UNIT 10 SAFETY AND ENVIRONMENTAL ISSUES IN MAINTENANCE MANAGEMENT

Objectives

After going through this unit, the students shall be able to:

- illustrate the close relation between safety and environmental issues and maintenance management;
- explain the methodology adopted to improve safety and environmental performance through maintenance management;
- strengthen and illustrate the correlation between maintenance and safety/ environmental issues through case studies.

Structure

10.1 INTRODUCTION

Management of the modern business enterprise is not just the culmination of producing products and services to sell to the customers and make profit. Due to the intrinsic network of various stakeholders of an enterprise starting from the shareholders to the general public at large, a management has to not only look for immediate results like profitability but also take care of long term goals like customer satisfaction, public image and goodwill etc. The assiduously built reputation of a company can be destroyed by a single incident of accident in its premises. A recent example was the accident in Bhopal in the Union Carbide factory, which sullied its reputation worldwide. Similarly, Governments and the general public are demanding safeguards for environmental performance of the products and processes of a production operation. In view of these requirements, safety and environmental issues have assumed priority over many other requirements for a business enterprise.

The earlier thinking in the safety assurance of an operation system was to stress on creation of a separate safety specialization, which had been primarily made responsible for the safety of men and machines. Such attempts have often been found to be inadequate due to non-participation of the grass root level personnel of the plant. The modern concept of safety assurance tries to stress the importance of involvement of all the people, right from the top most owner of the company to the lower most workers in the safety and environment movement of the company. Terminologies like 'Total Safety Management', 'Sustainable Development' etc are the result of such modern thinking to bring a holistic view into the subject.

The analysis of the causes of many safety and environmental accidents, have invariably identified 'improper maintenance' as one of the major reasons. While

simple preventive maintenance activities like inspections, timely replacements etc would be quite economical, the neglect of the same has been the reason for enormous loss of revenue running to million of rupees as a result of the accidents emanating from such causes, not to speak of the invaluable loss of precious lives. Needless to emphasize, safety and environmental issues need to be made an integral part of the maintenance management function, without which the basic objective of the maintenance function of assurance of plant availability is not complete. This unit tries to bring out the important facets of the interlinkage between safety and environmental issues and maintenance management.

Activity A

Prepare a safety and environmental audit system questionnaire for a small process plant identifying what maintenance elements you would insist on the same.

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10.2 THE COMPONENTS OF SAFETY AND ENVIRONMENTAL ISSUES AND THEIR RELATION TO MAINTENANCE MANAGEMENT

There are various issues concerned with the safety and environmental performance of an enterprise. Each of these issues has also linkage with the operation and maintenance management functions. These are briefly described below:

Corporate Objectives and Goals : The top management of the organizations is expected to clearly specify the corporate objectives and goals it would like to practice in terms of environment and safety assurance. Many a times, this is done through a widely publicized policy statement. The policy and objectives of the operation and maintenance functions are expected to dovetail them into the corporate safety and environmental objectives. For example, a policy of strict environmental cleanliness in terms of carbon dioxide emission norms may mean operation and maintenance policy practice of alternate use of clean fuels or the requirement for more frequent preventive maintenance overhauling.

Documentation of Process and Equipment : Another important requirement for the safety and environmental assurance for the company is the meticulous documentation of the vital specifications of the process and equipment in terms of their compliance to safety and environmental standards, statutory or otherwise. This documentation can be either independently prepared or integrated into the operation and maintenance manuals of the plant processes or equipment.

Risk Management : As it may not be possible to totally eliminate the risks to zero level, specifically in case of large complex process plants, it would be required to scientifically analyze the risks involved and prepare plans to mitigate them. Risk management involves use of multi disciplinary knowledge and participation to identify all possible hazards and also identify solutions to keep their risks at acceptable levels. The contribution of operation and maintenance in risk management is to contribute to the analysis process through inputs regarding various hazards of operation and maintenance processes. For example, many of the accidents in chemical process plants are due to typical maintenance operations like structure welding, catalyst change, overhauling etc. Hence the maintenance functions having intrinsic knowledge of these processes need to contribute in the process of study of these risks.

Change Management: In process plants, many of the environmental and safety failures arise from the failure to manage changes, both in the technology applications or systems. The Flixborough accident happened due to the failure to manage properly the change required in terms of providing a bypass line to a reactor during shut down of a reactor. Hence process safety guidelines insist on well laid out procedures for change management. As maintenance activities are the most prominent examples of unknown changes, due to their unique nature each time, these requirements are mainly applicable to the maintenance function.

Human Factors: The untrained or improperly placed worker is likely to commit mistakes, which may lead to safety or environmental consequences. Apart from this, there are other human factors like attitude, ergonomics, work culture etc, which have great bearing on the safety and environmental performance. Nurturing the human factors to enable achievement of best safety results is equally applicable to all plant functions, including operation and maintenance.

