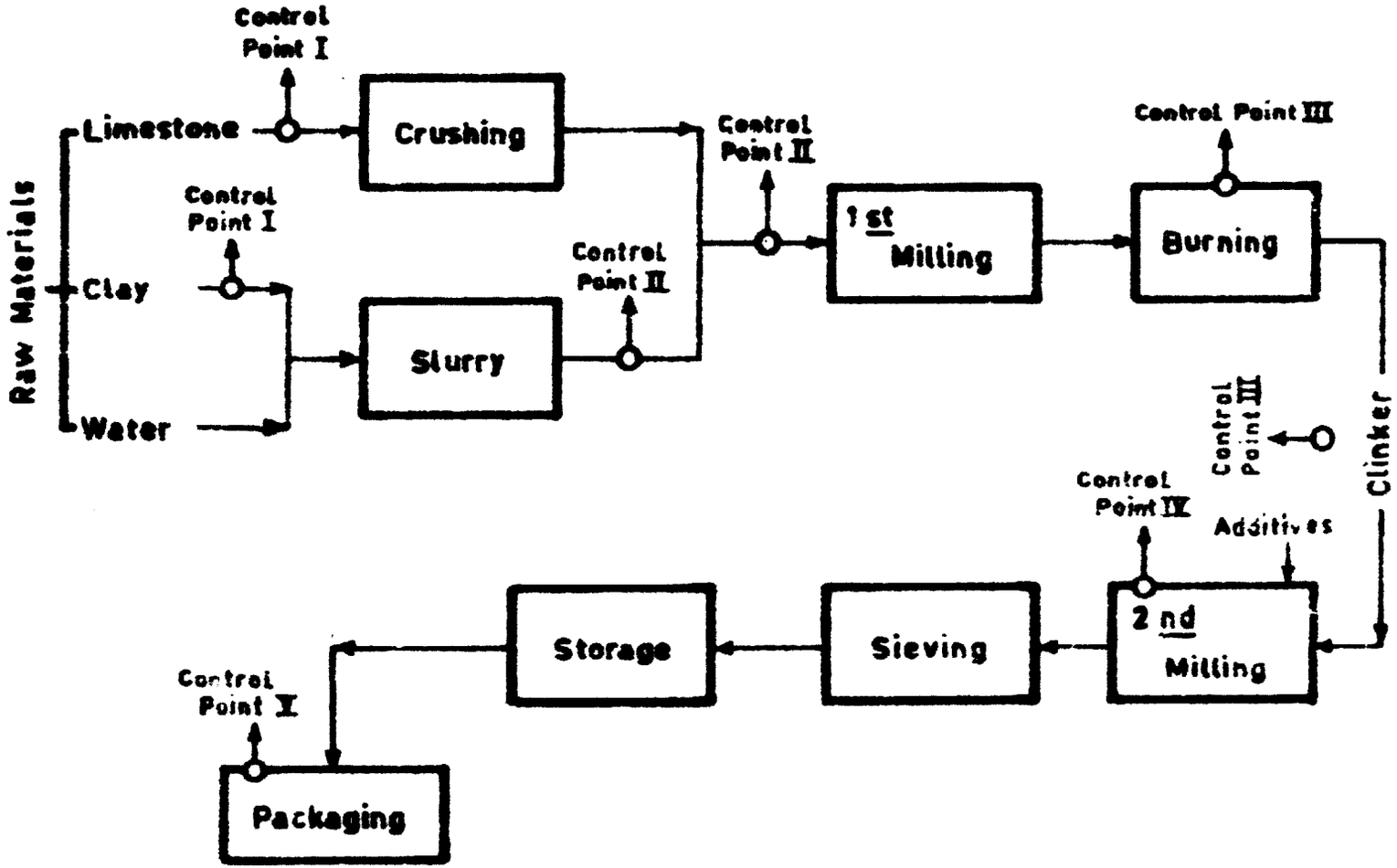
2 - Although the cement comply with the standard specifications yet some troubles may occur in Concrete . A Common Cause of a chemical process which may be altered or destroyed by unfavourable Conditions. Care, experience and supervision are always necessary in the use of Cement. However the consciousness of experience of utilisation are very low . So all the efforts must be done to treat and face this crucial problem.

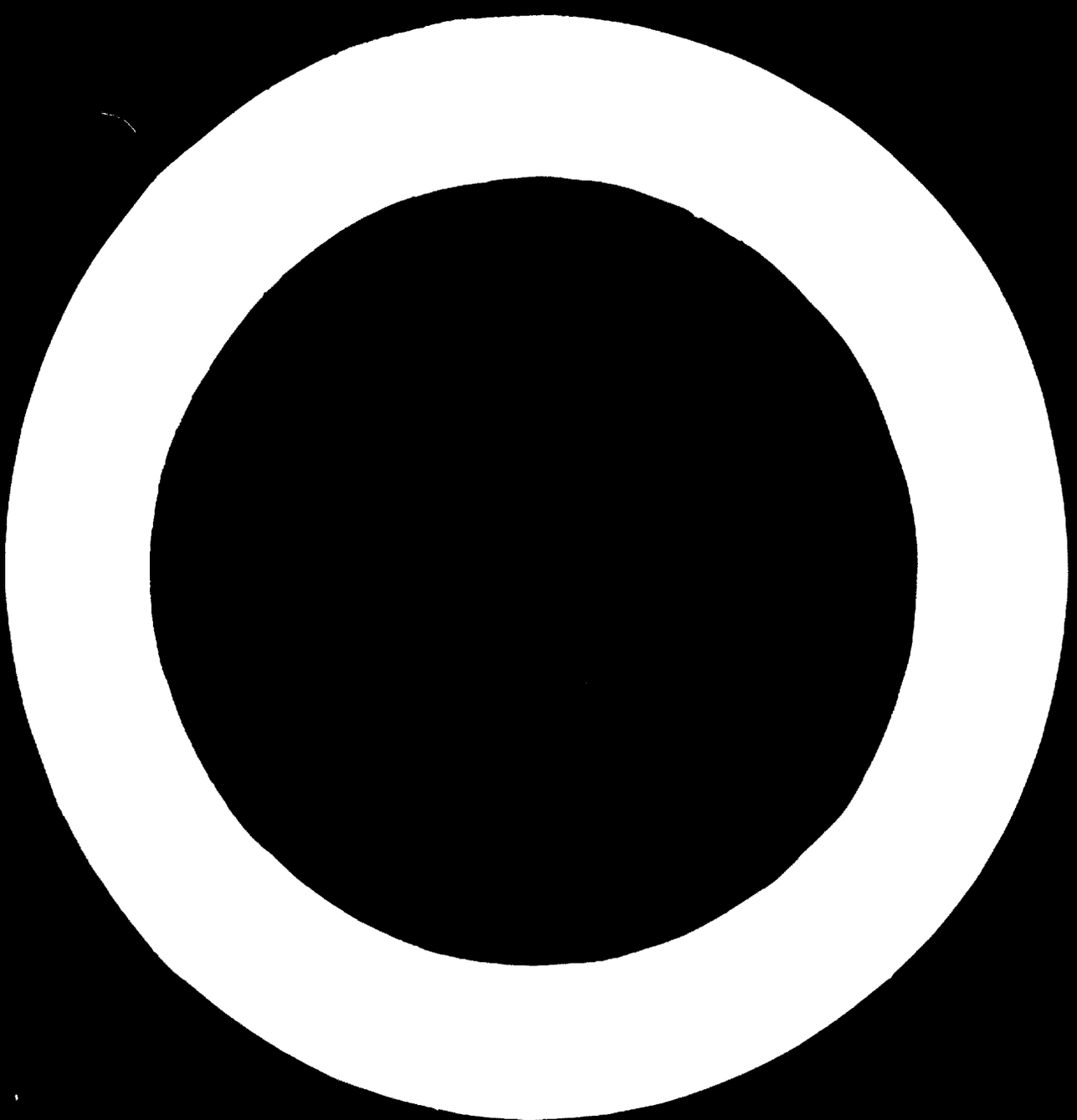
3 - Organizational Aspects :

The task of quality control organization is the administration of the activities of personnel who work within the technological frame work represented by the four quality jobs which are : new design, incoming-material control, product control and special process studies.

In factory I the quality control department belongs directly to the general manager of the factory while in factory II the responsibility is given to the production manager . It is evident that the 1 st type of organization i.e. factory I permits the Q.C. department to give neutral decisions concerning quality problems and ensures that the requisite level of quality is mainteined .

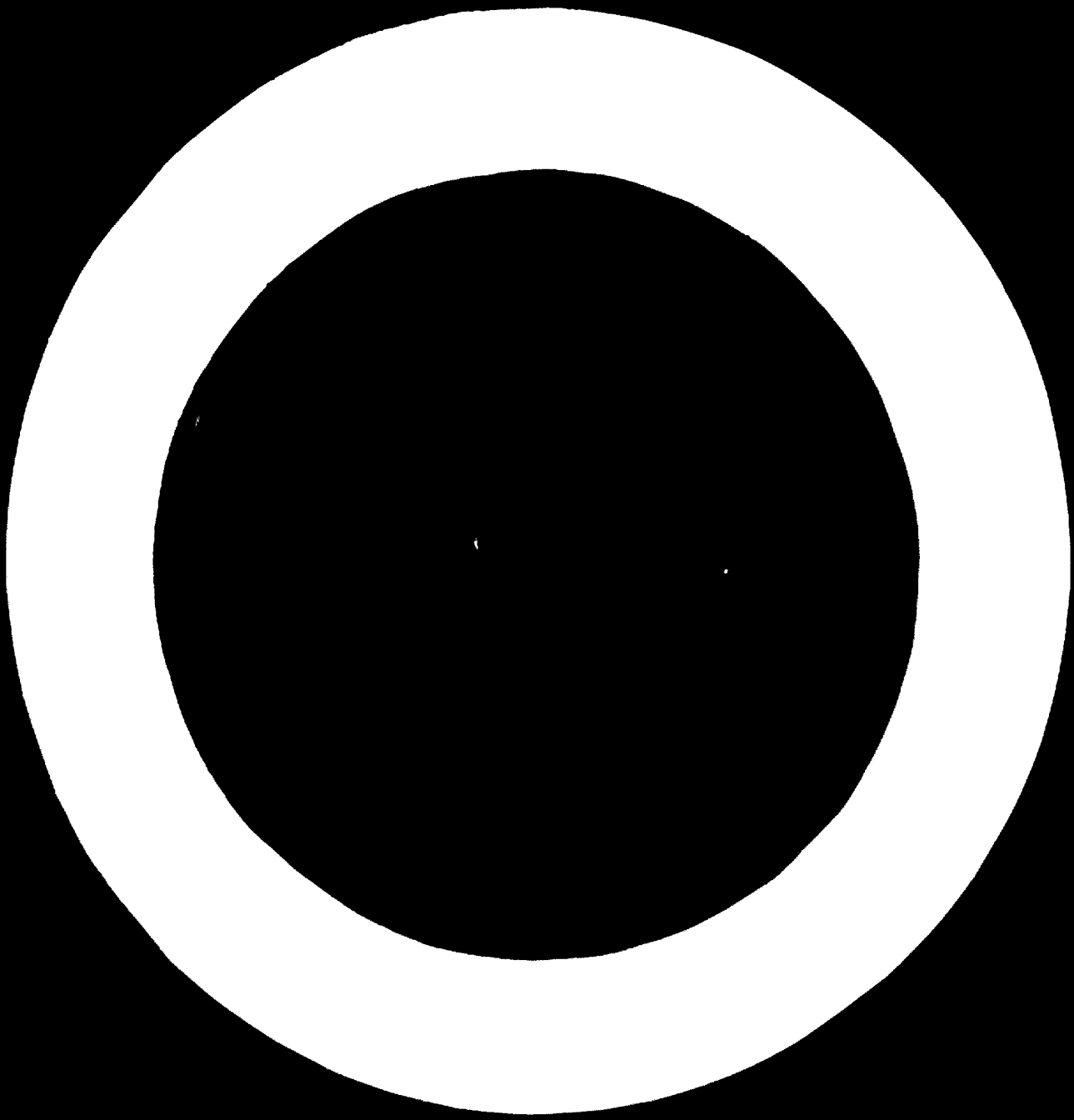
Portland Cement Manufacture & Production Control





