

Risk management is a widely applied management function which enables companies and organisations to identify, control and manage the risks inherent in their activities. In fast moving businesses the nature of the risks and the ability to be able to control them can vary enormously from one business cycle to the next.

Risk management



Capability statement

Entec

Entec is one of the UK's largest environmental and engineering consultancies. Our technical and business skills are dedicated to delivering strategic, technical and engineering solutions which bring commercial benefit to customers at home and overseas. This know-how is based on over 60 years' consulting experience in the public and private sectors.



Certificate No. FS 13881

Certificate No. EMS 69090

Entec operates a Quality Management System in accordance with the latest requirements of the international standard BS EN ISO 9001 and an Environmental Management System compliant with BS EN ISO 14001. Both are audited by BSI Management Systems.





Risk management

Companies that recognise that risks can be identified and controlled in a structured way can substantially improve their competitive positioning by actively managing the risks they carry. Entec has an extensive track record in working with companies to enhance and add value to the risk management function in client organisations. The expertise available from Entec helps our clients to remain profitable and competitive by addressing risk issues in a consistent way.

Benefits

Entec can demonstrate that a properly thought out approach to risk management can return substantial benefits. Well proven methodologies that have helped transform the way companies manage risk can be applied in a transparent way that enables the client to fully understand the nature of the risk exposure and the likely consequences if action is not taken.

We devise bespoke solutions to your risk management problems and recommend solutions that bring very real practical, regulatory and financial benefits.

Typical benefits include:

- Better business planning to avoid potential liabilities and costs
- A clear sense of priorities for action to minimise the risks associated with the business
- Minimum down time associated with poor project planning
- Improved safety and environmental performance
- Improved regulatory compliance
- Improved process performance and product yields

Services provided:

- ▶ Corporate risk/policy development
- ▶ Operational solutions
- ▶ Management systems
- ▶ Research & development



Why Entec?

Our Risk Management capability comprises a group of professionals that have a diverse range of risk experience across a number of key sectors including oil and gas, transport, industry, professional services, power, central and local government, minerals and mining, water and waste. We are well known for our generic interests in environmental and safety risk, and this expertise is supported with a track record in:

- Process safety studies including:
 - Fire safety
 - DSEAR (ATEX) requirements
- Management system implementation
 - Safety management and integrated systems
- Human Factors
 - Ergonomics
 - Staffing assessment
 - Workplace health



- Safety culture
- Risk perception
- Quantitative risk assessment
 - Hazard and risk analysis
 - Availability, Reliability, Maintainability
 - OBRA
 - FLIDS
 - Safety Integrity Levels (IEC 61508 & 61511)
- HAZOP (Hazard and Operability) studies
- Safety report and safety case preparation
 - COMAH, Pipelines, Offshore, etc
 - MAPP, MAPD
- Expert witness work
 - Accident investigation
 - Major hazards and land use planning
- Emergency response plans review
- Environmental risk management
- Pollution risks (air, water and land):
 - Contamination
 - Environmental impact
 - Human health
- Project risk



