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Implementation of Quality Improvement Tools In Brass Industry To Improve Quality & Enhance Productivity

Dr Sajjad Akbar[1*] Dr M Shahid Khalil [2]Hafiz Ihsanullah.[3]& Dr Tahir Nawaz

1. CESET, Islamabad. Pakistan
2. UET, Taxila Pakistan
3. UET, Taxila Pakistan
4. CESET, Islamabad. Pakistan

* E-mail of the corresponding author: col_sajjad_akbar@yahoo.com

Abstract

Significance of quality with increased productivity at an affordable cost is out of question. In this regard, applications of Statistical Quality Tools go a long way not only to improve the quality of a product but also to eliminate the causes, which gave birth to Non – Conforming units. In engineering production units where workforce is unaware to Quality Management system (QMS) it is very difficult to manage production with in acceptable quality standard. Heavy input costs at shrunk/ reduced outputs are no longer sustainable. In most of the production units the rejection of components is never analyzed and resultantly factors causing these high rejection percentages are not rooted out. The focus of study here has been Brass Industry with special emphasis on reducing rejection percentage to a lower possible limit in 70:30 Brass strip and Gilding Metal Claded Steel (GMCS Strip). Initially, data regarding rejection in Brass and GMCS Strip was collected for complete analysis. The process of applying relevant Statistical Quality Tools was started in order to find out the major defects and the root causes of the same. The analysis made so far revealed that existing rejection percentage in Brass and GMCS Strip has been in the range of ***Fifteen percent (15%)*** and ***Twenty one percent (21%)*** respectively, which is an alarming situation. The ultimate end of the study was to reduce the existing rejection percentage to a range of ***8 – 10 %*** in Brass, and ***12 – 14 %*** in GMCS, and thereby improve the quality, savings, enhance productivity and hence to reduce the wastages.

Keywords: Quality improvement tools, brass industry, productivity and quality

1. Introduction

Today in this competitive environment where every moment comes with a new challenge, the only way to remain in the business is through pacing up with the changes and focusing on the product quality and Productivity i.e. to take care of all the processes that reduce the cost involved in the re-production and re-work of the products. The importance of the quality cannot be overlooked during the development and production of new products and the improvement of existing products. Quality increases the relative total cost, productivity, capacity & profit while decreases the number of non-conforming units and their relative cost. Application of the Quality improvement tools intended to improve the quality of the products by using different techniques and activities. The main objectives of this paper are:-

- *Identification of critical processes causing production of defective products in Brass industry by using Pareto analysis.*
- *Diagnoses of defects and tracing out their causes by using "cause & effect diagram"*
- *Identification of major causes and recommendation for their remedial measures in Brass Industry.*
- To reduce rejection percentage, Improve Quality, reduce cost and to enhance productivity of Brass Industry

2. Methodology: -

The methodology adopted for implementation of quality improvement tools in Brass Industry is as under: -

2.1 Selection of Products for Analysis

The under mentioned two critical products of Brass Industry were selected for analysis/ study.

- **Brass strip (size 3.98 ± 0.04 mm)** used for manufacturing of 7.62 mm Cases
- **GMCS strip (size 1.37 ± 0.07 mm)** used for manufacturing of 12.7 mm Bullet

The rejection percentage in these two products is very high and our goal is to reduce the high rejection rate through application of Statistical quality Tools.

2.2 Process stability and Data collection: -

Process *Flow charts* for manufacturing of Brass Strips and GMCS were made for better understanding of Processes involved. Also critical processes can be identified through study of Flow charts. Data was collected using Check sheet technique. With the help of collected data in Brass Industry, statistical *control charts* were constructed during production of Brass strips. Control charts graphically represent the quality characteristics and showed whether or not the process was in stable state. In case of unstable state, an unsettled data point was plotted on the charts.

2.3 *Diagnosis of defects: -*

Pareto analysis was used to distinguish vital few defects from trivial many defects. After diagnosis of vital few defects (major defects), their causes were then traced out.

2.4 *Analysis of Causes: -*

Cause and effect diagram (Fishbone diagram or Ishikawa diagram) was utilized to show the relation between the quality characteristic and various causes of defects. Each and every process was strictly analyzed and the reasons of major defects were plotted on the Fishbone diagrams. Also reasons were elaborated which are self explanatory to help for taking remedial measures.

2.5 *Conclusion: -*

After collection of data and developing the control charts, Pareto analysis and using the cause & effect diagram for Brass and GMCS, an over all conclusion will be established through experimental results.

3. Application of S.Q.C Tools for Brass & GMCS

3.1 Flow Chart for Brass Strip: Flow chart is a diagram of activities involved in the process or in the solution of a problem. A flow chart should be the first step in identifying problems and targeting areas for improvement. The Process / Manufacturing steps are presented graphically in sequence so that an Analyst can examine the order presented and come to a common understanding of how the process operates. A simple Flow chart (Fig: 1) is established for Brass strip, which is given as under: -

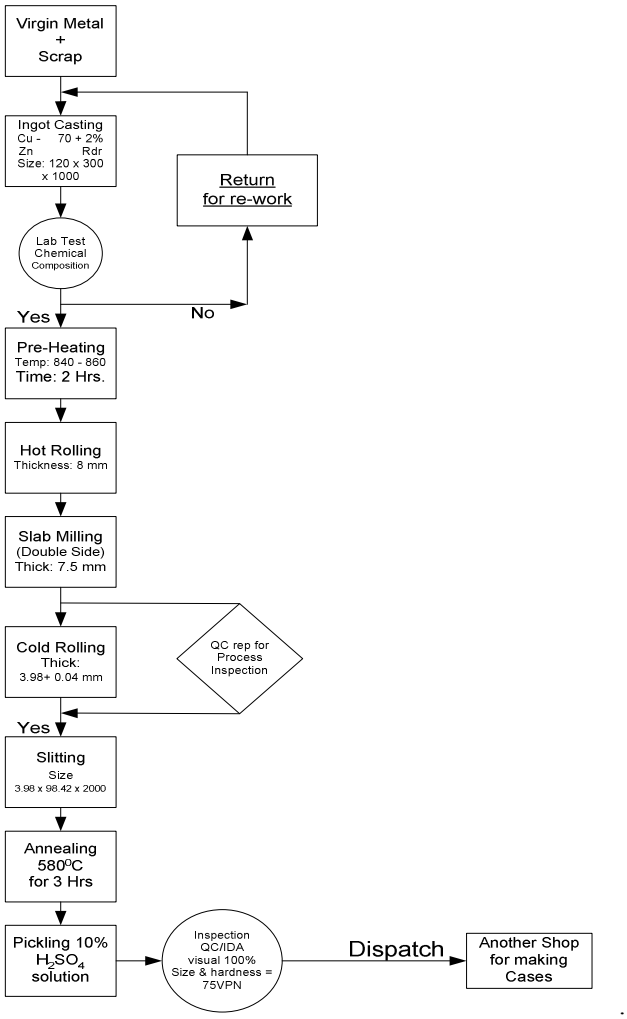

Fig: 1 - Flow Chart for Manufacturing of Brass Strip

3.2 CHECK SHEET FOR BRASS:

The inspection of Brass strips has been carried out after Slitting and shearing operations. Data regarding rejected material i.e Brass strip weighing each 5 Kgs approximately, has been collected with the help of Check sheet (A simple data collection form consisting of multiple categories with definitions. Data are entered on the form with a simple tally mark each time one of the categories occurs, to facilitate the collection and analysis of data).

3.3Defect Analysis of Brass Strip through Pareto Charts: Data (June & July 2007) regarding rejection, including types of defects, which contributed in the rejection of Brass strip, was obtained with the help of Quality Control rep. It is clearly evident from the combined Pareto diagram of June & July 2007 that most of the rejection in Brass strip is due to Scaly, Blister, thickness high/ low and dents. We should work against these defects first to kill the main causes

of rejection. The rejection figure touches 21 % in the month of July 2007, which is alarming and need immediate corrective action to reduce the wastage.

4. CONTROL CHARTS FOR BRASS STRIP: Control Chart is a powerful statistical tool that may have many different applications. For example, they may be used to monitor key product variables and process parameters (Thickness etc). They may also be used in the maintenance of process control and in the identification of *special and common causes of variation*. In addition, they may also be used for process improvement by showing the effects of process of change.

In the light of above statistics (Pareto charts, cause & effect diagram etc) it is clearly shown that due to variation in Thickness i.e High or Low, a large quantity of Brass strip is become wastage. A powerful method of Control charts was utilized to identify the assignable / special causes of variations and to control the thickness of Brass strip.

*CONTROL CHARTS FOR BRASS STRIP (THICKNESS), AUGUST 2007.*Data on various days and shifts for the month of August,2007 has been collected with the help of operators of Cold rolling mill, denoted by P1, P2 etc (where final size of Brass is maintained) and QC reps i.e Q1, Q2, Q3 and Q4 etc. Different types of calculations, required to generate control charts are done with the help of M.S Excel, using formulae as under.The central lines for the X and R charts are obtained using the formulas:

$$\overline{\overline{X}} = \frac{\sum_{i=1}^{R} \overline{X_i}}{g} \text{ and } \overline{R} = \frac{\sum_{i=1}^{R} R_i}{g}$$

Where $\overline{\overline{X}}$ = average of the subgroup averages (read “X double bar”)

$\overline{X}$ = Average of the i th subgroup.

g = number of subgroups.

R = average of the subgroup ranges

R_i = range of the i th subgroup.

