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Customer Feedback System for Continual Quality Improvement–A Case Study from *Lakshya* Experiences

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ABSTRACT

Customer's satisfaction is the measure of quality of a product or a service. Customers' feedback are important sources of product information on performance, improvements, and enhancement of ideas. The implementation of customer feedback system is essential to enhance the customers' satisfaction through continual improvement, which is essential for the survival of any organisation in a competitive environment. This study provides a structured approach to analyse and translate the customers' feedback into quality improvement of the product.

The defects reported by the customers' on the unmanned aerial vehicle *Lakshya* systems were investigated while carrying out their rectification. Prompt remedial measures were also instituted to prevent their recurrence. This has resulted in the improvement of reliability and quality of the product. Finally, the implementation of customer feedback system and formalisation of defect investigation procedure for improving the quality and reliability of *Lakshya* systems has been described. A case study on Barco monitors (RGD 651) has also been demonstrated from *Lakshya* experience.

Keywords: Customers' feedback, defect investigation, quality improvement, case study, quality, reliability, *Lakshya*, unmanned aerial vehicle

1. INTRODUCTION

Aeronautical Development Establishment (ADE), Bangalore, is committed to design, develop, and deliver world class products to the satisfaction of its customers, in the area of aeronautical systems. It is, therefore, essential to understand the customers' current and future needs, so as to meet their requirements and expectations.

The customers' feedback assume utmost importance for continual quality improvement of any product. ADE has, therefore, evolved a customer feedback system and has implemented the same to obtain views of all the customers on all aspects of the product.

The customers' feedback giving information about performance of a product and defects reported by the customers on any defective item, if analysed properly, will indicate the areas where improvements are possible. After the analysis of customers' response, corrective action can be taken for the improvement of quality of the product.

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2. CUSTOMER FEEDBACK PROCESS

The customers' feedback process being adopted at the ADE, Bangalore to evaluate the customers' perceptions, requirements, and the defects encountered on the products designed/developed for *Lakshya* (LSP) programme is shown in Fig. 1. ADE is using the data received through these techniques/direct and indirect feedback from the customers as the input to a structured process approach to achieve the output in the direction of overall customers' satisfaction. The output of this process, such as improvement in design of components, manufacturing process, maintenance support process, management review process, customers' support trainings, and standardisation and automation of the test procedures, is shown in Fig. 2. The structured process approach has resulted in value addition and design improvements to a number of LRUs/subsystems/test equipment.

2.1 Customers' Feedback & Data Collection

There are many ways for an organisation to monitor its customers' perceptions and requirements which would change with time. Some examples of techniques used by the organisations are:

2.1.1 *Direct Feedback*

- Customers' feedback on specific feedback proformas
- Face-to-face evaluations, which may be appropriate in many service organisations.
- Telephone calls or visits made periodically or after delivery of products and services
- Questionnaires or surveys carried out by the organisation itself, or by independent market researchers.
- Other contacts with customers, eg, by service or installation personnel.

2.1.2 *Indirect Feedback*

- Internal enquiries among the organisation's personnel who are in contact with the customers
- Evaluation of repeat orders

