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BROAD LINES OF CONTROLLING THE QUALITY OF SPIRAL PIPES AT EL NASR COMPANY FOR MANUFACTURING STEEL PIPES AND FITTING

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(1) INTRODUCTION

The economic development of an industry depends upon it's ability to supply products and/or services that fulfil the needs of customers and suppliers.

This means that the management's main function is to produce at the optimum quality and with the minimum costs (if management believes that quality means fitness for use with economic costs).

From this concept, we come to the fact that controlling the quality of production is a must.

This paper deals with spiral pipes plant at El Nasr Co. for manufacturing Steel Pipes & Fittings at Helwan, Egypt.

In this plant, spiral pipes are manufactured by two different machines:

- The first is called KOCKS m/c, it produces the pipes by rolling method and welding internally and externally. The machine has a movable head from which is possible to determine the pipe diameter according to the formula:

Sin = b/ D

Where:

Φ is the formation angle between m/c head and Prod. line
b is the width of steel sheet used
D is the required pipe diameter.

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- The second machine is called Draim m/c, it produces the pipes using a single forming die. It has a fixed die and a fixed head with a movable production line according to the pipe diameter. The moving range is about 23°.

(2) Features of quality control techniques suggested in this paper:

The aim of introducing the quality control system in that plant was to ensure the fitness of the produced pipes with the specifications with minimum defects, and to allow prevention of defects before its occurance.

Hence, the statistical quality control techniques were essential for achieving this aim.

The suggested system is based on two statistical techniques:

1. Control charts for number of defects, and
2. Sampling plans for attributes.

(3) Control charts for number of defects:

3.1- Objects of applying control charts:

The control charts are used here to:

1. Determine the maximum number of defects in the pipe due to chance (random causes).
2. Check the capability of each of the two machines and compare it with the required quality level (as expressed in number of defects per pipe).
3. Control the pipes while manufactured (controlling the process) and discover any deviation from the max. limit of random defects (the upper control limit of the chart).

3.2- Steps for constructing the control charts:

3.21- Defining kinds of defects:

Six kinds of defects appeared at this type of pipe:

Defect No. 1: Formation defects.

Defect No. 2: Uncontinuity of feeding the inner welding wire.

Defect No. 3: Shift in welding process.

Defect No. 4: Holes (due to change in voltage and current).

Defect No. 5: Porosity.

Defect No. 6: Uncontinuity of feeding the outer welding wire.

A definite description of each of these defects was explained to the quality inspectors in order to record their findings correctly.

3.2.2- Collecting basic data for constructing the charts:

Adequate number of pipes are taken from production of normal conditions of both machines, and each pipe is inspected for the six kinds of defects, the number of defects from every kind in each pipe is recorded in a table.

Twenty five pipes of KOCKS m/c and 12 pipes of Draim m/c were taken, and the findings of inspection were listed in tables like that in Tables 1 & 2.

Pipe No.	Defect No. 1	Defect No. 2	Defect No. 3	Defect No. 4	Defect No. 5	Defect No. 6	Total
1	-	-	2	-	-	-	2
2	-	1	-	-	-	-	1
3	-	-	-	-	-	-	0
4	2	-	1	2	-	-	5
5	3	-	-	1	-	-	4
6	3	-	1	-	-	1	5
7	-	-	-	2	-	-	2
8	1	-	-	2	-	-	3
9	-	-	1	2	-	-	3
10	-	-	1	1	-	-	2
11	3	-	-	2	-	-	5
12	1	-	-	4	-	-	5
13	-	-	3	-	-	-	3
14	-	-	-	-	-	-	0
15	1	-	-	-	-	-	1
16	2	-	2	1	-	-	5
17	1	-	-	-	-	-	1
18	-	-	-	-	-	-	0
19	-	-	-	-	-	-	0
20	-	-	-	-	-	-	0
21	1	-	1	1	-	-	3
22	-	-	-	-	-	1	1
23	-	-	-	-	-	-	0
24	1	-	1	2	-	-	[illegible]
25	1	-	-	1	-	-	2
Total	20	1	13	23	-	2	59

Table (1): Number of defects per pipe (ROCKS m/c).