Textile Industries

Cotton Yarn Manufacture
and
Quality Control



Textile Industries

Introduction :

The early excavations of pre-historic ages showed the use of hand spindles and looms by the ancient Egyptians Thousands of years ago and have also showed that they have achieved a remarkable degree of fineness and beauty in their textile production.

The consumption of textiles always comes out first among the consumable goods in all world nations. The textile industry is based on agricultural, animal and synthetic fibres as raw materials. The most important of which are :

Agricultural : Cotton - Flax - Jute.
Animal : Wool - natural silk.
Synthetics : Different man made fibres such as nylons and rayons.

Cotton comes out always first as regard to the highest figures of production and consumption. In the U.A.R. through the ages up till the late twenties, this industry has undergone many stages till the first mechanical works were erected in a limited scale. But from the beginning of the industrial development in 1958, many spinning and weaving mills were erected in different provinces. In this respect the public sector plays an important role. The Egyptian General Organization for Spinning and Weaving established in 1962. It supervises and coordinates the activities of 28 affiliated companies beside certain responsibility towards the private sector. The organization companies cover with their activities the production of cotton, linen, wool, natural silk rayon and jute fabrics in spinning, weaving, finishing, knitting, ready-made garments embroidery and carpets industries.

Quality Control in the textile industry :

Quality control is concerned with the evaluation of test data and its application to the control of the textile process, raw materials, intermediate products, and final product. It is concerned not only with quality level and the

cost of maintaining this level, but also with the presentation of tangible values to measure quality and changes in quality.

If the textile industry is viewed objectively, it will be seen that the ultimate effort, depending on the product, is to provide the best quality possible at the lowest cost. In the improvement of the ratio of quality to cost, the mill must view its own problems in manufacturing and customer relations before taking action. In some cases, it might be preferable to aim for improved quality with no increase in costs. In other cases where quality is stabilized at a satisfactory level, the objective should be to reduce the cost of meeting this quality level. In other cases, the product may be too good for the market, and both the quality level and cost can be reduced. It is through testing and quality control techniques that the changes desired can be tried, for without tangible values provided by a quality control program, any effort to alter quality or cost amounts to tampering with the unknown.

The program for successful testing and quality control must consider the following factors :

a) Tests to be performed and the equipment for these tests.
b) Personnel to perform the tests and evaluate the results.
c) The methods and procedures for sampling, performing evaluating and applying the results.

* * *

However this projects deals with a textile factory producing fabrics, yarn and broidery.

I have choosen out of the main activities of the producing firm, the cotton yarn manufacture and quality control with special reference to a statistical quality control study performed on one of the production processes.

A) Control of the raw materials :

The most important raw materials used by the cotton industry, the cotton fiber, is one of the most variable materials used by any industry. The properties of cotton

fibers vary for all different varieties of cotton, for different growth areas, for different climatic conditions, and from year to year. In the strictest sense, only a semblance of control can be maintained over these variables during the growing of the fibers even under ideal conditions. With all of these as well as other variables introduced into any crop, the problem of selecting the proper cotton for yarn processing can be complex.

Once the proper cotton has been selected, the cotton classer and the quality control laboratory measure the quality of the cotton purchased to be assured that the quality level is maintained.

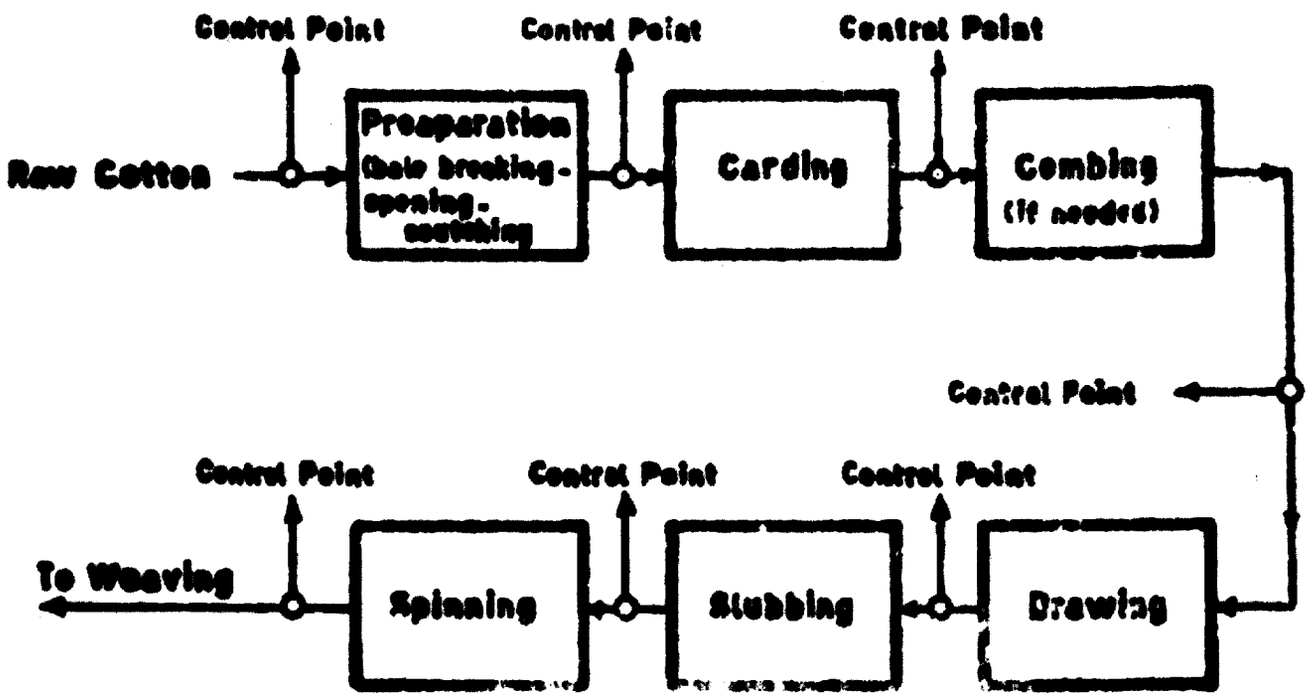
Several tests are carried out for cotton fibres, the most important of which are :

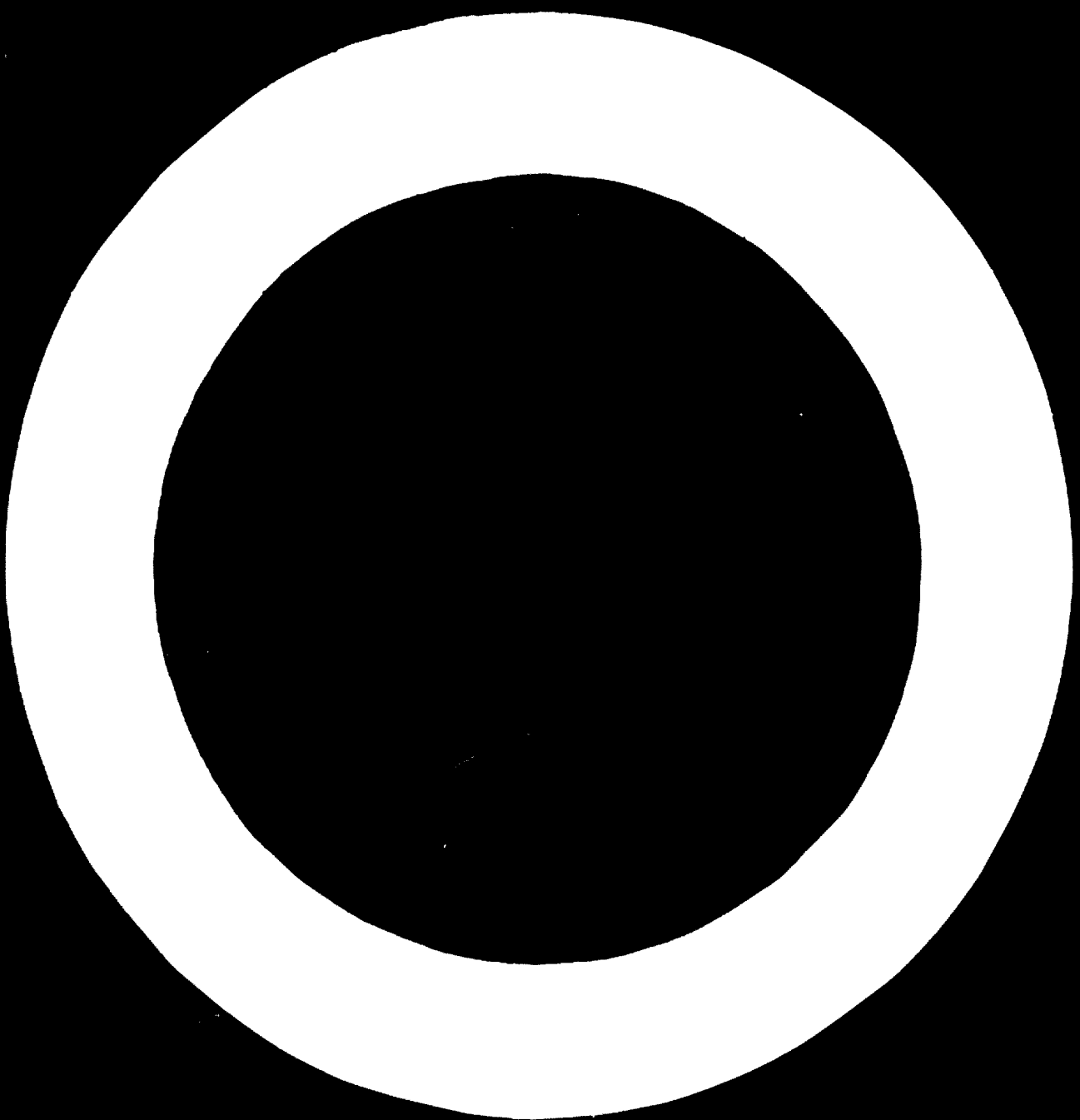
1. Tests measured by the cotton classer to define cotton grade as follows :
   - Staple length.
   - Colour.
   - Ratio of forigen matters.
2. Tests measured in the quality control laboratory as follows :
   - Fiber length.
   - Fiber strength.
   - Fiber fineness and maturity.
   - Non-lint content and nep.
   - Moisture content.