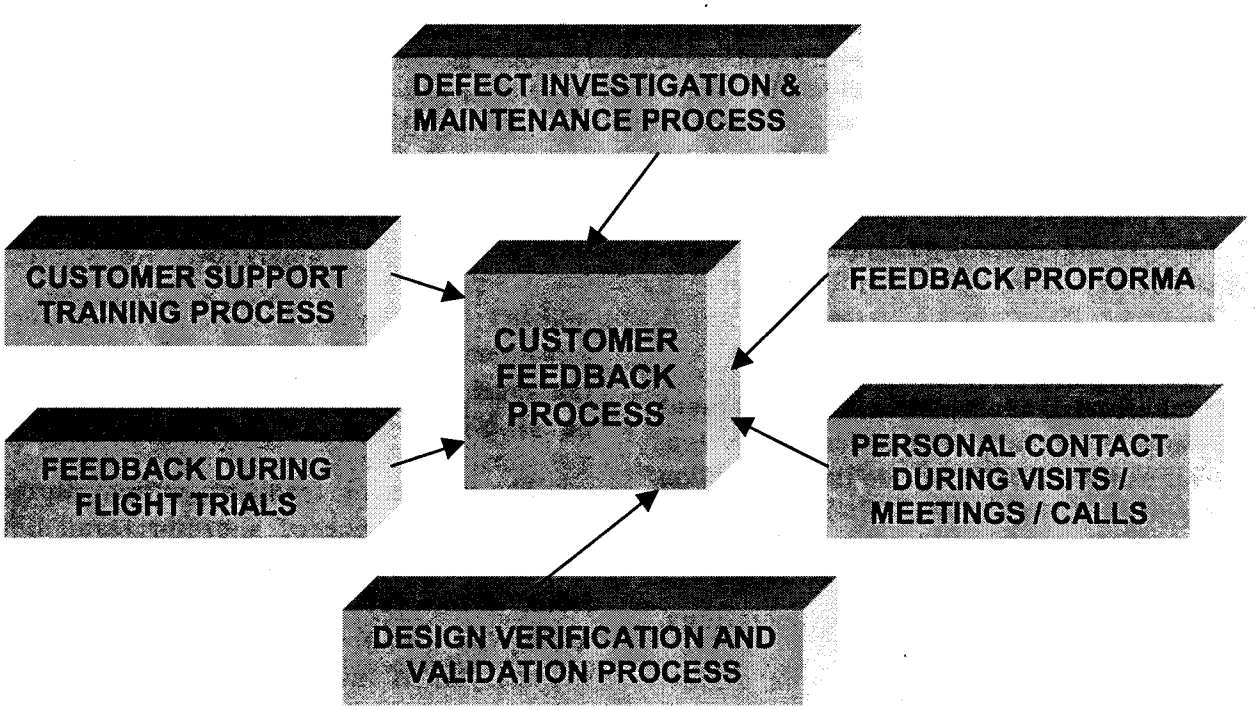

Figure 1. Input to customer feedback process for *Lakshya* (LSP)

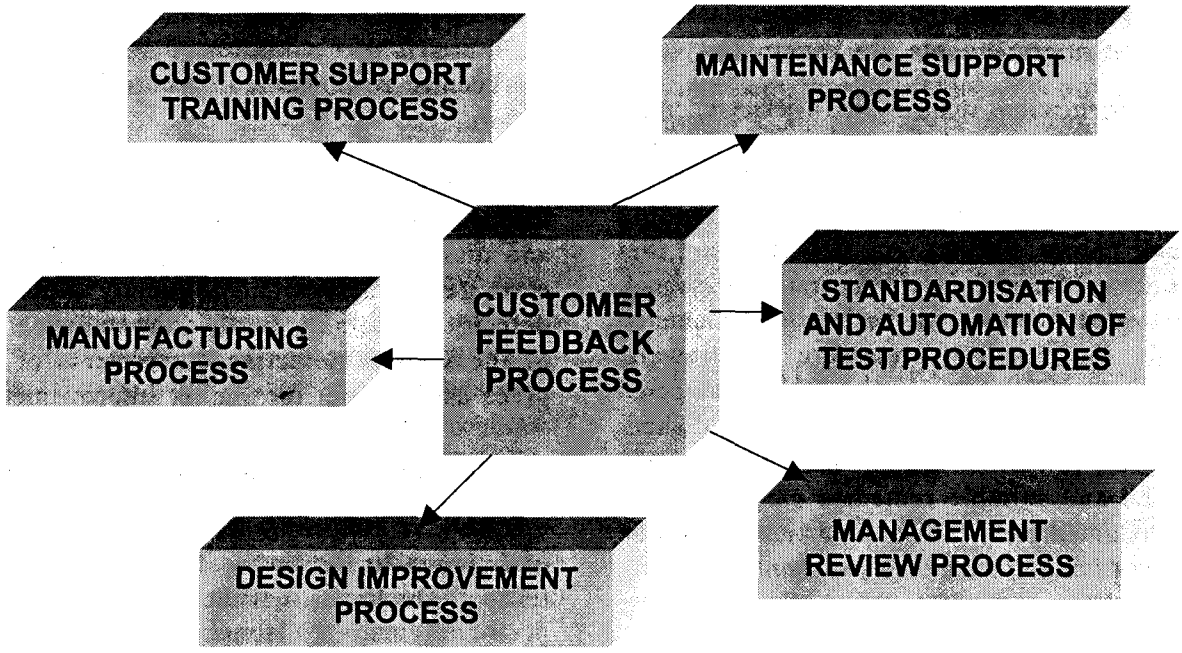

Figure 2. Output from the customer feedback process

- Monitoring accounts receivable, warranty claims, etc
- Analysis of customers' complaints
- Analysis of defects reported on each component by customers and respective defect investigation.