Investigation of Incidents: There is requirement, statutory or otherwise, to intensely investigate incidents, so that underlying causes can be found out and corrective actions for future improvements can be prescribed. The role of operation and maintenance personnel are important in such investigations, as they have to provide the correct sequence of activities before, during and after the incident to the investigating team and also implement the suggestions emanating from such investigations.

Safety and Environmental Audits: As already explained in another unit, there is increasing tendency to integrate the safety and environment audit requirements in the maintenance audits. The audits are mainly to identify whether the existing systems, techniques and procedures comply with the stated and required standards and suggest improvements wherever required. The maintenance executive is an important team member of the safety and environment audit team in many process plants.

Activity B

Study the ISO 14000 and OHSAS 18000 series of standards and identify the relevant requirements for the maintenance function to follow in these standards.

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10.3 MAINTENANCE TECHNIQUES FOR SAFETY AND ENVIRONMENTAL IMPROVEMENTS

The primary function of maintenance management is to ensure the availability of the plant and equipment. However, intrinsic to this requirement is the necessity to also provide maximum reliability and safety. Hence maintenance management needs to integrate their techniques to simultaneously improve safety and environmental aspects of operation and maintenance of plant and equipment. In this portion we would see what are the maintenance management techniques that can contribute in this direction.

Classification of Plant and Equipment: It is normally required for the maintenance management function to classify the equipment into various categories so that resource allocation can be facilitated according to their criticality. A factorization

method is sometimes used to rank the equipment in term of their criticality. Apart from the conventional broad factors of Operational Criticality, Maintenance intensiveness, Quality of Products, it is emphasized that Safety and Environmental factor is also considered in such classifications. The sub-factors under this category could be the accident potential and severity, emission of pollutants, extent of exposure of human elements to the equipment etc.

Preventive and Predictive Maintenance Scheduling: Regular checklists and preventive maintenance schedules should include important safety and environmental checkpoints. Nowadays preventive maintenance is often supported by instrument-oriented measurements called Condition Monitoring. Many of these monitoring instruments can be used as dual purpose techniques, for example, measurement of thickness of reactor wall thickness using ultrasonic gauges not only predicts wear and tear from maintenance replacement angle but also identifies potential dangerous situations of excessive material deterioration, cracks etc. Similarly, thermograph can identify both insulation wear and thermal breakdowns in high temperature reformers, furnaces etc.

Shutdown Maintenance Planning: Long shutdowns for annual turnarounds and major overhauls are important requirements of many process plants and heavier and complex equipment. Due to the tight time schedule under which such shutdown maintenance are executed, there are many possibilities of compromises on safety and environmental features and standards. Hence the planning process of such activities needs to meticulously include the steps required to ensure safety and environmental standards.

Communication between Maintenance and other Departments: Many safety and environmental hazards have emanated from improper communication between maintenance and other departments, especially the operations department. Proper information systems like log book entries, work order systems, work permit systems, lock out systems in case of electrical hazards etc are some of the requirements to ensure communication, thus enabling safety.

Maintenance Training: All maintenance personnel working in plant facility should be trained in the basic understanding of the process and mechanical hazards. The training should include mechanical skills, theory, on-the-job / apprentice training, safe work practices training and specialized craft training. Maintenance staff often forgets after a period, thus the company often loses valuable work information. Several accidents have occurred due to such 'corporate memory lapses'. The techniques useful under such circumstances are:

- Refresher training of all staff
- Use of incident investigation in training
- Publicity campaigns on safety
- Close supervision of new staff
- Continuous updation of maintenance instructions
- Safety compliance audits
- Counseling poorly performing staff

Activity C

Investigate a few safety and environmental incidents and identify the maintenance management system elements in the causes for these incidents.

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10.4 CASE STUDIES

Case Study 1 : Piper Alpha Incident

On July, 6, 1988, a gas explosion occurred on the Piper Alpha Petroleum Production Platform in the North Sea. This explosion was followed by a fire in the adjoining production module and engulfed the entire platform. A total of 167 people lost their lives in the disaster. The investigation of the incident led to the finding that miscommunication between operations and maintenance personnel was the basic factor leading to the accident.

The Factual Description of the Incident: there were two pumps A and B for pumping gas condensate. During the day shift, pump A was operating while pump B was standby. The LPG was flowing through the piping network containing pump A. operators during the day shift noticed excessive noise emanating from pump A, so they scheduled pump A for maintenance repair services. The operators switched pump B instead and a maintenance work order was written to provide service to pump A. upon review of the maintenance records, a second work order was issued to calibrate the pressure relief valve on the pump A discharge line. During the day shift, pump A service was completed, therefore completing work order number one. However, work order number two on the adjacent relief valve was not completed because a crane was not available to help with reinstallation. The maintenance staff intended to reinstall the pressure relief valve on the discharge line of A the next day. Shift change occurred at 6.00 PM. The new operators were of the maintenance performed on pump A, but did not understand that the pressure relief valve was not completely reinstalled. At about 10.00 PM, the pump B tripped. Having the efforts to restart pump B failed, the operators then began to switch the LPG flow to pump A but were unable to start pump A. electrical disconnects were observed, still in place following the earlier pump A maintenance, so electricians were asked to reconnect the motor. The power was restored to pump A and the isolating valves were opened and attempts were made to start pump A. LPG escaped from the blind flange on the discharge of the pump A during these attempts. The initial indication of gas from the flammable gas detectors was immediate following the opening of the valves in pump A line. The explosion occurred when the LPG vapors contacted an ignition source.