The test results are used as a means of selecting cotton to be purchased, or to measure the quality of cotton already purchased so that the blends and mixtures can be more intelligently established and processing difficulties anticipated before the fibers are actually processed.

The quality control department reviews the cotton characteristics and in case of non conformity to the required standards the cotton will be refused.

Yarn Manufacture and Quality Control





B) Yarn manufacture and production control :

The following is an outline of the yarn manufacture and the control points in the different processes :

1. Breaking: The bales as received from the cotton producing areas contain the fibres in a tightly packed form. The fibres have to be freed from the package, this being achieved in a series of operations. At first the bales are broken up into small lumps in bale breakers crude machines in which rotating arms tear into the bales.

2. Opening and Scutching : At the end of these operations the fibres are more or less separated and are delivered for further processing in the form of a lap. The opener may be variously constructed but essentially consists of a beating mechanism which loosens and opens the lumps of cotton. In this process the cotton is freed from its major impurities and dust. However the producing factory performs several tests which have designed to measure quality. The cotton is frequently oiled during the opening process to improve the running conditions in subsequent operations. In general this application of oils is claimed to reduce static, provide lubrication to facilitate and improve drafting and to reduce dust and fly. The amount of oil applied is of importance, in as much as an excess quantity might cause more trouble than good. For this reason periodic tests using simple and accurate methods of checking on content are carried out.

3. Carding : The carding engine combs the fibres of cotton as fed to it in lap form approximately parallel and purifies it from most impurities. The fibres are brought into alignment in the form of a sliver i.e. bunch of fibres which is essential for the production of yarn. After this process there is a control point where an inspector from the quality conformity section draws at random samples to be examined in the laboratory to ensure the carding sliver uniformity.

The tests carried out on the sliver are :

a. Weight per meter : this test is performed first to show the average actual weight of the product and second to show excessive variation in size from the standard of any individual card, where such variation may be indicative of mechanical trouble. In the every day test for card sliver weight, usually a program is set up to check the size of the sliver from each card in operation.

b. Nep count at the card web : Neppiness is measured at the card web because of :

1. The fact that this is the one step in processing at which it is relatively simple to get counts that are representative.

2. In grading yarn for appearance, neppiness is one of two important characteristics, the other factor being eveness.

Thus freeing from neps is deriable in the yarn and increases the uses to which the yarn can be put.

4) Combing : Although carding produces a sliver which is suitable for most requirements of yarn manufacture ; yet for high quality yarns the greater part of short fibres have to eliminated, for this purpose combing operation is introduced. The resulting sliver contains a greater proportion of long staple fibres than the sliver coming from the carding engine.

5) Drawing : (drafting): This process have been choosen for certain quality control statistical study. However further parallelization and reduction of thickness of the sliver takes place during this operation. Several slivers are reduced to the thickness of one sliver by being drawn out through successive pairs of rubber rollers of increasing speed. After this process thereis a control point, the drawing frame sliver sizing is performed one each shift of

operation and sometimes twice. Also controlling the drawing frame sliver evenness is one of the principal tests in the routine of the quality control department. This is due to the fact that the drawing operation is the last process before twisting and spinning and that the degree of evenness and homogenity of the ply and the thread produced depend to a large extent on it. Also controlling the gears and the speed in the drawing process is easier than that in the twisting and spinning processes. However it is sufficient to check the quality of the sliver produced at the last step of the drawing operation. Lengths of one meter each of the produced sliver are taken from each drawing head after exactly measuring them. These sliver lengths are allowed to stay for a suitable time in a standard conditioned laboratory and are then weighed . A sample of four weights is tested from each drawing head so that all the machines are tested once per week. The mean of each sample ($\bar{x}$) and the range(R) are calculated. Then the mean of means ($\bar{\bar{x}}$) from the total drawing heads, also the average range ($\bar{R}$) are calculated. By using the statistical tables, control limits for $\bar{x}$ chart and for R chart are calculated. The results taken from actual experiments proved that all the points were within upper and lower control limits in each chart ($\bar{x}$ & R control charts) i.e. the process was statistically controlled. Comparing the control limits with the specification limits, we have found that the control limits were within the specification limits i.e. the process can produce products conforming to specifications when it is under control.

6) Slubbing : The drawing is continued in the same manner over various stages (slubbing sliver, intermediate sliver). The roving is produced. It is thin enough to be spun into yarn, and its sizing is controlled daily, and in case of deviation from the standards it will be refused and the machine setting is to be checked.

7) **Spinning** : During spinning the final twist is inserted. This is done by turning the roving rapidly round its own axis between a fixed point at the end and a rotating point at the other end of the spinning system. This operation can be summarized in that the twist is drawn to the required degree by a set of cylinders and twisting the produced thread to the required degree. Then winding it on certain bobbins. The degree of twist depends on the rate of feeding the roving from the final drafting rollers to the spindle . The less roving is released by the feeding rollers, the greater is the twist .

However, after this process, there is a control point where the inspector from the quality conformity section withdraws at random representative samples to be examined in the laboratory to ensure the yarn uniformity and quality characteristics. The tests carried on the yarn are :

a. Yarn numbering.
b. Yarn strength .
c. Yarn grade and Appearance
d. Twist testing .
e. Evenness measurements.

In the case of deviations from the required values the machine setting is to be checked .

* * *

It is obvious from the abovementioned yarn manufacture processes that the producing firm has choosen some control points on the production line for the control of quality of the semifinished products, where representative samples are withdrawn at random at fixed intervals and tested according to the approved standards. Test results are recorded and plotted on the suitable control charts. In case of deviation the assignable causes of defects are studied and analysed to take the necessary corrective actions weather the reason is the man. material, machine, method.. etc. and feeback information takes place .

Some Quality Aspects :

a. Q.C. Manual : The Company compiles a quality control manual which lays down the following :

- The organization structure and functions of each department.
- The definitions of the major operational procedures and systems by which quality control is achieved.
- The standard specifications (national or foreign) for raw materials, intermediate materials, accessories, final products & packaging equipments and materials.
- The standard specifications (national or foreign) for methods of sampling analysis and investigations for all materials used in the process. This includes the visual inspection, physical and chemical tests.
- Description and flow diagrams for defining the operation and routing of all documentation which influence the operation of quality control in any aspect.

The purpose of this manual is to act as a record of how the company intends to carry out its quality control activity and to show for every one the correct procedure to be followed and applied.

b. Responsibility and authority of Quality Control :

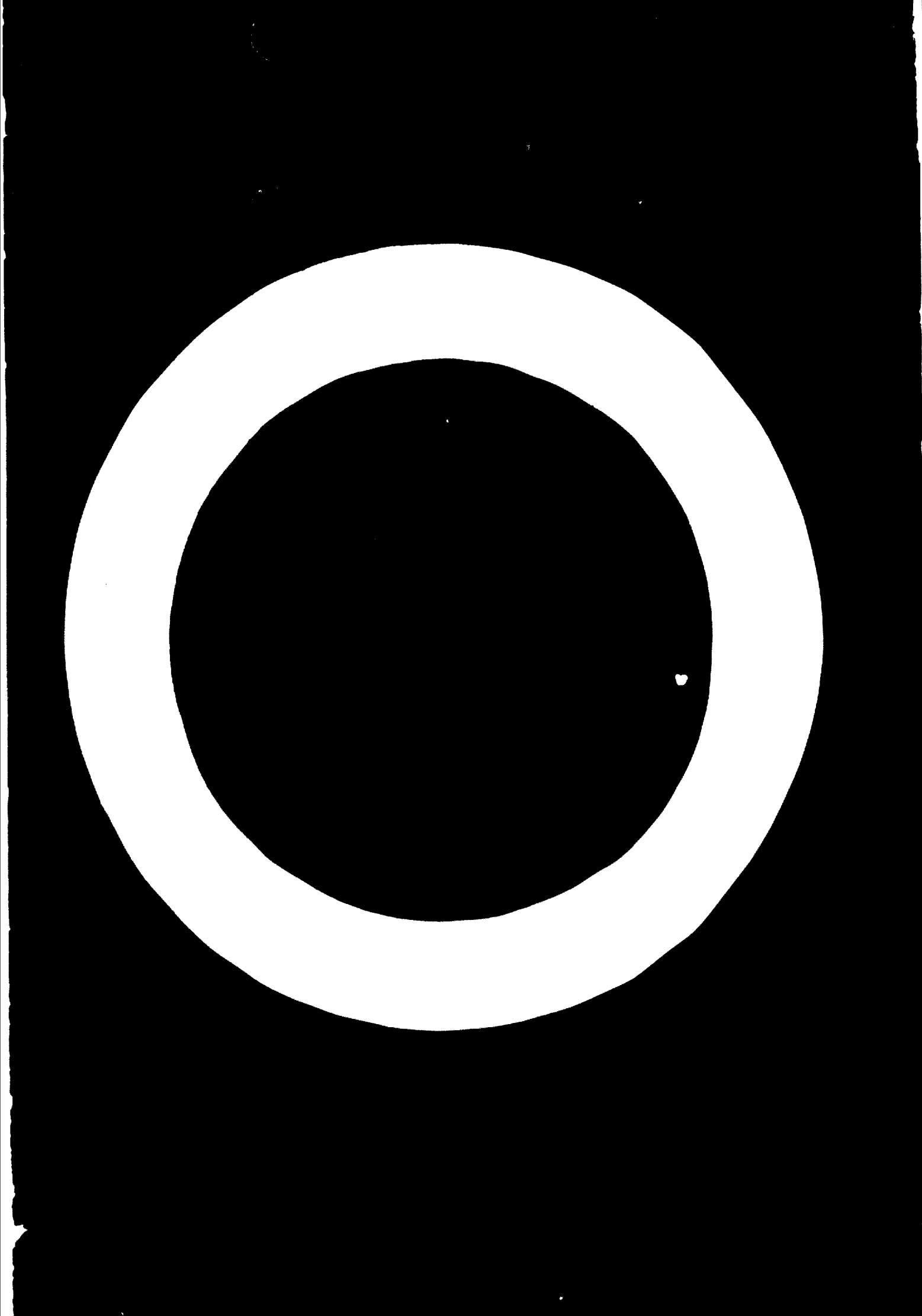
The objectives of the quality control in this Company is to achieve an agreed balance between production and quality, this therefore defines the status of Q.C. , it is equal to production at all levels. However Certain safeguards are taken. These are :