The following techniques for the evaluation of customers' perceptions, requirements, and the defects encountered on *Lakshya*, unmanned aerial vehicle (UAV), designed/developed by the ADE, are described.

2.2 Feedback Process

The customer feedback process is an essential part of the quality management system. Feedback from the customers are one of the primary performance indices that can be used to judge the overall effectiveness of the product. The customers' feedback are the sources to identify the critical area where quality improvement is essential. Customers' feedback on a structured questionnaire are the most convenient way to obtain the customers' comments/feedback on essential aspects of any product.

ADE has implemented a customer feedback system for the limited series production (LSP) supplies of *Lakshya* (UAV) to the Services, in which the feedback of customers on certain technical aspects of the product, managerial, and maintenance-related issues of the project, including specific areas needing immediate attention, and suggestions for improvement, are being obtained on customers' feedback proforma as per quality system procedure manual. (*Appendix* 1)

3. DEFECT REPORTING & INVESTIGATION

To improve the reliability of any product, it is necessary that the defects reported by the customers should be immediately investigated and prompt remedial measures be instituted to prevent their recurrence. A proper and systematic defect investigation into the various aspects will bring out the cause/causes of failure along with suitable recommendations to obviate the same in future. The defect/premature withdrawals of the equipment/ system could occur due to certain overlooks at the time of design, manufacture, acceptance, training, maintenance, and operation at the extremities, both within and outside the design parameters.

The investigation of such defects indicates the areas where improvements are required.

ADE has, therefore, implemented a defect reporting and investigation procedure for *Lakshya*[2]. As per this, the defects are classified as serious defects, recurring defects, or known defects, depending upon their nature. Further, any defect/failure that affects safety of the equipment or operating personnel, are to be treated as serious. All the defects, encountered repeatedly, that result in premature withdrawals, though not of serious nature, are also to be subjected to investigation until the causes are established. The defects, for which cause has already been established and suitable remedies exist, must be removed immediately. The statistics about the incidence of failures need to be maintained correctly and updated for analysis and to order for further investigation.

If it is not feasible to rectify the defect, the customer should submit an incidence report or a defect report under headings of serious/recurring or known defects. The defect report should indicate nomenclature of equipment with part number and serial number, particulars of defect (symptoms of failure), date of defect occurrence, circumstances in which defect occurred or was discovered, effect of failure, and comments and recommendations. As per the procedure, the defective part / assembly should be removed, identified, preserved suitably wherever required, packed and transported to the ADE for the items supplied under *Lakshya* limited series production programme and to HAL (a/c Division) for *Lakshya* supplied as a part of series production, for the defect investigation. The history card or log card of the product/component is also to be maintained and sent along with the defective item/assembly for systematic defect investigation.

The defects reported by the customers are to be registered and the defective items are to be passed to the concerned workcentre for defect investigation and remedial measures along with a copy of defect report from the customer in the prescribed format[2]. After completion of the defect investigation, the workcentre prepares a defect investigation report (DIR). The remedial measures, as recommended by the defect investigation officer/ team to prevent the recurrence of similar defects in future, is then coordinated with the concerned workcentre responsible for corrective/preventive action.

Involvement of all the concerned parties and individuals in prompt reporting, dispatching, investigation and dissemination of results, goes a long way in cutting down delays, and ultimately eliminating the defects considerably. Further, the statistical analysis of the various defective components or systems gives useful input for quality improvement.

4. FEEDBACK DURING FLIGHT TRIALS

ADE is providing support for the flight trials of *Lakshya* to the three Services. For supporting these flight trials, a team (consisting of 5 to 10 personnel) visits the launch site. The team monitors all the launch support activities, including integration of aircraft and pre-flight checks.

During the preparation for flight and integration checks, the team interacts with the personnel involved and obtains the feedback from the user on various aspects of the systems related to performance, reliability, maintainability, and safety. The team is also vigilant to notice the possibility of any improvement. After completion of trials, team leader prepares a brief report about the launch support activity, observation on problems faced, requirement of design improvement on particular component/system, and specific requirements of the customer.

