THE APPLICATION OF TOTAL QUALITY MANAGEMENT TO HAZARD STUDIES AND THEIR RECORDING

R D Turney

SYNOPSIS: Hazard Studies for the design of safe process plant are now well established, being applied in the process industries worldwide. The application of Total Quality Management forces us to ask, what procedures can be put in place to reduce variability and to consistently perform a study which meets the customer requirements.

The form of record and the features required of a computer aided recording system will be discussed.

INTRODUCTION

There is broad agreement within the process industries and amongst the public and the authorities, that processes must be operated in a way which reduces the effects on the environment to a practicable minimum. At the same time safety performance must be maintained and improved. This is reflected in the new environmental legislation being introduced in the UK, USA and other industrialised countries, together with the statements of commitment made by industry leaders. (1) In addition the Cullen Report, (2) on the Piper Alpha Disaster, has called for Formal Safety Assessment to be applied to new and existing North Sea Rigs. How is industry to meet these increasingly stringent requirements on the design and operation of plant?

New techniques will be needed. The most important will be the elimination or avoidance of hazards by the further development of the concepts of inherent safety (3,4), together with corresponding techniques for inherent environmental acceptability and inherent occupational hygiene. However, these will not, by themselves, be sufficient. We will also need to continue the improvement of existing procedures so that they are more effective in reducing the likelihood of accidents to people or to the environment. These will need to be applied throughout the life of a project, from development through design, commissioning, operation and maintenance to decommissioning and demolition. To achieve this, ICI has revised it's Hazard Study Procedure extensively to a new procedure, 'Hazard Studies for Safety, Health & Environmental Protection'. Revisions of this type are able to make use of experience built up through application over many years. The procedures will need to be applied with the same effectiveness as the best manufacturing processes.

TOTAL QUALITY MANAGEMENT

The most important approach which can be used to improve both operations and procedures is Total Quality Management (TQM). The effect of TQM on Japanese industry is well-documented. Companies in the US, Europe and the UK are finding the benefits which come from adopting the approach and building close relationships with their customers and suppliers.

An excellent overview of the quality procedure and its application to safety has been provided in the paper by Whiston & Eddershaw (5). How can these approaches be used in practise?

The most direct application is to plant operation and maintenance. An example of success in the application of the quality improvement process to plant operations has been reported from the ICI 'Fluon' Plant.

This plant involves, the handling of a toxic gas. An automatic analysis system is installed which makes 15,000 measurements a month. Before the introduction of Total Quality Management, several hundred 'excursions' were reported every month, requiring the staff to wear breathing apparatus. Following the introduction of TQM, more detailed data was collected and the source of the problem pinpointed. A number of valves were replaced and redundant sample points removed. These measures, coupled with the greater awareness by operating and maintenance staff, of the items most likely to cause problems, has reduced 'excursions' to a level of two or three per month.

APPLICATION TO HAZARD STUDIES

Although the above examples and other ways in which TQM is applied to manufacturing are most important, the quality improvement process has much wider application, particularly to the design process and to Hazard Studies themselves. There are a number of approaches to quality improvement based largely on the work of Crosby, Deming and Juran. The key elements of the Crosby approach are explained through four basic principles called 'absolutes' by Crosby and summarised by Whiston & Eddershaw.

Definition of quality: Quality is conformance to agreed and fully understood requirements, meeting what the customer wants in every way. There is no high or low quality. The product or service either satisfies what the customer wants or it does not.

System of quality: Prevention not appraisal. It involves focusing on work processes rather than on people to reveal where errors occur, and then taking action to prevent them. It can be regarded as the application of good planning techniques to every action taken in an organisation.

Standard of quality: Zero Defects. This means meeting the customers' requirements without errors.

Measurement of quality: By pricing non-conformance. By calculating the cost of doing something wrong, it is possible to understand what the financial impact on the business is.

IDENTIFYING THE CUSTOMER

Although in all businesses the company or individual who buys and uses the product is the most important customer; in the field of hazard studies it is the 'customers' of the study, both inside and outside of the company, who are of greatest importance. When Hazard Study Leaders are initially asked 'Who is the Customer?' or 'Who do you do your work for?' The answer is most likely to be 'The project manager'. This is understandable, the project manager is an important customer, he is usually responsible for requesting the study, for ensuring that the correct people attend, and he will almost certainly be responsible for the follow-up and implementation of the recommendations. However, further analysis shows other important customers. The results of a syndicate exercise carried-out with a number of experienced Hazard Study Leaders within ICI, identified the following 'customers'.