- Ensuring that entire manufacturing process as and all ancillary materials and services are adequately specified, including purchase specifications for raw materials.
- Ensuring that all necessary facilities by way of plant maintanance instructions, operating procedures, checks and tests are adequatily defined and specified.

- Ensuring that all routine production laboratory tests and measurements are correctly carried out in accordance with the pre-determined instructions and methods.
- Preplanning all Q.C. activities to ensure that the plant maintenance and manufacturing processes conform to the requirements and instructions. Included will be the methods and frequency of monitoring and sampling, together with the records to be taken and their disposal to the relevent departments.
- Checking the efficiency of the quality control function by random checking.
- Investigating the suitability of all raw materials and sources and checking and approving all specifications.
- Controlling the quality of all incoming goods and accessories needed for production purposes to their relevant purchase specification.
- Investigating all production problems.
- Controlling and operating central chemical and physical laboratories as a service to Q.C. and research departments.

Food Processing Industries

Chocolate Production
and
Quality Control



Food Industries

Quality must be initially recognized if it is to be produced. Whether a firm is producing chocolate, cutting cloths, making furniture or building electronic computers, it can only produce good quality items if it clearly understands what is meant by good quality, and when it has the equipment, procedures and skills needed to recognize and control it. Inspecting each product after it has been manufactured does not ensure that all the rejects have necessarily been found. People are fallible, the degree of defectiveness which leads an inspector to reject an item can vary from time to time, and an inspector may occasionally fail altogether to see an obvious fault. Thus one hundred percent inspection is not only costly, but may not be one hundred percent efficient. The efficiency of the inspection can be increased by understanding the physical, technical and social conditions in which people operate effectively as measuring instruments. The introduction of effective quality control procedures may ensure that the quality of the product remains so consistent that the need for elaborate accept-reject inspection is reduced, and statistical sampling schemes can then sometimes be introduced to replace one hundred per cent inspection.

However this project deals with a factory producing chocolate and applying the statistical techniques for the control quality. It comprises :

a) The different stages followed in the production process of chocolate from the raw material till the end product.

b) The statistical quality control system applied.

c) The organization and responsibility of the quality control department in the processing factory.

Raw materials

1. For chocolate : cocoa beans, sugar, milk powder , nuts, flavouring materials.

2. Packaging raw materials: Many kinds of paper, cartons, plastic packages, for chocolate and bakery, cellophane, corrugated board, aluminium foil for chocolate.

Planning

The planning section performs a general annual plan for raw materials. This plan includes estimates of the monthly and even the weekly amounts needed.

The plan is mainly based on the capacity of the stores, the output of the machines and the volume of consumption of the different products all over the year. It is also taken into consideration the consumption the consumption of previous years and the life time of the different raw materials, i.e. the longest period for keeping its quality characteristics during storage. The planning section applies the same procedure for planning for the production out put scheme.

The estimated plan is followed up by means of charts which give an up to date situation of the raw materials and products in both the stores and shops.

a) Control of Raw Materials of Packages

This control is carried out by the packaging raw material control section which belongs to the quality control department. This section performs the sampling plan applying the approved standard sampling methods.

The first control is 100 % visual inspection. The packaging laboratory gives the instruction for the sampling plan and the visual inspection.

The storeskeeper draws a certain percentage of boxes from the lot at random. From every box a certain number of sheets is taken. The sheets are sent to the packaging control laboratory to be tested.

The second control : In testing the samples in the packaging control laboratory . A standard test piece is taken out of each sheet, and the following tests are generally carried out for measuring the quality characteristics :

Introduction

Quality ... and Quality Control

a. Tensile strength.
b. Elongation.
c. Tearing strength.
d. Seal strength.
e. Folding.
f. Stiffness.
g. Weight of cm2, etc...

The test figures in each case are collected and plotted in mean ($\bar{X}$) and range (R) charts, as shown in figure 1. From these charts it can be concluded whether the supply is in conformity with the specifications or not.

The third control is the practical testings : Two or three boxes of the lot are drawn at random , and sent to the production section concerned for checking the practial application with the machinery. In case that the test results do not comply with those stated in the specifications, the packaging control section has to decide whether the lots are to be rejected or accepted. However, if there is slight deviation between the test results and the specifications, the lot can be accepted if the production department is in real need for the raw materials, and in this case a warning is sent to the supplier to avoid this in the future.

N.B. The packaging quality control section sets up the specifications of the packaging raw materials based on the practice and the long experience of several years. However, the control limits are fixed according to the requirements needed. The cost is also considered in this respect. Also the supplier has his control limits being discussed with the conformity section taking into consideration the cost and as a result of good cooperation between both sides, the contractual specifications are fixed.

Control of Raw Materials of Chocolate

In the stores, samples of the different raw materials of chocolate are drawn at random under the supervision of the quality conformity section. This section sets up the sampling

plan according to the approved standards. Samples raw materials are analysed in the chemical laboratory. Physical and chemical properties are determined, the results are tabulated in tables and compared against the standards. A quick information is sent to the stores about the test results i.e. a paper is sent indicating the name of the raw material, code number of the samples, the date, the name of the supplier and the test results. In case of non conformity the test results are sent to the supplier and in some important cases the general manager is informed . The quality conformity section has the final decision concerning rejection of lots of raw materials which are not in conformity with the standards.

Moreover, there is an information for the long run about the raw materials test results i.e. the chemical laboratory studies the tabulated test results of the whole year. Discussions and meetings take place between the concerned technical people, consequently the specifications are reviewed etc.

Chocolate Manufacture and Production

Control

The following is an outline of the chocolate manufacture and the control points in the different processes till the finished product :-

1. Roasting :

In this process the cacao beans of different origin are roasted. The normal roasting temperature is about 140° c, but it differs according to the different kinds of cacao beans. In this process the operator is self controlling the colour, taste and odour (by experience).

2. Breaking :

The roasted cacao beans are broken and the outer cover is separated from the inner contents. There are some kinds of cacao beans especially those from Ghana are first broken then roasted. However, after the breaking process there is a control point where the inspector from the quality conformity section takes at random samples to be

examined in the laboratory to ensure that there is no contamination between the outer layer (cover) of the beans and the inner contents.

3. First milling :

In this process the roasted broken cacao beans are ground for the first time, and the cacao mass is formed.

4. First Conching (Homogenization) :

In this process the cacao mass is passed in the first conching containers for homogenity, removal of volatile matter and bad odour. After this process, there is the second control point. The quality control inspector draws at random a sample twice a week to be examined in the chemical laboratory for the determination of moisture content, ash content and fat content. There is short run information between the quality control dept., and the production dept., by direct contact, concerning the control results in order to adjust the process conditions in case the test results are not in conformity with the standards.

5. Mixing :

In this process the cacao mass after first conching is mixed with milk powder, cacao butter, and sugar.

6. Second Milling :

The chocolate mass is ground for the second time. After this process there is the 3rd control point. The Q.C. inspector takes at random one sample/milling machine/day. The particle size of sugar and cacao are examined in the lab. There is a quick information between the laboratory and the production dept. concerning the results, to adjust the process conditions in order to obtain more or less the required particle size (fineness).

7. Second Conching :

In this process the chocolate viscous liquor is conched for homogenity to attain the required fineness. After this process there is the fourth control point,

the Q.C. inspector takes samples at random to be examined in the chemical laboratory for the determination of :

a) Viscosity.
b) Moisture content.
c) Particle size (for cocoa & sugar).
d) Sugar content.

The test results are compared against the standards and recorded in special tables. There is short run information by direct contact between the Q.C. dept. and the production dept. concerning the test results for adjusting the process conditions in case of non conformity of the results with the standards. Long run information takes place by periodical meetings between the heads of the different departments to take measures for quality improvement.