Pipe No.	Defect No. 1	Defect No. 2	Defect No. 3	Defect No. 4	Defect No. 5	Defect No. 6	Total
1	-	1	2	-	1	1	5
2	1	-	-	2	1	-	[illegible]
3	-	-	1	-	-	-	1
4	1	1	1	-	-	-	[illegible]
5	-	-	-	[illegible]	-	-	[illegible]
6	-	-	-	-	-	2	[illegible]
7	-	-	-	[illegible]	[illegible]	1	[illegible]
8	-	-	2	[illegible]	-	-	[illegible]
9	-	-	[illegible]	[illegible]	-	-	[illegible]
10	2	1	[illegible]	-	-	-	[illegible]
11	2	-	2	1	-	-	[illegible]
12	3	1	[illegible]	-	-	-	[illegible]
Total	12	3	17	18	[illegible]	2	[illegible]

Table (2): Number of defects per pipe [illegible]

3.2.3- Analysis of data and calculate the control limits:

- For KOCKS m/c:

From Table 1, the average total number of defects/pipe $= 59/25$, $\bar{c} = 2.36$

Then, Upper Control Limit $= \bar{c} + 3\sqrt{\bar{c}}$

$= 2.36 + 3\sqrt{2.36} = 6.968$

Lower Control Limit $= \bar{c} - 3\sqrt{\bar{c}}$

$=$ Zero.

Calculations with the same procedure are made for each kind of defects produced each of the two machines. The results are as in the following table:

Defect No.	KOCKS Machine			Draim Machine		
	Upper Control Limit	Average	Lower C. Limit	Upper Control Limit	Average	Lower C. Limit
Total	6.968	2.36	0	10.934	4.25	0
1	3.48	0.8	0	4	1	0
2	0.64	0.04	0	2.353	0.416	0
3	2.68	0.52	0	4.98	1.4166	0
4	3.79	0.92	0	3.571	0.833	0
5	0	0	0	1.39	0.166	0
6	0.92	0.08	0	2.353	0.416	0

The control charts based on these calculations are plotted in the figure.

3.2.4- Calculating the capability of each machine:

The capability in our case will be expressed by the most probable number of defect in the produced pipe.

It comes from the analysis of the results of inspection (Tables 1 & 2), as follows:

For KOCKS m/c:

We calculate the accumulative number of defective pipes after arranging the data in classes by number of defects/ pipe.

We stop after arriving to the median class and calculate percentage of accum. pipes in the median class.

Then, from poisson accum. values we determine the expected number of defects in the pipe in normal conditions (λ in the Poisson tables).

By this way, the median class is 2 defects, accum.number of pipes in this class is 14 (out of 25 pipes).

Probability of finding 2 defects or less in the pipes is then 14/25 (or 0.56).

From poisson tables for accum. probabilities,the prob. is 56 for finding 2 or less defects per pipe when λ = 2.438 i.e. the KOCKS m/c capability is 2.438 defect per in normal conditions.

For Draim m/c:

The median class is of 5 defects.

The comulative number of pipes in this class is 9 i.e. probability of finding 5 defects or less per pipe is 9/12 (= 0.75) from poisson tables λ = 4.21.

The capability estimates calculated by this way could be used to estimate the rejection rates for any quality standard by the customer, and to select the proper sampling plan to achieve the requirements of the customer with definite risk.

(4) Inspection plans by samples for outgoing produced batches

4.1- Objectives:

The inspection work needs to be based on sampling principles to decrease the inspection costs.

That is the reason of designing an economical sampling plan for inspecting the batches produced with minimum costs.

The objective can be achieved if some basic figures are defined by the management like:

- The accepted consumer risk and the relative percentage of defectives.
- The batch size introduced to inspection.
- The average quality level of produced batches for both machines.
- The maximum number of defects in the accepted pipe.

