THESIS: THE HEALTH ENVIRONMENT AND SAFETY INFORMATION SYSTEM - KEEPING THE MANAGEMENT SYSTEM 'LIVE' AND REACHING THE WORKFORCE.

A. Lidstone
EQE International Ltd., 500 Longbarn Boulevard, Birchwood, Warrington, WA2 0XF

THESIS is a relational database designed to be used by line management and the workforce to collect, analyse and store HSE data for a facility or operation. In addition to compiling information for a HSE Case or HSE Management System Manual, the data held can be output in a wide range of formats to promote dissemination and use amongst the workforce.

The heart of THESIS is the so-called 'Bow Tie' Diagram which provides for a readily understandable visualisation of the links between hazards, the controls preventing their release and the remedial measures available to mitigate the consequences of a release. The use of a relational database permits the linking of these controls to specific tasks, instructions and responsible individuals.

The paper describes the programme key features and some experiences gained during its application world-wide over a number of differing industries and operations.

Keywords: Thesis, HSE Management, Relational Databases, Risk

INTRODUCTION

One of the recommendations arising from Lord Cullen's report on the Piper Alpha disaster (1), was that operators' Safety Management Systems should be based upon quality management principles. In 1991, the Exploration and Production (E&P) sector of the Royal Dutch/Shell Group of companies endorsed and adopted the majority of the Cullen requirements, including the requirement for integrated Health, Safety and Environment Management Systems (HSE-MS) based on quality principles for world-wide application.

A general principle underpinning HSE policy within all Shell E&P companies is that

> '... work should not start before it is confirmed that essential safety systems are in place and that staff are accountable for this requirement. Where safety cannot be ensured, then operations should be suspended...' (2)

A safety, or more generally, HSE Case, in addition to being a regulatory requirement in a number of operating areas, also serves as a formal demonstration of the effectiveness of the facility/operation specific HSE-MS, and that essential controls are in place.

Early experiences in the development of such documents rapidly led to the conclusion that a standardised method was required to ensure the collection, evaluation and presentation of the data necessary to 'make the case'. It was also readily apparent that the preparation of a HSE Case was regarded as a 'paper exercise' with little or no relevance to the management activities conducted on the ground. Part of the problem was that a considerable amount of useful data was relatively inaccessible within the documentation.

To counter these problems, and to increase the perceived relevance of the HSE Case, Shell began the development of an IT tool in 1993 which eventually became THESIS.

BENEFITS OF INFORMATION TECHNOLOGY

THESIS (The Health, Environment and Safety Information System) is a relational database designed for the line management and workforce, to enable the application of the risk control process and the building of management systems. The real benefit of the tool is that it holds relationships between data, for example the hazard, the measures controlling its release and the persons responsible for ensuring each control is effective at all times.

The benefits of IT systems relative to paper-only documents include:

- Quicker activity and hazard analysis
- Provision of a corporate memory to assist the learning ability of the organisation
- Improved accuracy, completeness and consistency
- Visibility of gaps in hazard information
- Automated compilation of areas for improvement
- Easier maintenance and updating of information to keep pace with changing operations
- Cost, time and resource savings
- *Presentation of information in multiple formats to suit the end user*
- On-line management system information tool
- Implicit relationships between responsibilities and hazards are visible
- Support for multiple users.

THE RISK MANAGEMENT PROCESS

As stated earlier, one of the principle recommendations arising from the Cullen enquiry was that the standards and processes applied in quality management should also apply to the management of safety by operators. Developing on from the Deming Cycle [3] of

PLAN - DO - CHECK - FEEDBACK

Figure 1 shows the key processes in a HSE-MS. At the core of this cycle is what is known within the Shell group of companies as the Hazards and Effects Management Process (HEMP), or more generally known as the risk management process. This is based on the principle that managing risks means that the hazards and effects associated with a particular operation, facility or business process have to be properly managed. HEMP requires the four stages of:

- Identify - Are people, environment, assets or reputation exposed to potential harm?
- Assess - What are the causes and consequences? How likely is the loss of control? What is the risk and is it ALARP?
- Control - Can the cause be eliminated? What controls are needed? How effective are the controls?
- Recover - Can the potential consequences or effects be mitigated? What recovery measures are needed? Are recovery capabilities suitable and sufficient?

i.e. that the hazards and effects should be identified, fully assessed, necessary controls provided and recovery preparedness measures put in place to control any hazard release.