Risk management process

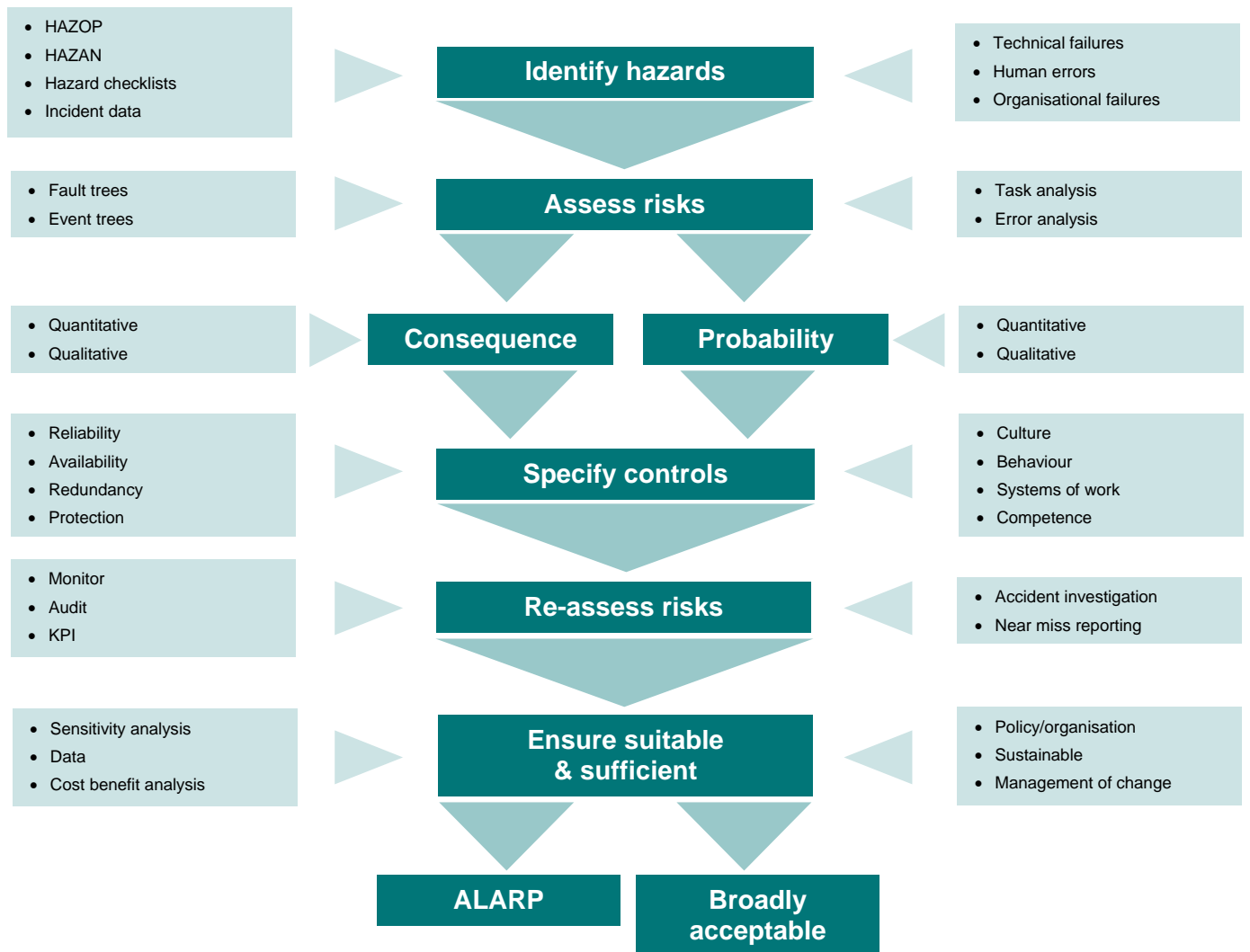
To effectively manage your risks you need to ask three basic questions:

- What are the risks inherent in your activities?
- Are the risks acceptable?
- What is the management intervention required to control the risks?

The risk management process involves:

- Hazard identification. Identify and characterise the circumstances or practices which lead to risks being taken.
- Risk estimation. Estimate the level of risks associated with the hazards taking into account the likelihood and the consequence.

- Assess acceptability. Assess measured risks for acceptability against a set of fixed criteria.
- Management intervention. Develop practical risk control alternatives and take appropriate action.
- Control and review. Establish systems for monitoring implementation and review ongoing effectiveness.



Risk management

Entec can provide you with a complete risk management service that applies this process in its entirety or selectively delivers parts of the process. To support these steps in the risk management process the following tools and techniques are available:

- Hazard identification
 - HAZOP (Hazard and Operability) studies
 - FMEA (Failure Mode and Effect Analysis)
 - Workplace inspection and surveys
 - Checklist
- Risk estimation
 - Risk calculation
 - Consequence analysis
 - Frequency analysis
 - Risk representation
- Acceptability assessment
 - Individual criteria
 - Societal criteria
- Management intervention
 - Risk elimination, prevention or mitigation
 - Risk ranking and cost/benefit analysis
- Control and review
- Management system implementation



In any risk management strategy there are four basic types of management intervention:

- Elimination: By removing the hazard or using an alternative non (or low) hazard process or materials
- Mitigation: By improving hardware, systems or reducing the potential for human error
- Retention: Can be either intentional or inadvertent
- Transfer: By contract or insurance cover
- Avoidance: By ceasing activity

The full range of these techniques may be deployed in Quantitative Risk Assessments (QRA) where justified. However, in many circumstances this depth may not be required and the techniques will be tailored to suit the severity of the consequences and the significance of the risks that you are considering. Minor risks can be assessed, for example, with simple inspection and risk ranking methods. In these circumstances a risk ranking matrix can be defined, combining the likelihood with the severity. Furthermore, a full range of human factor services are also provided.