4.2- Design of economical plan for inspection by samples:

4.2.1- Statistical procedure:

- Determine the Average Quality Level of each machine.
- According to the consumer risk and the percentage of defectives (L.T.P.D.) could be obtained from poisson accum. values for an assumed acceptance number.
- As $\lambda = np$ (P = L.T.P.D.), then n is calculated.
- When the batch is rejected, the whole batch is inspected, then we have to calculate probability of rejecting accepted batch (from poisson tables) knowing av. Q.L. and n (i.e. knowing λ).
- Prob. of rejecting accepted batch x batch size + Prob. of accepting accepted batch x sample size, will represent the average inspection rate p-r batch.
- Assume another acceptance number and repeat the same steps.

- From many trials (until the average inspection rate increases again) the economic sampling plan is attained.

4.2.2- Basic figures:

- Consumer risk = 10 % at L.T.P.D. = 0.06
- Average quality level: (From capability analysis) for KOCKS m/c (pipe is accepted if containes 5 defects at maximum) A.Q.L. = 0.04.
  Acceptable Quality Level for Draim m/c (pipe is accepted if contains 6 defects at maximum) A.Q.L. = 0.08.
- Batch size = 500 pipes.

4.2.3- Calculations:

A) For KOCKS m/c:

- Assuming acceptance number c = 0
- From Poisson cum. distribution λ of 0.10 prob. of acceptance = 2.3 = n x 0.06
  i.e.n = 2.3/0.06 = 39
- For accepted batch (with A.Q.L.) λ = 39 x 0.04 = 1.56
- Prob. of acceptance for this batch = 0.212 (from Poisson cum. dist.).
  Prob. of rejection for this batch = 0.788.
- Average inspected number of pipes per batch
  = 0.212 x 39 + 0.788 x 500 = 402.2.

The following are the results of calculating the previous steps for different values of acceptance number.

Acceptance number c	Sample size n	Prob. of rej. accepted batch (producer risk)	Av. inspected pipes per batch
0	39	0.788	402.2
1	65	0.733	383.8
2	89	0.688	371.7
3	112	0.658	357.3
4	134	0.615	359
5	150	0.554	343.9
6	177	0.552	355.3
7	200	0.53	359

It is clear that the economic plan (of minimum average inspection rate per batch) is: Sample size n = 150
Accept. No. c = 5

B) For Draim m/c:

As the A.Q.L. is higher than the L.T.P.D., it is not practical to use sampling (i.e.) total inspection is the only method unless the capability of the Draim m/c is improved to reach that of KOCKS m/c.

If the capability of Draim m/c becomes also 2.438,then the same sample plan (150/5) can meet our requirements.

The following curve represents the relation between probability of accepting a batch, and the percentage of diffective pipes in that batch.