The challenge is then to draw the information recorded during this process into a cohesive structure, rather than a set of items linked in an ad-hoc way (**Figure 2**).

THESIS

THESIS is designed to be used by the personnel of a facility, operation or location to collect, analyse and store HSE data. It provides a structured method to assist, control and check the data collation process. The data held within THESIS may then be presented in a number of custom report formats and may also be used as an on-line information tool, permitting access by multiple users. Later updates to data, to reflect for instance a change in the plant parameters or organisational indicators, is considerably easier given a database approach.

The primary function of THESIS is to identify hazards, the controls preventing their release, the recovery measures required should they be released, and most importantly, to identify and link these controls to the person responsible for their enforcement. THESIS thus guides the user through an Identify - Assess - Control - Recover format, and provides checks to record for example, where data is not available or controls are not defined.

There are many standard techniques available for the identification of hazards, such as HAZOP, HAZID, FMEA, checklists and historical loss analysis. These may then be readily assessed by means of a risk matrix such as that shown in **Figure 3**. This may be used at the outset to qualitatively estimate the people, asset, environment and reputation risks to the business. THESIS contains a comprehensive list of hazards, including the immediately catastrophic (e.g. flammable gas), to long term environmental (e.g. land take, discharge) and chronic health (noise levels >85dBA) effects.

Following on from this comes the important step of identifying the existing controls, assessing their effectiveness and identifying additional controls where current measures are unnecessary or ineffective. At the heart of THESIS is the so called "bow tie" diagram, **Figure 4**, which has been found to be an extremely useful means of presenting data at all levels from the shop floor to the board room.

The terminology which is adopted throughout THESIS may be summarised as:

Hazard - something with the potential to cause harm, including ill health or injury, damage to equipment, product, the environment or reputation, production losses or increased liabilities.

Top Event - the release of the hazard; this is the undesired event arising from the hazard's release e.g. loss of containment, not the ultimate effect e.g. fire or explosion.

Threat - something which may release the hazard to cause an incident e.g. corrosion, operator error etc.

Consequences - the final results of the hazard being released and not being controlled e.g. fire, explosion.

Barriers - the controls that are put in place to prevent a threat from releasing a hazard e.g. isolations, inspections, physical barriers.

Recovery Preparedness Measures - controls that may be applied to limit the chain of consequences arising from the top event e.g. provision of emergency shutdown systems.

Escalation Factors - conditions that could act to reduce the effectiveness of a barrier or recovery preparedness measure e.g. safeguard system not available.

Escalation Factor Controls - the controls that are put in place to prevent the escalation factor from affecting the barrier.

The hazard bow-tie therefore serves to demonstrate for each hazard/top event pairing, the threats that could cause its release, the controls that are in place to prevent the top event occurring and the recovery measures that are, or need to be, identified to mitigate the consequences of a release. Also shown are the escalation factors which may serve to reduce the reliability or effectiveness of any control barrier, and the secondary controls that are in place for their control.

Facilitated workshops, involving the people who are confronted with the risks on a regular basis, supported by specialist technical advisers if appropriate, have been found to be very effective at identifying the components forming the bow-tie. This process also promotes ownership of the final product amongst the workforce, as they have been involved in the identification and development of the information.

However, the identification of hazard controls is insufficient in itself because the analysis is a 'static' record of the risk situation at a particular point in time only. Linkages must be made to those workplace, business or management activities which put in place or maintain the controls *shown in the bow-tie diagram, as shown by* **Figure 5**.

Such tasks may be deemed "*HSE-critical tasks*" and are a sub-set of all the tasks carried out by employees, management and advisers. The tasks may be design, inspection, operational, financial or administrative tasks, etc. It is only by performing such tasks at the appropriate time that assurance can be gained that hazards are being managed properly.