Trail control limits for the charts are established at ± 3 standard deviations from the central value, as shown by the formulas:

$$UCL_{\overline{X}} = \overline{\overline{X}} + 3\sigma_{\overline{X}} \quad UCL_R = \overline{R} + 3\sigma_R$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - 3\sigma_{\overline{X}} \quad LCL_R = \overline{R} - 3\sigma_R$$

Where UCL = upper control limit

LCL = lover control limit

$\sigma_{\overline{X}}$ = Population standard deviation of the subgroup averages (X’s)

σR = Population standard deviation of the range

In practice, the calculations are simplified by suing the product of the range R and a factor (A_2) to replace the three standard deviations (A2 $\overline{R} = 3\sigma\overline{X}$) in the formulas for the X chart. For the R chart, the range R is used to estimate the standard deviation of the range (σR). Therefore, the derived formulas are:

$UCL_{\overline{X}} = \overline{\overline{X}} + A^2\overline{R}$ $UCL_R = D_4\overline{R}$

$LCL_{\overline{X}} = \overline{\overline{X}} \_ A_2\overline{R}$ $LCL_R = D_3\overline{R}$ where A_2, D_3 and D_4 are factors that vary with the subgroup size and can be found in ***Appendix – 'B'*** [2].

†: P1 – Plant Operator # 1 and Q 1 – Quality Control rep 1

Similarly data have been collected on different dates and shifts (August 2007) and Control charts have been established. Only those are reproduced here which are prominent i.e where variation is clearly shown.

Similarly variable control charts have been established for various dated and causes of defects were analyzed through Cause & Effect diagrams.

5. ANALYSIS OF CAUSES FOR BRASS & GMCS (causes of defects and their remedial measures)

All the critical processes / steps involved in the manufacturing of Brass & GMCS were studied, keeping in mind the relevant Flow charts of these two products. Following team consisting of 4 members along with one leader was formulated, to investigate the main causes of defects using ***brainstorming*** techniques..

- *The Analyst …….. Leader*
- *Rep of Quality Control Deptt……..Member*
- *Rep of Design Office……..Member*
- *Rep of Production Deptt……..Member*
- *Rep of Met Lab……Member*

On the basis of Pareto charts and control charts of both the products i.e Brass and GMCS strips, as mentioned earlier, a list of irregularities / flaws were obtained. These are discussed in a chronological order as under.

5.1 CAUSE & EFFECT DIAGRAM FOR BRASS STRIP:

On the basis of Pareto analysis, we found that ***Blister, Scaly, Red stains, Dents & scratches and Thickness High/ Low*** are the main defects/ non- conformities in Brass strip resulting in high rejection percentage. Primary and Secondary causes of each defect were analyzed and finally Cause & Effect diagrams (Fishbone Diagram) were established, which are given as under

I. CAUSE & EFFECT DIAGRAM FOR BRASS (showing primary causes)

The first step in analyzing an effect is to establish a Fish bone diagram showing primary causes of the main effect. In our case the main effect is Non- conforming or high rejection rate of Brass and GMCS. Fig: 14, below 'Cause & effect diagram for Brass' showing primary causes by using Pareto analysis.

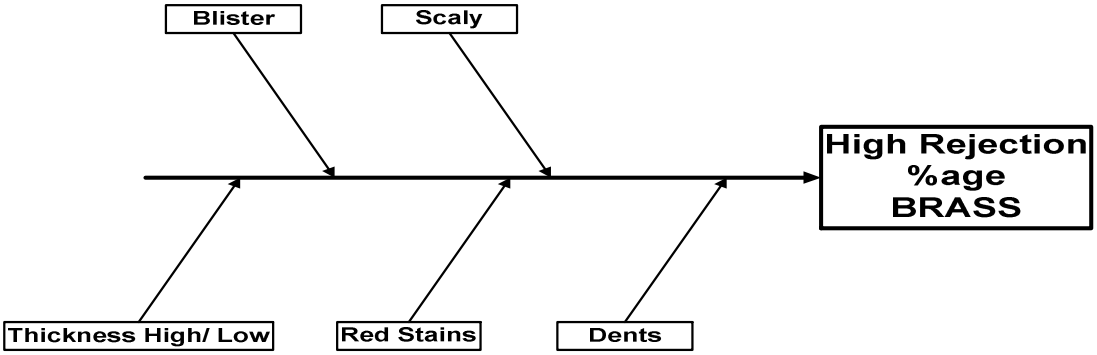

Fig: 14 - Cause & effect diagram for Brass (showing primary causes)

II. CAUSE & EFFECT DIAGRAM FOR BLISTER (showing secondary causes)

Next step is to analyze each & every Primary cause to further know about secondary and sub causes by using brain storming techniques. Fig.15 shows secondary causes of Blister defect which is self explanatory. The detail description is also given in the coming paragraphs.

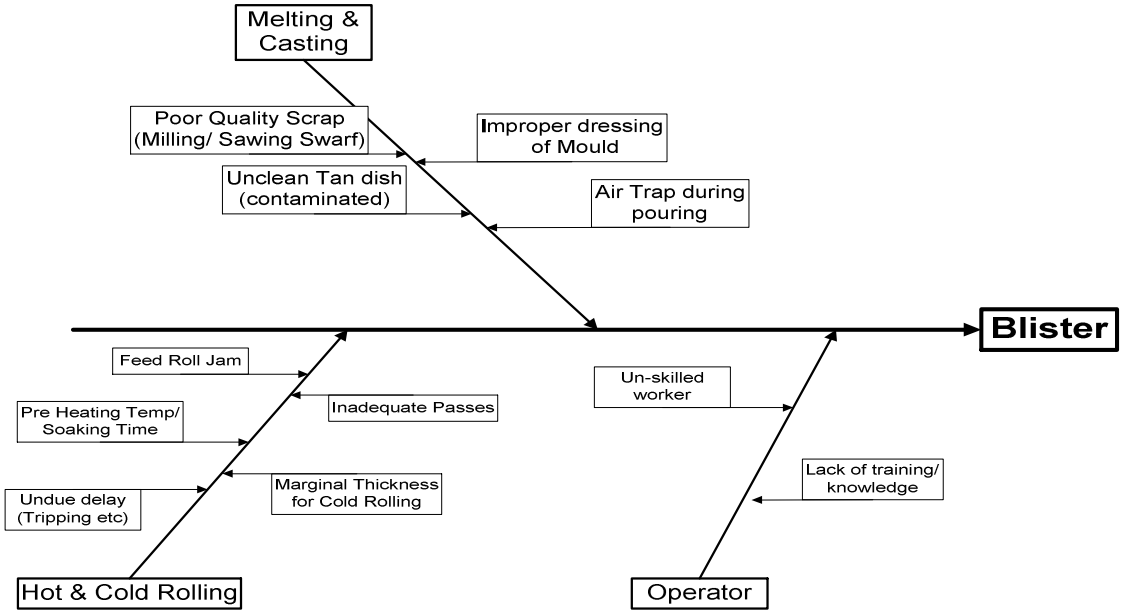

Fig: 15 - Cause & effect diagram for Blister (showing Secondary & sub causes)

III. CAUSE & EFFECT DIAGRAM FOR SCALY(showing secondary causes)

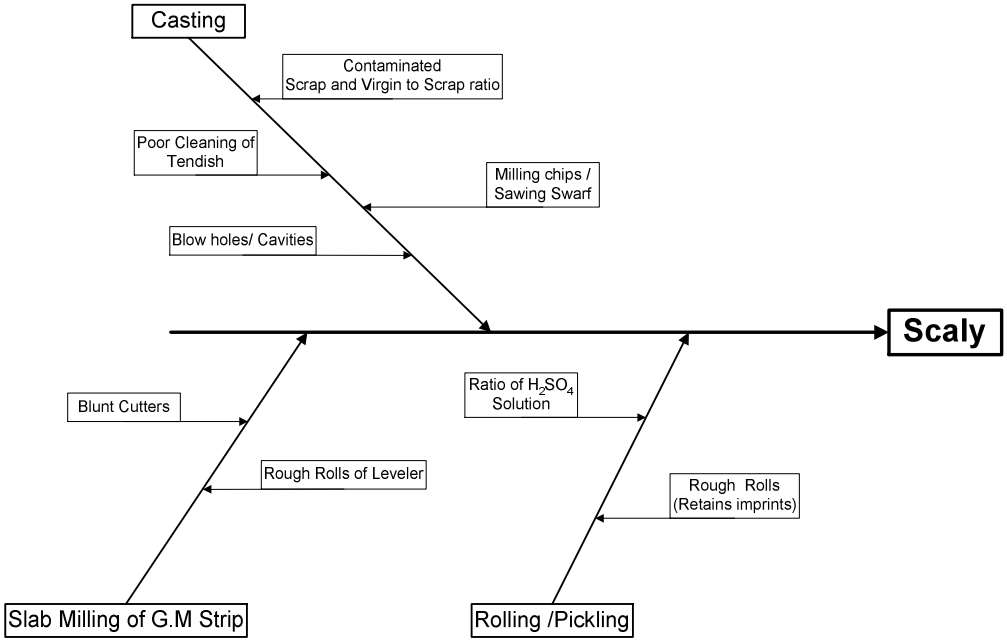

Fig: 16 - Cause & effect diagram for SCALY (showing Secondary & sub causes)