Case studies

The following pages demonstrate Entec's capabilities in the area of risk management, using case study examples. ►



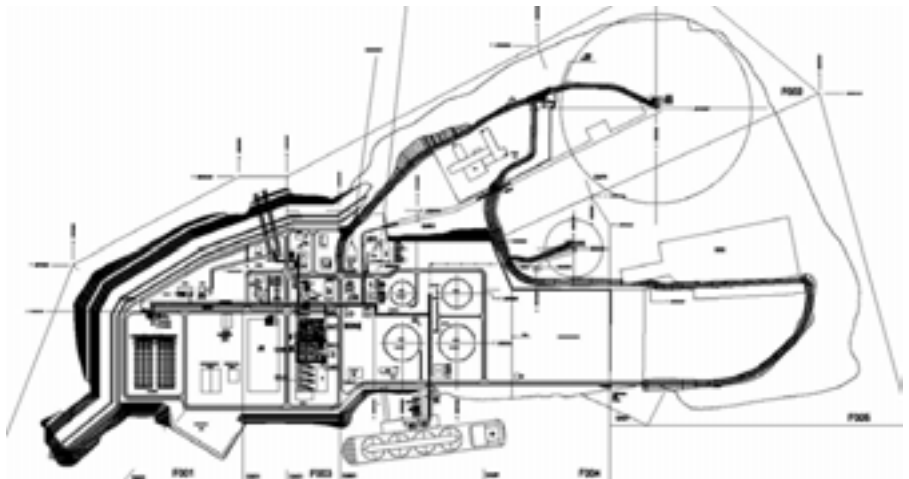
Safety Advice for Hammerfest Liquefied Natural Gas Terminal Tractebel Industry Engineering (for Statoil)

Entec was commissioned by Tractebel Industry Engineering to undertake various safety services for the design and construct contract they were undertaking for Statoil and Linde. The scope of the contract was for the storage and loading facilities for the Hammerfest liquefied natural gas (LNG) terminal to be located in northern Norway. The equipment covered in this work included 2 x 125,000m³ LNG storage tanks handling LNG at 145mbar and -168°C, 1 x 45,000m³ LPG storage tank and 1 x 75,000m³ condensate storage tank, pipelines, jetty and loading facilities.

Entec's scope of work included:

- a detailed quantified risk assessment (QRA) for the storage and loading package;
- a review and update of the design accident load for the facilities;
- analysis of the potential for escalation of incidents;
- a hazardous area classification review for the facilities;
- a fire safety analysis for the facilities; and
- an emergency plan for the storage and loading facilities.

The safety advice involved spending a number of weeks in the contractor's office



as part of the team. This included working closely with the various disciplines of the design engineers to agree the appropriate approach for the various aspects of the work that needed to be covered.

The QRA involved the use of PHAST computer software for consequence modelling, which provided input to the risk assessment model SAFETI. The risks associated with the plant were evaluated against Statoil's in-house criteria for tolerability and the design was modified to reduce the risks, where possible, to an acceptable level. For example, impoundment basins for the LNG, LPG

and jetty locations were sized large enough for containment of 'reasonably foreseeable events' but not so large that the thermal radiation levels from fires within the basins were unacceptable. For determining thermal radiation levels from elongated basins the software model BREEZE (based on the USA GRI model) was used.

In the fire safety analysis the location of fire, gas, and smoke detectors was defined as well as the location of the emergency shutdown buttons for the plant. This was done in conjunction with the requirements of the emergency plan.

The whole package of work was delivered on time (within 4 months) by a team of experienced engineers working on different aspect of the project.

The approach adopted allowed issues to be resolved promptly, provided expedient advice to the design team allowing them to keep up the momentum in the design of the plant and helped them to keep to their contractual schedules. The advice provided has allowed the risks to be reduced to tolerable levels and to meet ALARP requirements identified in Statoil's health and safety strategy. Cost savings were achieved without compromising safety; and were further boosted by demonstrating that some additional, planned precautions had no significant safety benefit.