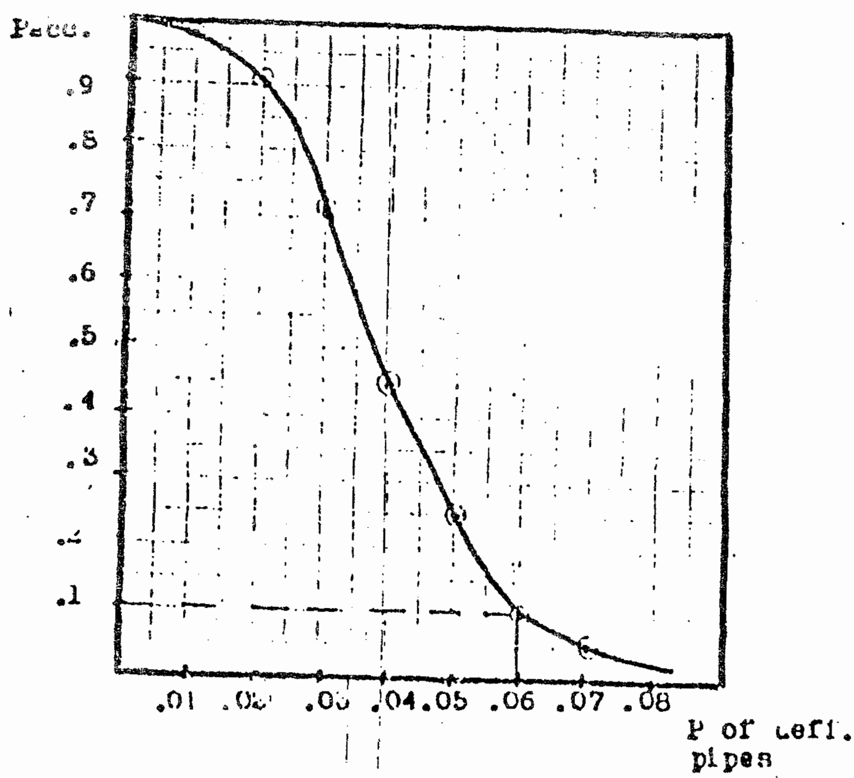

Fig. (8): Operating characteristic curve for the plan (150/ 5) for pipes produced on KOCKS m/c.

CONCLUSION

The application of the statistical system described in this paper assists management of this plant in measuring and controlling the defects in production, and hence proper decision may be taken about the need of any of the two machines to be adjusted, and the type of adjustment in suitable time.

Also the sampling plan determined for the batches of pipes produced on KOCKS machine results on the decrease of inspection with 31.2 % (as the average inspection rate is 343.9 per batch of 500).

The application of these two statistical techniques will guide the management to the application of further techniques is controlling the quality, as quality auditing systems and the analysis of reliability of products and its elements, hence arriving to the concept of (Total Quàlity Control).

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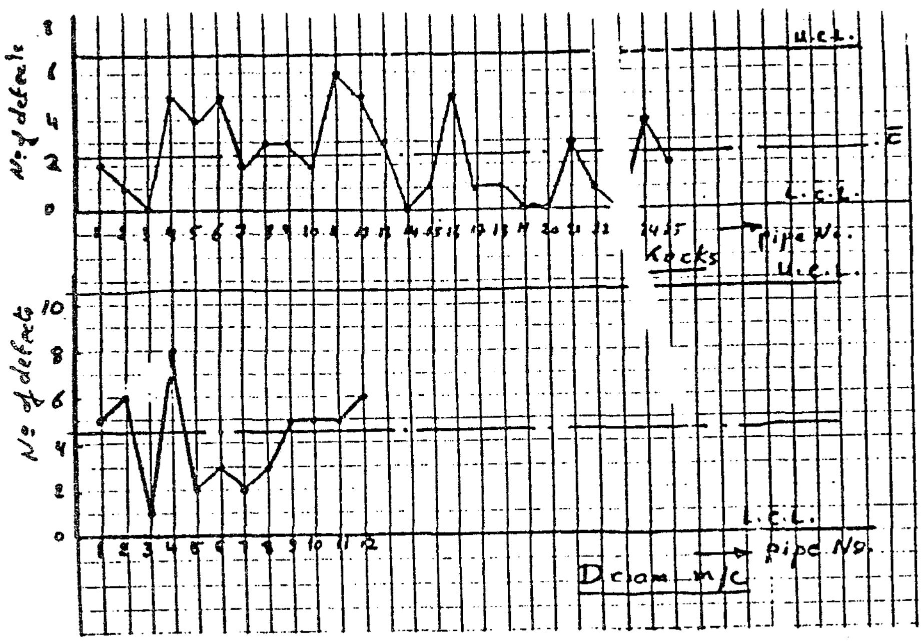
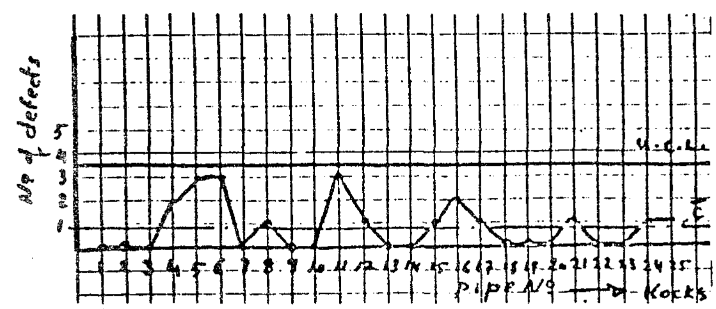


Fig.1) Control charts for total number of defects



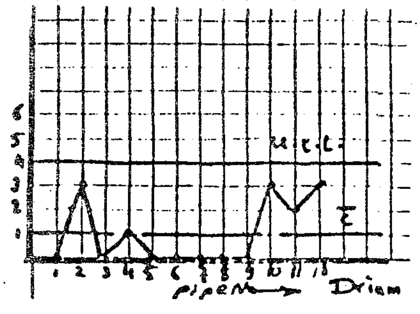


Fig.2) Control chart for defect No. 1(Formation defects).

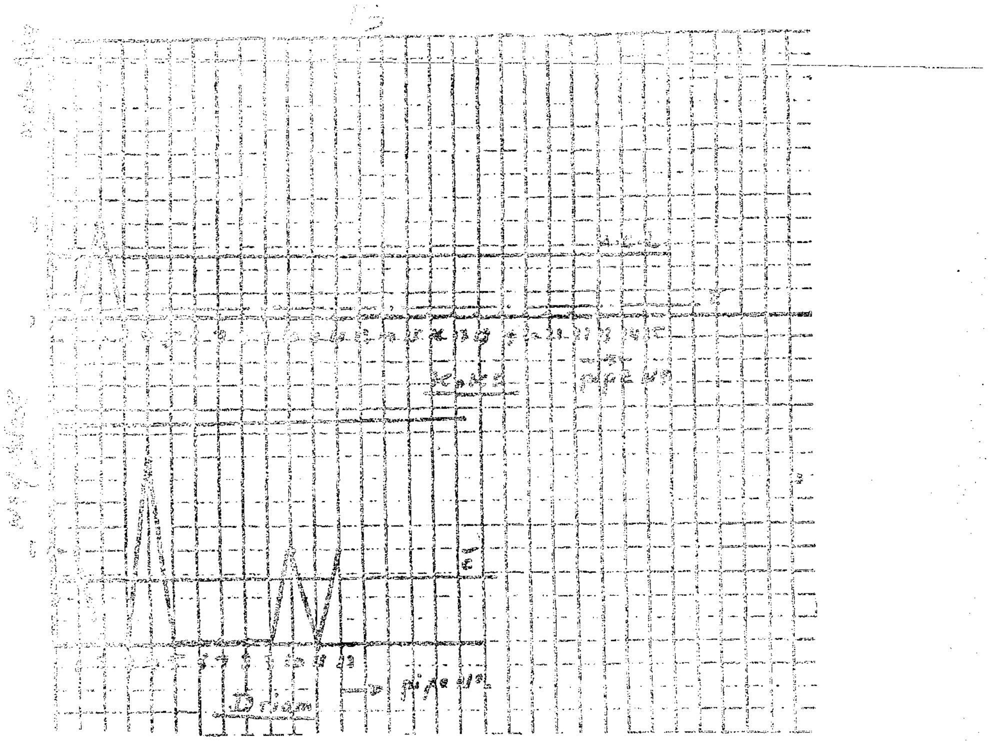
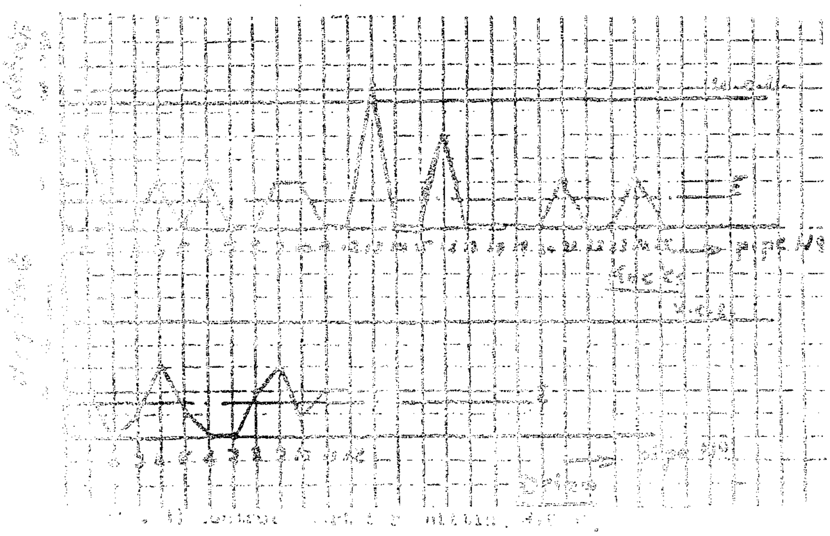


Fig.3) Control charts for uncontinu.ty of inner [illegible] wire



[illegible]

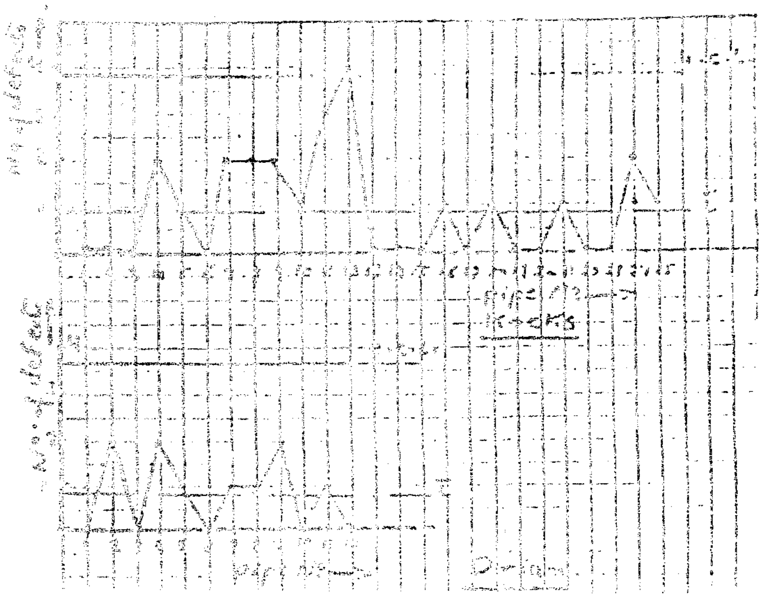


Fig.5) Control charts for holes

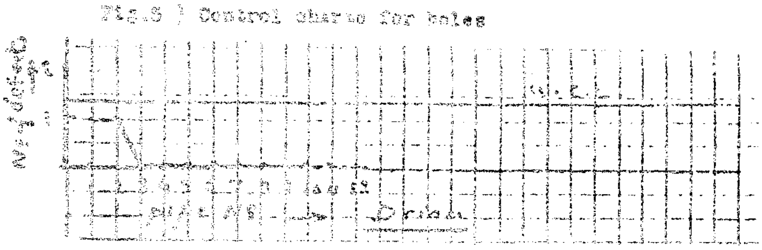


Fig.6) Control chart for porosity([illegible])

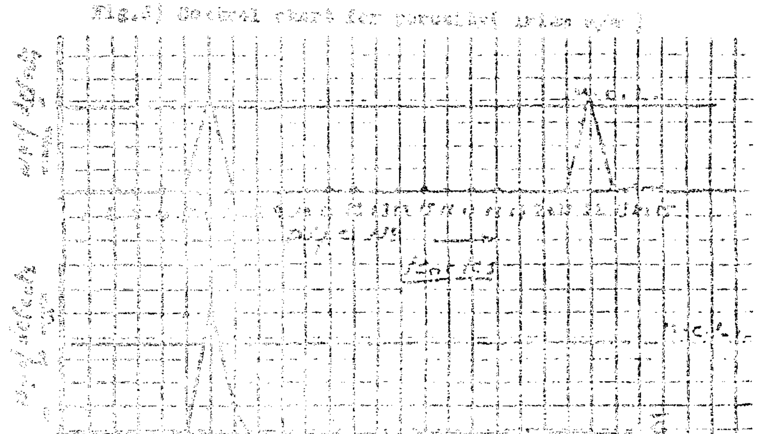


Fig.7) Control charts for discontinuity of feeding the outer welding wire.