IV. CAUSE & EFFECT DIAGRAM FOR RED STAINS (showing secondary causes)

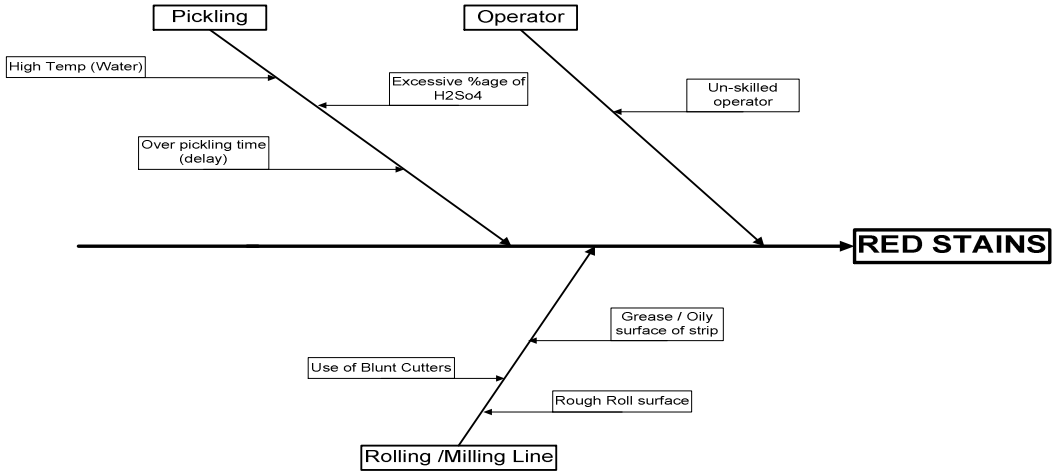

Fig: 17 - Cause & effect diagram for RED STAINS (showing Secondary & sub causes)

V. CAUSE & EFFECT DIAGRAM FOR DENTS/ SCRATHES (showing Sec; causes)

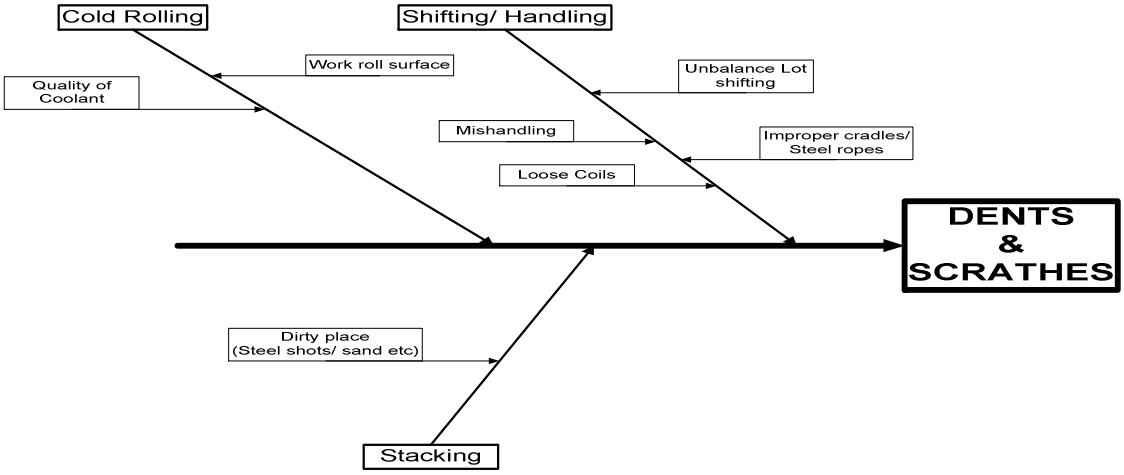

Fig: 18 - Cause & effect diagram for DENTS (showing Secondary & sub causes)

VI. CAUSE & EFFECT DIAGRAM FOR THICKNESS HI/LOW

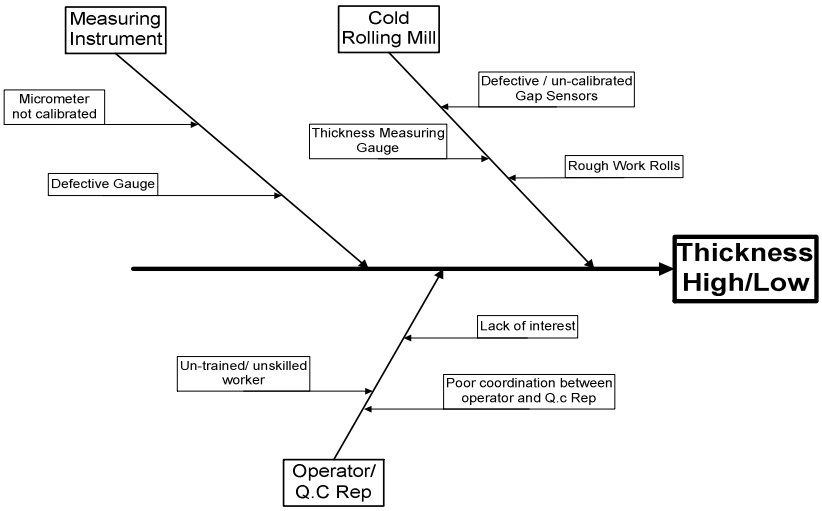

Fig: 19 - Cause & effect diagram for Thick; Hi/Low (showing Secondary & sub causes)

5.2 CAUSE & EFFECT DIAGRAM FOR GMCS STRIP:

On the basis of Pareto analysis, we found that ***Blister, Scaly, Paint Marks, Poor Coating (Coating Defects) and Thickness High/ Low*** are the main defects/ non- conformities resulting in high rejection percentage of GMCS strip. Primary and Secondary causes of each defect were analyzed and finally Cause & Effect diagrams (Fishbone Diagram) were established, which are given as under

I. ***CAUSE & EFFECT DIAGRAM FOR GMCS (showing primary causes)***

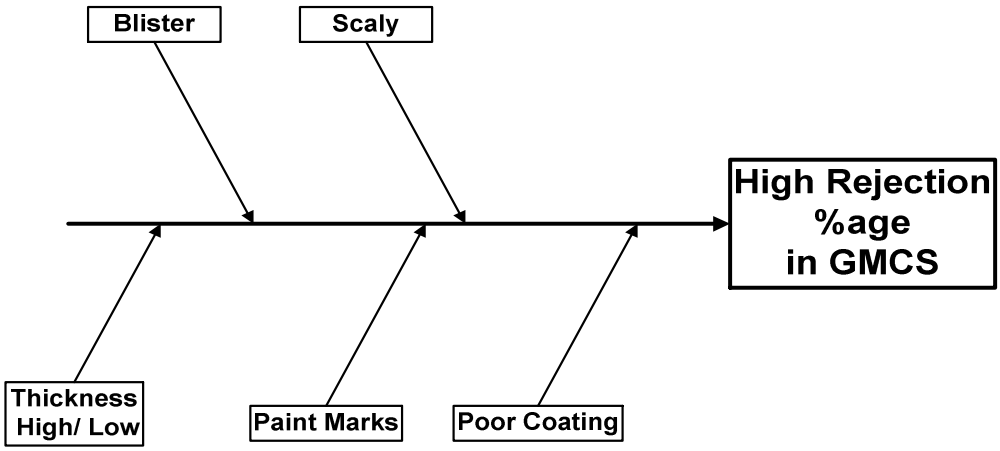

Fig: 20 - Cause & effect diagram for GMCS (showing primary causes)

Similarly Cause & Effect diagrams for sub causes of defects for GMCS were also established as we done for Brass.

5.3 REMEDIAL MEASURES (FOR BRASS AND GMCS)

If the root causes responsible for the defects mentioned earlier in the light of cause & effect diagrams are addressed / overcome not only quality of GMCS will be improved but also will bring the rejection percentage to a negligible level. The practice was followed in the manner by taking necessary corrective / preventive actions concerned supervisory staff / operators were trained & made then quality conscious maintenance of plants and machinery was improved to enhance their efficiency and quality of products supply of raw materials (direct / indirect) were properly checked / watched and thereby eliminated chances of sub standard materials.

In a nut shell, all the inputs (Men, Materials, Method, and Machines etc) were set right which intern left far reaching results on quality out put / production.

6. RESULTS AND DISCUSSIONS

During normal / routine production of Brass and GMCS, the rejection percentage was noted in the month of June & July, 2007, which was 14.9 % & 14.3 % **(Mean: 14.6 %)** for Brass and 19.7% & 21.8% **(Mean: 20.75 %)** for GMCS respectively. Since the purpose of research study was to minimize the said rejection percentage and thereby improve quality, increase productivity and reduce cost. Consequently major defects being the causes of high rejection %age were ascertained with the help of relevant Statistical Quality Improvement Tools.

Efforts were made to remove/ eliminate the observed defects by critically watching the related production processes, educating concerned staff/ workforce, introduction of process inspection (with the help of QC rep) at requisite level, taking remedial measures as pointed out in the "Cause & effect analysis" etc. Again the rejection percentage was checked during October 2007, for Brass and November 2007, for GMCS respectively.