The problems faced during prelaunch activities are also being observed and the action taken to overcome the problems encountered. Steps for the reduction of the preflight checks, standarisation of the test method, and automation of the tests, have also been taken up by the ADE. Further, development of digital version of *Lakshya* is under progress for better performance, including increased endurance, based on the feedback from the customers.

5. PERSONAL CONTACT DURING VISITS/ MEETINGS

Visits are also made periodically from both the sides for review of requirements and discussion on

the technical issues. These have proved to be very useful for quality improvement of products and the services.

6. ANALYSIS OF CUSTOMERS' FEEDBACK DATA & CORRECTIVE ACTION

ADE has been using the results of the customers' feedback process to trigger corrective and/or preventive actions, and the customers' feedback act as one of the measurement technique for the quality performance. The output from the customers' feedback forms an important input for data analysis, management review, and continual improvement processes. The data received through customers' feedback and other sources, as described above, are very useful for the quality improvement of product and identifying the areas of immediate concern as well as futuristic plans for the product improvement.

After the delivery of four *Lakshya* UAVs to the Indian Air Force and two *Lakshya* UAVs to the Indian Navy from September 1999 to May 2002, 71 defects were reported on various components/ subsystems / LRUs of *Lakshya* by the Indian Air Force and the Indian Navy. The details are given in the pie chart (Fig. 3). These were investigated and analysed at the ADE. Subsequently, cause(s) and remedial measures for each occurrence of the defect were established. These defects were further segregated as related to design, fabrication, operations, storage, maintenance, handling, and process-related. The details are given in the pie chart (Fig. 4). Based on this analysis, corrective actions for design improvement, workmanship, selection of material/ components, and adequacy of testing, or as applicable, were taken up and these failures were eliminated considerably. The root cause of failures in Barco monitors was not established at that time and the study was undertaken in 2004, which is demonstrated as a case study below:

7. CASE STUDY ON BARCO MONITORS

Barco Monitor (RGD 651) for Ground Control Station of *Lakshya*

ADE had supplied Barco monitors (RGD 651) to the Services as part of ground control station. During the course of flight trials, it was observed that the failures in the Barco monitors (RGD 651) were quite frequent. This was a serious concern to ADE as the operational capability of the Services was restricted because of the failures. ADE had therefore taken the initiative for suitable investigation and corrective action of this defect.

Investigation

The investigation included the analysis of customers' feedback where seven failures were reported by the three Services on nine numbers of Barco monitors during 2001 to 2004. The defects reported by the customers were investigated.

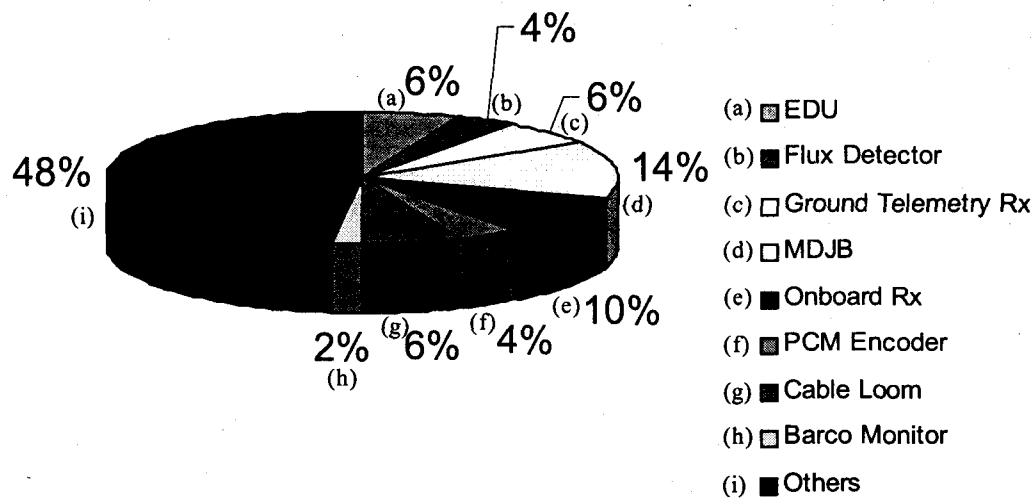

Figure 3. Failures on *Lakshya* LRUs (after delivery)