The major contributary factors to the above case were the inadequate permit to work system and shift handovers of work in progress. Procedures should have required the departing staff to make sure that the incoming shift knew about the status of all work in progress that would have eliminated the possibility of recommissioning the spare pump. Also it was found that the diesel fire pump was on manual mode, which inhibited fire fighting, and emergency drills have not been properly conducted at proper frequencies.

Case Study 2 : Breathing Air System Incident

A special system of piping was installed for compressed air to be used with breathing apparatus only. A branch was replaced, but no one appreciated why the original branch was on the top of the compressed air main. The replacement branch was installed at the bottom of the supply main. The system was used for years without any incident. Then one day a worker who was wearing a face mask while working inside the vessel, received a full blast of water that nearly drowned him. Fortunately, he could get help and was saved. The investigation showed the compressed air main had been renewed and that the branch to the plant had been repositioned at the bottom of the supply main instead of the top. When a quantity of water entered the system, it drained into the breathing apparatus.

The case explains the necessity for documented management of change procedures for maintenance actions which were not employed. Also safety knowledge are subject to loss of memory unless continuous process knowledge is documented and training imparted.

Case Study 3 : Pipe Repair Incident

A fitter was to repair a leaking joint in some pipe work carrying water on the pipe bridge. Staging was erected, but because of the difficulty of access, the process supervisor pointed out the joint to the maintenance supervisor from the ground. The maintenance supervisor, in turn, pointed it out to the fitter. The fitter opened a wrong joint in carbon monoxide line, was gassed and lost his life.

The investigation of this case leads to the contributing causes that the work permit should have been properly implemented with proper safety procedures and proper tagging procedures.

Case Study 4 : Erroneous Maintenance Information Incident

Two pressure vessels, with similar identification numbers, had the same type of relief valves, but with different pressure settings. During the calibration of the one of the relief valves, the higher pressure setting, erroneously read from the maintenance files of the wrong vessel, was used. The error was not discovered until a few years later when the vessel was damaged by unrelieved pressure. The case illustrates the problems of improper equipment identification and equipment maintenance files.

Case Study 5 : Improper Material Usage In Maintenance

In a crude production utility, a weld on a 12" pipe containing heavy hydrocarbons at high pressure and temperature was identified as close to failure. The section of the pipe was isolated and the pipe was rewelded; however, the new weld failed the post weld inspection. A decision was made to replace a section of the pipe. Because, proper materials control and an identification system was lacking, a section of pipe was fabricated from incorrect materials and installed. After the welding was compelted and the weld tests were passed, the insulation was put back in place and the pipe was brought back into service. Two days later, the new section of pipe failed releasing a large quantity of flammable hydrocarbons. The ensuing vapors ignited, causing extensive property damage and seriously injuring several workers. The incident identified the improper material controls applied by the maintenance department and improper repair procedures.

10.5 SUMMARY

In this unit, the close correlation between safety and environmental issues and the maintenance management function has been explained. The factors that cause the safety and environmental and safety issues to be considered in importance and their relation to maintenance function were also brought out. The main management sub factors in maintenance management that can improve safety and environmental performance of plant and equipment have also been highlighted. Case studies were explained to extract the practical connotations of above factors.

10.6 SELF ASSESSMENT QUESTIONS

Introduction

1. Why are safety and environmental issues important for a manufacturing concern?
2. What do you understand by the term 'Total Safety Management'?
3. "Improper Maintenance is a major cause of Accidents"- Give your arguments in favour and against this statement.

The Components of Safety and Environmental Issues and their Relation to Maintenance Management

4. What are major components of safety and environmental issues of an enterprise?
5. How do the maintenance goals and objectives take care of safety goals of an organization?
6. What types of maintenance documentation do you think are important from safety and environmental point of view?
7. How can a maintenance function help in Risk Management?
8. Change Management has greater relevance to the maintenance function – Do you agree, if so why?
9. List out the important human factors in maintenance function related to safety performance.
10. Differentiate between investigation of incidents and audits.

Maintenance Techniques for Safety and Environmental Improvements

11. How classification of plant and equipment help safety? Give an example.
12. What safety checks are possible in preventive and predictive maintenance – give some examples
13. How can the communication between maintenance and other functions can be enhanced?
14. What types of training techniques are available for preparing maintenance personnel to enhance safety and environmental performance?

10.7 BIBLIOGRAPHY AND SUGGESTED READINGS

1. 1995, "*Guidelines for Safe Process Operations and Maintenance*" – Centre for Chemical Process Safety AICE
2. Brian Rothery, 1995, "*ISO 14000 and ISO 9000*", Gower Publications,