The average rejection Percentage noted was **8 %** for Brass and **11.3 %** for GMCS respectively. The same improvement / encouraging results were chiefly due to implementation of Statistical Quality Tools in the Brass Industry selected for study. A brief detail of the above results, supported by different charts and tables is given hereunder for ready reference:-

7. OUTCOME OF THE PROJECT STUDY:

Calculations (as shown in the Appendix – A) have been done to obtain different types of savings/ improvements due to application of Quality improvement tools in Brass industry. Comparison is based on data collected during the month of June/ July 2007 (before application of SQC tools) & October 2007 for Brass and November 2007 for GMCS (after application of SQC tools), Net outcome of the Project study is given as under: -

7.1 OUTCOME IN BRASS:

➢ **Saving in PRODUCTION:**		
• saving in Production	=	**7471.20 Kgs/ month**
• Improvement in reduction of Rejection Percentage	=	**45.2 %**
• Percentage increase in Production	=	**7.17 %**
• Saving Labor Hours	=	**560.34 Hrs / month**
➢ **Saving in COST:**		
• Saving in Full Cost	=	**Rs. 2458024.8**
• Percentage saving in Full Cost	=	**7.2 %**
• Also saving in Labor Cost	=	**Rs. 35861.76**
• and saving in material Cost	=	**Rs. 2316072**

7.2 OUTCOME IN GMCS:

➢ **Saving in PRODUCTION:**		
• Saving in Production	=	**1663.20 Kgs/ month**
• Improvement in reduction of Rejection Percentage	=	**45.5 %**
• Percentage increase in Production	=	**10.65 %**
• Saving Labor Hours	=	**615.384 / month**
➢ **Saving in COST:**		
• Saving in Full Cost (Rs)	=	**Rs. 485654.4**
• Percentage reduction in Full cost	=	**10.6 %**
• Also saving in Labor Cost (Rs)	=	**Rs. 37422**
• and saving in material Cost (Rs)	=	**Rs. 342619.20**

8. CONCLUSION & RECOMMENDATIONS

8.1 CONCLUSION:

The purpose/ goal of the research study has been achieved to a greater extent regarding minimizing/ eliminating the rejection percentage in Brass strip and GMCS. In course of the said study, rate of rejection in Brass strip was brought down from 15% to 8 %. Similarly, rejection percentage in GMCS was reduced from 21% to 11.3 %. The study has given new dimensions and awareness to management as well as workforce, to improve and maintain

Quality in letter and spirit. A new culture has been observed that shows phenomenal increase in Productivity, reduction in rejection percentage (reduction in waste0, and improvement in operator's skill

In fact, the rate of rejection being on the higher side was due to the existence of major defects like Blister, Scaly, Thickness high / low, Dents/ scratches, red stains, milling defects, Coating defects and Paint marks. The target of the study was to arrest these defects by eliminating its causes. The main causes being observed/ pointed out were: -

- Production processes (Casting, Hot rolling, Cold rolling, Packing of sandwiches for GMCS, heat treatment and pickling)
- Direct Materials (Brass scrap, steel slabs) and Indirect materials (wrapping sheets, paint powder, coolant oil and acid for pickling)
- Plants & Machines (Shot blasting, Preheating furnaces, Hot Mill, Slab Milling line, Cold rolling Mill and Annealing & Pickling Plant)
- Workforce involved in (Casting, packing of sandwiches for GMCS, Hot Rolling, Milling, Cold rolling, Annealing & Pickling, Shearing/ Slitting)

The above defects/ causes were successfully controlled which left far reaching results on Quality, productivity and Cost

The ultimate goal of enhancing the quality & productivity and reduction in cost was achieved to a considerable extent, that is: -

- Rejection percentage of Brass and GMCS was reduced by 45%
- Productivity increased by 7.1 % in Brass and 10.7 % in GMCS.
- Also Full Cost of Brass is reduced by 7.25 and That of GMCS is reduced by 10.6%

The aforementioned improvement in Quality, productivity and reduction in cost owe its roots mainly in the application of Statistical Quality Tools.

8.2 RECOMMENDATIONS FOR FUTURE PLANNING:

After having a detailed study of the production complexities in Brass Industry, factors causing high rejection of Brass and GMCS products and their economic implications following are recommended for future.

1. Complete Flow / Process chart should be established for each product, for better understanding of the processes and identification of critical operations.
2. Pareto Charts (Rejection categorization) should be implemented in production units to point out the major defects causing high rejection.
3. Rejection categories should be analyzed carefully (by using Cause & Effect diagrams) and preventive actions should be taken to control recurrence.
4. Supervisory staff / Work force should be trained before start of operation.
5. Process sheets should be well laid out so that these are well read / understand by Technicians.
6. Management responsibility as regards provision of material should be discharged carefully for putting into operation-qualified material only.
7. Extra care should be given to maintenance of plants & machinery to always put them in Upkeep condition for smooth production of quality products.

8. Results obtained i.e. high rejection rate with main defects & Cost of poor quality, should be displayed at prominent places so that every one in the factory is conscious of Quality.
9. After each batch/ lot of production, rejection results should be analyzed and proper corrective & preventive actions should be taken timely, where necessary to avoid any loss in future.

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Date: 03-6-2007 **Time**: **Material:** 70:30 Brass (After Slitting & Shearing) **Shift:** 2nd							
CHAECKSHEET	**Lot # 1**	**Lot # 2**	**Lot # 3**	**Lot # 4**	**Lot # 5**	**Total strips (Nos)**	**Weight (Kgs)**
Scaly	~~IIII~~ ~~IIII~~ IIII	~~IIII~~ ~~IIII~~ ~~IIII~~	~~IIII~~ ~~IIII~~ ~~IIII~~	~~IIII~~ ~~IIII~~ ~~IIII~~ IIII	~~IIII~~ ~~IIII~~ ~~IIII~~	78	390
Blister						0	0
Thickness High	~~IIII~~ II	~~IIII~~ III	~~IIII~~ ~~IIII~~	I	~~IIII~~ ~~IIII~~	36	180
Thickness Low	~~IIII~~ ~~IIII~~	~~IIII~~ ~~IIII~~	~~IIII~~	~~IIII~~ II	~~IIII~~ ~~IIII~~	42	210
Dents	II		II	I	I	6	30
Red Stains	III	II	III	~~IIII~~	IIII	18	90
Milling Defect	I		I			2	10
Miscellaneous						0	0
Total						**182**	**910**

Table 1. Check sheet of Brass strip for 03-6-2007 is given as under:-

Date	Qty Submitted (Kgs)	Qty passed (Kgs)	Qty rejected (Kgs)	Rejection %age	DEFECTS IN Kgs						
					Scaly	Blister	High	Low	Dent	R/Stain	Milling Defect
03.06.07	6840	5930	910	13.3	390	0	180	210	30	90	10
15.06.07	8430	7290	1140	13.5	600	0	150	180	200	0	10
18.06.07	10000	8126	1874	18.7	800	456	100	135	232	136	15
20.06.07	9000	7913	1087	12.1	472	120	150	135	56	75	79
21.06.07	8000	6546	1454	18.2	392	344	152	208	208	150	0
25.06.07	13000	11297	1703	13.1	624	456	150	140	232	96	5
26.06.07	12000	10377	1623	13.5	700	350	140	160	131	142	0
27.06.07	5910	4920	990	16.8	450	0	400	110	0	0	30
28.06.07	8000	6674	1326	16.6	464	344	240	0	160	104	14
30.06.07	12000	10272	1728	14.4	744	416	160	24	184	200	0
30.06.07	8190	7050	1140	13.9	120	0	600	300	0	0	120
SUM=	***59100.0***	***86395.0***	***14975.0***	***164.1***	***5756***	***2486***	***2422***	***1602***	***1433***	***993***	***283***
			Average Defects		***523.3***	***226.0***	***220.2***	***145.6***	***130.3***	***90.3***	***25.7***
			%age Defects		***38.4***	***16.6***	***16.2***	***10.7***	***9.6***	***6.6***	***1.9***
Average Rej %age w.r.t Total Qty Submitted =					***9.74***	***4.21***	***4.10***	***2.71***	***2.42***	***1.68***	***0.48***

Average Rejection %age for June, 2007 = 14.9 %

Table:2 – Defect Analysis of Brass for the month of JUNE 2007

Defect Analysis of Brass for JUNE 2007.

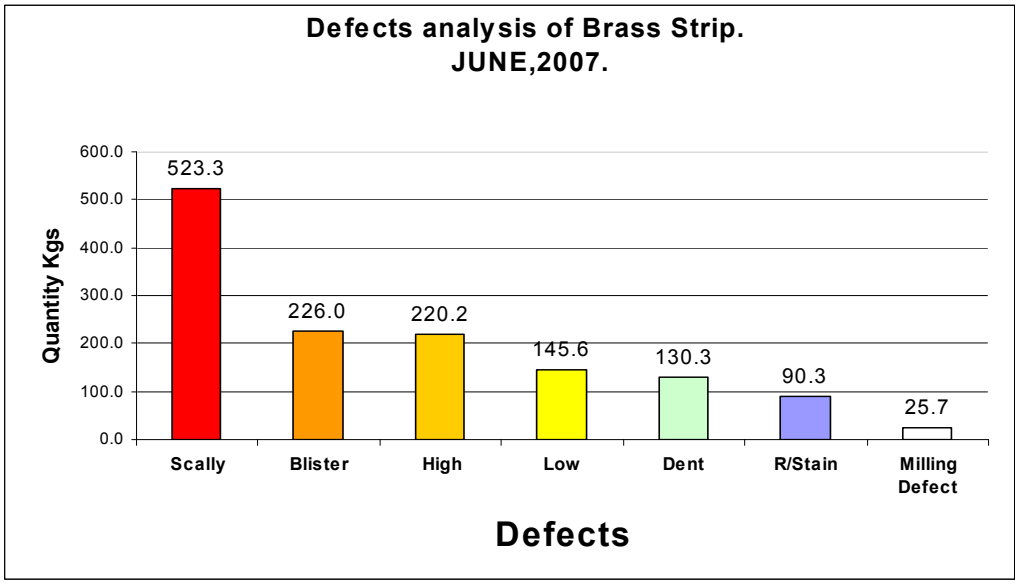


Fig. 2 – Pareto Diagram for Brass based on average defects – JUNE 2007.