By courtesy of Statoil



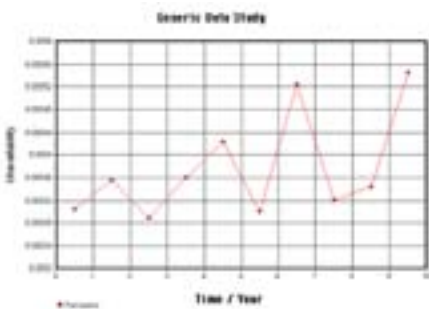
Crude Oil Terminal and Pipeline Transportation Network Availability, Reliability and Maintainability (ARM) Study Transpetro

Transpetro is the wholly owned subsidiary of the Brazilian state oil company Petrobras. The company is responsible for operation and maintenance of the crude oil and products infrastructure (terminals and pipelines) network in Brazil. Transpetro commissioned Entec to undertake an availability, reliability and maintainability (ARM) study of the TEBAR-OSVAT crude oil transportation network. This network handles 50% of the Brazilian national import of crude oil and consequently it is strategically very important for the company as well as the country.

Crude oil is imported from the Campos Basin in the southern Atlantic Ocean to the Terminal Admiral Barossa (TEBAR). The terminal at São Sebastião has over 20 crude oil storage tanks each having a capacity of 80,000m³ and it is strategically one of the most important both for Transpetro and for the country. One of the functions of the terminal is to transfer the crude oil along 275km of the OSVAT system pipelines to the refineries at REVAP and REPLAN.



Assessing crude oil infrastructure in Brazil



The study was to investigate the current system configuration and alternative configurations for optimisation and evaluate them for their impact on reliability, availability and cost/benefit ratio. The study investigated international performance and benchmarks against Transpetro system performance. To allow this to be undertaken a database of generic failure rates was compiled. Failure rates for pipelines were included as a Weibull probability of failure distribution.

The reliability software AvSim+ was used to build a reliability block diagram of the whole network. Key inputs to the blocks are the failure rate data of individual components including mean time to fail (MTTF) and mean time to repair (MTTR).

The study identified some important features of the system including some common cause failures that have the

potential to shut down the network.

The study was able to determine the impact of these failures and what increased reliability can be obtained from the system if improvements were made. It was able to compare the costs and benefits of different options. The study evaluated the use of additional pumps to increase the system capacity, as well as duplication of some key equipment items that were less expensive.

The reliability model developed allowed an evaluation of the current and potential future performance of the system using different configurations. The approach allows a critical assessment of the system and provides an important element into the decision making process for upgrading and future assessment of the terminal and pipeline network.



Pipeline HAZOP and Safety Studies, India Gas Authority of India



Safety studies for the longest LPG pipeline in the world

The Jamnagar to Loni LPG Pipeline, at some 1250km long, is the longest pipeline carrying exclusively Liquefied Petroleum Gas in the world. It has three dispatch terminals and nine receipt terminals, where the LPG is transferred to storage spheres for bottling and bulk transportation.

The Gas Authority of India Ltd (GAIL) is moving to the supply of LPG by pipeline as part of a strategic decision. The safe and successful operation of the line is of paramount importance and GAIL required that the safety reviews were conducted by a company with a high regard and reputation in the industry.

In 1998, Entec undertook a 'HAZOP' study of the design by Engineers India Limited, together with representatives from GAIL. A detailed report was prepared and the actions followed up. In

December 2000 the pipeline was commissioned and a second hazop study and safety review was undertaken early in 2001. This was to review the design as installed, and in particular, any modifications from the first hazop. It also looked into the application of the actions from the first hazop and how effectively they had been incorporated into the design. The study was able to use operational experience gained in the first few months of operation to discuss and resolve some of the issues that had arisen. A site visit to one of the receipt terminals was included, which acted as a safety audit of the design and operation.

The client is very pleased with the success of the project to date and is considering retaining Entec for further safety studies and HAZOP studies for this, and other, planned LPG and LNG pipeline projects.



Peer Review of Accident Investigation and Risk Assessment Gutteridge, Haskins and Davey

Entec was commissioned to perform a 'peer review' of the accident investigation and risk assessment carried out by a contractor, following an incident during the remediation of the former Maralinga nuclear weapon test site in Australia.

During application of the in situ vitrification (ISV) process on pit 17 at the Maralinga site, an explosion occurred in 1999 which caused severe damage to the ISV equipment, and expelled some of the contents of the melt.

The operator of the process, Geosafe, was asked to provide an incident review report. A team from Entec and RobSearch Australia Pty Ltd. (Robsearch), was commissioned by Gutteridge, Haskins and Davey Pty Ltd. (GHD), the project manager for clean-up of the site, to review the incident report and undertake a risk assessment of the ISV process.

The approach taken was to:

- review initial information (including historical information, witness statements geological data, video footage of the incident, etc.);
- review the approach taken by Geosafe and its consultants in carrying out the incident investigation;
- review the arguments put forward for causes of the accident; and
- review the conclusions of the investigation.