Furthermore, accountabilities for action must be defined so that risk management becomes a real part of line management activity. Therefore as a minimum it is essential to:

- specify who is responsible for each HSE-critical task;
- the competencies required to ensure the task is carried out properly (in terms of experience, qualifications, training and personal attributes);
- the documentation where the task is defined (e.g. plan, procedure, job description, etc.); and
- how it will be verified that the task has been undertaken properly and at what interval.

It is important to differentiate between *HSE-critical tasks*, which are those which contribute to the control of a hazard, and *hazardous tasks*, which are those which in themselves may present a risk to the person performing the task. Two simple examples illustrate the difference:

- confined space entry is a hazardous activity as it exposes the operator to hazards such as asphyxiation;

- atmosphere checking is a HSE-critical task as it provides one of the barriers necessary to control the hazard of insufficient oxygen atmosphere.

THESIS provides for the identification, assessment and linkage of the HSE-critical tasks necessary to provide the controls to ensure that the major hazards within an operation are controlled. Hazardous activities require to be controlled by the application of local workplace controls such as permit-to-work systems, STOP, etc. The approximate level of distinction is illustrated in **Figure 6**.

The relational database structure of THESIS thus provides for the :

- ***identification*** of hazards applicable at an operation, facility or area;
- ***assessment*** of the number and efficacy of the barriers in place to ***control*** the release of the hazard and also to ***recover*** from this top event;

- identification, assessment and linkage of the activities necessary to ensure the controls are effective.

This is illustrated in **Figure 7**, which shows some of the information that may be held within the THESIS database for a particular operation or facility and the linkages between them.

Prior to the preparation of the analysis it will become necessary to make a definition of the acceptance criteria to be used. This is generally found to be a combination of:

Quantitative - based upon the position of the hazard within the risk matrix (**Figure 3**), a set number of independent and effective barriers are required between any threat and the top event, the top event and the consequences and also for the control of escalation factors; and

Qualitative - during the preparation and review process of the analysis, experienced judgements are made as to whether the controls identified are suitable and sufficient.

Facilities exist within THESIS for the assessment of barrier effectiveness, for recording and prioritising shortfalls and remedial actions and also for internal error checking e.g. that all barriers are assigned tasks and that all tasks are assigned responsible persons.

BENEFITS OF THE THESIS PROCESS

One of the most significant benefits that has been realised during the development of THESIS based analyses has been increased participation by the workforce in the development, review and implementation of the HSE assessment. The provision of an easily accessible on-line reference tool has helped to remove some of the resentment towards remotely prepared 'paper cases'.

The custom reporter function within THESIS, and especially the graphical bow-tie outputs (**Figures 8** and **9**), mean that specific information can be extracted when required and are easily presented in a readily understandable format.

Some of the uses that THESIS databases have been put to include:

- preparation of HSE/Safety cases, audit plans and emergency planning scenarios;
- assessment of specific high risk operations;
- reviews of operating procedures;
- hazard management awareness training;
- input for contract specifications (following assessment of design concepts); and
- input for workplace hazard management systems.

One notable example of the increased understanding gained from the bow-tie diagram, was an exercise undertaken to take an existing 'paper case' and use the bow-tie diagram to explain to the workforce the levels of safeguards that were in place for their protection and also to show why their contribution to the operation was important.

THE FUTURE

Subsequent to the first version of THESIS being available in January 1996, EQE International Ltd. has partnered with Shell with two principal aims for THESIS:

1. Its continued development as a tool for decreasing the risk faced by organisations; and
2. The development of applications external to the exploration and production oil industry.

The application of THESIS was originally in the oil and gas industry, and HSE Cases have been prepared for operations in a number of countries world-wide, including Europe, South America, Africa and Australasia, some of which have no regulatory requirements for formal risk assessment.

The type of operations that have utilised the method to date include;

- land and marine drilling operations;
- storage and processing facilities;
- logistics activities;
- corporate business risk;
- distribution operations;
- shipping; and
- construction.

The future development of THESIS is continuing with additional features being developed as is the range of industries and applications to which it may be put.

SUMMARY

THESIS leads the user through a structured process to identify and record essential information about each risk management critical task, such as which posts are responsible for executing and supervising these tasks, and how the task is documented and verified. This allows the practical implementation of the risk management process and provides full visibility of risk controls.