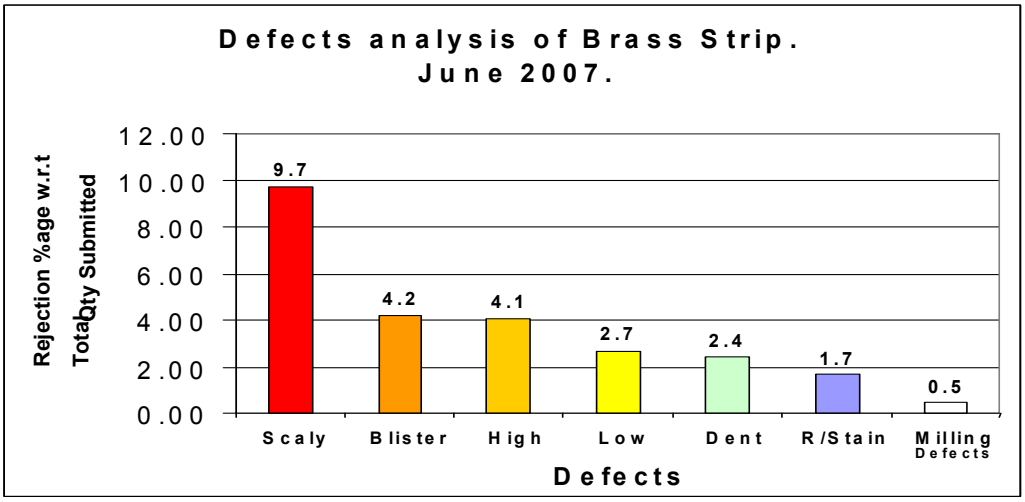


Fig. 3- Pareto Diagram for Brass w.r.t average
Defects & Total Quantity submitted – JUNE 2007

Similarly Pareto Analysis was also carried out for the month of July 2007, which is given as under.

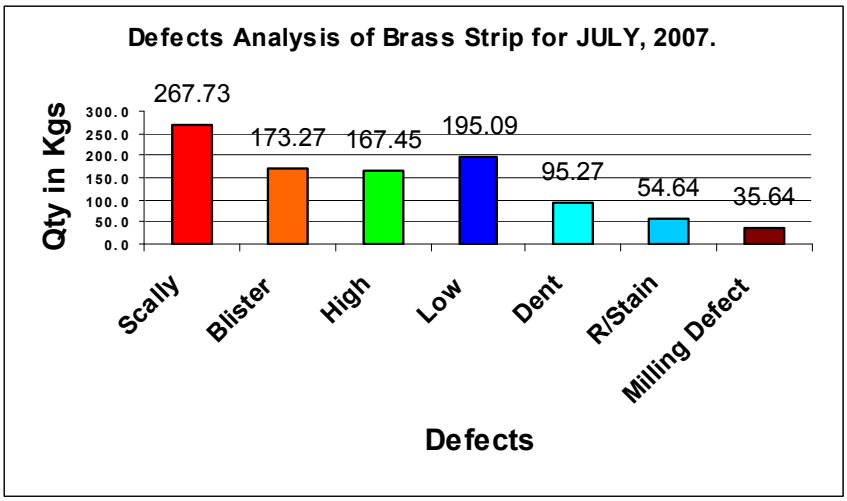


Fig. 4 – Pareto Diagram for Brass based on average defects – JULY 2007

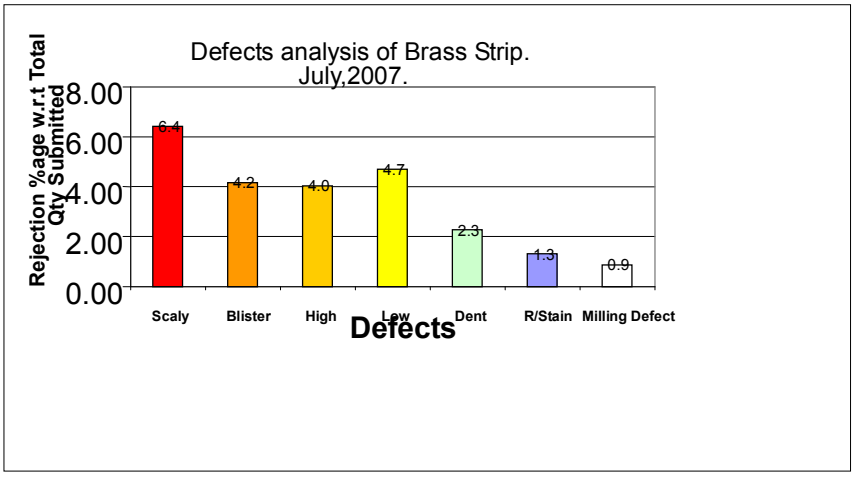


Fig.5- Pareto Diagram for Brass w.r.t average defects & Total Quantity submitted – JULY 2007

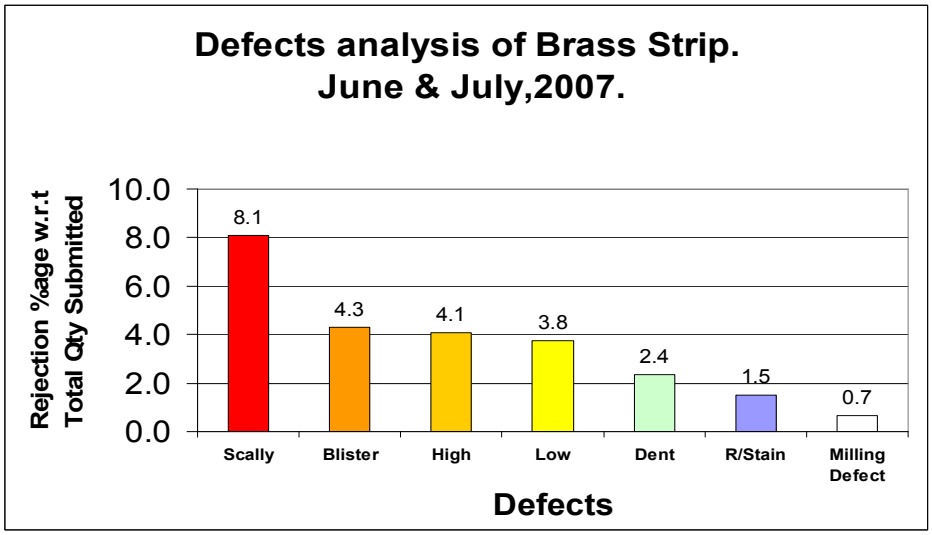


Fig: 6 – Combined Pareto Diagram for the Months of June-July,2007

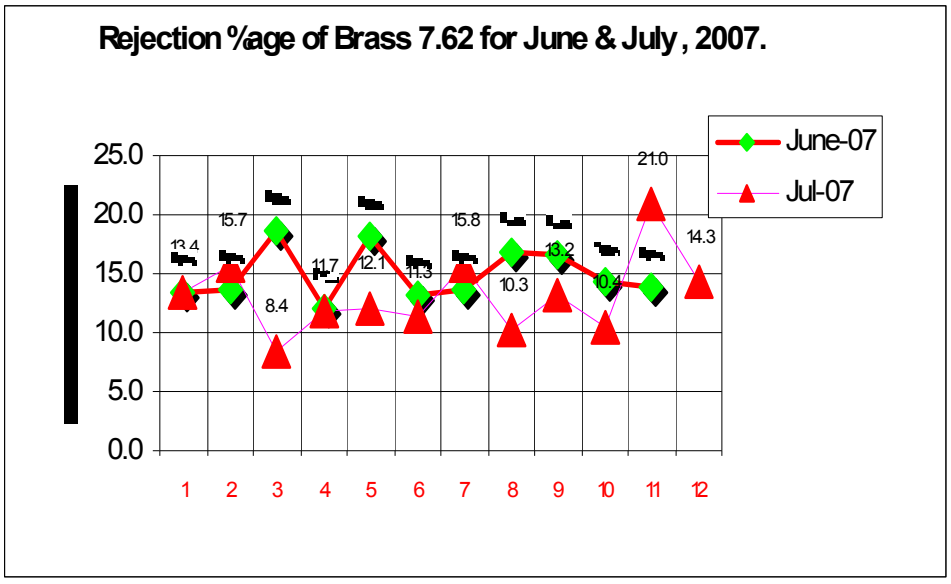


Fig. 7 – Line Graph showing rejection %age of Brass JUNE & JULY 2007

DAILY PRODUCTION REPORT 01-8-2007 to 22-8-2007.

Caliber: **Brass Strip 7.62 mm Case**					**Strip Size: 3.988 ± 0.04 (4.028 – 3.948)**				
Shift: 1st		**Operator**: P1			**Q.C Rep:** Q1			**Date: 01-8-2007**	
Coil No.	**Readings**				**SUM**	**Average**	**Range**	**R*100**	**Remarks**
1	3.99	3.99	3.98	3.99	15.95	**3.988**	0.01	1.00	
2	4.05	4.02	4.01	4	16.08	**4.020**	0.05	5.00	Thickness High
3	3.96	3.96	3.95	3.93	15.8	**3.950**	0.03	3.00	
4	3.99	3.98	4.01	4.02	16	**4.000**	0.04	4.00	Thickness at center will be High
5	3.96	3.95	3.95	3.95	15.81	**3.953**	0.01	1.00	
6	3.93	3.94	3.94	3.93	15.74	**3.935**	0.01	1.00	Thickness Low
7	3.97	3.95	3.94	3.96	15.82	**3.955**	0.03	3.00	
8	3.96	3.95	3.95	3.94	15.8	**3.950**	0.02	2.00	
9	3.93	3.9	3.98	3.93	15.74	**3.935**	0.08	8.00	Thickness Low
10	3.94	3.93	3.94	3.94	15.75	**3.938**	0.01	1.00	Thickness Low
					Avge of Averages =	**3.962**	**0.029**	**2.90**	
UCLAverage=		***3.983***	***LCLAverage=***		***3.941***	***UCLRange=***	**6.618**	***LCLRange=***	**0**

Table: 3 – Data of the Thickness (Brass Strip) 01-8-2007 - .