*Independent review of accident investigation
on behalf of the Government of Australia*



Employee Involvement and Communication of Health and Safety in the Construction Sector Health and Safety Executive



*Best practice
examples of employee
involvement in health
and safety, and how
health and safety
can be effectively
communicated*

The Health and Safety Executive (HSE) provides advice and guidance to employers about how health and safety hazards can be managed in order to safeguard the health and safety of employees and the public. This guidance may be provided through the HSE web site, in technical research reports or concise, user-friendly guidance booklets. The research and development of such guidance is often commissioned externally. Entec has assisted HSE in developing a number of such documents.

This project investigated the extent of employee involvement and current approaches for communicating health and safety. A telephone survey was conducted across a sample of construction companies in the UK. The survey highlighted the extent to which employers involve their workforce in health and safety management and the methods by which they achieve this, as well as highlighting the range of methods used to communicate

health and safety issues. A number of organisations demonstrating best practice approaches were identified, including small as well as large organisations. Interviews were conducted with a range of stakeholders in each organisation, such as health and safety professionals, senior management and employees. These discussions formed the basis of case studies demonstrating how health and safety can be more effectively managed through employee involvement in decision making and effective communication.

The case studies will be launched on the HSE 'Working Well Together' web site and published as part of HSE's 'Contract Research Series', providing valuable advice to employers seeking to improve their health and safety performance.



Workforce Health and Safety Benchmarking Balfour Beatty Rail

Owing to the increased accent upon health and safety in the rail industry and the focus upon rail maintenance and renewals operations in the light of industry events, Balfour Beatty Rail's management wanted to benchmark its health and safety performance against current best practice across industry. Particular focus was given to the maintenance and renewals organisations and how they operate, and the findings from the study fed into a fast track performance improvement programme, which was piloted in one of the maintenance regions.

Entec has wide experience of the application of risk and health and safety management techniques / tools, to a variety of business sectors. Entec's health and safety benchmarking tool incorporates an objective grading system for

performance against best practice measures, and a scoring system which may be used by organisations for setting health and safety performance improvement targets.

Based on total quality management (TQM) principles, the benchmarking tool incorporates the analysis of recognised performance parameters, such as effective risk management, attitudes to risk, resourcing (human, financial and hardware), communications and learning by the organisation. A 'slice' was taken through Balfour Beatty Rail's organisations from top to bottom. By interview, review of health and safety documentation and observation of work being carried out 'on the ground', the organisation was benchmarked against best practice parameters that are pre-set into the

questionnaire framework. The output from the benchmark process was a report detailing issues and action points, which was intended to form the basis of improvement action plans. The tool provides a 'ready reckoner' on performance and can be revisited as action plans are executed, to compare past and present performance.

The fast track improvement programme took outputs from the benchmarking study. With the co-operation and input of staff at all levels in one of the regional organisations of the maintenance division, some 'quick win' improvements were generated that could be rolled-out across the organisation, to encourage both workforce involvement and consistency of health and safety performance improvements.

The features and benefits of this approach were that:

- the management and 'men on the ground' questionnaire formats highlight different attitudes down and across the organisational structure;
- the combination of interview, observation and system / documentation review provides a robust mechanism for highlighting and cross-referencing issues;
- outputs are easy to interpret and act upon;
- the tool provides a scored result to gauge past and present performance; and
- the tool can be used across business units or departments within an organisation, or to benchmark against competitors in an industry.



Benchmarking Balfour Beatty Rail's health and safety performance against current best practice



Assessing the Safety of Staffing Arrangements for Process Operations in the Chemical and Allied Industries Health & Safety Executive

This study has been completed on behalf of the Hazardous Installations Directorate (HID) of the Health and Safety Executive, who have observed that a number of chemical sites are taking steps to reduce staffing levels in their operating teams. There is a concern that such reductions could impact the ability of a site to control abnormal and emergency conditions, and may also have a negative effect on staff performance through an impact on workload, fatigue, etc.

A method has been developed that emphasises when too few staff are being used to control a process. It is not designed to calculate a minimum or optimum number of staff, however, if a site finds its staffing arrangements 'fail' the assessment, it is not necessarily the case that staff numbers must be increased as other options may be available. The method also allows duty holders to benchmark how they manage staffing arrangements.

The method has been trialed and from the experience and comments of those participating, it is judged that the method brings staffing issues into the open, is practical, useable and intelligible to duty holders and inspectors, and is robust and resistant to manipulation and massaging of its output.

This work was funded by the Health & Safety Executive with additional support from the companies involved in the case studies. The research and results are published in the Contract Research Report: HSE CRR 348/2001.



*Systematic method to address safety issues
associated with staffing arrangements*



Provision of Expert Reports, Opinion and Expert Witness to the Ladbroke Grove Rail Inquiry Lord Cullen's Inquiry Secretariat



Independent expertise for the public inquiry into major railway disaster

Lord Cullen's Inquiry into the Ladbroke Grove accident retained Entec in October 1999 to provide independent expert advice and opinion on wide-ranging aspects of safety in the railway systems throughout the UK.

Four specific reports were commissioned and presented in expert witness form to the inquiry. A summary of findings is as follows:

- **The Railway Safety Case Regime:**
The approach in the UK to regulation of the privatised railway industry, involved the production of 'safety cases' to demonstrate safe operation by the infrastructure controller (Railtrack) and each train and station operator. In the past, the train and station operators' safety cases were accepted by Railtrack, under a system described in its safety case. Each operator retained responsibility for its own safe operation, and Railtrack was responsible for safety of the track and signalling systems, plus the stations it operates. Entec has reported on what a safety case should do, and on how its contents may be validated and verified by internal and external audit. An addendum report was produced on the contents and use of a selection of railway safety cases and the compliance audits carried out on the same operating companies, illustrating both good practices and deficiencies in the current regime.

- **Safety Management and Culture:**
The railway industry has the clear potential to kill or injure many people, amongst employees and the public alike. In common with other hazardous industries that are governed by stricter safety regimes, such as oil, gas, chemicals and air transport, safety should also be paramount in railway operations. Individual and collective safety responsibilities need to be clear, and not clouded by commercial considerations. The principle of 'safety first and last' should pervade the whole industry; all personnel need to be aware of their responsibilities, and have a clear appreciation of human factors. In practice, financial penalties and adverse publicity associated with delayed or cancelled trains may be perceived as more important than the consequences of failure to maintain the highest standards of safety. Nevertheless, operational safety tends to go hand-in-hand with reliability and efficiency, and vice versa, so emphasising the basic imperatives for effective integration of safety and operational management systems.
- **Group Standards System:**
The UK has set up a goal-based safety regime, the primary regulatory instrument being the safety case to demonstrate safe operations. There is a need for common standards, particularly where a number of rail

operators interact with each other and with the infrastructure controller. In the UK, these standards have been controlled by a directorate, related to Railtrack. Some parts of the industry believe that the directorate has not always acted in the best interests of all participants, and that there has been evidence of the potential for conflict between the goal-setting safety case approach and prescriptive standards.

- **Accident Investigation:**
The primary purpose of accident investigations should be to learn lessons to prevent recurrence of similar incidents. In a fragmented industry, such as the rail system, investigation can be led into apportioning blame and unloading corrective actions onto others. In this situation, improvements are not made, and the same mistakes do recur. This is not to say that people or organisations are not to blame for accidents, but the investigation should probe deeply enough to uncover the fundamental causes, and not merely lay blame for behaviour which had its roots in a defective system of operating safety and safe working practices.

The inquiry also commissioned our experts to attend specialist seminars on the employees' perspective on safety, and an experts' meeting on risk assessment, to assist the inquiry in these detailed and controversial areas.



Risk management

Sample client list

Associated Octel	Millennium Inorganic Chemicals
Balfour Beatty Rail	M W Kellogg
BASF	Nalco Ondeo
Bord Gais Eireann	National Grid
BP	Northumbrian Water
Clifford Chance	Petrobras
Clyde & Co	Portland Port
Commonwealth of Australia	Qatar General Petroleum
Contract Chemicals	Shanks
Distrigaz (Fluxys)	Shell
Egyptian General Petroleum	Sofregaz
ExxonMobil	Southern Water
Fire Research Development Group (Home Office, Department of Transport, Local Government & the Regions, Office of the Deputy Prime Minister)	Syngenta
Gas Authority of India	Synthomer
Gloucestershire County Council	Tata Power
Health & Safety Executive	Texaco
Huntsman Chemicals	TotalFinaElf
Indian Petrochemicals Corporation	Tractebel
Ladbroke Grove Rail Inquiry	Transco
London Fire Brigade	United Utilities
Lovell White Durrant	Warwick Chemicals
	Wessex Water
	West Berkshire District Council



Risk management

Entec

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