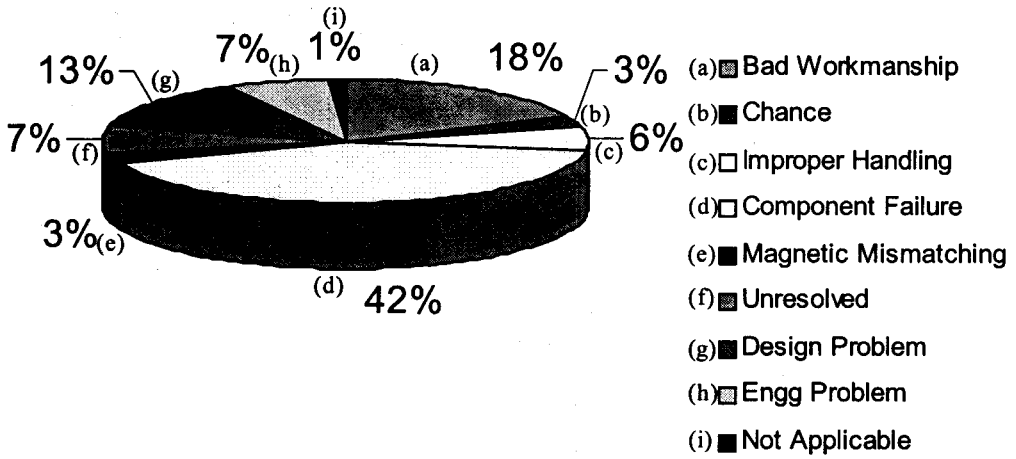

Figure 4. Causes of failures on *Lakshya* LRUs

The details of failures in these monitors are given in Table 1.

It was observed from the data received in the feedback from the customers that the EHT module failed four times, power supply module failed twice, and one failure was due to loose contact at an RF input point. After analysis, it was felt that the cause of the six failures was due to higher humidity at the trial site and one failure was due to the bad workmanship. The causes of failures in Barco monitor are shown in the pie chart (Fig. 5). EHT module requires 25 kV power supply, which is very sensitive to high humidity. It can work satisfactorily up to 95 per cent relative humidity for this model, but once humidity level increases beyond 95 per cent, it burns due to short circuit.

Corrective Action

The corrective actions taken by the ADE at the time of occurrences of these defects are depicted in Table 1.

Preventive Action

The supplier was suggested to carry out encapsulation of EHT module, power supply module, and other parts with a protective layer as the RH levels at the operational site were exceeding 95 per cent. Subsequently, all the modules of Barco monitor (RGD 651) were humiseal coated with a double layer silicon-based coating to overcome the component failure and the EHT module was replaced by upgraded/humiseal encapsulated EHT module to minimise the failure of these monitors.

Table 1. Defects reported and the corrective actions taken for the Barco monitors

Sl. No. of Monitor	Part No.	Defect reported	Corrective action taken
5118180	V 9517754	Loose contact at RF input point	Coaxial pin cable pin refitted
5118179	V 9517754	No display on screen	EHT module was replaced
5118180	V 9517754	- do -	-do-
5118183	V 9517754	- do -	-do-
5118182	V 9517754	Display flickering	Power supply module was replaced
5199251	V 9519872	No display on screen	EHT module was replaced
5199250	V 9519872	- do -	Power supply module was replaced

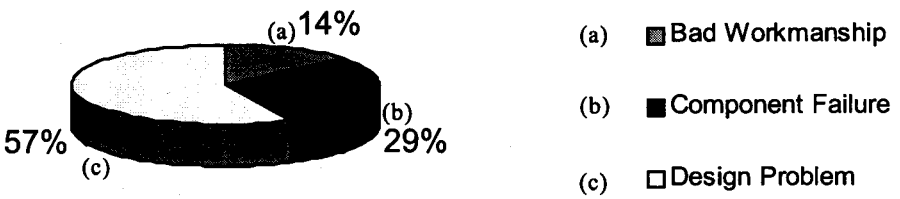

Figure 5. Causes of failure on Barco monitors (no. of failures: 7)

To avoid these failures completely in the future, ADE stopped procurement of RGD 651 display monitors for *Lakshya* ground control station, and currently, rugged flat displays (RFD 251) are being used for extreme environment.

