CHAPTER 9
MAINTENANCE QUALITY AUDITING

9.0. INTRODUCTION

During the recent years, many innovative manufacturing philosophies including TQM are reported to have experienced failures (Garwin, 1995). A perusal on literature (Murugesh et al., 1997) indicates that the absence of models that are compatible to the current needs is found to be a major cause of such failures. Hence, installing a maintenance quality system, which will have no impact or significance in the current manufacturing trend, would lead to failures. At this juncture, we were tempted to develop the maintenance quality system based on an ISO 9000 series quality system model. However, subsequent study on the recent trends indicated that, currently, the manufacturers are of the opinion that the ISO 9000 series models are lenient towards attaining quality. As a matter of fact, the interest among manufacturers towards implementing the ISO 9000 series models of quality systems has been reduced to a great extent (Yates and Aniftos 1997). Presumably on sensing this trend, MCB University press, United Kingdom has launched an Internet conference entitled “Does ISO9000 have a future” (Site address: http://www.MCB.co.uk). Meanwhile, many companies have started to evolve their own standards by keeping the ISO 9000 series standards as a base. The recent outbreak in this direction is the emergence of a QS 9000 quality system standard. Three American companies, namely Ford, General Motors, Chrysler and a group of truck manufacturers (Some of them are Mack Trucks Inc., Navistar International Transportation Corp., PACCAR Inc. and Volvo GM Heavy Truck Corporation) have formulated this standard. Though the penetration of QS 9000 quality system models in present day manufacturing enterprises is not very effective, casual and informal interviews with personnel
from companies which have adopted QS 9000 model hinted that this model provides better solutions for quality improvement. The QS9000 standard is more specific as it encompasses three sections, of which one section deals completely with ISO9000 based requirements. The superiority of QS9000 standard over ISO9000 series standards can be realised by referring to Peach (1997). Hence, it was anticipated that in place of ISO 9000 series models, in future, enterprises would try to adopt the QS 9000 model. After realising this trend, we decided to explore the feasibility of adopting the QS 9000 standard for design and installation of a maintenance quality system. Such a system shall encompass the policy, procedures, records, work instructions, customer and sector specific requirements which would aid in attaining a continuous improvement of maintenance quality.

9.1. STRUCTURE OF QS 9000 STANDARD

Before describing the design features of the maintenance quality system, the contents of a QS 9000 standard (Hoyle, 1997) are presented in this section. A QS 9000 standard encompasses three sections and its organisation is shown in Figure 9.1. The first section deals with ISO 9000 based-requirements. In this section the ISO 9001 model is adopted directly and the necessary specific modalities are added under each clause. The second section deals with sector-specific requirements. This includes three specific areas of manufacturing: production part approval process, continuous improvement, and manufacturing capabilities. A few concepts are emphasised under each clause with more and close specification of tools and techniques for attaining higher degree of quality. For example, the concepts like design of experiments, parts per million, benchmarking etc., are stipulated for attaining continuous quality improvement. The third section deals with customer-specific requirements. Under this section, the specific requirements of companies namely Ford, General Motors, Chrysler and a specific group of truck manufacturers are included. These specifications provide a very
Figure 9.1 STRUCTURE OF QS 9000 STANDARD

effective reference for any manufacturing enterprise to adopt the quality standards insisted by these leading four companies. As these companies belong to the automobile sector today, QS 9000 is viewed as a standard applicable only to automobile manufacturers. However, the QS
9000 standard can be made applicable to more types of industries (Peach, 1997) by suitably refining and amending its clauses.

9.2. KNOWLEDGE BASE SYSTEM

An overall study indicated that, the designed QS 9000 based maintenance quality system would be useful to the manufacturing company for the purpose of infusing quality in maintenance function (Zukerman, 1995). In particular, it was anticipated that, on implementation, the designed system would facilitate enterprises to attain the major and ultimate goals of TPM.

As the knowledge on both the QS 9000 standard and maintenance quality system is very feeble among both manufacturing and academic communities, it became imperative to search for devices to disseminate information and knowledge on a QS 9000 based maintenance quality system. The industrial world has been following various methodologies such as conducting seminars, conferences, training and education programmes etc., with a view to imparting theoretical and practical knowledge on various manufacturing philosophies and technologies. Casual interviews hinted that, manufacturers would require continuous knowledge support to sustain the implementation of a QS 9000 based maintenance quality system. This is not completely fulfilled by the methodologies mentioned above. Further, most of the TQM programmes have failed (Juran, 1993) to yield authentic results due to the absence of appropriate knowledge support. As the availability of human knowledge is not guaranteed continuously and economically, the need of exploiting machine support arises. Meanwhile it is to be noted that the field of information technology has brought out high-powered software and hardware features. In particular, in the case of computers, developing codes has become an easy task, thanks to the availability of user-friendly software packages. It has been made economically feasible too. Hence, we realised that it would help the manufacturing community
If a knowledge base system were devised for implementing a QS 9000 based maintenance quality system. Hence, we expanded the scope of our research work to the design and development of such a knowledge base system, which is named KMQS-9000 (Knowledge base for Maintenance Quality System based on the QS 9000).