THESIS provides for:

- a structured method of activity and task analysis
- a structured method for qualitative analysis of hazards and effects, or for recording results of more formal hazards and effects analysis
- clear references to company standards and procedures
- clear cross referencing between hazards and the activities and tasks providing control
- the ability to set objectives and targets for hazard management
- facilities to check on completeness of data and to highlight conflicts or gaps
- an easily comprehensible graphical presentation of HSE information
- customised hard copy reports.

The relational database permits:

- cost, time and resource savings
- on-line access for multiple users
- easier updates for changing operational circumstances
- automated compilation of areas requiring improvement.

CONCLUSION

'The quality of our individual contributions to the management of safety determines whether the colleagues we work with live or die"

- Brian Appleton, ICI, Technical Advisor to the Piper Alpha Enquiry.

THESIS provides the linkages to develop, demonstrate and enforce these contributions and in doing so provides a useful addition to the process of making HSE management real and live to the workforce.

REFERENCES

1 The Hon. Lord Cullen, 1990, The Public Enquiry into the Piper Alpha Disaster, HMSO, London, Cm 1310.

2 Primrose M.J., Bentley P.D., Van der Graaf G.C., 1996, Thesis - Keeping the Management System "Live" and Reaching the Workforce, SPE 36034.

3 ISO9001

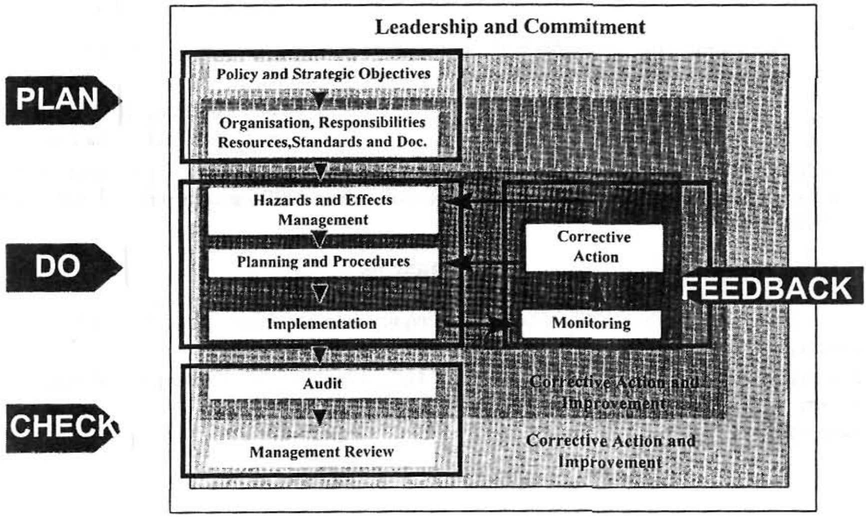

Figure 1 : A structured HSE-Management System, based on the quality management principles of "plan-do-check-feedback".

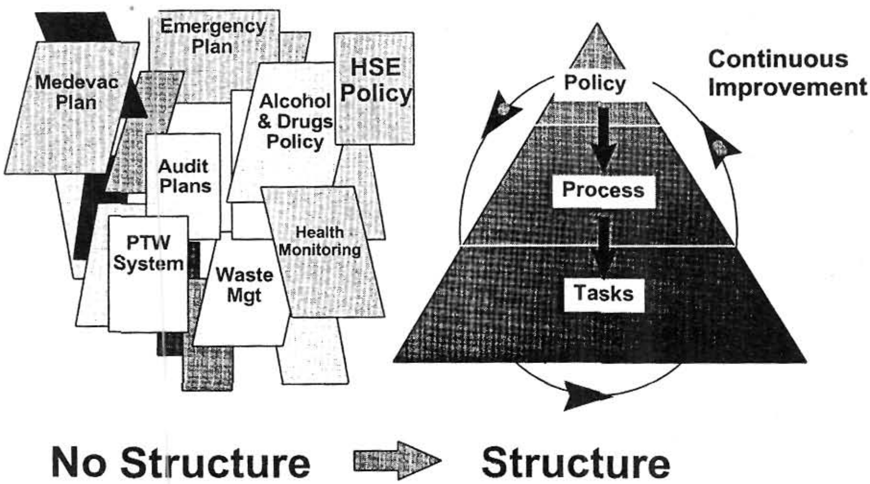

Figure 2 : Developing and documenting the Management System aims to apply a structure to an often ad-hoc approach to risk management.

Rating	IMPACT				INCREASING LIKELIHOOD				
					A	B	C	D	E
	People	Asset Damage	Environ-mental Effect	Impact on Reputa-tion	Never heard of in our industry	Has occurred in our industry	Incident has occurred in our company	Happens several times/yr in our company	Happens several times/yr at one site
0	No injury	None	None	None					
1	Slight injury	Slight	Slight	Slight					
2	Minor injury	Minor	Minor	Limited					
3	Major injuries	Localised	Localised	Considerable					
4	Single fatality	Major	Major	National					
5	Multiple fatalities	Extensive	Massive	International					

Manage for continuous improvement

Incorporate risk reduction measures

Figure 3 : A risk assessment matrix may be used to assess the exposure to identified risks and to decide on the most appropriate level of control.

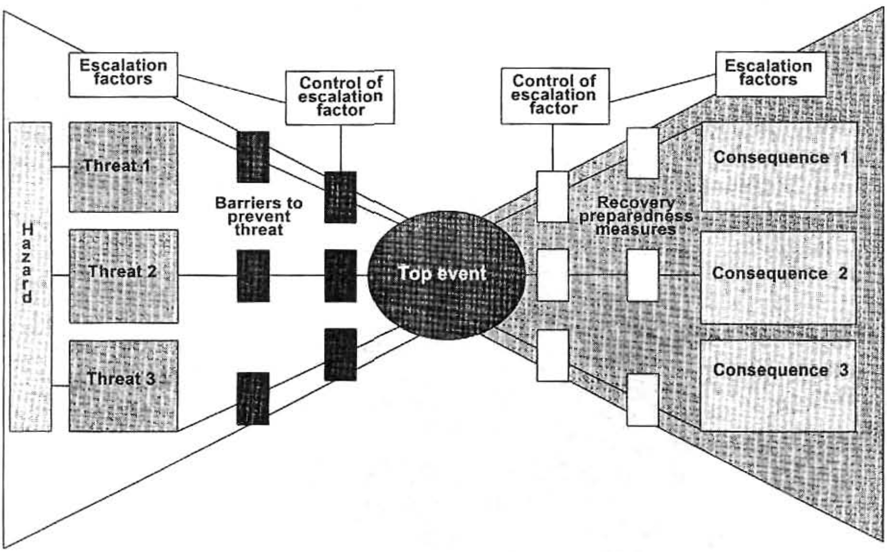

Figure 4 : The "bow-tie" concept has been found to be an extremely useful representation of HSE management and is readily understood at all levels in organisations.

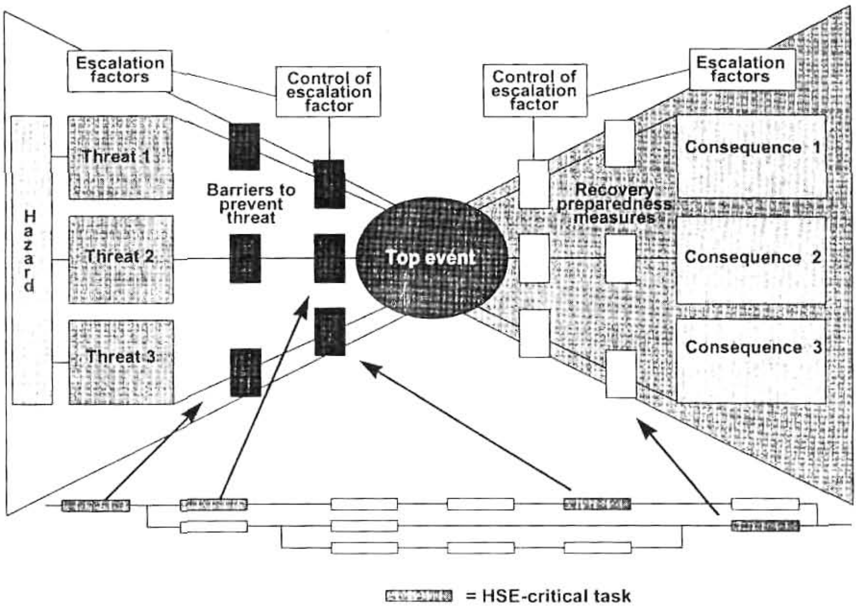

Figure 5 : The identification of the risk controls is insufficient in itself. Linkages need to be made to "HSE-critical tasks" which put into place or administer the controls.

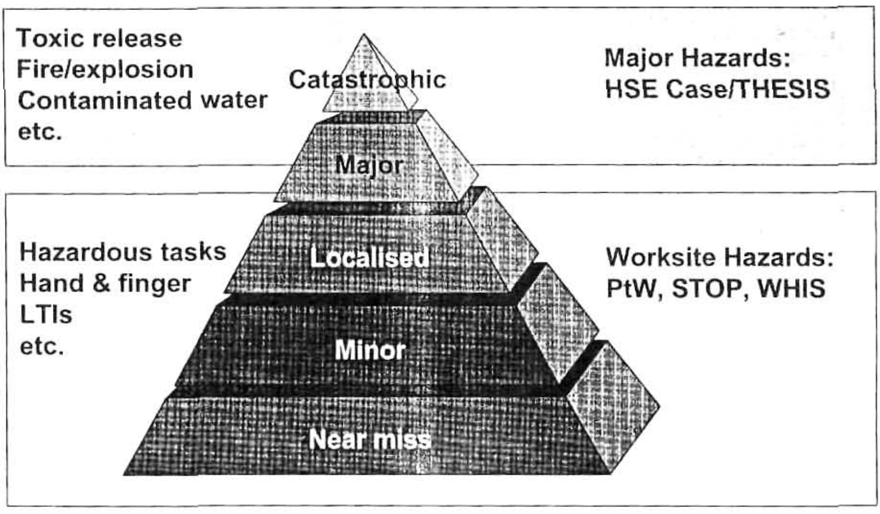

Figure 6 :The range of hazards to be managed

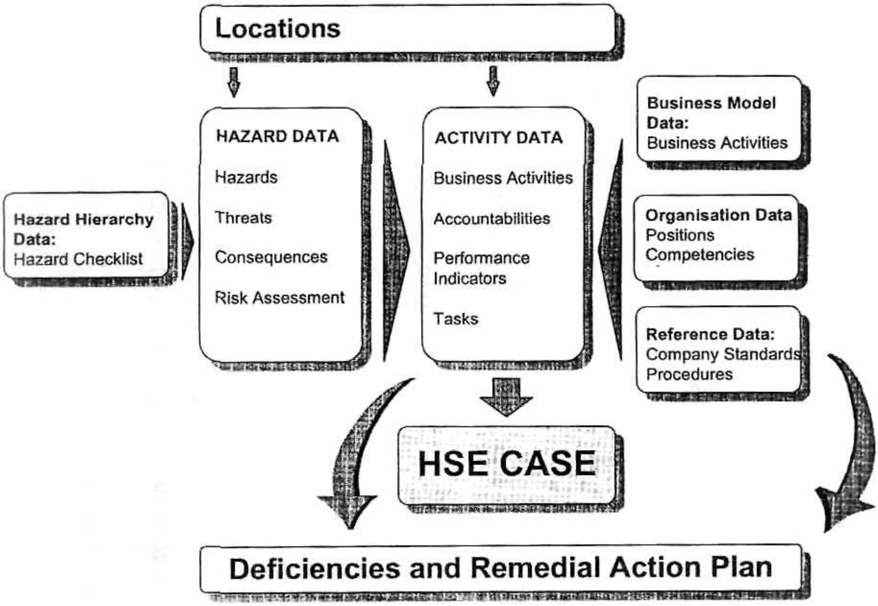

Figure 7 : Illustration of the information that may be held within the THESIS database for a particular operation or facility and the linkages between them.

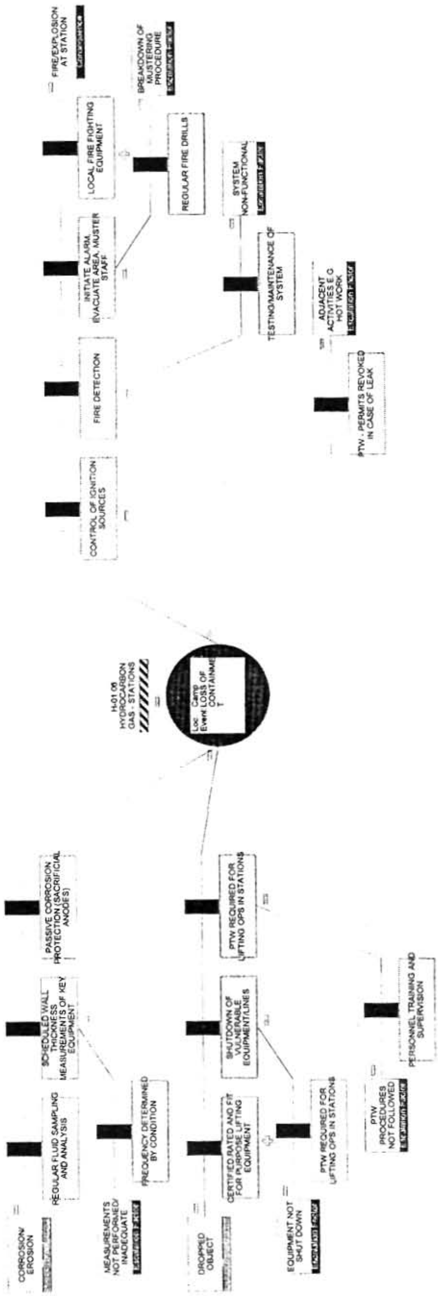

Figure 8 : Example of a Hazard "bow-tie" showing the hazards involved with the loss of containment of hydrocarbon gas.

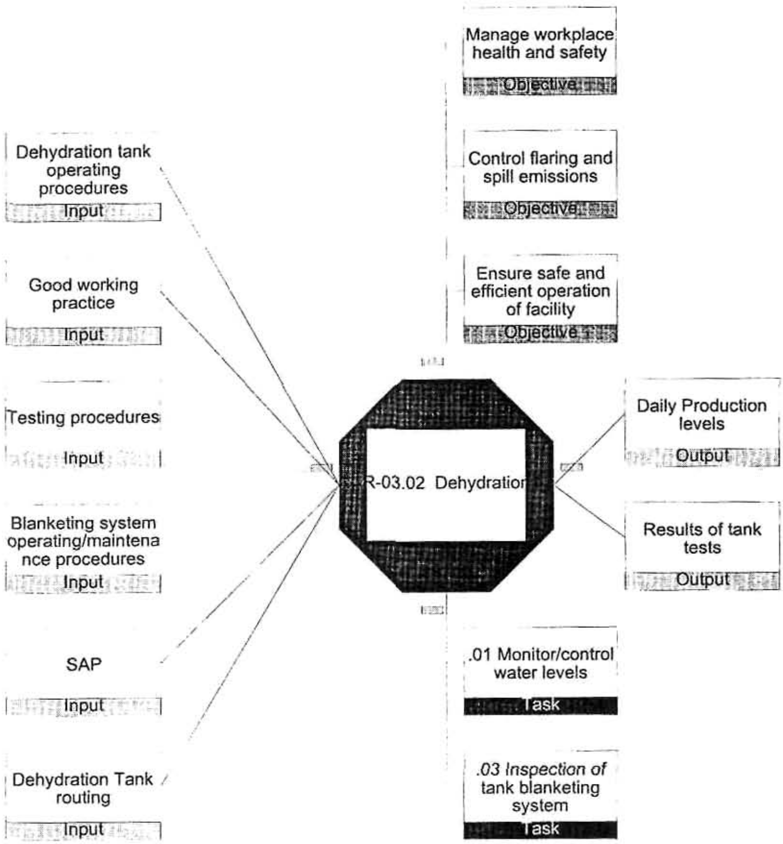

Figure 9 : Example of an Activity "bow-tie" showing the activities involved in the dehydration of hydrocarbons.