Primary Customers (Using the results of the study directly):

Project Manager
Plant Manager
Commissioning Manager
Safety, Health & Environmental Managers

Most people would have little problem in identifying this group as customers. It is, however, by going to an even wider group of 'secondary customers', that we gain an insight into some of the most important aspects of the whole process.

Secondary Customers (Indirect use of results of study)

Plant Operators
The Business Group
Company Executive
The Public
Authorities

These groups have very different requirements which must be born in mind when carrying out the study. For example, the knowledge of how upset conditions will be indicated, is of value to operators. The business group need to know that corporate standards are being met in the most cost-effective way, an interest shared with the executive. Similarly, all of these groups, together with the public and the regulatory authorities, require assurance that safety, health and environmental hazards are identified in a thorough manner by competent staff.

CUSTOMER REQUIREMENTS

With such a wide range of customers, we must expect that there will be a very broad range of requirements. This may, at first sight, appear to be a problem, but the exercise of identifying the customer requirements is crucial. It enables us to ascertain what is expected of the study and ensure that this is delivered. Considerable time and a great deal of talent is devoted to a Hazard Study and it is most important that we gain the maximum benefit from this investment. Making use, once again, of the syndicate work of ICI Hazard Study Leaders, a number of requirements were listed:

Project Manager Requirements

- Significant hazards identified and understood.
- Money spent on safety, health & environment in an effective way.
- Clear definition of problems and action required.
- Study completed 'on time'.
- Information produced to use in discussion with authorities.
- Effective use of team's time.

Plant/Commissioning Managers' Requirements

- Plant which will be safe and operable.
- Hazards identified and understood.. -Consequences of failure described.
- Protective and preventative measures defined.
- Clear definition of problems and action required.
- Information which can be used for:
    - Discussion with authorities.
    - Preparation of COSHH & CIMAH Reports.
    - Training
    - Assessment of plant modifications.
    - Information presented in a form suitable for ongoing use.

Other customer requirements can be developed in a similar way and will vary to a certain extent between one organisation and another. These must be detailed and made available to the Hazard Study Leaders if they are to meet the requirements.

SYSTEM OF QUALITY

The System of Quality is prevention not appraisal, often expressed as 'getting it right first time'. This is just as important in the design process as in manufacturing. There are, however, cases where 'getting it right first time' in design, is not as simple as in production.

For example, optimising the design of a distillation train through two or three design cycles, is a quality approach if this was the intended method. However, redesign of an instrument system because the correct information was not available initially, would not be a quality approach. The Hazard Study Process includes elements of both of these situations and since it aims at correcting poor design before the plant is constructed, it must form part of the system for quality. It is however, in everyone's interest that the number of changes required by the Study are minimised. Ideal as it would be, we cannot expect Hazard Studies to be completed without the need for revision. The procedure is applied to complex interactive systems. In this situation, any attempt to assess the study in terms of the number of actions raised is likely to be counter productive. This must not, however, be allowed to become an excuse for poorly prepared designs.

The input/output model can be very useful in improving the process. Applied within ICI it has lead to a number of important conclusions:

- The output of the study in terms of the records made, the actions identified etc., must be clear and recorded in a way which will ensure that the customer requirements are satisfied.

- Those leading and taking part in the studies must be made fully aware of these requirements through training.

- The information needed for the Study must be properly prepared and thought out.

For example the Hazard & Operability Study (ICI's Hazard Study 3) will invariably involve the consideration of overpressurisation. For an effective study the design of protective systems to prevent overpressurisation should have been completed before the study and the engineer responsible briefed himself on the key aspects before the Hazard Study meeting. The Study then acts as an effective check on this work and the time of those attending the study is not wasted in uncertainties or the search for data.

Recognition of the importance of these factors has spurred the production of improved guidance for Hazard Study Leaders, bringing together the 'best practise' gained from a wide range of businesses. It has also emphasised the need for thorough training of leaders. A simple calculation shows that a small increase in the effectiveness of all those attending a Hazard Study easily offsets the time spent in training of the Study Leader.

For example if a study leader leads, on average 3 meetings a week each comprising 5 people and lasting for ½ day the total effort in a 47 week year will be

$$47 \times 3 \times 5 \times \tfrac{1}{2}$$

$$= 352 \text{ man-days/year}$$

If the investment of an extra 3 to 5 man-days in the training of the leader increases the effectiveness of the meetings by 10%, the total saving over one year will be 35 man-days. Even greater savings may be made by ensuring that the significant problems are identified and major incidents avoided.