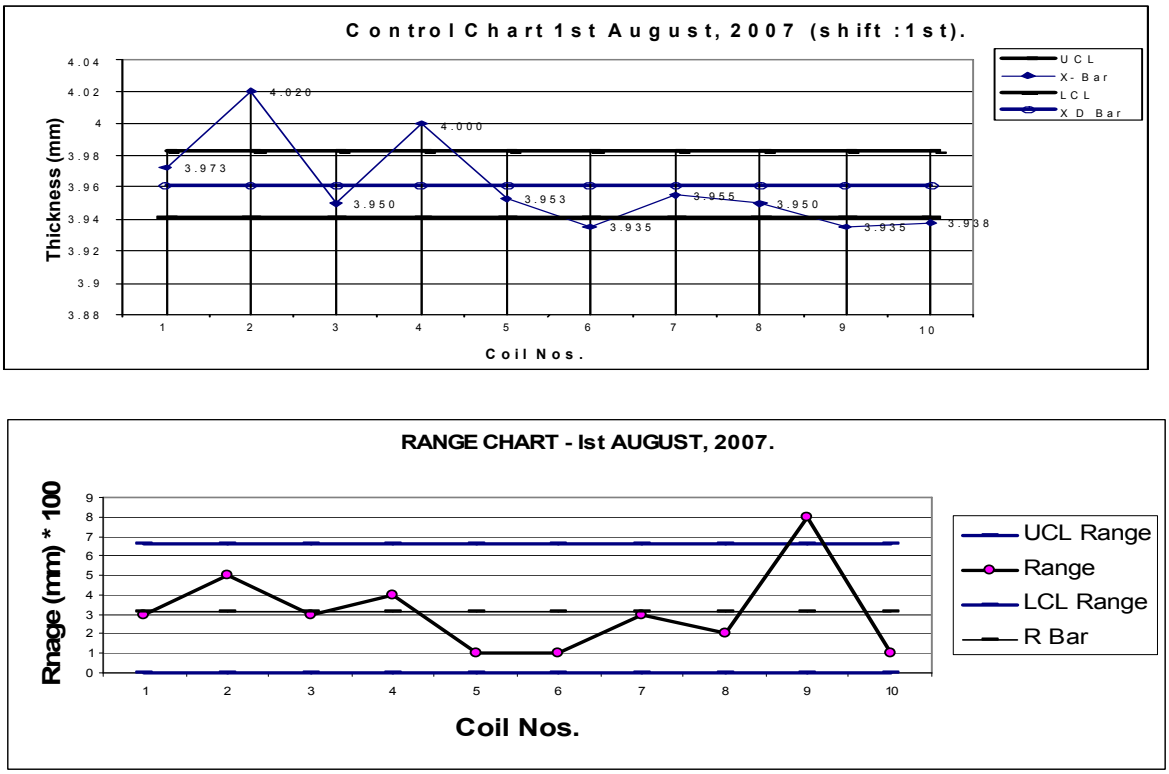


Fig: 8 - $\overline{X}$ & R Chart – 01-8-2007 (1st Shift) – P1/ Q1 †

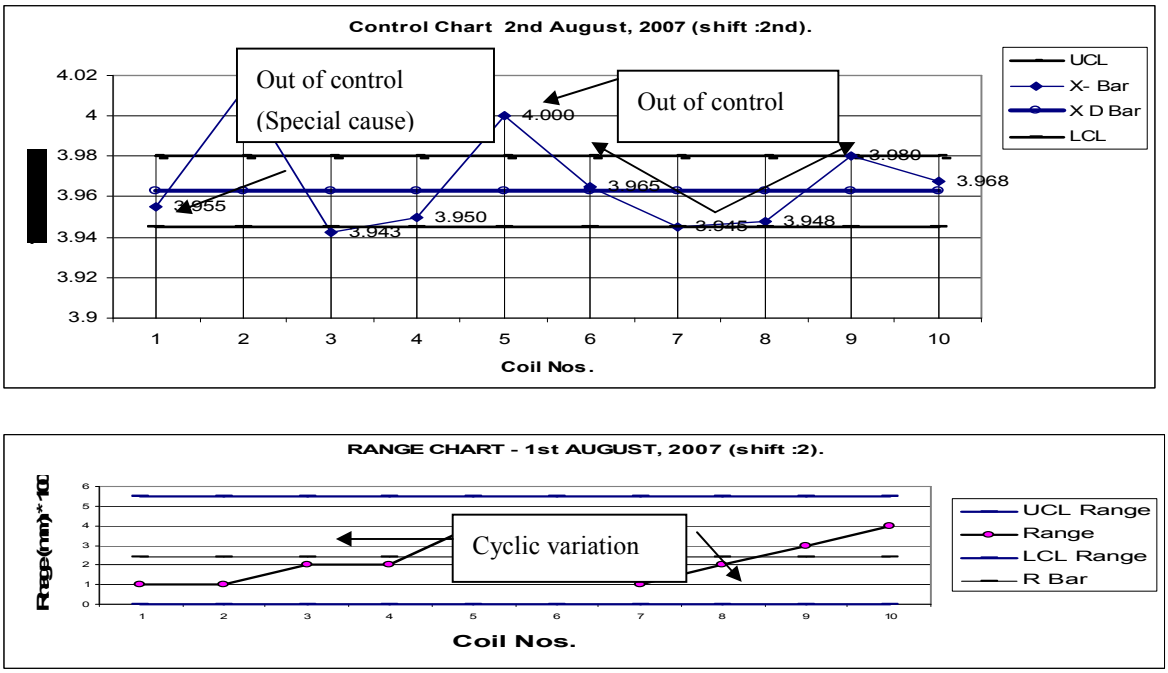


Fig: 9 - $\overline{X}$ & R Chart – 01-8-2007 (2nd Shift) – P2/ Q2

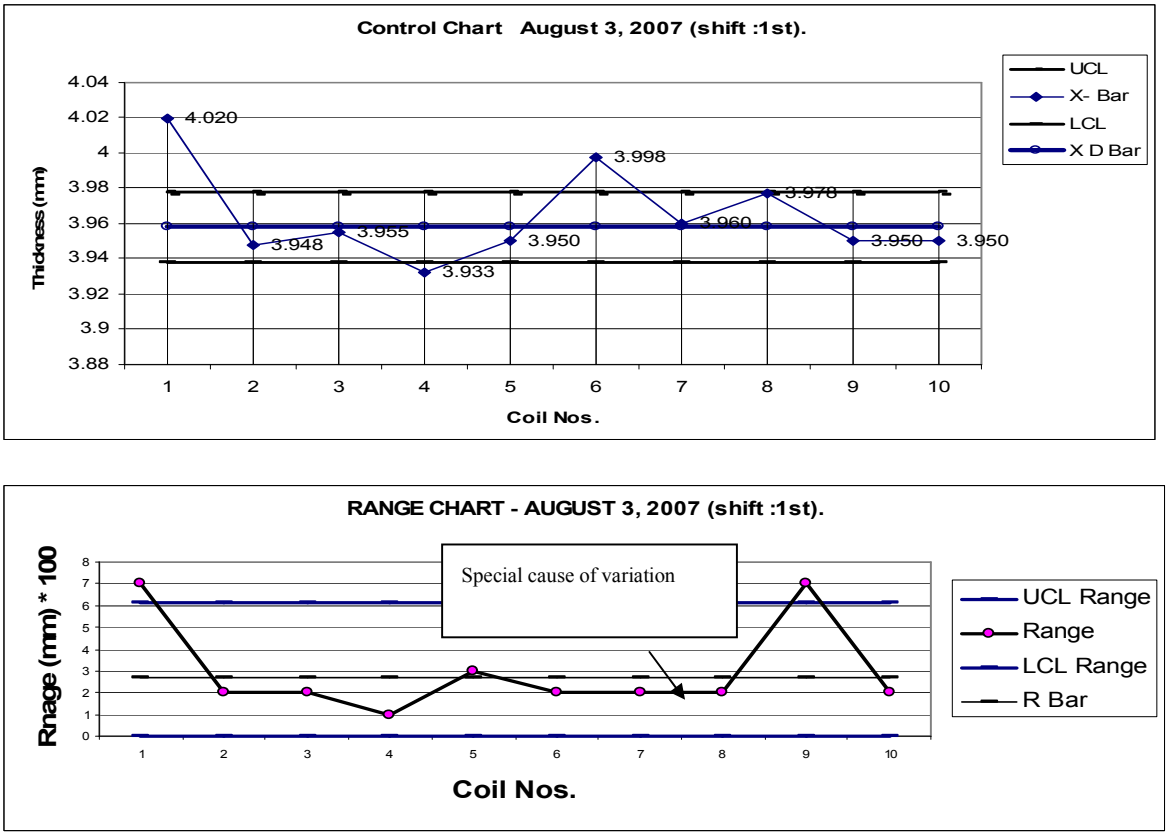


Fig: 10 - $\overline{X}$ & R Chart – 03-8-2007 (1st Shift) – P1/ Q1

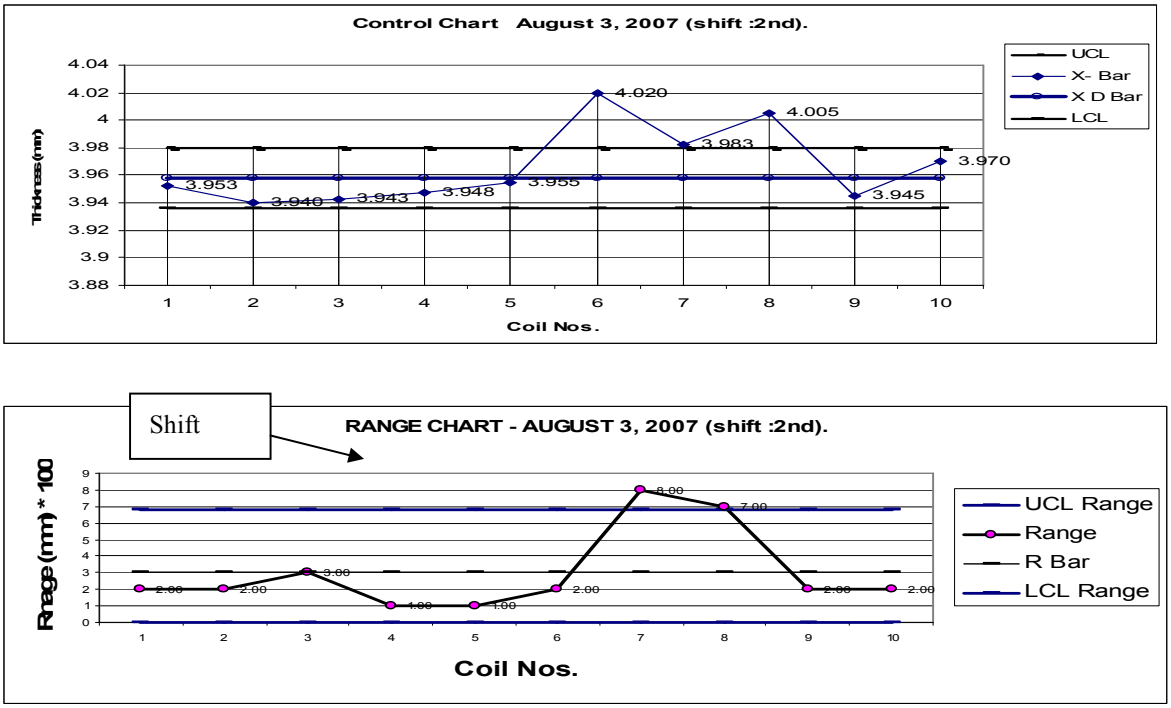
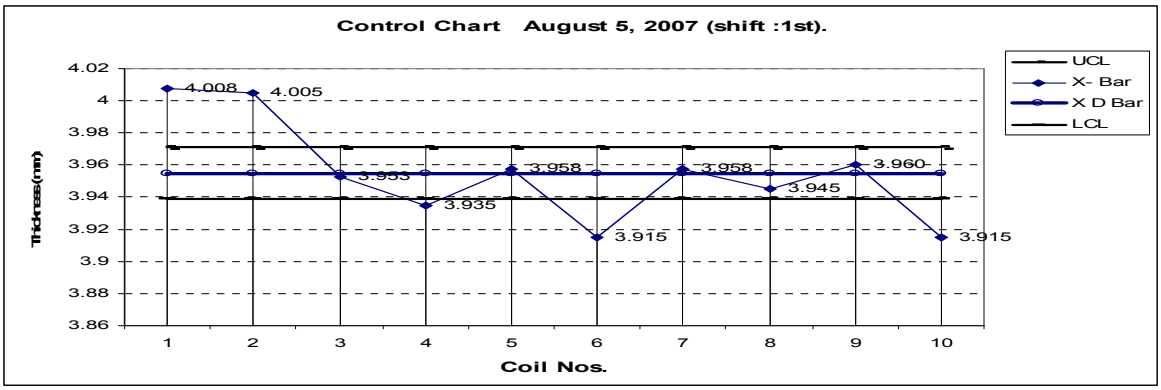


Fig: 11 - $\overline{X}$ & R Chart – 03-8-2007 (2nd Shift) – P2/ Q2