8. **Forming :**

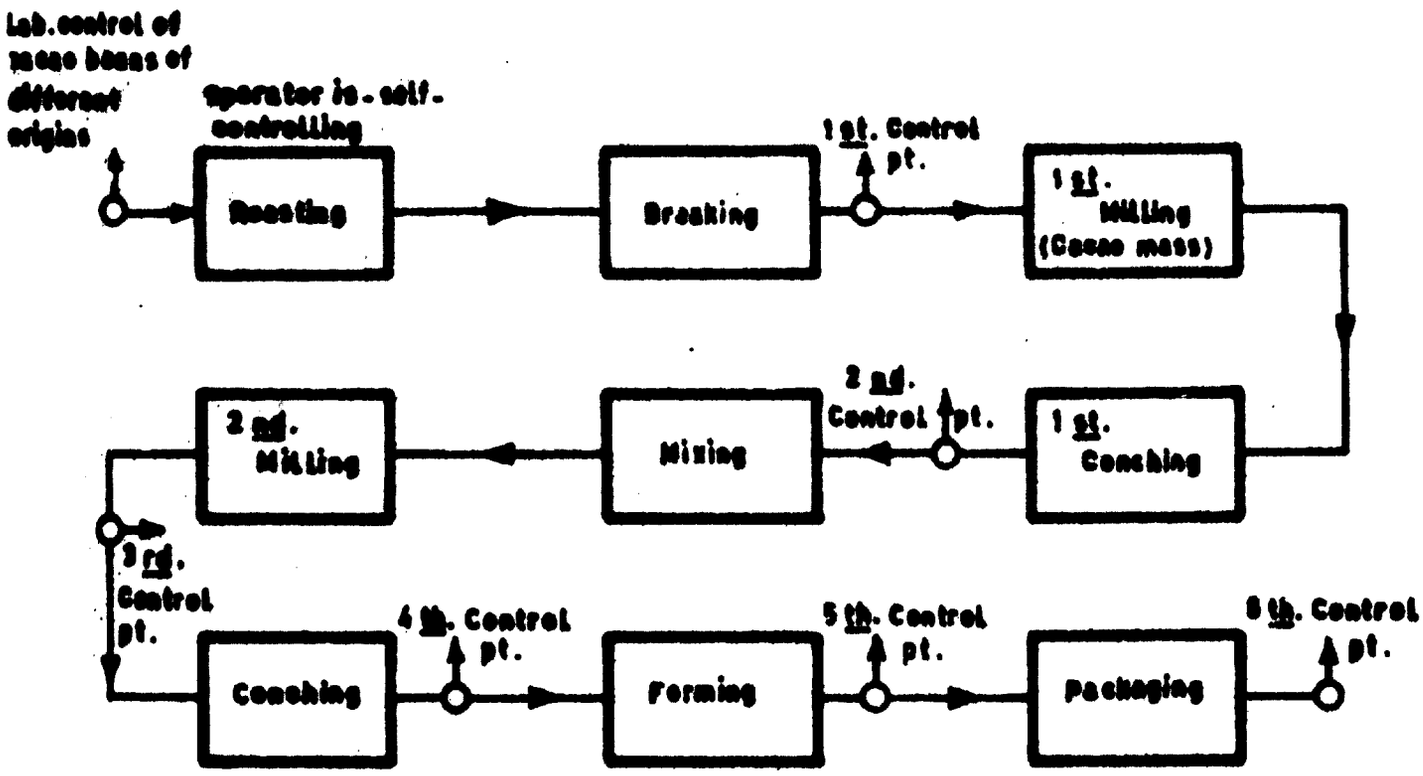
After the second conching, the chocolate viscous liquor is gradually cooled by passing through gradual coolers and formation of chocolate takes place. After this process there is the fifth control point. The production inspector takes at random samples and examines for weight, the results are plotted in median range charts as shown in the figure. The production inspector advises the operator by direct contact to adjust the machine when there is deviation in the mean and to find out the wrong position in the process when the range is out of limits. The control charts are analysed by the quality analyst of the laboratory and a quick information takes place concerning the results between the quality analyst and the production inspector. Also the quality analyst performs a weekly survey information to be sent to the manager of the quality control department , manager of production, and other concerned heads of departments.

9. **Packaging :**

Formed chocolate is packed automatically and by hand. After packaging there is the sixth control point. The production inspector draws at random samples of packed

finished products, examines the packages condition and the attributive defects are recorded in special tables. Also the weight of the packed finished products is controlled and the results are plotted in median, range control charts, if there are some deviations the operator is advised to adjust the conditions. There is also control concerning the chemical composition of the chocolate finished products. The Q.C. inspector draws at random every day some samples of finished products to be chemically analysed in the lab.

The following is a rough flow sheet of the production scheme of chocolate indicating the different control points :

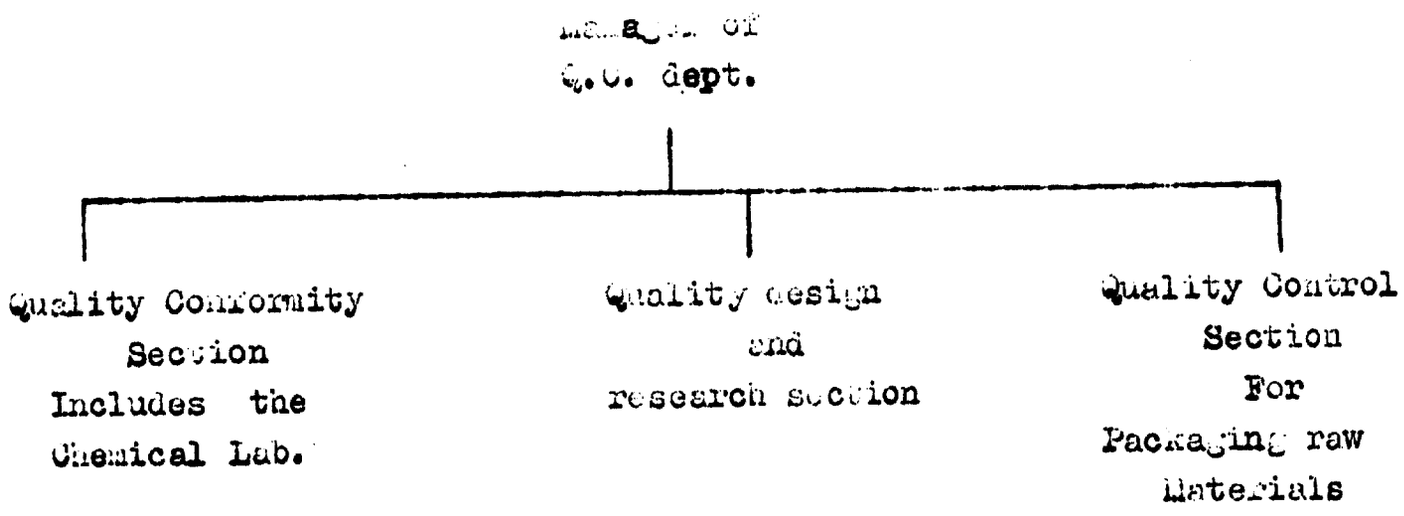


Quality Control Department

It is the responsible department for quality control. It supervises the inspection all over the firm. It has the final decision concerning rejection of lots of raw materials. It has an advisory task concerning rejection of lots of finished products. However in this concern the responsibility is divided

between the Q.C. dept., and the production dept., the final decision is attained by the general manager.

In the following, there is an organizational scheme of the Q.C. department :



The functions of the quality conformity section in the producing factory can be summerized in the following :

- Chemical and physical investigations of raw materials, semi finished product and finished products.
- Microbiological examinations.
- Statistical analysis and sampling inspection for both process and finished product control.
- Establishing specifications for the required raw materials.
- Establishing the sampling plan for raw materials, production and finished products control.
- Supervision of inspection through out the firm, and devising new methods of inspections.
- Training of the production inspectors.
- Advisory task concerning rejection of lots of finished products and final word concerning rejection of lots of raw materials.
- Analysing the control charts of production inspection results, make short run informations by direct contact, and long run information by weekly survey reports about production control results.

The quality conformity laboratory comprises the different apparatus for chemical, physical, and biological investigations.

Quality design and Research Sections

These two sections are responsible for :

- Setting the specifications of the products based on the long experience in this field. They perform small laboratory experiments to find out the proper recipes for the different products which has to be executed by the production dept.
- Conducting the necessary research for establishing new products or improving the quality of the existing products. Initiation in this respect takes place from the sales dept. and sometimes from the quality design section. In both cases samples of the competitors products are analysed, many laboratory experiments and trials are carried out till the proper constitution is achieved. This can be assured by taste tests which are carried out in the taste panels in the following way :

Samples of the new products, or the already existing products after improving their quality are introduced in the taste panels with the similar competitor products. Many employees from the firm and sometimes externals are invited in the taste panels to evaluate and record their preference and mention the reasons. The taste-test results are analysed and the number of concuring choices necessary to establish the significance of results is indicated from special tables.

However, in some cases no significance is achieved from the taste-test results. In both cases the sales dept. is informed and it has the final decision in this respect due to its long experience about the customer's requirements. Also the cost aspect plays an important role in this concern.

Conclusion and Comments

There are some conclusions and comments concerning the producing firm which can be summarized in the following :

Co-operation :

The most remarkable observation is that all the departments are working in close co-operation. Each operator feels as if it is his own plant. There is no sharp separation between the different departments and sections. They are co-operating together for the sake of producing quality products. This fact manifests itself in the regular contact between the quality control department and the production dept. about the control results and in the joint information in meetings periodically held between heads of departments. Also in the co-operation between the quality control dept., the sales dept., and the production dept., in case of producing new products or improving the quality of the existing products. The q.c. dept., co-operates and intervenes in every inspection. It controls the raw materials, the different production processes and the end products. Also it analyses the different inspection results and make the necessary feed-back information in collaboration with the production inspectors

Responsibilities :

In this producing firm every operator is responsible of his work. The quality control dept. has the final decision concerning rejection or lots of raw materials. In case of finished products the responsibility in this respect is divided between the quality control and the production departments. The final decision is taken by the general manager. The advantage of this system is that both departments share the responsibility of quality and this emphasises their co-operation for the sake of producing quality products. This system also renders each operator to be interested in his work and self controlling.

- Organizational aspects :

The quality control dept. is independent from the production departments. It belongs directly to the general manager. It is on the same level of the production department. Thus it has the power of inspecting the different production processes and giving neutral decisions freely, out of any external influence.

- Packaging raw materials control results :

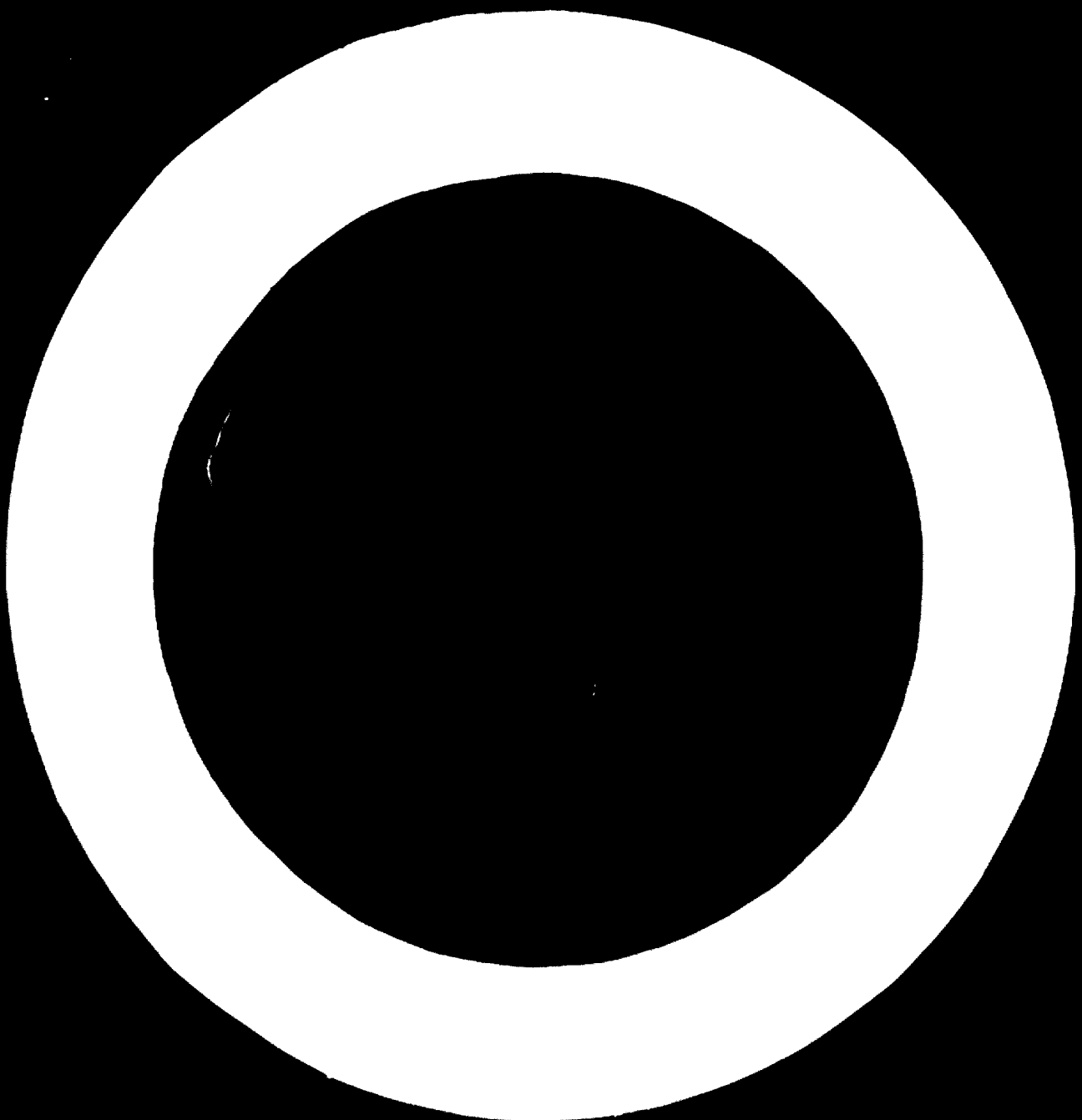
The packaging raw material control section plots the results in [illegible] control charts. It would be very much appreciated if these charts [illegible] charts. Calculating the median is more quick and easier. Also in this case the effect of outliers do not appear as in the case of the mean.

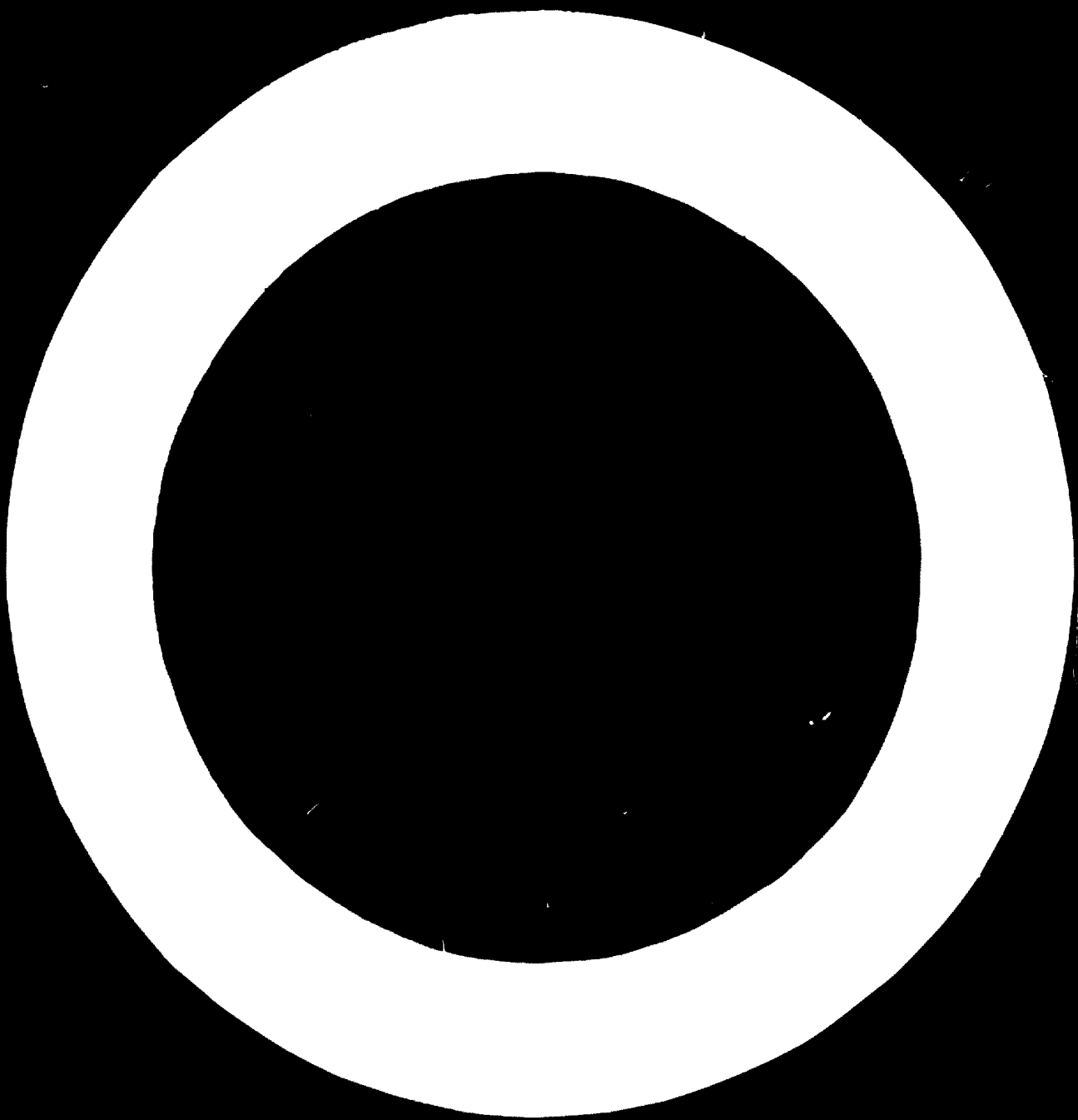
- Experiments for establishing new designs or improving the quality of the existing products :

It would be very much appreciated if the producing firm establishes a pilot plant for carrying out these experiments. This pilot plant will be the link between the laboratory and the production. Also it will be of great benefit in finding out the ideal production conditions.

- Quality incentives :

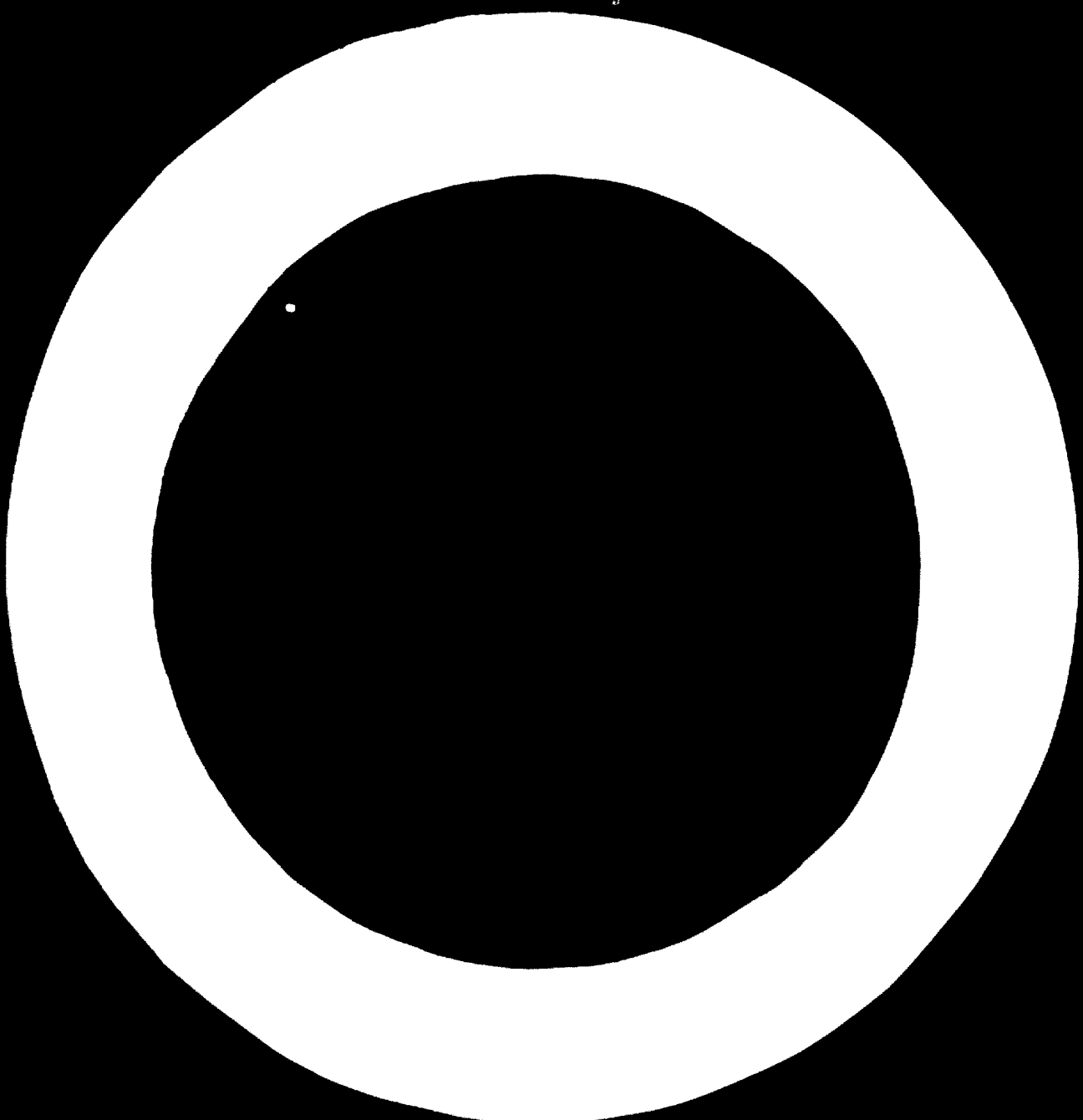
For encouragement of producing quality products, there must be an evaluation of the production of each department, operator ... e.c. not only for quantity but also for quality. It would be very much appreciated in this respect if a yearly quality control conference or seminar is held to spread out the sense of quality and to introduce bonus, medals, certificates ... etc. to operators , or sections which produce the biggest amount of quality products.





Engineering Industries

Quality Control
In
Electric Refrigerators



Engineering Industries :

A company producing Electrical Refrigerators :

1) **Production** : One type of refrigerators in three sizes 6,0 and 10 cu.ft. (160, 220 & 270 litres) is produced at a total maximum rate of 400 per day.

The work of this factory does not demand high presision, except for certain tool making features. The maintenance of quality is largely dependent upon machine capabilities.

2) **Design office** : The functions of this office are :

a. To direct and to coordinate the work of engineers engaged in the design and development of new products and to improve the design of existing products taking into consideration the requirements of the consumers.

b. To translate the design requirements into complete and precise manufacturing instructions through the specifications, drawings, process instructions and material requirements. Each and every part of the product is specified.

The design office has the responsibility of specifying the whole of the manufacturing process, this means that there are specifications for raw materials and components, drawings for piece-parts, process planning sheets for assembly and process operations, against which quality control checks that the inspection function is operating as planned.

3) **Laboratories**

The company has two types of laboratories :

a. Laboratories for research and technical studies.

b. Ordinary laboratories for quality control and routine tests.

The functions of the research and technical studies laboratories are :

1- Precision measurements of first off newly designed parts and parts from new or repaired tools.

2- Checking every new gauge or measurement device upon receipt by the laboratory and rechecking regularly all devices and gauges and calibrated as necessary.

3- To compile a series of method instructions, & which are included in the Manual .

4- To conduct reliability tests on new components and devices by the way of simulating operating conditions and running tests to establish the failure rate and primary causes of failure.

5- To undertake trials on complete equipment to establish the mean-time between failures and their causes.

4) Quality Control Department

Effective quality control depends very much on the internal organization within the plant and on correctly designed systems, procedures and documentation and their application.

One of its functions is to check that the manufacturing process is operating in accordance with an agreed plan as interpreted through a system of formal procedures, routines, specifications, drawings, operational planning sheets, movement controls ... etc. The organization should be consulted , therefore in the design and operation of such systems. The functions of the Q.C. organization are :

a- Preparation and planning to ensure satisfactory control over all quality aspects. (Quality assurance).

b- Routine examination and appraisal of the materials and products in accordance with the planned instructions. (Inspection).

c- Monitoring all phases of the manufacturing and inspection functions to ensure that they are in continuous control and operating correct according to preplanned instructions? (Quality control).

5) Quality control manual :

The company compiles a Manual which lays down the organization, structure and functions of each and every department, descriptions of the major operational procedures and systems by which quality control is achieved, descriptions and flow diagrams for defining the operation and routing of all documentation which concerns and or influences the operation of Q.C. in any manner.

This manual serves for two purposes : (1) it is a record of how the company intends to carry out its quality control activity (2) it records for every one's use and reference, the correct procedure to be applied ..

6) Levels of Responsibility :

The company has defined the levels of responsibility and the degree of qualification, experience and skill necessary to carry out the work at the relevant level. These are:

a- Viewer
b- Inspector
c- Superintendent
d- Chief.

7) Quality Control System :

In the following there is an outline of the Q.C. system applied starting from the raw materials till the finished product with special reference to the inspection system.

1. Raw Materials :

Samples of materials and components used in the production of the electrical house-hold refrigerators complying with the relevant standards are regularly inspected :

- Steel sheets : The steel sheets used in the manufacture of the refrigerators conform to the relevant standards and there is a certificate of its compliance issued from the manufacturing company, for fulfilling this adequate analysis & tests are applied by the company to prove conformity.

- Cooling pipes : (for evaparator and cooler)

They are tested to ensure complying with the relevant specifications and meeting their requirements.

- Parts treated by electrical deposition for rust resistance comply with the required specifications.

- Paint : The paint complies with the relevant standards and is accompaired by a certificate indicating such compliance to the requirements of standards.

- Plastic Parts : They comply with the standards and the tests are carried on the raw materials according to the corresponding standards approved by the concerned authority.

2. Process Control :

The main manufacturing operations is covered by a skilled inspector assisted by a number of viewers. The inspector carries the responsibility for acceptance and rejection in his department. Where more than one shift is operating, the inspector for the shift is responsible. The inspectors report to either the superintendent or the chief inspector. Where viewers are responsible directly to the assembly superintendent, he will in this case perform the functions of the inspector.

After all assembly, inspection and test operations are completed, a final inspector visually checks that all operations have been satisfactorily completed, that all ancillaries are present and correct and that the overall appearance is satisfactory.

Each unit carries an Inspection check card which records each stage of inspection of the assembly by means of a rubber stamp with the viewers number and overall the final Inspector's stamp who also endorses the serial number of the machine on the relevant card and on his log sheet. Through out the system, all viewers and inspectors maintain a daily log recording " numbers accepted ", numbers rejected " and reason for rejection,name date, .. etc

One inspector is responsible for supervising the packaging and despatching operation. The methods of packaging for both home and export transportation are specified in detail.

In the Mechanical workshop, each machine tool has a capability study performed upon it at least every six months or whenever a major repair on the machine is undertaken.

The company adopts a systematic method of Patrol Inspection for routine checking of piece-parts. The Frequency of sampling depends on the rate of production per hour and the sample size is fixed so as to give a predetermined Average Outgoing Quality level suitable to the assembly requirement.

Finally all finished parts pass through a finished part store where any parts requiring 100% inspection of specific dimensions and/or finishes can be arranged. The routing of all parts between operations are controlled by a route card on which the order and type of operation, Quantity, part No. etc... are previously recorded by the production planning department. For assembly , each operation is cleared by an inspection stamp and a record of the result is maintained on the Inspectors daily record sheet. The card indicates the tools and gauges required together with the inspection instructions.

The corrections of all manufacturing processes and their controlling features are regularly and systematically checked: painting, temperature, times, air pressures, welding, correct density, timing devices, electrodes, plating, vat analysis, current densities ... etc.

The services of the S.C. laboratories are used. Full comprehensive records are kept and opened to examination by the supervising inspectorate.

8) Investigations and tests carried out through the production line :

Every unit shall be investigated for the following :

1. Compression test.
2. Electrical insulation test.
3. Door-lock test.
4. High voltage test.
5. Earthing test.
6. Leakage test.
7. The range of cooling rates.
8. The rating power.
9. The protection of the electrical element to prevent accidental touching by hand.
10. Good fixation of the handles, keys and the other parts in the body of the refrigerator.
11. Protection of the electrical insulation against condensation.
12. Protection of metallic parts not carrying electric current shall be satisfactorily earthed.
13. Quality of paint (interior and exterior coats).
14. Quality of external connections.
15. Installation and fixation of shelves & suspended containers used for foods.
16. Stability of the refrigerator.

Periodic tests :

1. Investigation of shelves and suspended containers used for food.
2. Earthing test.
3. Motor electric power test.

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Introduction

Quality ..... and Quality Control :

Quality is the degree to which the product satisfies the personal needs of the customer for whom it has been made. It has a relative meaning obtained by comparing the personal wants of a customer or a group of customers and the manufactured product. The manufacturer is only interested in integrated control of product quality in so far as the result is a customer satisfied as to quality.

The first stage of quality decision is made as a policy of the factory concerned. Product quality at this stage is called quality of Design which is determined with a view to striking the optimum balance between cost of quality and value of quality. Quality of design is realised as a plan or a specification after research and development.

Materials are purchased by order and accepted through receiving inspection and then they come into a manufacturing process. The quality of Acceptance is determined at this stage.

Product quality is built in manufacturing process according to the approved standard procedure. Quality at this stage is called " Quality of Conformace. However product quality is not perfectly consistent with the standards concerned. Sorting good units from bad is done to determine "Inspection quality " which assures the consumer's requirements. The customer will determine the ultimate useful nese of a product after using it for some time. He makes the last stage of quality evaluation. This evaluation is done to secure "Quality of Reliability" which implies serviceability, maintainability, life span and conformation. We can conclude that quality has various meanings according to the various stages of a production process namely:

- Quality of Design.
- Quality of acceptance.

- Quality of Conformance.
- Quality of Inspection.
- Quality of Reliability.

However we cannot define quality absolutely but must define it relative to its price.

Higher productivity is nothing but higher quality at lower costs.

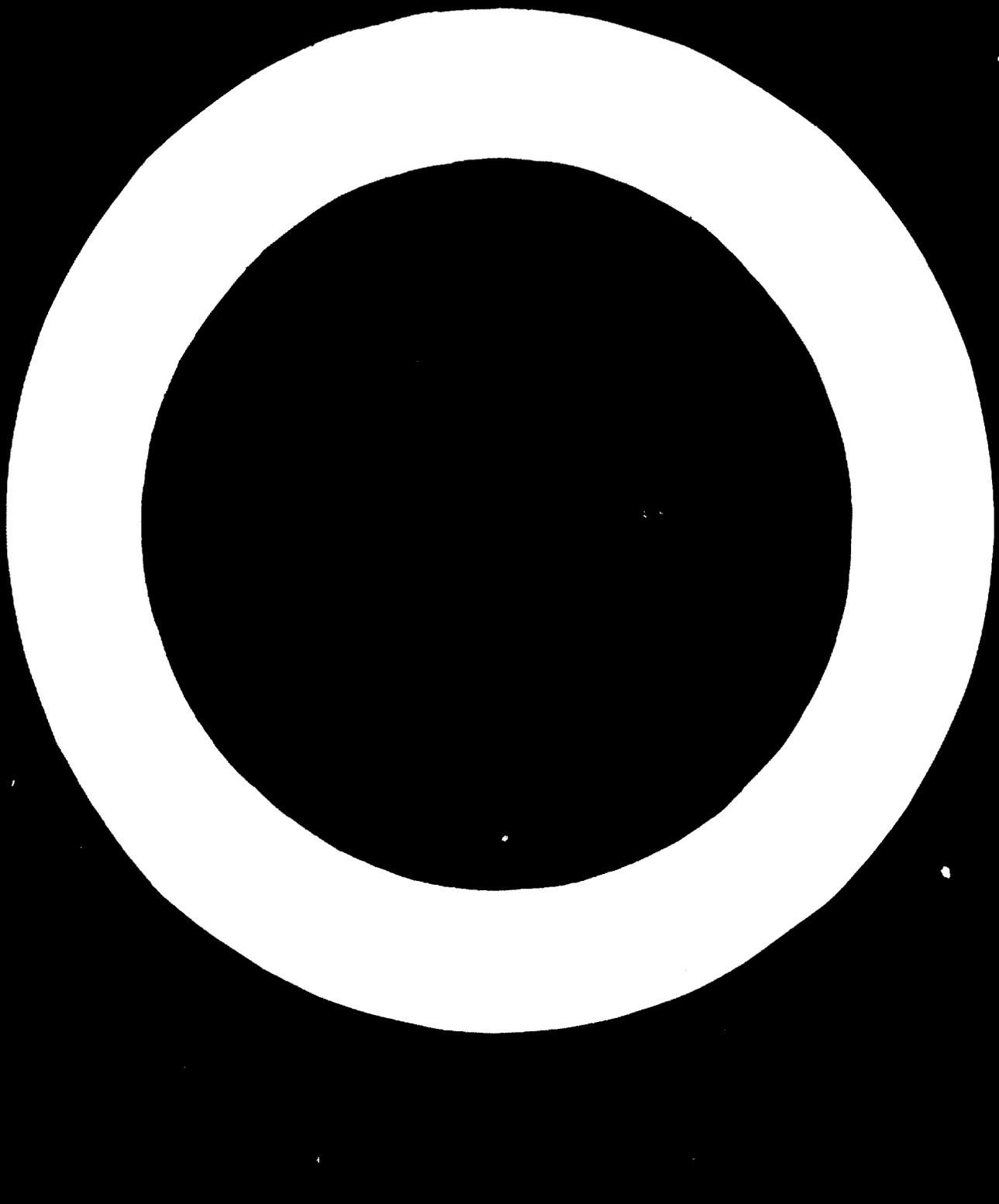
The term Quality Control is used to mean statistical quality control. It denotes the use of charted results, obtained from routine samples taken during the manufacture of a product, to secure, the control of the process, in order to maintain a desired quality in the product. Quality control replaces wholly or in part, inspection after manufacture which only detects defective product when it has been produced, possibly in large quantities. The scientific method is to hold the required quality at each stage of the process, to such a level that the properties required to make the product acceptable are built into it during manufacture. When such a system is in being it reduces to minimum the cost both of inspection and of waste by rejected work. Moreover, if results are recorded on a control chart, they provide a picture which is soon understood by the operator and all others concerned with the process, who thereafter learn lessons from it. The phychological effect of the chart provides a stimulus towards improved quality which has to be experienced to be believed. The statistical quality control system gives a warning signal to the operative that he must take here and now, corrective action on his machine or process to ensure maintenance of quality in further production. Its effectiveness therefore, depends on the promptness with which the warning is heeded.

In the conclusion, I would like to stress out that industrial quality control that is planning the properties of industrial products according to the needs of the users, and maintaining these properties during the production and distribution process, is of growing importance to any industry.

It is an essential condition for the building up of new industries in the developing areas.

Quality control in the limited sense of the word is the establishing of control of the production process, resulting in the manufacture of products of consistent quality.

Quality control in the wider sense of the word i.e. integrated quality control includes all phases of programming, designing, manufacturing, distributing and servicing industrial products as shown in the quality circuit.



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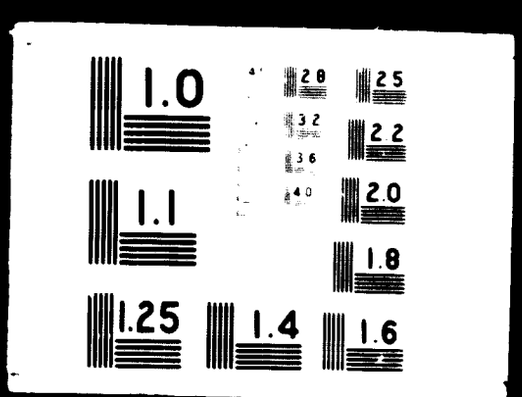


4. Connection between the external cord to the electric conductor.

5. Glazed parts test.
   5/1- Citric acid test.
   5/2- Alkali test.
   5/3- Scratch test.

6. Zinc paint test.
   1) Paint :
      1/1- Colour test.
      1/2- Scratch test.

Type test :

1) Food - spoil test.
2) Loading test.
3) No load test.
   3/1- Electric power.
   3/2- % of unit working time.
   3/3- Mean temperature of the frozen food.
4) Ice making test.

Reliability tests :

Each month a minimum of 2 shall be tested over 500 continuous working hours during which time there shall be no failure in the type tests.

Note : All tests mentioned above shall be done according to the National standards.

9) Sampling :

Test samples shall be selected at random at a ratio of 1 % of the daily production.

10) Record of Results :

The results of the above mentioned tests are to be recorded continuously and in such a way that the inspector shall be able to analyse them and estimate the extent of conformity of production with the relevant national standards over the specific periods. These records shall be identified and related to the batch produced.

9) Packaging and storage :

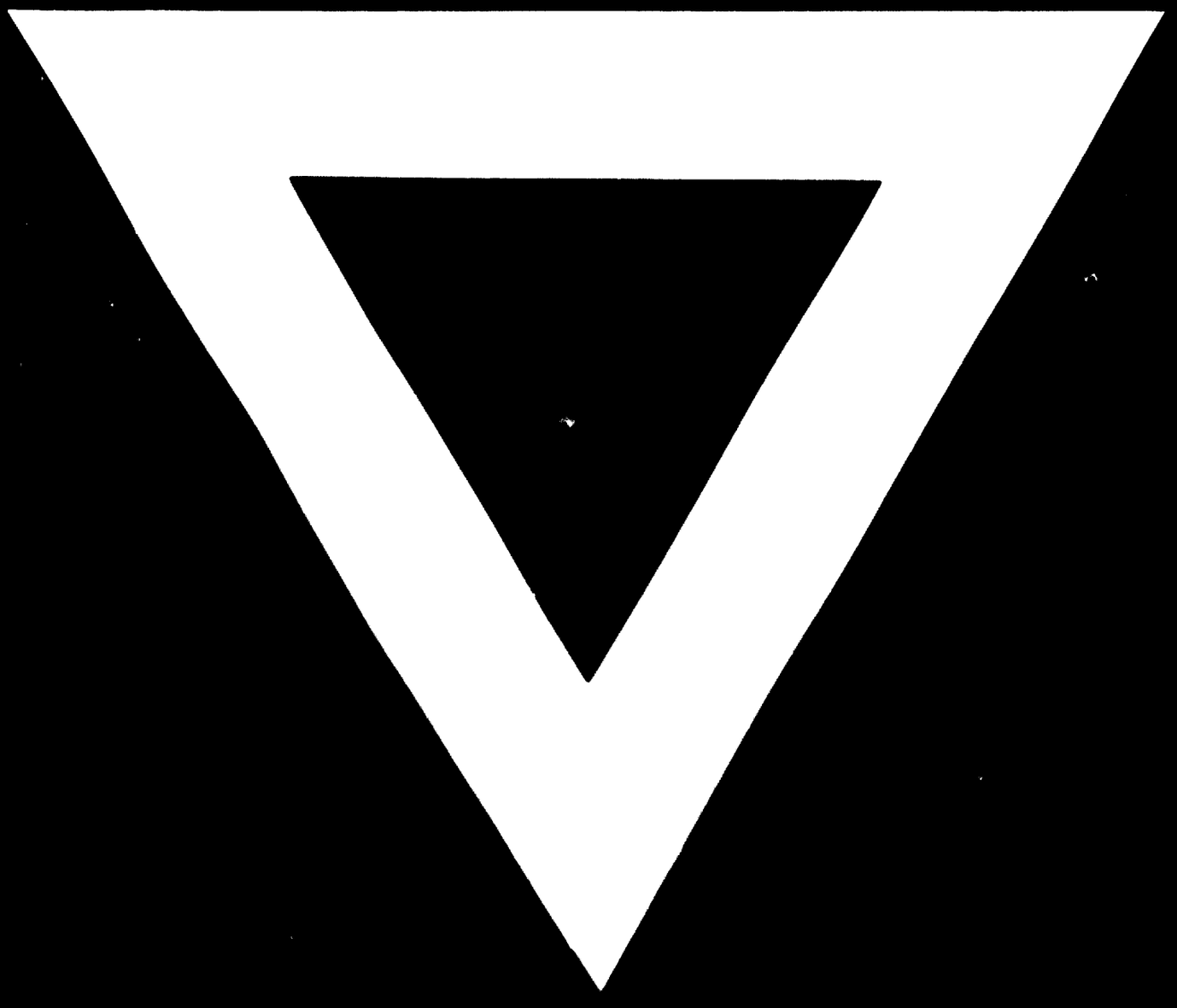
The steps taken to optimise between packaging costs and damage prevention during transport, storage and installation would provide a special case study. Suffice to say that a sample is safe transit tested and the results analysed to ensure that the quality of packaging is being maintained. All product packages are submitted to vibration type testing on a vibration platform and inclined impact tester. The results are only considered satisfactory if there is no evedince of damage, chipped enamel, loose screws , components etc.

10) Instruction Books :

The manufacturer issues an instruction book written explicitly in non-technical language with the aid of clear photographs and diagrams and a simple index, which is understood by the customer.

11) User experience feedback :

This comes through specific written and verbal complaints and service engineer's reports.



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