STANDARD OF PERFORMANCE

The standard of performance has been expressed as 'Zero Defects', meeting the customer requirements. This obviously means the absence of any major incident or operating problems and few people would accept any other standard. Although this is of prime importance, the need to satisfy all of the other customer requirements must not be overlooked. Thus a Hazard Study which has zero defects will not only have identified all the hazards but will have produced the records required by the project and plant managers, will have been completed on time, made effective use of the team's time and be based on well-prepared and thought-out designs.

To assist in the improvement process, some measurements of performance are needed.

MEASUREMENT

Wherever possible, measurements should be converted into money terms, enabling us to compare a number of items on a consistent basis. A major incident leading to possible injury, environmental effects, damage and loss of production, can have major financial effects. (Whiston & Eddershaw have listed the factors which need to be considered.)

In addition to measuring the potential costs arising from failure to identify a hazard, we must also consider those costs which can arise during the design process. Individually these are likely to be very much less than the cost of a major incident. However, repeated on a regular basis, costs due to poorly prepared meetings, failure to complete the procedure, inaccuracies or ambiguities in the record of actions etc., can build up substantial costs over the life of a project.

TQM requires that these elements are measured whenever possible.

IMPLEMENTATION OF A QUALITY PROCEDURE

As with any other process, implementation of a quality Hazard Study Procedure requires commitment from all of those involved, from senior managers through to study leaders, designers and others taking part in the studies. In addition, there is a need for careful planning, a clear definition of requirements and the provision of adequate and effective training for all of those who have defined responsibilities.

BENEFITS OF COMPUTER RECORDING SYSTEMS

Although computer systems for the recording of Hazard Studies are not essential to implement a quality procedure, the systems do offer benefits which need careful study. A number of systems are available, one of which has achieved a dominant position in the market. What benefits are these systems likely to produce and what features are necessary?

It is important that the prospective user starts by listing the features which he wishes to see. No system is likely to offer all the features of the ideal system but the list, subdivided into essential and desirable features, forms an important basis for assessing the suitability of alternative systems. One list of features, by no means a definitive one, is produced below:

TABLE 1 - Features of a Recording System:

Recording of
- Project Title
- Project Number
- Meeting Date
- Attendance
- Line Diagram Number
- Line or Plant Item Number
- Keyword & Deviation
- Consequences
- Causes
- Protective & Preventative Measures (Safeguards)
- Action No.
- Action
- Responsibility
- Action taken/Reply
- Date of Review

- Sorting and printing of action lists by person responsible.

- Horizontal linkage of entries retained during editing.

- Customisation of displays, column widths, headings etc.

- Word processor to keep comments within confines of columns.

- Set-up procedure to store customised lists.

- Ability to "scan" work sheet both horizontally and vertically on screen.

- Programme stored with data for archive purposes.

- Automatic allocation of action numbers.

- Suppression of unnecessary headings.

Although systems may be used outside of the Hazard Study meeting to achieve a consistent record, the greatest benefit is likely to come from their use within a meeting.

In this case it is likely that the system will be connected to a large VDU or a display tablet on top of an overhead projector. Used in this way the system helps to focus attention on the deviation being considered and ensures that all those present are clear on the notes and actions recorded. This does, of course, place a high demand on the competence of the Study Leader.

The use of any such computer system requires capital outlay for the equipment, software and training. How can this be justified? Although a trial system may be purchased on a speculative basis, the eventual use of the system must be justified in hard financial terms. It is unlikely that there will be any reduction in meeting times, the most tangible benefit. However, improvements in the following areas may be capable of quantification.

- More effective meetings.

- More accurate action lists.

- Actions completed more rapidly.

- Fewer misunderstandings.

- Better records.

Can we say that the systems produce these benefits? Although within ICI the systems are being investigated at the time of writing, the jury is still out.

CONCLUSION

The application of Total Quality Management to the Hazard Study procedure will further increase its effectiveness and value. Important aspects of the process will be

- Identification of the "customers" of the study.

- Determination of their requirements.

- Provision of guidance and training to all those involved in the study.

- Measurements of performance.

Although not essential to the application of TQM to Hazard Studies computer aided recording systems are likely to assist in increasing effectiveness.

REFERENCES

1. Henderson, D. 1990 "Investing in the Environment", conference "Petrochemicals in Europe - The New Scenario", London November 1990.

2. Hon Lord Cullen, "The Public Inquiry into the Piper Alpha Disaster" HMSO November 1990.

3. Kletz, T.A., 'Cheaper, Safer Plants'. I.Chem.E., 1984.

4. Hawksley, J.L., 'Risk Assessment & Project Development'. Royal Society of Chemistry Symposium, Edinburgh 1985.

5. Whiston, J., and Eddershaw, B., "Quality & Safety - distant cousins or close relatives?" The Chemical Engineer, June 1989.