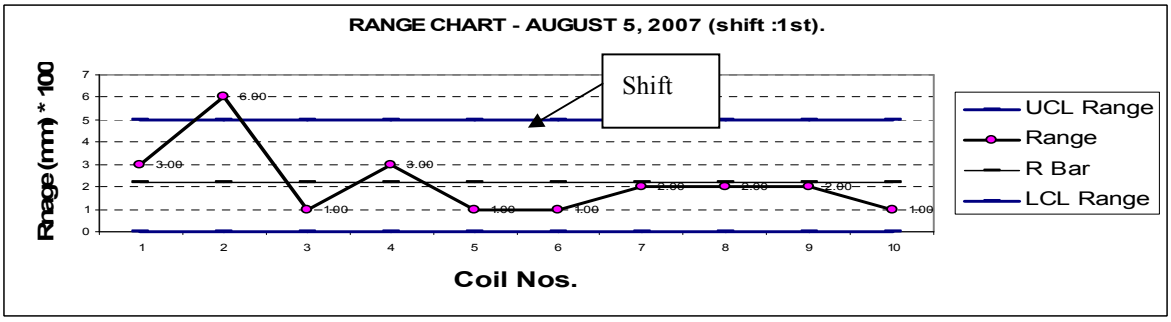
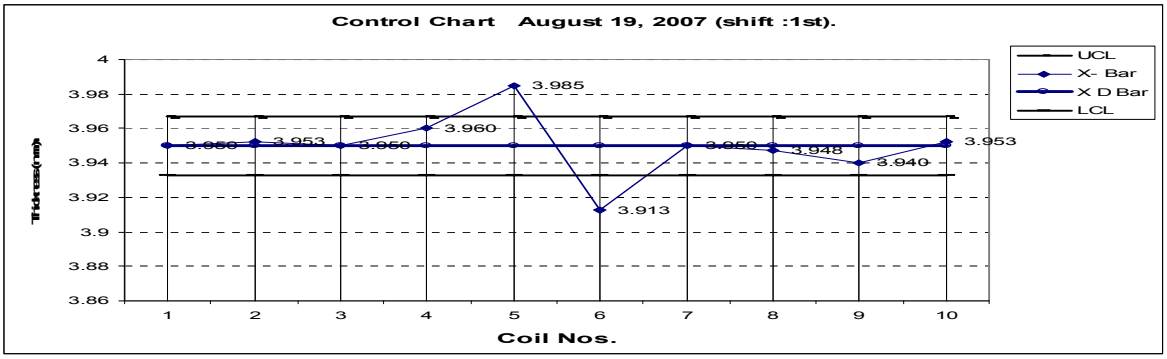


Fig: 12 - $\overline{X}$ & R Chart – 05-8-2007 (1st Shift) – P1/ Q1



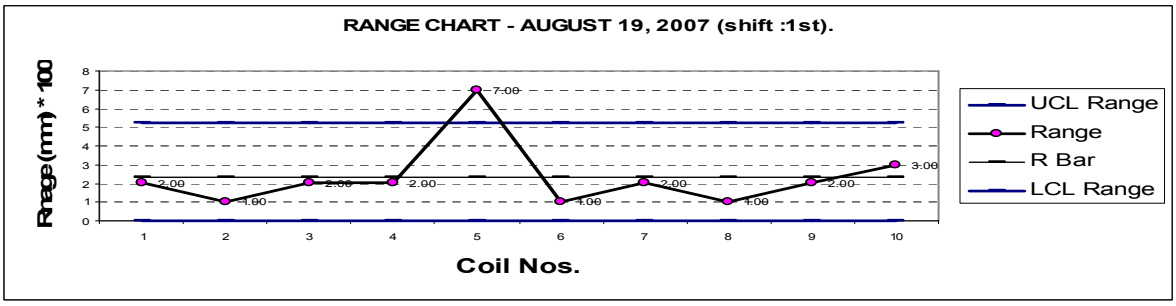


Fig: 13 - $\overline{X}$ & R Chart – 19-8-2007 (1st Shift) – P1/ Q1

Defect Analysis of Brass for October, 2007.

Caliber: Brass Strip for 7.62 mm Case, Size: 3.988 ± 0.04 mm

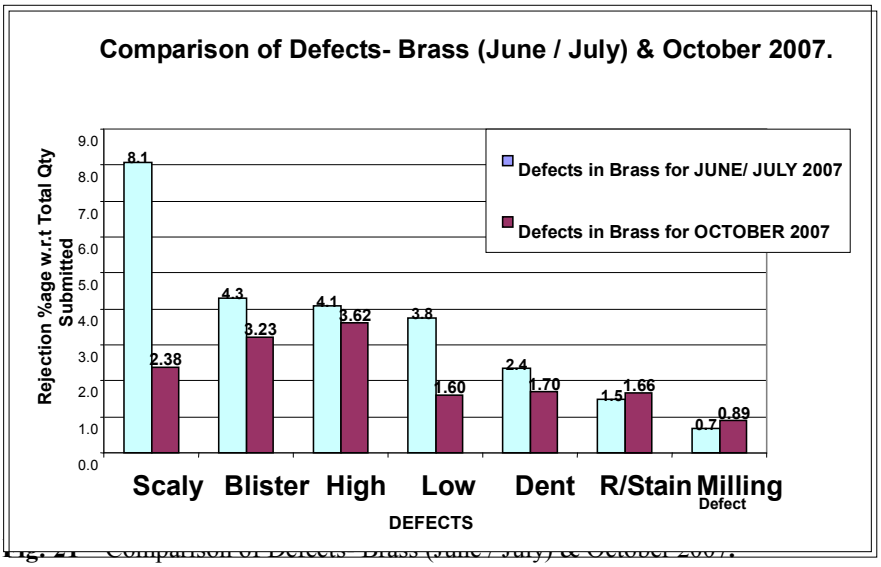
Month: OCTOBER 2007.

Date	Qty Submit Kgs	Qty pass; Kgs	Qty Rejec; Kgs	Rej; % age	DEFECTS IN Kgs						
					Scaly	Blister	High	Low	Dent	Red Stain	Milling Defect
03.10.07	7500	6900	600	8.0	75	100	175	85	60	85	20
05.10.07	8500	7810	690	8.1	75	150	200	80	65	70	50
06.10.07	11000	10078	922	8.4	150	250	300	35	32	120	35
08.10.07	10500	9645	855	8.1	175	120	275	35	90	75	85
10.10.07	5000	4550	450	9.0	65	110	95	50	80	50	0
11.10.07	13000	12100	900	6.9	150	110	150	140	130	190	30
13.10.07	8900	8080	820	9.2	50	205	190	70	165	140	0
15.10.07	9000	8300	700	7.8	200	150	45	110	0	65	130
17.10.07	6500	5975	525	8.1	40	140	165	50	65	0	65
18.10.07	12300	11335	965	7.8	180	210	200	170	120	50	35
20.10.07	11500	10645	855	7.4	170	190	200	60	100	75	60
23.10.07	9500	8855	645	6.8	80	175	150	60	100	65	15
SUM=	***113200***	***104273***	***8927***	***95.7***	***1410***	***1910***	***2145***	***945***	***1007***	***985***	***525***
			Average Defects		***117.5***	***159.2***	***178.8***	***78.8***	***83.9***	***82.1***	***43.8***
			%age Defects		***15.8***	***21.4***	***24.0***	***10.6***	***11.3***	***11***	***5.9***
Average Rej %age =					**8.0 %**						
Average Rej %age w.r.t Total Qty Submitted =					**2.38**	**3.23**	**3.62**	**1.60**	**1.70**	**1.66**	**0.89**

Table: 4 - Defect Analysis of Brass for the month of OCTOBER 2007

6.1Comparison of Defects in Brass based on Average Rejection w.r.t Total Qty submitted- (June/July combined) and October 2007:

In the under mentioned Bar chart the comparison of different defects in Brass strips for June/July (combined average) is represented by simple bars while the same for October is represented by Block bars after application of quality improvement tools. It clearly envisages that sufficient improvement in the rejection of Brass strip due to Blisters, Scaly and Thickness high/ Low has been recorded in the month of October as compare to June/ July 2007.



Comparison of Rejection Percentage in Brass June/July and October 2007:

In the under mentioned Line graph the comparative analysis i.e rejection percentage of Brass strip for June, July and October 2007, is shown. The rejection percentage for June 07 & July 07 is represented by square boxes and diamonds respectively, while the same for October 07 is represented by triangles.

It is very clearly shown that rejection percentage of Brass strip in the month of October 2007 has been improved as compare to June / July 2007. it is totally due to application of SQC tools.

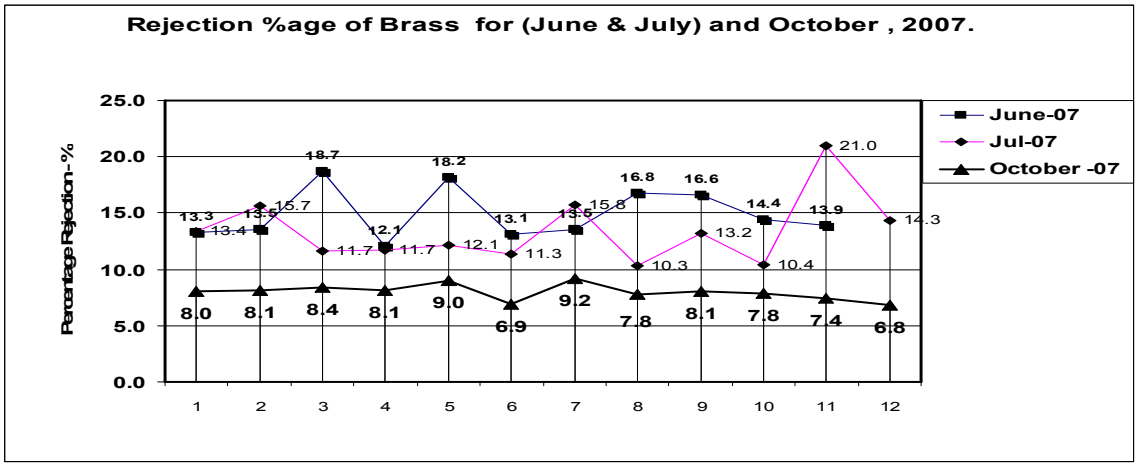


Fig: 22 - Comparison of Rejection Percentage in Brass June/July and October 2007

Comparison of Defects in GMCS based on Average Rejection w.r.t Total Qty submitted- (June/July combined)

and November 2007:

After application Statistical Quality tools for improvement / reduction in the highly rejection %age of GMCS, data has been collected for the month of November 2007, and was plotted in comparison with the data as collected in the previous months i.e June & July.

In the under mentioned Bar chart the comparison of different defects in GMCS for June/July is represented by simple bars while the same for November 2007 is represented by Block bars after application of quality improvement tools.

It clearly envisages that sufficient improvement in the rejection of GMCS due to Blisters, Scaly, Paint marks and Thickness high has been recorded in the month of November 2007 as compare to June/ July 2007. It is also pointed out that rejection due to Thickness Low, coating defects and miscellaneous defects are slightly increased, which should have to be arrested / improved during next months.

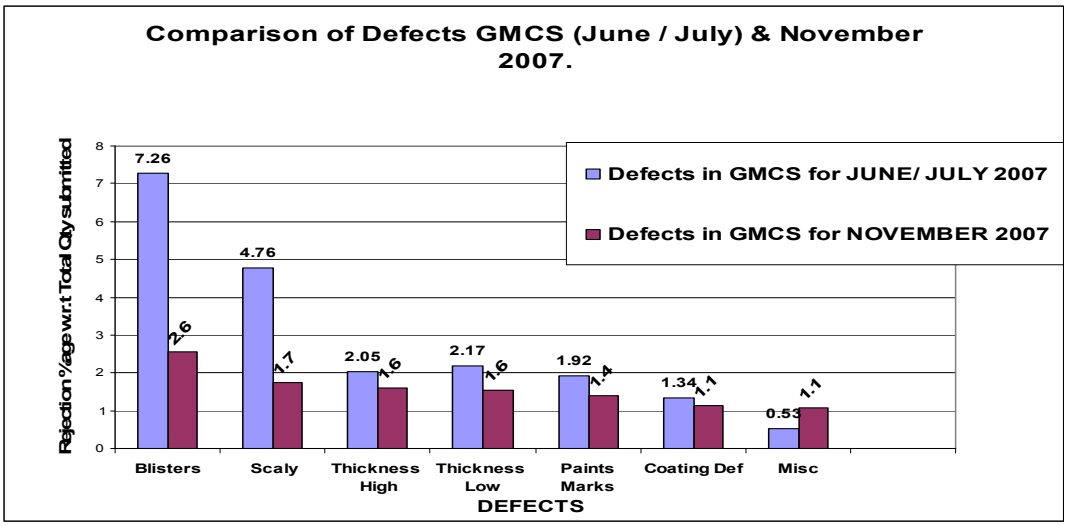


Fig: 23 - Comparison of Defects GMCS (June / July) & November 2007

6.5 Comparison of Rejection Percentage in GMCS June/July and November 2007:

In the under mentioned Line graph the comparative analysis i.e rejection percentage of GMCS for June, July and November 2007, is shown. The rejection percentage for June 07 & July 07 is represented by square boxes and diamonds respectively, while the same for November 07 is represented by triangles.

It is very clearly shown that rejection percentage of GMCS in the month of November 2007 has been improved as compare to June / July 2007. it is totally due to application of SQC tools.

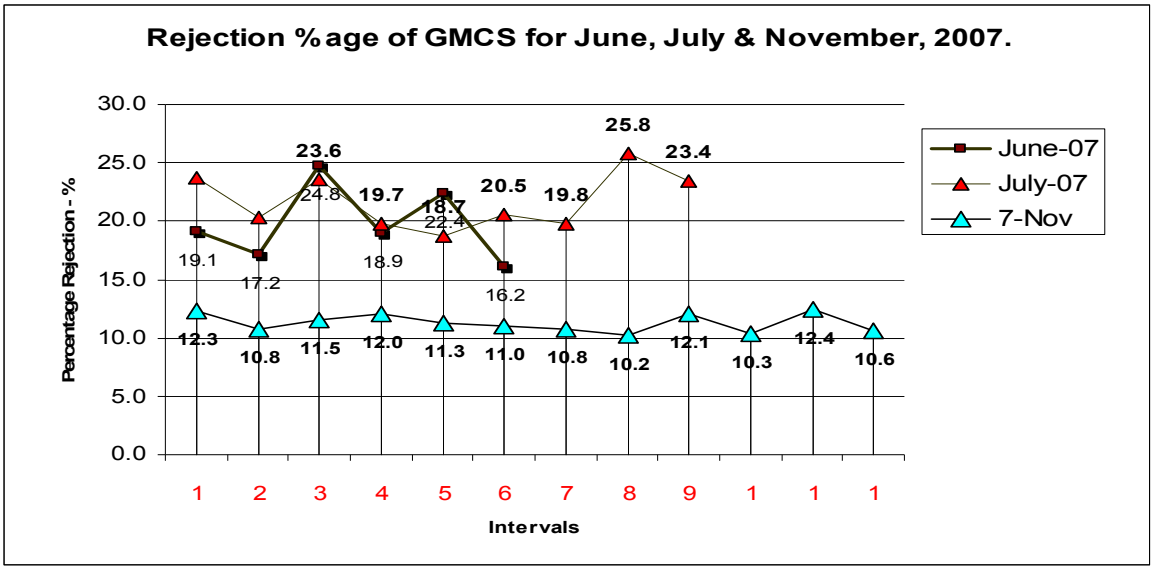


Fig: 24 - Comparison of Rejection Percentages in GMCS June, July and NOVEMBER 2007

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