Since a QS 9000 based maintenance quality system is new to the industrial world, it is not reasonable to expect any company to readily and successfully implement a QS 9000 based maintenance quality system. In this situation, the companies would fail to reap the benefits if the feasibility of implementing a QS 9000 based maintenance quality system in them are not properly checked. Hence, a module titled “Pre-auditing” was included in the KMQS-9000. The purpose of this module is to prevent any company from implementing a QS 9000 based maintenance quality system, in case it does not possess basic facilities and has not made preliminary preparations. Besides, this module was designed to guide the manufacturers for making initial preparations and creating necessary facilities. The management representatives of the company who consult this module should respond to the questions. Based on these responses, this module would assess the capability of the company to implement a QS 9000 based maintenance quality system. If found capable, KMQS-9000 would allow the user to proceed for consulting the “Design” module. This module would interact with the users and help to design the maintenance quality policy, procedures, forms and work instructions for implementing a QS 9000 based maintenance quality system.

9.3. QUESTIONNAIRE DEVELOPMENT

So far, the development of a pre-auditing module of the KMQS-9000 has been completed. To begin with, based on the designed maintenance quality system, 101 questions were prepared. The questionnaire is available in section A 9.1 of Annexure A. The questions...
were framed in such a way that the user would reveal the status of the company with regard to the implementation of the QS 9000 based maintenance quality system. The questions were grouped under three major sections of the QS 9000 based maintenance quality system namely,

1. ISO 9000 Requirements
2. Sector-Specific Requirements and

Besides, the questions pertaining to the clauses of ISO 9001 requirements of this system were grouped under four main classifications (Todorov, 1996) namely,

(i) Leadership and People Management

(ii) Management of Maintenance Quality System

(iii) Management of Processes and

(iv) Management of non-conformities and Processes.

The latter classification was done to identify the main strengths and weaknesses under major areas of ISO 9001 requirements. An analysis into the possible responses revealed that, against all questions, the user cannot pronounce a definite ‘yes’ or ‘no’ response. Hence, it was decided to offer the user to react with three choices, namely, ‘Yes-Satisfactorily’, ‘Yes-Partially’ and ‘Yes-Feebly’. The user is required to respond ‘Yes-Satisfactorily’ if the facility or device exists or followed to an extent of more than 80% of the total practice or area of the company. The user is required to declare ‘Yes-Partially’ if the corresponding facility or device exists or followed to an extent between 50% and 80% of the total practice or area of the company. In the remaining case, that is, if the facility exists or followed to an extent below 50%, the user is required to respond ‘Yes-Feebly’. Apart from this, it was realised that, if the user belongs to a company which is certified to either ISO 9002 or ISO 9003, then certain clauses of ISO 9001 requirements would not be applicable. Likewise under “Customer-specific Requirements”, all the questions may not be applicable to a particular company. For
this purpose, a fourth option namely 'Not Applicable' has been added. Finally the questionnaire containing 101 questions was appended with the four options of responses against each question was developed.

In order to assess the feasibility of successfully implementing the designed QS 9000 based maintenance quality system, the following simple mathematical model was developed.

\[ P = \frac{X + 0.5Y}{X + Y + Z} \]

Where ‘P’ refers to performance index

‘X’ refers to the number of responses with ‘Yes-Satisfactorily’

‘Y’ refers to the number of responses with ‘Yes-Partially’

‘Z’ refers to the number of responses with ‘Yes-Feebly’

If the value of ‘P’ is 0.8 or more, then KMQS-9000 would declare that the company is feasible enough to successfully implement a QS 9000 based maintenance quality system. If the value of ‘P’ is between 0.5 and 0.8, then it would declare that the company can implement a QS 9000 based maintenance quality system provided certain weak spots are strengthened by executing necessary actions. If the value of ‘P’ is equal to or less than 0.5, then it would declare that, at present, it is not at all advisable to implement a QS 9000 based maintenance quality system in the company.

9.4. PRE-AUDITING USING KMQS-9000

The entire questionnaire along with the mathematical model described in the previous section was fed in Oracle 7.3 database using Developer 2000 as a front-end tool. This process was carried out in an IBM compatible stand alone PC. One input screen was designed for each
question. The user can choose his choice by clicking the mouse at the option buttons. Five screens were designed to provide the output in precise form. One screen was designed to declare whether the company is capable of implementing the designed QS 9000 base maintenance quality system with or without strengthening actions or not. The second and third screens were designed to disclose strengths and weaknesses (if any) respectively of the company for implementing a QS 9000 based maintenance quality system. The fourth screen was designed to exhibit the graphical output of the company’s status against each clause of the system in the form of a bar chart (horizontal type). The fifth screen was designed with a combination of bar and pie charts for the purpose of benchmarking the status with other companies. Thus, the user can avail the report by referring to just five screens without losing any clarity of results.

The reason for developing the KMQS-9000 using Oracle software is the possibility of its integration with Enterprise Resource Planning (ERP) packages, which have largely been developed using Oracle software. It was thought that integration of KMQS-9000 may aid in improving the performance of maintenance module of ERP packages. As ERP packages have just now only started catching the manufacturing arena, it was not possible to locate any company, which has installed either ERP or Oracle software package. As the KMQS-9000 requires Oracle in IBM compatible stand alone PCs, it could not be installed and demonstrated to the management of various companies for the purpose of getting their feedback and subsequent validation. Hence, we used the questionnaire to get the feedback. First, the questionnaire was given to one of our colleagues who had worked as a maintenance engineer in a process industry for little more than five years. He was requested to respond to the questions imagining that he was still working in that industry. As we are doubtful whether the management of that industry would have any reservation over revealing the identity, we entered its name as ‘XYZ’. The options he chose against each question were entered in the
KMQS-9000. Figures 9.2 to 9.7 are some of the screen displays that appeared while using the pre-auditing module of the KMQS-9000 for entering the responses provided by our colleague. Figure 9.2 (Please see the figure given in Annexure-A) shows the first screen which appears after choosing pre-auditing module. Sample input screens under the sections “ISO 9001 requirements”, “Sector-specific requirements” and “Customer-specific requirements” are shown in Figures 9.3, 9.4 and 9.5, respectively. After responding to the questions, the user is shown the current performance of the company with narration. This is shown in Figure 9.6. Further, the user can have the option of viewing the strengths and weaknesses of the company. These are shown in Figures 9.7 and 9.8. In addition to this, the user can view the company’s performance with reference to individual clauses and sections in one screen, which displays the output graphically. This is shown in Figure 9.9. (The figures 9.2 to 9.9 are given in Annexure A).

After responding to the questions, we asked our colleague to express his opinion about the questionnaire. He appreciated the contents of the questionnaire and pointed out that they are practically relevant and would be useful to the managers. Besides, we mailed the questionnaire to two units of a company named Sundram Fasteners limited in which TPM programmes are being effectively implemented. Unlike ‘XYZ’ company, this company’s performance was good and rated by the KMQS-9000 as 99 percent. Apart from this we entered the details pertaining to a company ‘PSG Industrial Institute’ with which we are closely associated. After this, the performances of the companies which have so far consulted the KMQS-9000 were benchmarked. The output screen pertaining to benchmarking is shown in Figure 9.10 (given in Annexure A). As shown, the overall performance of the companies against the requirements of QS 9000 based maintenance quality system is compared using Pie-chart. The user can see more details about a company’s performance by clicking the
corresponding area in the Pie-chart. This will help the user to recognise in which clause he needs to show more interest in order to improve the overall performance. On the whole, we are convinced that the pre-auditing module meets the requirements of its practical validation.

9.5. CONCLUSION

As mentioned in the introduction section, TPM concepts attempt to integrate TQM with maintenance engineering. On analysing in this direction, it clearly revealed that TPM concepts are not yet exhaustive as many of the TQM concepts are yet to be incorporated with it. Particularly, the TQM field itself has moved to an advanced stage and is currently being addressed widely under the terminology ‘Strategic Quality Management’ (SQM) (Aravindan et.al., 1996). This approach pinpoints various quality strategies to be attained to effect continuous quality improvement. Many quality strategies are still yet to find a module in the currently followed TPM approach. One among them is the maintenance quality system, which has been considered in this research work. The major contribution of this work is the pre-auditing module of the KMQS-9000, which would ensure successful implementation of the QS 9000 based maintenance quality system.

While the concept of developing the pre-auditing module of the KMQS-9000 is simple and straightforward, in reality it is very useful in disseminating knowledge and identifying the actions to be taken to successfully implement the QS 9000 based maintenance quality system. Besides, it saves considerable time and expenditure. Pre-auditing module of the KMQS-9000 can be used by various ways. We recommend that a team of management representatives can sit throughout the execution (which may hardly take around three hours) of one session of pre-auditing module of the KMQS-9000 and respond to the questions with their consensus replies by selecting the appropriate respond buttons. As the output runs through only few screens, results can be analysed quickly and subsequent actions can be initiated within the shortest
module of the KMQS-9000 individually and the respective outputs can be compared and following an agreed strategy, subsequent actions may be taken. In the absence of a KMQS-9000 package, this would take a very long time and result in delaying the project from six months to one year. In future, we will be developing the design module and trying to commercially exploit the KMQS-9000.