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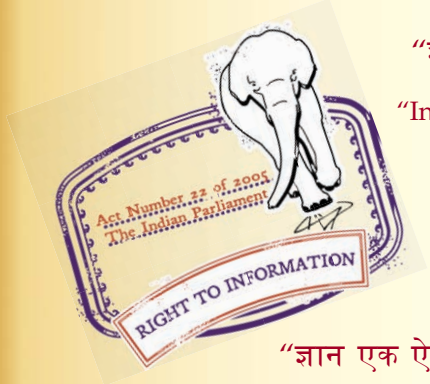
IS 10708 (1985): Guide for the analysis of quality costs
[MSD 2: Quality Management]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 10708 - 1985
(Reaffirmed 2000)

Indian Standard

GUIDE FOR THE ANALYSIS OF QUALITY COSTS

(First Revision)

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GUIDE FOR THE ANALYSIS OF QUALITY COSTS

(First Revision)

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(*Continued on page* 20)

Indian Standard

GUIDE FOR THE ANALYSIS OF QUALITY COSTS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 14 Feburary 1986, after the draft finalized by Quality Control and Industrial Statistics Sectional Committee had been approved by the Executive Committee.

0.2 The considerations of cost are of paramount importance in any successful business administration of an organization. Whereas competitiveness is a direct function of the sale price of a product, the relationship between cost and quality is more subtle. All the same, it is now universally accepted that optimum quality of any product is determined taking into account the cost factor also. Consequently, any reduction in the cost without affecting the quality of the product adversely would go a long way in improving its competitiveness in the market or in enhancing the profit margin or both.

0.3 The operating quality costs of a product, consisting of prevention, appraisal and failure costs, provide an excellent field for cost control efforts through reduction of re-work, re-inspection, delays, loss of production potential, etc. It is obvious that failure costs reduce the profits. The preventive quality control activities and appraisal of quality standards also cost money. The increase in prevention costs results in reduction of failure and appraisal costs, but the relationship is not proportional. Therefore, the optimization of the operating quality costs should be done by evaluating and analysing various quality costs. This will help in identifying the areas of concentration of quality losses and measure overall effectiveness of the quality programme.

0.4 This standard was originally published in 1983. The Panel for Handbook on Statistical Quality Control, while reviewing this standard for inclusion in the Handbook, felt that this standard needs a large number of changes and also the presentation can be improved by condensing the write-up. The committee, therefore, decided to revise this standard. In this revision, apart from other corrections, Fig. 1 and 2

have been re-drawn by taking the quality level in non-decreasing order on the horizontal axis. The write-up on various components of operating quality costs, and the measurement bases for quality costs, have been abridged so as to make the contents more clear. The write-up on collection of cost data and also an example of operating quality costs are included in this revision.

0.5 Quality costs shall be evaluated and analysed periodically and the results shall be flashed to the management. The management shall maintain a close watch on the continuing score board of quality costs and initiate action to minimize avoidable quality costs.

1. SCOPE

1.1 This standard gives the broad guidelines for the collection and analysis of operating quality costs of an organization with an objective of achieving the desired balance among various components, so that control of these costs may lead to an effective and profitable business management.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Operating Quality Costs — The expenditure incurred in defect prevention and appraisal activities together with the losses due to internal and external failures.

2.2 Prevention Costs — The costs of any action taken to investigate and prevent or reduce defects and failures.

NOTE — Prevention costs include the cost of planning, setting-up and maintaining the quality control system.

2.3 Appraisal Costs — The costs of assessing the quality mainly during the 'first time through'.

NOTE — Appraisal costs include the cost of a inspection, testing, etc, carried out for incoming materials, during and on completion of manufacture, b) materials and services consumed in testing, and c) evaluation of quality of stocks.

2.4 Failure Costs, Internal — The costs arising within the organization of the failure to achieve quality specified.

NOTE — The term includes the cost of scrap, re-work and re-inspection and also consequent losses within the organization.

2.5 Failure Costs, External — The costs arising outside the organization of the failure to achieve the quality specified.

NOTE — The term includes the costs of claims against warranty such as, replacements and repair.

2.6 Quality Level — A general indication of the extent of departure from the ideal, usually a numerical value indicating either the degrees of conformity or the degree of non-conformity.

NOTE — Quality level is a tem used in a comparative sense. Where possible a more precise term should be used, for example, 'proportion effective', 'fraction effective', 'fraction defective', 'acceptable quality level', 'limiting quality level', and 'average outgoing quality limit'.

2.7 Economic Quality Level — A quality level at which the operating quality costs are minimum.

3. MODEL FOR OPERATING QUALITY COSTS

3.1 This standard is mainly concerned with the analysis and control of direct operating quality costs (and not indirect operating quality costs, *see* **3.3**). This consist of the following four main components:

a) Prevention costs,

b) Appraisal costs,

c) Costs of internal failures, and

d) Costs of external failures.

3.2 The operating quality costs of prevention and appraisal activities are considered to be a controllable quality costs whereas the internal and external failure costs are not directly controllable. It is easy to visualize that the quality level increases with the increase in prevention and appraisal costs. Again, as the prevention and appraisal costs increase, the internal and external failure costs decrease. The typical curves corresponding to prevention and appraisal costs and also internal and external failure costs, plotted against the quality level of the product are shown in Fig. 1. Combining these two curves the total direct operating quality costs curve is obtained. Theoretically, it can be presumed that the quality level corresponding to the minimum of total direct operating quality costs is the economic quality level.

3.2.1 It has been observed that the curve of the total direct operating quality costs tends to be rather flat near its minimum. In the case of a market which inclines towards consistently higher quality demands, it may be useful to go for little higher quality level, which means paying relatively more attention to prevention and appraisal efforts.

3.2.2 In practical situations, the price which one gets for product depends upon supply, demand and quality level. Therefore the optimisation of the quality costs is not the only criteria for deciding upon the quality level.

3.2.3 In the event of the quality level changing due to an essential change of the process (for example, the introduction of new machinery), the trend of operating quality costs must be determined again for this new situation.

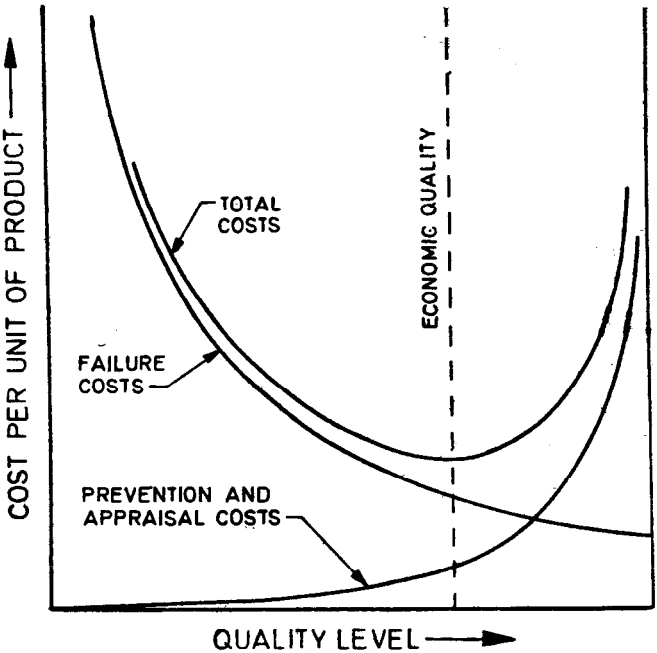

FIG. 1 DIRECT OPERATING QUALITY COSTS CURVES

3.3 In addition to the direct operating quality costs, the in direct quality costs and their effect on the total cost curve should also be considered. Although it is not the intention of this standard to try to quantify the indirect quality costs, the attention of the users of the standard is drawn to the indirect quality costs to highlight their importance. The important indirect quality costs may be the following:

a) Consumer incurred quality costs (including the cost to the consumer due to equipment down time, repair cost after the warranty period, transportation cost, etc), and

b) Consumer dissatisfaction quality costs.

3.3.1 Although it is difficult to measure these intangible indirect quality costs, they do affect the total cost curve. A typical indirect cost curve is given in Fig. 2. It is easy to visualize that the indirect cost curve is high for low quality level and drops off as the quality level increases. Taking the direct operating cost curve and indirect cost curve together, a total cost curve may be drawn as shown in Fig. 2. It may be noted that the economic quality level for the total cost curve has moved to the

right than that obtained by the direct operating cost curve, thereby indicating that there is a need for a higher quality level. A higher quality level can be obtained by increasing the prevention and appraisal costs which subsequently reduce the internal and external failure costs.

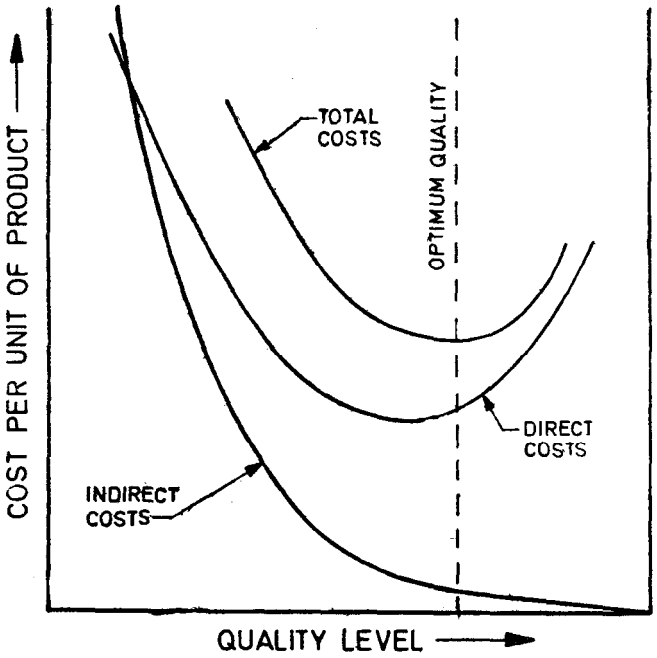

FIG. 2 DIRECT AND INDIRECT QUALITY COSTS CURVES

4. COMPONENTS OF OPERATING QUALITY COSTS

4.1 Since the working and set up of different organizations vary enormously, it is not possible to give an exhaustive and foolproof check list of the various components which contribute to the operating quality costs. It is essential that the classification of cost data should be relevant and consistent with other accounting practices within the organization so that comparisons may be made between costing periods of related activities.

4.2 For control purposes, it is necessary to allocate quality costs to the accountable area. The use of account codes within cost centres is the convenient method. The allocation of cost is important for the analysis and prevention of failure. There is likely to be a need for arbitration when accountability is disputed. The decision for allocation of cost

should not be made solely by the accountant. Arbitration may need to be carried out by an independent technical authority such as technical director or engineering manager. In some cases, it may be necessary to refer the allocation to an appropriate arbitration committee.

4.3 Prevention Costs

4.3.1 *Quality Engineering* — This is usually reported in two parts: Quality control/engineering and process control/engineering.

4.3.1.1 *Quality control/engineering* — Represents those costs associated with planning the quality system and translating product design and customer quality requirements into manufacturing quality controls on quality of materials, process and products. The areas and titles of personnel performing this type of work may include the following:

a) Quality control engineers,

b) Quality control systems engineers (includes procedures, standards and manual writers),

c) Quality planning engineers,

d) Assembly inspection and test planning personnel,

e) Final inspection and test planning personnel,

f) Special process engineers,

g) Reliability engineers,

h) Engineering statisticians, and

j) Formal design review and reliability committee activities.

4.3.1.2 *Process control/engineering* — Represents those costs associated with implementing and maintaining quality plans and procedures. The areas and titles of personnel performing this type of work may include the following:

a) Process control engineers,

b) Process control testing engineers,

c) Reliability testing engineers,

d) Defect analysis engineers, and

c) Process or capability study engineers.

4.3.2 *Design and Development of Quality Measurement and Control Equipment* — The areas and titles of personnel performing this type of work may include the following:

a) Test equipment engineers,

b) Test equipment planners and designers,

c) Inspection equipment engineers, and

d) Gauge engineers and designers.

4.3.3 *Quality Planning by Functions Other than Quality Assurance* — This represents the costs of quality planning incurred by personnel who do not report to a quality function. The personnel outside the quality assurance function who may perform prevention functions include the following:

a) Laboratory engineers who plan the testing of incoming, inprocess and final products;

b) Manufacturing engineerings who plan inspection and/or test equipment;

c) Manufacturing or industrial engineers who develop inspection and test procedures for quality measurements as required by the quality plan;

d) Engineering personnel who plan and direct initial product qualification;

e) Sales personnel who develop visual quality standards; and

f) Engineering personnel who develop acceptance standards.

4.3.4 *Calibration and Maintenance of Production Equipment Used to Evaluate Quality* — This includes the costs of calibration and maintenance of templates, jigs, fixtures and similar items.

4.3.5 *Maintenance and Calibration of Test and Inspection Equipment Used in Control of Quality*

4.3.6 *Supplier Assurance* — This represents the costs of personnel engaged in the preventive activities of a supplier quality assurance programme. These activities include the following:

a) Evaluation:

1) supplier surveys, audits and ratings;
2) identifying new sources of supply;
3) design evaluation and testing of alternative products; and
4) purchase order review before placement.

b) Planning:

1) determining and documenting methods of supplier control;
2) planning incoming inspection and test requirements; and
3) carrying out supplier process capability exercises.

4.3.7 *Quality Training* — This represents the costs of developing, implementing, operating and maintaining formal quality training programmes.

4.3.8 *Administration, Audit and Improvement*

4.3.8.1 Administration represents all other expenses associated with planning, implementing and maintaining a quality system not specifically included elsewhere, such as secretaries, telephone, rent and travelling.

4.3.8.2 Audit represents the costs of personnel engaged in planning documenting, implementing and maintaining audits on the quality system.

4.3.8.3 Improvement represents the costs of formal quality improvement programmes and motivational activities.

4.4 Appraisal Costs

4.4.1 *Laboratory Acceptance Testing* — This represents the costs related to tests to evaluate the quality of purchased materials (raw, semi-finished or finished) which become part of the final product or that are consumed during production operations.

4.4.2 *Inspection and Test* — This represents the payroll cost of inspection and test personnel, including supervision and clerical support (including receiving inspection). The costs associated with inspectors or testers visiting or stationed at vendor operations to perform or witness evaluations should be included.

4.4.3 *In-process Inspection* — This represents the costs of personnel (not inspectors by job classification) engaged in the in-process evaluation of product conformance to quality requirements.

4.4.4 *Set-Up for Inspection and Test* — This includes the payroll cost of setting up equipment or products for inspection or functional testing.

4.4.5 *Inspection and Test Materials* — This includes the costs of materials consumed or destroyed in control of quality.

4.4.6 *Product Quality Audits* — Payroll costs of performing quality audits on in-process or finished products.

4.4.7 *Review of Test and Inspection Data* — The costs incurred for regularly reviewing inspection and test data before release of the product for shipment, for example, to determine whether product quality requirements have been met.

4.4.8 *Field (on-Site) Performance Testing* — Costs incurred in testing for product acceptance on site.

4.4.9 *Internal Testing and Release* — The costs of setting-up and testing in-house of the complete product for customer acceptance.

4.4.10 *Evaluation of Site Material (Field Stock) and Spare Parts* — The costs of evaluation, testing or inspection of site material, resulting from engineering charges, storage time (excessive self life) or other suspected problems.

4.4.11 *Data Processing Inspection and Test Reports* — The costs incurred in accumulating and processing test and inspection data used in evaluation work.

4.5 Internal Failure Costs

4.5.1 *Scrap* — All scrap losses incurred in the course of meeting quality requirements.

4.5.2 *Rework and Repair* — The costs incurred in meeting quality requirements where material can be restored for use.

4.5.3 *Troubleshooting or Defect/Failure Analysis* — The cost incurred in analysing non-conforming materials, components or products to determine causes.

4.5.4 *Reinspect, Retest* — The costs of reinspection or retesting material that has failed previously.

4.5.5 *Scrap and Rework; Fault of Supplier; Downtime* — The losses incurred due to failure of purchased material to meet quality requirements, and payroll costs incurred.

4.5.6 *Modifications Permits and Concessions* — The costs of the time spent in reviewing products, designs and specifications.

4.5.7 *Downgrading* — The losses due to non-conformance for quality reasons, resulting in a reduced selling price.

4.6 External Failure Costs

4.6.1 *Complaints Administration* — The payroll costs of administrating complaints.

4.6.2 *Product or Customer Service; Product Liability* — The costs of product services directly attributable to correcting imperfections, including any product liability costs.

4.6.3 *Products Rejected and Returned; Recall; Retrofit* — The costs of handling and accounting for rejected products, including any recall and retrofit costs.

4.6.4 *Returned Material Repair* — The costs associated with analysing and repairing customer returned material.

4.6.5 *Warranty Replacement* — The costs of replacing failures within the warranty period.

4.6.5.1 *Marketing errors* — The costs of replacing products due to marketing error, that is, wrong interpretation of customer specifications requirements.

4.6.5.2 *Design/specification errors* — The costs of replacing products due to supplier's design and/or engineering specification errors or inadequacies.

4.6.5.3 *Factory or installation errors* — The costs of replacing products due to production or installation errors.

5. COSTS DATA

5.1 Collection of Costs Data — When the list of costs elements has been identified (*see* **4.3** to **4.5**), the collection of costs data can begin. More analysis may be needed in an organization that does not already have a departmental costing system than in one that has. The guidance that follows, however, gives all organizations enough information to see what depth of analysis will be needed.

5.1.1 The steps given in **5.1.1.1** to **5.1.1.5** refer to a 'quality' function as being an existing budget centre. The analysis may require all or most of these five steps to identify the quality costs.

5.1.1.1 Calculate those costs that are directly attributable to the 'quality' function. These will normally include:

a) payroll costs of people specifically controlled by the quality function or department, and will include wages, salaries and pension costs;

b) a proportion of building occupation costs related to the persons mentioned in (a) above, for example, rents rates, insurance, heating lighting and security;

c) a proportion of canteen costs, office services and other administration costs;

d) the costs of depreciation of specialized quality control and assessment equipment; and

e) the costs of smaller items that the organization does not capitalize.

5.1.1.2 Identify costs that are not directly the responsibility of the 'quality' function but which should be counted as part of the total quality costs of the organization. These costs will usually be incurred by other departments and organizations. It is not necessary to make a formal accounting transfer to the 'quality' function costs centre, but they should be included in memorendum account. A number of departments may incur these costs, for example, purchasing, stores planning. Costs in this category should be apportioned to quality on an equitable basis.

The costs identified in **5.1.1.1** and **5.1.1.2** will be mainly concerned with prevention and appraisal, and those in **5.1.1.3** to **5.1.1.5** deal with failure costs.

5.1.1.3 Identify and enter in the memorandum account the internal costs of 'budgeted failures'. For example it may be normal practice to make a product in batches of 100. To be certain of completing 100 it may be a matter of routine to plan 110 starts. Only experience will eventually tell whether it is worth calculating the cost of the additional 10, but the costs should be calculated, at least for a trial period.

5.1.1.4 Identify the internal costs of unplanned failures, where failures are not allowed for in the initial production planning. (It is common to find the costs of failures in the accounts of manufacturing overheads). Related costs may include materials that have been scrapped or the cost of reworking to put the defective item right, or even of completely remaking. The costs will usually lie either in the accounts of the department causing the failure or in the department doing the rectification. Wherever they lie the costs should be noted in the memorandum account.

5.1.1.5 Identify the cost of failures after change of ownership. Costs will include the time spent by the quality department in investigations and of other department, such as, marketing, customer servicing, and accounts. These costs will rarely be identified at all in existing systems. An initial estimate should be made and the results entered in the memorandum account. Where the customer is eventually charged for the investigation and any costs of rectification, the income should be noted in the memorandum.

5.2 Cost Data Sources — It is advisable to confer with the management accountants to review the list of elements and data sources. It will be found that a good percentage of the desired information is available in one form or another, though this might not appear to be the case at first.

5.2.1 Although there are no established rules for searching out data, the following are recommended as valuable source documents:

a) Payroll analysis;

b) Manufacturing expense reports;

c) Scrap reports;

d) Rework or rectification authorizations/reports;

e) Travel expense claims;

f) Product cost information;

g) Field repair, replacement and warranty costs reports;

h) Inspection and test records; and

j) Material review records.

5.2.2 Data extracted from source documents should be transposed by appropriate collection work sheets and coded for easy tabulation. The aim is to have all cost data reported by code. The use of coding permits consistency of collection regardless of the source or size of the costs.

Each department should report its costs. Data from all sources should then be accumulated by code.

5.2.3 Where actual costs cannot be directly associated with specific elements, it may be necessary to make an expense allocation by arbitration. If these costs are significant, it is recommended that the necessary records be established in order to record the data factually.

5.3 Data Tabulation — After all costs have been collected, they should be tabulated to give a breakdown of costs by element code. An example of a proforma for quality costs period reporting and breakdown of costs elements, period and category is shown in Appendix A.

6. MEASUREMENT BASE FOR QUALITY COSTS

6.1 Operating quality costs by themselves present insufficient information for analysis. A measurement base is required which will relate operating quality costs to some aspect of the business which is sensitive to change. Some typical measurement bases are given below. An organization may not have all the measurement bases. The choice of a base depends upon the activity of an organization.

6.2 Labour Base — Internal failure costs related to total labour or direct labour costs, that is,

$$\frac{\text{Internal failure costs}}{\text{Total (or direct) labour costs}}$$

6.3 Costs Base — Total failure costs related to manufacturing costs or total material and labour costs, that is,

$$\frac{\text{Total failure costs}}{\text{Manufacturing costs}}$$

6.4 Sales Base — Total quality costs related to nett sales billed or value of finished goods transferred to inventory, that is,

$$\frac{\text{Total quality costs}}{\text{Nett sales}}$$

6.5 Unit Base — Test and inspection costs related to the number of units produced, that is,

$$\frac{\text{Test and inspection costs}}{\text{Units of production}}$$

6.6 Value Added Base — Total quality costs related to a measure of manufacturing activity unaffected by fluctuations in sales price, that is,

$$\frac{\text{Total quality costs}}{\text{Value added}}$$

6.7 As a matter of caution, measurement bases are only as good as the methods for keeping them consistent. Consideration should be given and adjustments made when bases are affected by:

a) direct labour replaced by automation;

b) manufacturing cost changes due to the use of alternative materials, methods or processes;

c) changes in gross margins, selling prices, distribution costs and market demand;

d) changes in product mix; and

e) time scale of numerator that differs from time scale of denomenator.

6.7.1 The above factors should be considered and understood when comparing quality costs with a measurement base.

7. OPTIMIZING QUALITY COSTS

7.1 It may be of interest to an organization to optimize the operating quality costs. Although the models described in **3** indicate the optimum level, it is not very easy to arrive at this in practice.

7.2 One of the technique to determine the optimum quality costs is to compare it with other similar organizations. This pre-supposes that quality costs are being maintained and analysed by other similar organizations. Another technique to determine the optimum level is to analyze the inter-relationship among the various cost components. Theoretically, the prevention and appraisal costs should be equal to or greater than the failure costs. If reverse is the case in any practical situation, it indicates the need to give greater emphasis on prevention and appraisal costs so as to approach the optimum quality level. The optimum level of operating quality costs could also be arrived by optimizing the different components. Failure costs and appraisal costs are optimized when there are no indentifiable sources or profitable projects to reduce them.

7.3 One of the most effective cost analysis tools is the use of pareto analysis. After identifying the cost component which is significant (for example, the cost of failures), it is further broken down into different elements either by cause-wise or by the departments to which the cost can be allotted. These are then arranged in descening order of magnitude. The first few elements which contribute the main portion of the cost are referred as vital few and the remaining as trivial many. Once the vital few are known, the projects can be developed to reduce the cost contributed by them. In other words, money is spent to control the vital few whereas little or no money is spent to control the trivial many.

8. PERIODIC REVIEW OF QUALITY COSTS

8.1 The quality costs shall be evaluated and analyzed periodically. A periodic study of quality costs have the following advantages:

a) to inform the management of the amount of money involved, and to reduce arguments for making efforts for improvements, in other words, to invest money in prevention;

b) to isolate the most promising direct action points and to formulate plans for the successive elimination of excessive costs;

c) to measure the effectiveness of the efforts; and

d) to seek the optimum balance among prevention, appraisal and failure costs.

8.2 The management will be stimulated by all this to consider and to take following steps:

a) the task of top management with respect to quality control;

b) the formulation of an optimal quality policy;

c) the review of the functional organization;

d) the involvement of all levels of the company (vertically) and all sectors (horizontally);

e) coordination;

f) education and training; and

g) the quality of design, quality specifications, etc.

APPENDIX A

(*Clause* 5.3)

EXAMPLE OF PERIODIC QUALITY COST REPORTING

(Rupees in 000's)

Organization .....

Period 4th Quarter
(1 September-31 December 1985)

Costs for 4th Quarter				Costs for Year 1985		
Budget	Actual	Difference (Actual-Budget)		Budget	Actual	Difference (Actual-Budget)
			Prevention Costs			
			(a) Quality engineering:			
50	60	10	(i) Quality control/engineering	190	202	12
40	43	3	(ii) Process control/engineering	150	146	— 4
70	73	3	(b) Design and development of quality measurement and control equipment	250	248	— 2
50	53	3	(c) Quality planning by other functions	180	180	0
20	16	— 4	(d) Calibration and maintenance of production equipment used to evaluate quality	65	56	— 9
25	23	— 2	(e) Maintenance and calibration of test and inspection equipment	85	79	— 6
20	27	7	(f) Supplier assurance	80	90	10
15	20	5	(g) Quality training	60	68	8
10	17	7	(h) Administration, audit and improvement	40	56	16
300	332	32	Total prevention costs	1 100	1 125	25
5·0	5·2	0·2	Percent of total quality costs	4·9	4·8	— 0·1

(*Continued*)

Costs for 4th Quarter				Costs for Year 1985		
Budget	Actual	Difference (Actual-Budget)		Budget	Actual	Difference (Actual-Budget)
			Appraisal Costs			
250	242	— 8	(a) Laboratory acceptance testing	950	949	— 1
200	199	— 1	(b) Inspection and test (including 'Goods inward')	750	781	31
175	185	10	(c) In-process inspection	700	726	26
75	85	10	(d) Set-up for inspection and test	300	335	35
225	228	3	(e) Inspection and test material	875	893	18
175	171	— 4	(f) Product quality audits	650	670	20
50	43	— 7	(g) Review of test and inspection data	190	167	— 23
120	114	— 6	(h) Field (on-site) performance testing	450	446	— 4
75	71	— 4	(j) Internal testing and release	300	279	— 21
60	57	— 3	(k) Evaluation of field stock and spare parts	225	223	— 2
35	28	— 7	(m) Data processing inspection and test reports	110	112	2
1 440	1 423	— 17	Total appraisal costs	5 500	5 581	81
24·0	22·3	— 1·7	Percent of total quality costs	24·4	24·1	— 0·3

			Internal Failure Costs			
425	430	5	(a) Scrap	1 600	1 654	54
900	893	— 7	(b) Rework and repair	3 500	3 535	35
200	198	— 2	(c) Troubleshooting or defect/failure analysis	700	763	63
625	628	3	(d) Re-inspect, retest	2 400	2 418	18
600	595	— 5	(e) Scrap and rework; fault of vendor; downtime	2 300	2 390	90
300	297	— 3	(f) Modification permits and concessions	1 100	1 145	45
250	264	14	(g) Downgrading	900	1 019	119
3 300	3 305	5	Total internal failure costs	12 500	12 924	424
55·0	51·7	— 3·3	Percent of total quality costs	55·6	55.7	0·1
			External Failure Costs			
50	80	30	(a) Complaints	200	212	12
150	226	76	(b) Product or customer service; product liability	600	601	1
175	255	80	(c) Products rejected and returned; recall; retrofit	675	692	17
275	413	138	(d) Returned material repair	925	996	71
50	77	27	(e) Marketing errors	200	216	16
75	106	31	(f) Design and specification errors	300	318	18
125	172	47	(g) Factory or installation errors	500	531	31
900	1329	429	Total external failure costs	3 400	3 566	166
15·0	20·8	5·8	Percent of total quality costs	15·1	15·4	0.3
6 000	6 392	392	Total quality costs	22 500	23 196	696

(*Continued from page* 2)

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