8. CONCLUSION

It can be concluded that the implementation of the customer feedback system is essential when an organisation needs to demonstrate its ability to consistently provide products that meet both the customers' and applicable regulatory requirements, and aims to enhance customers' satisfaction through the effective application of the customers' feedback system, including processes for continual improvement of the system, and the assurance of conformity to the customers and applicable regulatory requirements.

The defects reported by the customers should be properly analysed to overcome the problems and to achieve the quality improvement of the product. Such analyses are essential to improve the quality of the subsystems/LRUs/equipment to achieve customers' satisfaction and overall effectiveness of the product.

It can be inferred from this case study that each subsystem / LRU /equipment should be designed and tested for extreme environmental conditions to which it is to be exposed before introducing a system or a product to the Services.

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Contributor

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Appendix 1

QMC	AERONAUTICAL DEVELOPMENT ESTABLISHEMENT, BANGALORE – 560 075			QSP
	CUSTOMER FEEDBACK	FORM NO	QSP 15: FM01	
		REV. NO.	0	
		PAGE NO.	Page 1 of 3	

1. Name of the customer:
2. Product to which feedback relates:
3. Customer requirements (Project Name / Project No. / Reference):
4. Feedback:

   (a) First grade the aspect for importance. An aspect most important to you gets 10 and vice-versa. Then grade each aspect for the degree of satisfaction experienced with that aspect on a scale of 1 to 10. [10 implies high satisfaction and vice-versa]

   (b) Kindly provide detailed feedback for each aspect to enable ADE to analyse the problem faced by you to be able to improve its product(s).

   (c) Kindly restrict your feedback to aspects as applicable to your product.

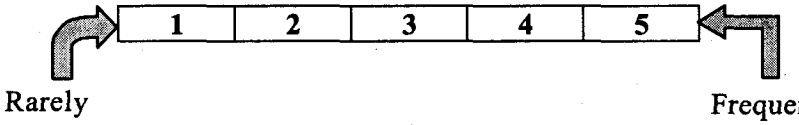
Sr No	Aspect	Importance [1 to 10]	Satisfaction [1 to 10]	Detailed feedback [Attach separate sheet if required] (b)	Shortcoming can be attributed to [to be filled by ADE]
1.	Compliance of technical requirements stated by customer				
2.	Compliance of other requirements (including future requirements of customer & requirements of the organisation)				
3.	Response to customer complaints / customer feedback				
4.	Adequacy of documents supplied to user				
5.	Ease of operation by user				
6.	Ease of maintenance				
7.	Mobility				
8.	Fitness for specified environmental conditions				
9.	Fitness for specified terrain				
10.	Effectiveness of training imparted				
11.	On time completion and delivery				
12.	Eligibility for repeat orders				

QMC	AERONAUTICAL DEVELOPMENT ESTABLISHEMENT, BANGALORE – 560 075			QSP
	CUSTOMER FEEDBACK	FORM NO	QSP 15: FM01	
		REV. NO.	0	
		PAGE NO.	Page 2 of 3	

Sr No	Aspect	Importance [1 to 10]	Satisfaction [1 to 10]	Detailed feedback [attach separate sheet if required] (b)	Shortcoming can be attributed to [to be filled by ADE]
13.	Reliability of product				
14.	Price and life cycle cost				
15.	Built-in safety aspects				
16.	Quality of equipment/test equipment				
17.	Adequacy of self-test features				
18.	Adequacy of spares				
19.	Quality of packing				
20.	Courtesy of contact persons				
21.	Competence of ADE personnel [identify areas needing improvement]				
22.	Completeness of supply				
23.	State-of-the-art technology–as seen by customer				
24.	Professional ethics and credibility – customer's view				
25.	Quality of customer support				

5. State any statutory / regulatory requirement not met.

6. How often is the item being used:



If rating is 2 or 1, state reasons for the same and suggestions for improving the product/alternate application.

QMC	AERONAUTICAL DEVELOPMENT ESTABLISHEMENT, BANGALORE – 560 075			QSP
	CUSTOMER FEEDBACK	FORM NO	QSP 15: FM01	
		REV. NO.	0	
		PAGE NO.	Page 3 of 3	

7. Specific aspect needing immediate attention (Please give details):

8. Your suggestions for product improvement:

Date :

Place:

Signature :

Name :

Designation: