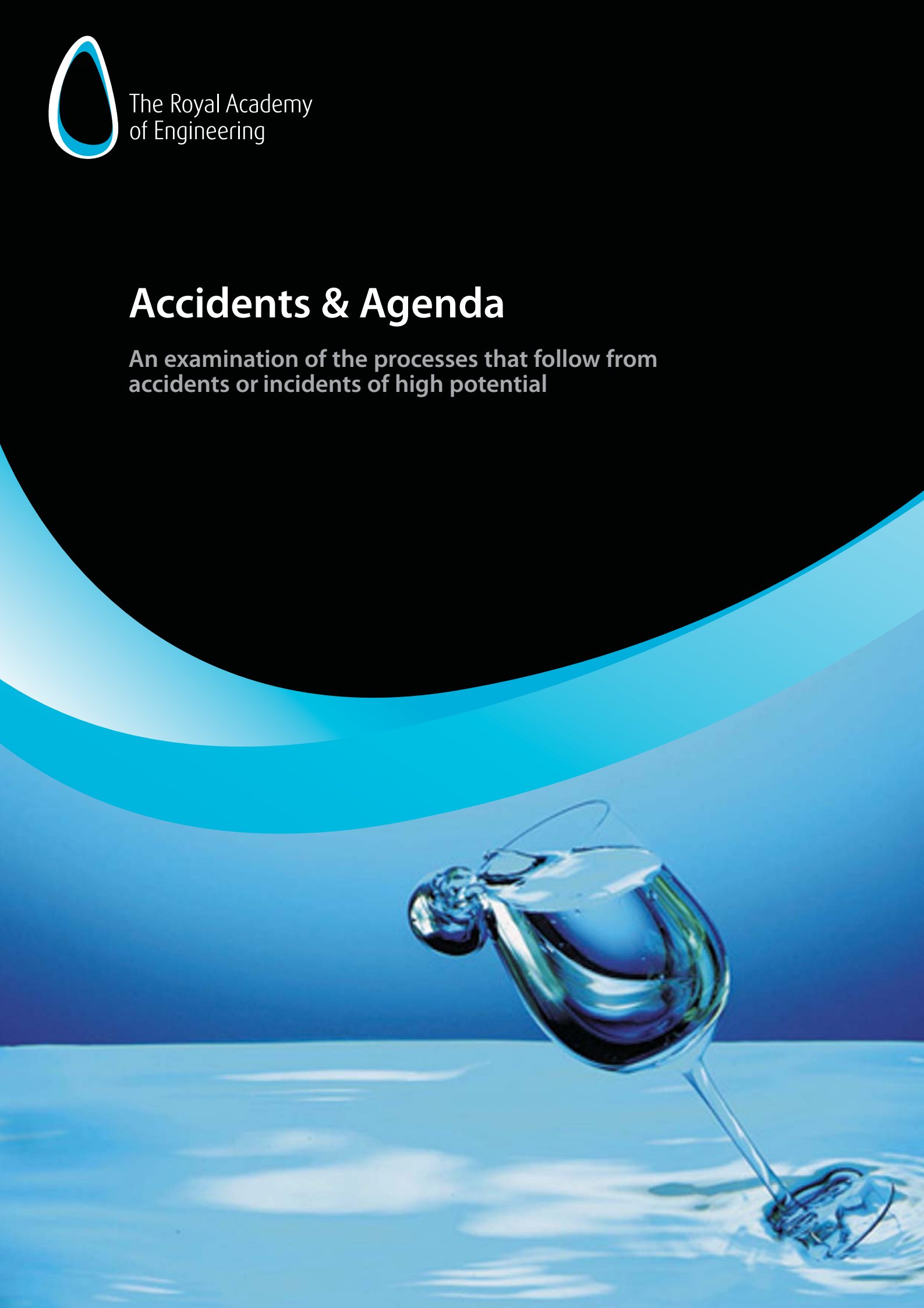
The Royal Academy of Engineering

Accidents & Agenda

An examination of the processes that follow from accidents or incidents of high potential



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Accidents and Agenda

An examination of the processes that follow from accidents or incidents of high potential in several industries and their effectiveness in preventing further accidents

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Foreword

A Community Learning from Experience

One of the civilising forces is learning from experience. Technical advance falters when our control over machines fails and accidents occur, although progress is nevertheless made if we understand why these events happened. Increasingly such understanding is beyond the ordinary citizen who often sees only the end result of our complex systems that are assumed to be safe and reliable.

Citizens may, in taking these things for granted, assume that everything about them is known and that they will go on providing generations of people with services without any reverses. A moment's reflection dispels that thought. Firstly, because most systems are in constant evolution as we continue to learn new things and wish to incorporate them. Secondly, because all these systems work with, indeed usually depend upon, that most inconstant of resources the human mind. Sometimes these come together in what is popularly called an "accident" – a disastrous combination of circumstances that results in people killed and maimed and in property destroyed and the environment damaged.

Today's world supplies us with a vast range of products and services. Some of them use tremendously powerful forces and when these get out of control their potential for damage is great. It is evidently desirable that we should prevent accidents occurring but it is particularly necessary that we should learn from any failures that do occur in these systems, so that we can make them safer and can create new generations of systems that can be operated more safely.

In the aftermath of an accident there may be several separate agenda according to the role of the individual or group. Victims will look for "justice", investigators will look for truth, individuals may seek to evade or attribute blame, others may seek to prosecute and hold companies or individuals to account.

This Report is an examination by the Academy into these issues and explores ways in which the process of investigation after an accident or serious incident may be improved.

Executive Summary

The Academy wanted to look at accidents in industries in which potentially large forces or dangerous substances could cause severe consequences in terms of loss of life, injury, and plant or environmental damage. What it found through the work of this group was:

a) That the situation in these sectors is variable but overall the UK industrial safety record is good with a number of separate processes contributing to a low accident rate.

b) That the situation will become more challenging, as control systems become more complicated and extensive in the processes they control.

c) That a number of improvements to performance in these sectors should be taken forward if good performance is to be made more usual under these challenges.

The Report addresses the origins of the Academy's concerns for safety in highly complex and powerful plant. It sets out the previous contributions of the Academy and discusses the aspirations for this Report. The nature of the area of concern is discussed and the aspirations for the Report are considered.

The record of the UK in industrial accidents compares very favourably with other nations in Europe. On two basic metrics of accident rate relevant to the focus of the Report we are near to the best in Europe. We conclude from this that our basic approach is good but there remains the possibility of making further improvements. It is probably this constant attention to improvement that has already delivered our present good performance and more of the same is therefore required. This is likely not to give rise to radical change but to a broad front of improvements.

The Report addresses the particular class of accidents of concern to the Academy - those that use complex control systems to manage the containment of powerful forces, or dangerous materials in bulk quantities that have the clear potential for serious injury and damage if the containment breaks down. The Report excludes a number of areas of accidents including road transport, hospitals etc. where these large forces, or dangerous materials are not present actually or potentially.

Much of what we say about this class of accidents, and about incidents that have the same potential, is valid also for many accidents and incidents of a lesser kind. But the generality of accidents is not our specific concern.

The focus of the Report is discussed in terms of the severity of the class of accidents within 7 industrial sectors:

- Aviation
- Chemical
- Construction
- Nuclear
- Offshore Oil and Gas
- Rail
- Marine

Each sector is reported on by an expert in the field and these reports are included in full in the accompanying CD-ROM. As well as these sector articles we have included transverse reports that are applicable across the span of sectors.

During and After the Accident

This major section begins with a consideration of the range of agencies that may become involved in the accident or in its consequences and recovery.

The Report discusses the kinds of developments that will take place in the immediate aftermath of the accident as well as in the following 24 hours and in the longer term. During this period the leadership of the investigation will become established and witnesses will begin to give their knowledge of events.

The challenges to the effective management of the investigation in to cause are discussed along with possible ways in which these may be further alleviated. Finally in this section the different kinds of inquiry are considered.

Accident Prevention through Feedback

The Report moves on to discuss the nature of accident prevention through feedback and in this class of accident how this works through the cycle of developments; from investigation to distributing knowledge gained to learning something from that to making plants and systems better for the future. Some of the obstacles to making this process fully effective are discussed.

Routes to Improvement

This major section of the Report discusses the practical and realistic steps that could be taken to give the public more reassurance that these complex and powerful plants and equipments are being managed as safely as is possible within present knowledge. It deals with every stage of the post-accident process from investigation through dissemination to receipt and learning to actually doing something about it.

Conclusions and Recommendations

Our study of these accidents and of incidents that could easily have developed into major accidents did not reveal that any radical change in the British approach is called for although sustaining these standards will become more difficult in future. Accident rates compare favourably with most other countries. There are some areas that could contribute to even lower accident rates and the outlook for the future is one that suggests that constant attention to these topics will be needed if accident rates are to be kept at their present low level.

We reached five main conclusions

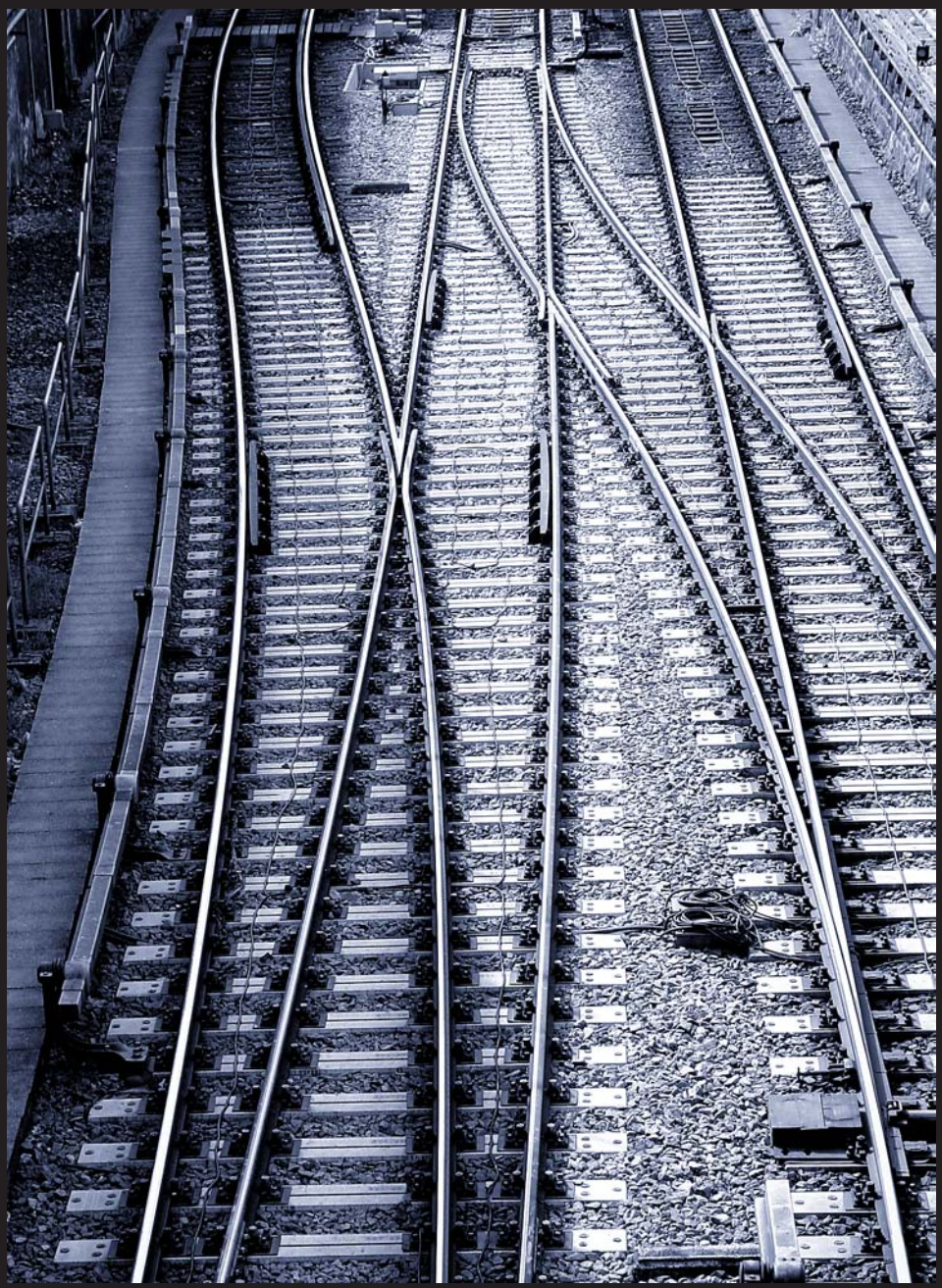
a) The primary aim of any post accident investigation into cause should be to allow accidents having similar causes to be prevented for the future.

b) After a serious accident it is important to the quality of the appropriate investigation that a decision on the agency to lead it should be reached quickly.

c) There are significant challenges ahead in sustaining low accident rates in powerful plants and equipment as control systems become more complex.

d) Incidents that by chance fall short of developing into major accidents should attract an equal intensity of investigation if they are to serve as sources of insight into causes and allow future accidents to be prevented that may not benefit from the same fortuitous chance.

e) A powerful contributor, possibly the most important one, to preventing accidents is by companies and individuals learning from those that do happen, digesting their causes and consistently applying them throughout their own organisation wherever it is relevant to do so.



1 Introduction

1.1 The Academy's previous contributions

1.1.1 The Royal Academy of Engineering took a keen interest in marine safety matters as a consequence of the sinking of the *Herald of Free Enterprise* in 1987 and the sinking of the *Estonia* in 1994 issuing a statement on the safety of Ro-Ro ferries in 1995. Subsequently, the Academy submitted evidence to the House of Commons Transport Select Committee inquiry into Cross Channel Safety later that year. The debate precipitated by the Academy's statement eventually led to the adoption of new regulations for Ro-Ro ferries.

1.1.2 The Academy also responded to the Department for Transport consultation on the establishment of a Rail Accident Investigation Branch (RAIB) in October 2002. The Academy broadly welcomed the move to establish the RAIB along similar lines to the Air Accident Investigation Branch (AAIB) and Marine Accident Investigation Branch (MAIB), offering only minor additional suggestions concerning the protocols to be put in place to manage the RAIB's interaction with other bodies such as the British Transport Police and the Health and Safety Commission.

1.2 Current concerns

1.2.1 The last several years have seen a number of serious accidents and failures in major systems on which companies, employees and the public depend. It is asserted by some that public confidence in the systems of modern life is reducing with possible long-term consequences. At the same time our society is getting ever more litigious and the disposition to call institutions and individuals to account is at unprecedented levels. The media who quite often shape public opinion, but, in at least some degree, do reflect public concern, view these serious accidents as very news-worthy.

1.2.2 Modern society responds to such events very differently than did our forebears. Investigations that are wholly independent are now more likely to be demanded. Often there is a call for public or judicial inquiries. There is a more entrenched belief that when things go wrong somebody must be to blame and a more frequent suspicion that there are matters being hidden from view.

1.2.3 In many cases pressure for a particular kind of investigation appears to be brought about by the victims of an accident or their relatives. It seems to follow from this more litigious approach that people whose lives are affected by a major event of this kind want to see "justice" done and the suffering they have endured to be recognised, for responsibility to be accepted and for their suffering to be compensated. The concept of an "accident" or, in older language "an act of God" has less currency these days as the tendency to search for someone to blame has increased and engineers are expected to be more in command of nature than their predecessors.

1.2.4 Where the accident involves some major public system or carries risks for the public there are other concerns (see also section 1.2.6. and 2.3.) that must also occupy focused attention if a similar event in the future is to be made less likely. In all of this the operator of the system also has an interest. Coincident with a, normally, genuine desire to find what went wrong and to remedy any deficiencies, the operator also has to be left, in most cases, with the ability to carry on its operations. Draconian remedies that make the system inoperable by the application of excessively cautious safety measures must also be resisted. Finally there is the interest of the public both here and abroad. A post-accident process that presides over a slow reduction in public confidence, even whilst it succeeds in other areas, would seem to be one that fails to use every accident as a means to improve performance and thereby progressively to increase public confidence.

1.2.5 The public searches for reassurance. In media reports there will often be calls to make sure that "in future the XYZ system is absolutely safe" and this reveals the widespread misapprehension about risk in our society. There is, for example, little understanding in the population generally about such concepts as ALARP "As Low As Reasonably Practicable" which recognise that safety measures need to be balanced against their cost and

impact on the operation. Very few systems lend themselves to any notion of absolute safety, or even "as safe as possible" but in the emotional aftermath of a newsworthy accident even the suggestion that the probability of an accident had been present in the design or operation might well be painted as an admission of some kind of guilt.

1.2.6 It is clearly not the case that the public can reasonably be expected to take a homogenous, rational and informed view of safety. Very often we see that the public take up varying positions often based on sketchy and incomplete knowledge. In the area of public information the public may be helped by government and industrial information that is presented not only at the time of an accident but also available at other times.

1.2.7 All of these interests are legitimate. Their weight and importance may vary from case to case and there may be no single approach that will meet all of the pressures that will be exerted in the full range of circumstances that can be expected to arise. This Report sets out to examine this range of agenda and to examine the extent to which the post-accident processes that are currently being used in different sectors are similar and how successful they are at meeting the desirable objectives of the process.

1.3 An aspiration for the Report

1.3.1 This Report is a response to a number of conversations in the Academy that echoed concerns about safety and risk in a modern society. Engineering is often at the heart of modern systems and there was a clear sense that the Academy should add to the debate on these issues especially perhaps in more complex systems. Our overall aspiration was to contribute to reducing accidents and to a safer society.

1.3.2 Observation tells us that industry increasingly emphasises accident prevention and there are a number of processes for anticipating and avoiding accidents in design and operation such as Hazard and Operability Studies (HAZOP) and learning from accidents. Preventing accidents is highly beneficial in both lives saved and damage done when compared to letting them happen. The processes are becoming international and increasingly lessons from one country are applicable to others. But this process starts from the investigations of cause and goes through a cycle of investigation, dissemination, learning and application all of which we shall consider

1.3.3 In contributing to the public debate the Academy recognises that just looking at how engineering causes are determined and corrected is too narrow a view even though its importance may be very great. We therefore consider, if only briefly, the impact of the prosecution of people thought to be at fault and the ways in which these two investigative processes can interact. We have also considered how future developments may influence the way in which we see investigations into the causes of accidents.

1.3.4 The potential scope of this work could be very wide. In the UK, about 1000 people are estimated to die each year from the unintended infection of the MRSA bacterium whilst in hospital; about 3000 die each year in road accidents; and about 4000 die as a result of accidents in the home. In contrast it is extremely rare for anyone to die as a result of a nuclear accident, or for lives to be shortened as a result of exposure to radiation from nuclear facilities. We have, however, limited our scope, confining ourselves to sectors where enormously powerful forces are routinely harnessed for the public service and where the potential for massive damage or environmental impact is present. There are three reasons for taking this view:

- Many industrial accidents occur for well-understood reasons that often combine haste, short-cuts and risk taking and much less often from misunderstood technologies. There is a major opportunity for improvement here but this Report is not its main focus. Their causes are repetitious and their potential for multiple fatalities combined with severe damage and/or environmental impact is of a lower order than those we had in mind. We wished to concentrate upon those accidents where serious technical failings might be factors.

- Systems that are complex cannot readily be understood either by the public or by individual workers in

them. The analysis of the causes of such accidents is, therefore, a matter of special importance. Accidents in complex systems that have the potential for very serious aggregates of injury and damage may therefore be caused by less than obvious factors. We wished to explore the investigation of these factors.

- Accidents in large and powerful systems are investigated in different ways and we wanted to explore whether this was beneficial or not to creating a safer environment.

1.3.5 Even within this field there is a range of accidents we could have considered. Our main concern was with those incidents that cause, or could cause, accidents that unleash the potential of the plants to cause severe damage to life, plant or the environment. By this criterion we were, for example, more concerned with accidents on the railways that concern moving trains than with accidents with a fork-lift truck in a servicing unit. We have confined our interest in the nuclear field to the prevention of incidents related to the uncontained release of nuclear radiation and excluded a range of "ordinary" industrial accidents in that sector. The accidents that we are concerned with here would normally coincide with the HSE category of major incidents (or be lesser incidents having this potential). The HSE recognise that no cast-iron definition of a major incident is possible and their guidance reflects this in defining one as "a significant event, which demands a response beyond the routine". We believe that the collection of circumstances needs to be considered which may include: the number and class of fatalities; the release of toxic or damaging materials; injury to members of the public; damage to public facilities or services; or severe damage to the environment. In each case we have taken the overriding view that the high energy of the system should also be involved in the incident.

1.4 An idealised process aim

1.4.1 Although circumstances will differ considerably from case to case we have identified a set of generic aims for a good, modern, post-accident process. The details of each case will depend upon its circumstances and there can be no hard and fast view that fits every accident. In general it will be important to distinguish between the part of the process that deals with investigating cause and the part that is concerned with prosecution. We believe that most people would want to see both of these processes succeed although the reality is that they are not wholly independent and we shall look at this interaction later in the Report. At the outset however we see that a successful post-accident process would have as many of the following attributes as possible:

- The Investigation of Cause:
  - The establishment of the full causal chain[1] of events, including broader management actions and policies as well as specific practical actions or omissions.
  - The identification of changes to policy, procedure, design, operation or use that are used to prevent that or a similar chain of events from recurring in relevant situations.
  - The capture, dissemination and absorption of more generally applicable lessons that add to the wider body of knowledge and inform the education of people concerned with future systems and make them safer.
  - The communication to interested parties, which may include the general public, of such facts as may be appropriate to their future confidence in the failed system and in others related to it.

1 "the full causal chain" is intended to include every relevant issue and answer every link in the chain of "and what led to that" with a "why did it happen that way" and reaches as far back in time and as far around the accident as it is reasonably possible to go. It is intended to embrace the concepts of omissions as well as deliberate acts, and those by people indirectly connected to the specific accident as well as those directly involved.

- Safety remedies, that whilst being entirely sufficient and appropriate against the assessed profile of risk, are neither excessive nor deliberately penalising in their impact on future operations.

- The recognition of bereaved relatives as interested parties to the accident by way of regular, open and consistent information about the progress of investigations.

- The Prosecution and Legal Process:

  - The identification of any criminal act by any persons, whether Board, management, or individual that may lay responsibility for the accident partly or wholly with one or more of these persons.

  - The punishment of those persons who have committed criminal acts relevant to the accident outcome.

  - Redress, by way of fines, constraints or other appropriate remedies, against those persons who have committed serious criminal or civil wrongs or damage.

  - The appropriate compensation of those who have suffered from the incident subject to proof or acceptance of civil liability.

2 How Safe is Britain?

2.1 The general situation

2.1.1 There is widespread concern in Britain when certain kinds of accidents occur. A train crash in which a small number of people are killed excites much interest, and this is much more sustained than, for example, a road accident in which the same numbers of people are killed. The same public takes a serious view of even minor incidents at nuclear power stations, in which no one is harmed, compared to the deaths caused by procedural deficiencies, for example in hospitals. It is inadequate to dismiss these apparently irrational responses to emotion or lack of knowledge although the public's lack of comprehension of the underlying technologies is also a factor. Train crashes grip the public imagination in ways that car crashes do not, while public fear of nuclear plants is greater still, despite their having by far the best safety record of all the industries we address. Clearly, the public attitude is mainly affected by the scale of the perceived ultimate consequence of an accident, however improbable and overstated, while frequently occurring accidents, despite causing death and injury, become accepted and lose their ability to shock. In this Report we shall assert that this is because certain industrial accidents have such a high and obvious potential for greater damage that they deserve a special consideration. It is a perception of the citizen and the media, even if not well understood, that any nuclear accident might have led to a much more serious accident with catastrophic conclusions. At the same time a single patient who dies in hospital through a deficient cleaning process is not perceived to carry any risk to the generality of the population.

2.1.2 A rational view of deaths through accident might dwell on major causes, frequencies, and probabilities of a person being involved in such an accident. If we wish rationally to avoid the chance of death by accident we should take notice of the large number of accidents in the home, the relatively few at work, and we should travel by train when we can. It is remarkable from this standpoint that the amount of "media steam" generated over road safety is in response to Britain having achieved the lowest accident rate in Europe per mile travelled by car. The response to accidents and the concern of society is apparently not therefore related always to their numbers or incidence but in large part to their character. It seems especially related to perceptions of accidents that could happen to anybody - train crashes etc. - and in those where the victims have no influence or control over the accident or its outcome and even more in those in which large numbers of people can be killed, even if they were not.

2.2 Industrial Accidents

2.2.1 Industrial Accidents (IAs) are, of course, a specific sub-set of all accidents and are governed by their own panoply of regulations and law. In Britain the principal law is the Health & Safety at Work Act 1974.

2.2.2 The principal agent for the regulation, inspection, prosecution and investigation of IAs is the Health and Safety Commission (HSC) and its operational arm the Health and Safety Executive (HSE). In the main areas of transport operations, air, sea and rail, Accident Investigation Branches (AIBs) take on similar responsibilities for investigation that are otherwise performed by the HSE.

2.2.3 IAs vary enormously in their scale, potential for damage and complexity. At one end of the spectrum there are accidents indistinguishable from those in the home – burns, scalds, dropping weights, falling from ladders. At the other there are accidents involving huge forces with the capacity to inflict death and damage over a wide area. Some accidents are caused by simple misjudgements although some of these have massive consequences as, for example, in an aircraft crash. Others are caused by complex technical installations that fail in ways not anticipated. Lesser accidents, because of their greater number, accounted for most of the work related fatalities – 227 in 2002/3 – and for most of the accidents involving serious injury – over 29,000 in 2002/3. These were subject to a variety of other investigations. The HSE view of a major accident is one in which the normal processes of investigations are inadequate set against the severity of the accident, its potential or its outcome or the degree of public concern.

On a European comparison the British record of IAs is good. For the year 2000 the European average for IA incidence[2] is 4016 and that of Britain is 1607 – in the best three nations for accidents causing more than three days absence from work. For work related fatalities the EU average rate[3] is 2.8 and the UK is 1.7 second lowest in the EU. The lowest country is Sweden.

2.3 Why worry?

2.3.1 Overall the accident rate in Britain is good on a European scale. What then is the purpose of this Report?

2.3.2 Firstly we join with others in the conviction that our present performance is only the product of continued attention and of a determination to do better. We are not convinced by spurious trade-offs between safety and profits. We believe that safe companies are generally better able to compete compared with unsafe ones. It is a common fallacy to believe that safer plants must cost more. While additional protective equipment does increase capital and operating costs, inherently safer designs are usually cheaper as well as safer. For example, if we can use a non-flammable or non-toxic reactant or solvent instead of a flammable or toxic one we need less added-on protective equipment. And while such equipment can fail or be neglected, in the inherently safer plant the hazard has been eliminated rather than controlled.

2.3.3 Secondly we are concerned that more of our industries are relying on complex, often computerised, control systems the fundamentals of which may be imperfectly understood by those who operate them and hardly at all by the common man. When computerised these complex systems may be extremely competent and reliable but are more impenetrable to the ordinary person. When they have been refurbished or updated this impenetrability increases. These considerations seem to imply that it will only be feasible to ensure the safety of such systems by a seamless process of management and design that begins with the conceptual design and ends with the unit being taken out of service at the end of its planned life. Any of these elements may contain the seeds of future disaster and this disposes us to urge the careful investigation of incidents that are influenced by these systems and their management.

2.3.4 Thirdly we wish to prevent or reduce the severity of accidents and this seems to us to be best achieved by study of technical and managerial causes that together create a disposition to an accident situation. By making available information about accidents, their causes and the analysis of them, in a form that can be used, the aim of less accidents will be served. By encouraging companies to take active learning measures about accidents in relevant industries further accidents may be avoided.

2.3.5 Fourthly, to help educate people as to the nature of accidents so that political response does not lead to a waste of resources.

2 Incidence expressed as accident involving over 3 days absence per 100,000 workers.

3 Fatality rate per 100,000 workers.

3 The Focus of the Report

3.1 Major Industrial Accidents

3.1.1 Major Industrial Accidents (MIAs) vary in their character and the reasons that have caused them to be classified MIAs. At the physical level the damage may be mainly to people, to plant, or to the community outside the boundary of the plant. We may also consider the potential of different accidents: from those that realise practically their full potential to those that could have been much worse. The control structures of the operation may also vary from transport vehicles with individual "drivers" to major industrial plants which are "driven" by teams of people assisted by complex and sophisticated control systems.

3.1.2 For the purposes of this Report our definition of a major industrial accident or incident reflects that of the HSE but narrows it to the class of accidents that we wish to study. Our definition is:

> *"An accident, or an incident short of an accident, in which there are circumstances that require special treatment and in which there has been a clear potential for, or actual impact, causing death or injury to multiple people, and/or serious damage to plant or to public or private property or to the environment."*

This definition covers the special circumstances of HSE major accidents but extends it to incidents having similar potential and qualifies the accident or incident by having the potential to cause damage or injury. The definition also implies the exercise of judgement; whether there are special circumstances, whether the incident could have developed into an MIA and so on. We believe that judgement is inseparable from safety but needs to be accompanied by experience and training for it to be effective.

3.1.3 Under this definition an accident causing the death of a worker by being run over by a truck in an industrial plant would not be categorised as an accident covered by this Report. But an incident in which there were no injuries but which had the potential to release large quantities of, say, ammonia, into a housing estate would be covered.

3.1.4 The Report definition above includes incidents short of accidents. This reflects our concern that these should be treated equally seriously from an investigative[4] perspective. One might view these incidents as having all the possibilities for learning from experience but without the injuries and cost of the damage. As such they should be seen as an equally important learning opportunity for investigators and operators.

3.2 The Industrial Sectors

3.2.1 The industries that we have selected to compare are all areas where there is clear potential for major industrial accidents to occur. Each of them deals with some combination of high power systems, high potential or kinetic energy, or aggressive materials. Each of them has the potential to cause multiple fatalities, severe plant damage and/or serious environmental impact. The characteristics of each of the sectors we have selected are different but each carries the potential for its own set of forces to get out of control and to wreak great damage as a consequence.

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4 We accept that investigation is necessary for both determination of cause and for prosecution but generally throughout the Report we shall use investigation to mean the process of determining cause and prosecution to mean the whole process of determining whether and in what ways groups or individuals were at fault. "Work-Related deaths – A protocol for liaison"

3.2.2 The seven sectors we have studied are:

- Aviation
- Chemical and Allied Industries
- Construction Industry
- Nuclear
- Offshore Oil and Gas [OOG]
- Rail
- Marine

3.2.3 Each of them employs a relatively large workforce and depends upon a different mixture of control measures to preserve safety in the field that we have studied. They differ in the number of accidents that they have both of those in the category we have studied and in the much more common range of accidents of a lesser kind.

3.2.4 A sector by sector survey of the practices for preventing and dealing with accidents and incidents in each of these industries is set out at Annex 3.

3.2.5 Industries in a particular sector will vary in nature even though some of the accidents that they suffer may be similar. The main determinants of the character of an industry may be seen as:

- Numbers of people employed in safety critical roles.
- The level of technology employed in safety critical functions.
- The number of employees in the industry.
- The relative scale of the average unit of operation.

3.2.6 At Annex 7 there is a list of the industrial sectors with these characteristics compared. What we see from this table is the difference in character between, for example, the nuclear and railway industries. In nuclear safety compliance is in the hands of a few highly trained people whereas in railways it is the responsibility of many. The technology applied to nuclear safety is consistently high, on the railways it can vary over a wide spectrum. Few people are employed in the nuclear industry compared to the many that are employed by the railways. In the nuclear field the scale of the average unit of operation is high and on the railways it is only medium. This is an extreme comparison but the same type of assessment gives rise to the disposition of an industry towards accidents. The outcome for this comparison is between nuclear which has vanishingly small numbers of nuclear accidents against railways where the total number of accidents is very large.

3.2.7 There is one character that seems to separate the industries studied here into two clear camps – those in the transport sector with individual "drivers" compared with process industries having a team in control assisted by a complex and sophisticated control system. With the exception of road transport, which is not covered in this report, transport industries have now, or will shortly have, Accident Investigation Branches that look into transport accidents. If we take the aviation sector we find that the majority of accidents are attributed to pilot error, despite the sophisticated safety management systems at work. In contrast "process" industries rely heavily on systems that have been carefully thought through to deal with every aspect of the plants

behaviour. The operators of these systems have comparatively little freedom of action but are expected to apply the process control rules. Those with experience of the AIB system believe it to be well suited to their industrial sector and those with experience in the process sector are wedded to the investigative systems that they use. Rail is in transition and no clear evidence can be taken of the working of the Rail AIB.

3.2.8 How do these two systems differ in their approach? The fundamentals of major accident investigation are applicable to any sector and both systems seek to examine the evidence, take any witness statements and seek relevant papers from the operator in coming to the causes of accidents they investigate. The AIBs differ from the HSE in that they are independent of any responsibility for regulation, inspection or prosecution although they may have useful contributions to make on all three topics. Insofar as aviation and marine are concerned they are protected in their independence by international agreements. Investigations under the HSE are undertaken within the same organisation that has responsibility for inspections, for regulation and for consequential prosecution. In exercising these related responsibilities the HSE maintain separation between the functions and they are conscious of the risks to independent investigation that co-responsibility could carry. They deal with the whole range of accidents from minor to major and have accumulated a vast knowledge of industrial processes and methods. They are able to deploy their inspection and regulation experience in deciding how to conduct investigations and whether or not to prosecute in individual cases.

3.2.9 The rail sector is in transition. It is to come under the safety investigation remit of the Rail Accident Investigation Branch although the operation of the full scope of the RAIB is not yet established and it is too early to see what, if any problems or benefits will arise. We have not thought it right to comment in detail on the rail situation at this time although we record a view of the rail sector before the change in the sector reports. It is clear that under any regime the railways will continue to employ large numbers of people working near to and on fast moving trains. The scope for accidents is clear enough and the potential for reducing their severity is plain.

3.2.10 The implications for these two systems co-existing are discussed in section 6.9.

3.3 The Tranverse issues and Integration

3.3.1 The sector reports are a key part of this Report. In order to address the aspiration of the work it has also been essential to look across the sectors and to address the common issues that arise.

3.3.2 Our approach has been to examine four aspects of common concern; how investigations are established, the legal considerations present in a post accident process, the human factors that contribute to accidents, and the impact of accidents and their treatment on society.

3.3.3 By looking first at the sectors and then across the sectors the group has been able to identify a number of issues that require separate examination.

3.3.4 These different perspectives are included in Annexes 3 and 4 as summaries and are included in full on the CD-ROM accompanying this Report.

3.4 Statistics

For the purposes of this Report we have looked at a division of IAs by the scale of potential damage that may be caused by the accident or incident. We are concerned with those having a high potential for damage. In the period 1999 to 2004 twelve accidents were classified by the HSE as major incidents of which one (Morecombe Bay cockle pickers) would be excluded from our study. In addition there were the incidents investigated by the AIBs that would have been classed as major by similar criteria, and in all sectors a number of incidents that did not develop into major accidents. Although it is impossible to be precise about the number that would have fallen into our categorisation we may consider that less than ten major incidents may occur annually in the UK across all sectors.

4 During and After the Accident

4.1 Who is involved during or after an accident?

4.1.1 An accident in the ordinary understanding is something that happens instantaneously. Nothing was perceived and then – Bang – an accident. In the variability of real life accidents sometimes occur over a period and the investigation needs to recognise that this has been the case. Or in other cases the critically dangerous event may have been created some hours, days, or weeks beforehand and waited only upon some other circumstance to trigger its devastation.

4.1.2 The treatment below is not intended to be comprehensive. It seeks to deal with some of the main features that are peculiar to the class of accidents and incidents that we have looked at. In passing much of what is set out is also relevant to other accidents.

4.2 The agencies and their roles

4.2.1 When an accident happens that will become designated a major accident there will be, at the very least, considerable disruption to normal working. Normal working needs to be restored. The public needs to be informed and protected. An investigation into the causes must be established and its results communicated to those who can benefit from its insights. By the time the investigation has been completed, and the case closed it will have involved a considerable number of agencies. With special reference to the major industrial accidents we looked at, but in passing also covering some lesser accidents, the agencies could involve the list below.

a) **Police and BTP:** In the nature of the national police presence, the random incidence of accidents and the need for control to be established quickly the police forces are often first on the scene of accidents. Police forces work within a protocol agreed with the HSE (or with the relevant AIB if appropriate) and other agencies that govern their conduct at the accident site when fatalities have arisen[5]. This protocol sets out the intentions of the parties and the action to be taken at the site immediately after the accident. The protocol itself cannot be expected to be familiar territory to every police officer but through the area control rooms the requirements of it can be looked up and check-lists provided for action guidance at the site. The police unit on site will secure evidence and seek preliminary identification of victims and witnesses. They will record all activity, ensure that the relevant agencies are informed and will make contact with the HSE to discuss immediate actions. The police may be more deeply involved if the case results in prosecution. The processes involving AIBs are similar but may differ in their details. In areas where the AIB has authority the contact will be with them.

b) **The Fire and Ambulance Services:** These may be at the site as quickly as the police and may have a role to play in the immediate control of the situation. They may be needed to deal with the injured, to mitigate any further injury and in the case of the Fire Service to assist in making the site safe for the accident investigators.

c) **The Coroner:** May become involved if there are deaths. In Scotland the Procurator Fiscal has special powers over the Coroners' Office and the Police and it is he that decides whether he will prosecute in a particular case. For details of how the law in Scotland is applied specialist advice is needed.

d) **HSE:** The HSE has responsibility for investigating accidents in a large variety of work situations. They also draft and implement regulations and inspect premises periodically to ensure that regulations are implemented. Through their regional offices and through hot-lines from other agencies the HSE should be informed relatively quickly after a serious or major accident at work. Getting onto the site may take longer and getting experts on scene may take longer still. The HSE will always confer with the police

5 "Work-Related deaths – A protocol for liaison"

and the local authority or other enforcing agency at all stages of the investigation. The HSE will be concerned with the immediate site and circumstances of the accident but will also be giving consideration to other matters. These may include, for example, the disclosure of evidence between interested parties, forensic examination of evidence, the extent to which corporate failures are to be investigated. They will want to see a strategy develop for keeping bereaved families informed as well as handling media interest constructively. In all of these aspects the HSE will confer with the police, and local authority.

e) **Industry:** Although the industry in which the accident has happened may have no responsibility for investigation under the law they will, in a major accident anyway, be concerned to understand how the accident has happened and will wish to take immediate and longer-term steps to prevent recurrence. In some situations the industry may also conduct its own inquiries as to cause and may contribute to any inquiry run by other agencies. The industry, often in the shape of the company on whose property the accident happened, will also be extremely interested in the process by which work is going to be allowed to be re-started and the site cleared for restitution.

f) **AIBs:** In areas subject to AIB investigation the AIB concerned will have statutory authority over the site of the accident and the actions to be taken with regard to protecting and securing evidence from when they are first informed. Taking command of the accident site may be difficult in some marine accidents but in general the AIB is to be regarded as the agency in command. Their task is to investigate relevant accidents and to determine their cause(s). They will, of course, have the same relationship as the HSE with the police forces over the immediate actions after an accident and will receive assistance from the police and local authorities in relevant ways.

g) **Inspection agencies:** These may be involved as part of the immediate inquiry process but they are not concerned in the aftermath of an accident unless called upon to give evidence or to assist the investigators.

h) **Regulators:** May be involved immediately if there is any initial doubt about the efficacy or appropriateness of any regulation and the possibly urgent need to review any extant regulations or issue emergency new ones. This requirement may surface at any time during the investigative process. Upon receipt of the final findings of the investigation the regulatory agency will review the causes and check to ensure that no change is required in regulation or that any required changes have been initiated with appropriate speed. The job of the regulator is to take into account any new knowledge flowing from the accident investigation process that should influence the regulatory framework.

i) **Prosecutors:** These may involve the police, the HSE and the Crown Prosecution Service (CPS) or, in Scotland, the Procurator Fiscal. When prosecution is identified to be a possibility the agencies will sometimes confer together to determine the importance of prosecution over investigation and the requirements for both. The requirements for a successful prosecution will be different in a number of respects from those of a successful investigation. The CPS, however, operates as an independent prosecution service.

j) **The Local Authority:** Local Authorities have responsibility for certain local provisions, such as roads, services and health matters. They will normally have some interest in a major accident in order to determine what action they must take as a consequence of it. In some situations they may be the most interested party although in others their interest will be peripheral.

k) **The Health Authority:** In certain accidents there may be a risk of wider public or private injury to chemicals or radiation that has spilled into the community. In these cases the Health Authority will need to advise on injury containment, reduction, treatment and clean up.

l) **Water Companies:** Where there is danger to water courses, or where this may be the case, the Water Authority will be involved. They will carry out tests and take such following measures as the incident may require so as to preserve the cleanliness of the public water supply and to prevent further injury.

m) **The National Radiological Protection Board:** In nuclear incidents the NRPB will be required to advise on the steps to be taken.

n) **The Food Standards Agency:** Where there is any possibility of dangerous materials or radiation having affected the food supply chain the FSA should be called upon to advise.

o) **The Department of Transport:** In cases where the transport network of the region is likely to be affected by the accident or by the management of it the Department will advise on the transport implications and will take necessary steps in conjunction with the accident management operation.

p) **The Government:** The Government may become involved in a major accident when the whole circumstances of the accident have become a matter of public interest. In this event the Government may determine that a public or other form of special inquiry should be held and if this is the case this becomes the senior inquiry.

4.3 Immediate Aftermath

4.3.1 The police will often be the first external body to reach the accident scene, probably alongside the Ambulance and Fire Brigade. Upon their arrival they will need to assess the immediate priorities – making the site safe and secure, identifying responsible people and so on – they will also have the opportunity to make the first decisions about the investigation process by identifying evidence that must be preserved, by identifying witnesses or other responsible parties. The police officer, and indeed the local police force, will sometimes be inexperienced in major accidents and will always be responding to multiple demands. But police forces have the HSE Protocol for the action at the site and their Control Rooms are able to guide PCs on site. The AAIB has similar protocols for use in situations under their authority.

4.3.2 The first tasks on site will be to care for the injured, prevent further injury, inform safety agencies, and to secure the site from interference (for example by members of the public or press etc.).

4.3.3 An early task will be to ensure that appropriate agencies have been informed and police operations rooms are likely to be central to this function augmented by the company's own communications. Major safety agencies are likely to hear of the accident from more than one source. It is also important that the first agencies on site ensure minimum disturbance to potential evidence for the subsequent investigation, consistent with the saving of life and the safety of all concerned.

4.4 Within the first day

4.4.1 By the time that the more distant agencies are able to reach the site the immediate chaos of the site will likely have subsided somewhat. The circumstances, if not the causes, of the accident will be becoming apparent. Those people who were not only witnesses but who are seen to have something of particular importance to contribute can start to be identified. Early views of a range of possible causes might be taken and these scenarios of cause can help to determine what kinds of evidence may be needed. Along with the possible causes the police and HSE will start to consider whether there are reasons to consider a prosecution and views will start to emerge of possible culpability. These early stages of the investigation will not, of course, be decisive but they will influence the views of the agencies present. Progressively views will start to narrow around causes and blame although not taking any firm views. Based on these early positions it is necessary to appoint a lead agency in the light of what is then known or suspected. Normally the investigative body will become the lead agency but if prosecution is considered a probable outcome then it

may be preferable for the police to lead. The choice of lead agency is not fixed and it can change as more becomes known. But it is advantageous to have one agency appointed to lead from soon after the accident. This allows the decisions to be taken coherently – for example concerning witness interview approaches – and for evidence to be secured by the people who might most need it.

4.5 The work of inquiry

4.5.1 With the lead agency in place work can continue to gather the evidence and information that the agency is likely to need. Close consultation between the agencies will be maintained throughout this period and information will be shared between them. But the lead agency will determine which evidence is needed – some of which may be remote from the site of the accident – and will determine which witnesses or other people should be interviewed, and importantly how the witness interviews shall be carried out. Interviews may be formal or informal and different settings may be chosen which serve to encourage the witness most appropriately. The choice of these approaches and their sequence forms the witness interview strategy under the hand of the lead agency. As this process develops there may be a collective reappraisal of the accident and what was once thought an unlikely interpretation may gain favour. This may prompt the lead agency to be changed, possibly even more than once. Whilst many changes of lead agency are undesirable it is always preferable that the most appropriate lead agency should be chosen to take the case forward.

4.6 The challenges

4.6.1 The actions required by the various agencies have been set out between them in protocols. These have been consulted and revised and whilst they now represent the best guidance that can be devised for those on the ground there remain a number of challenges to the smooth and successful outcome of an investigation.

4.6.2 Conflicting autonomies, necessary for their own purposes, can lead to conflicting actions early in the accident history. In the immediate aftermath of the accident the police, probably the only regulating agency on site, automatically has full authority. Whilst the police will consult with other agencies it is natural that they will also have one eye upon protecting their possible future role. In this sense the site may become regarded as a "scene of crime" and evidence relevant to a possible crime may be given more prominence than evidence needed for investigation. These conflicts stem from conflicting objectives and not from intransigence.

4.6.3 Occasionally the government will call for a public inquiry. This decision will be taken because of the whole public interest in the event, or some consequence of it. It need not be an inquiry focused solely upon finding the cause. The decision is one that serves government's needs and it may or not be the most efficient process for establishing the cause(s) of the accident. Public Inquiries are very costly and may last for many months. However there are too few public inquiries for this to be of major concern, even though there may be important issues in these specific cases, unless their processes delay the dissemination of important lessons.

4.6.4 The issue of witness management can be problematic if the aims of the various agencies are not aligned in discussion. The fundamental difference that can exist is between witnesses for prosecution (whether of companies or individuals) and witnesses for investigation. In the one case full evidential processes will be needed with their accompanying formality. This can be inhibiting and may make witnesses inclined to answer questions with the minimum of information. Witness may be inhibited from giving evidence to the police of otherwise on the ground that it may prejudice their rights in relation to subsequent legal proceedings. They may also have in mind fear of personal consequences short of prosecution. In the case of investigation witnesses may be interviewed in a way which is calculated to elicit maximum useful information by appearing to be less formal although it ends up still with the witness signing a statement of their evidence. An investigation team can also be more open about why the questions are being asked and where they might lead the investigation. This openness will usually not be possible for a prosecution interview. The problem is sometimes in the perception of the witness – are they concerned that they are, or may become, an accused person or are they reassured that the information being sought from them is to help the investigation. Other witnesses may be more inclined to help an investigation rather than a prosecution – even if they are not themselves worried about prosecution. Witnesses who are compelled to

give evidence by the HSE cannot have that evidence used in any subsequent prosecution and this may make them more inclined to be helpful. This is also the case regarding evidence given to the AIB's. Protocols exist to ease this possible problem area and it is clearly an advantage if the choice of lead agency can be firmly decided at an early stage – although this will often not be possible.

4.6.5 Bereaved relatives have a natural concern with the investigation even though it is not undertaken for their benefit. Whilst they should not be allowed to influence the investigation (except insofar as they have material evidence to bring forward) the reality of the situation is that relatives can, often through frustration, become a ginger group that cannot be ignored. If they are not treated with appropriate sensitivity, including recognising their need for information, they can become a challenge to an investigation. In the early hours after the accident the police Family Liaison Officer [FLO] will take the weight of the immediate care and will be experienced in caring for the after-accident trauma that the relatives experience. Often, and sometimes sooner than has been expected, the thoughts of relatives turn to trying to answer a whole range of questions that naturally passes through their minds. These may include "Who was to blame"; "How did this happen"; "How was it possible"; "Why was it not prevented" and so on. If these questions can be addressed openly and accepted as natural human reactions problems may be averted. If, on the other hand, these questions are answered either not at all or in an incomplete and "shifty" manner lacking frankness the attitude of relatives may turn quickly to a more accusatory slant. When this happens the questions become "Why is this being covered up"; "Why can't we be told who did XXX"; "Who is hiding something here" and similar questions. This kind of pressure can divert an inquiry and can create misleading counter-information in the media. They can, in the most extreme cases, cause the direction of the inquiry to be changed and the relatives are not always wrong to take this view. In the case of the Derbyshire we see that pressure from the bereaved relatives was a major factor in getting the inquiry re-started leading to the eventual resolution of the mystery. If they had been engaged earlier the inquiry process would have been speedier and cheaper. If the inquiry is being conducted without being complicated by prosecution issues there is plenty of best practice knowledge available to indicate how relatives should be treated but these best practices are, sadly, not always employed. Rail has been among the worst and the AAIB among the best of the sectors we looked at but good examples occur everywhere and much can depend on the attitude of the individuals concerned. Best practice is summarised as treating the bereaved relatives as interested parties who are entitled to know everything that the authorities know unless there is a sound case for not telling them. This means that information should be given out periodically through the inquiry and the relatives told of the problems and the unknown areas as well as what is known. Importantly it also means that they should be informed of matters before these are released to the media. Efforts to resolve doubtful areas should be explained and progress reported. In this way the authorities stand the best chance of keeping the relatives "on side" during the inquiry and to giving them the satisfaction of knowing what happened to their relatives.

4.6.6 The "penetration" quality and depth of the inquiry is sometimes an issue. It is always important for an inquiry to get to the truth of the cause(s) of the accident or incident but this may be done either at a superficial or a deeper level. In the Concorde Gonesse incident, for example, it could be said that the cause of the accident was a piece of metal that had fallen onto the runway from another aircraft taking off minutes beforehand. However, aircraft (including Concorde) are certificated to be able to tolerate being struck by such debris without a resulting catastrophic event. It was only after a detailed highly technical investigation that the cause of the accident was attributed to a previously unknown structural failure mechanism and a suite of modifications could be incorporated to assure the safety of continued operations. In other accidents the penetration of the inquiry may be balanced between the accurate but superficial technical causes and the underlying managerial weaknesses that led to these technical causes being present. The media will often seize upon early statements and will want to be first with the "analysis" of the accident. The media will also seize upon partial information and be ready to criticise inquiries before they complete their work. The media will keep the story in the headlines while public concern exists and they are better told what is known and what is planned than forced to use partial, misleading and speculative information. This can only be achieved by competent inquiries giving the media an explanation of what is going on. In a number of cases the most important lessons are those from the underlying causal factors and these may not be as headline grabbing

as the former type. Inquiries need to take a stand about when and what interim statements they will provide publicly (which should not be too late or nothing) and should be allowed freedom, time and resources to get into the underpinning causes of the accident they are investigating.

4.7 Accident investigation processes (for our focus)

4.7.1 Health and safety regulation for the great majority of industry in Great Britain is the responsibility of the Health and Safety Commission, with enforcement either by HSE or local authorities. The HSE has several safety responsibilities (see above) including that of investigating the causes of accidents. The management of these investigations is undertaken by staff independent of those engaged on considering prosecution, inspection or regulation – although individuals may be asked to contribute expert knowledge. For major accidents the investigation chairman will be drawn from a section that has not been involved with the area in which the accident occurred. The HSE believe that in the generality of industrial situations their ability to integrate knowledge of different industrial systems, and combine the strengths of regulation, inspection and prosecution with investigation gives them a stronger grasp on the issues. The HSE are parties to and often leading contributors to various protocols with other agencies that give guidance on the procedures to be adopted. HSE investigators into major accidents generally release interim statements to relevant parts of industry where they judge it is appropriate to do so and where urgent action needs to be taken.

4.7.2 The transport related industries (excluding road transport) are either looked after by AIBs or are in the process of moving to that system. AIBs have sovereignty over the investigations that they run and are answerable for the conduct of these directly to the Secretary of State. AIBs have compiled their own Protocols for working with the police at the site and these also contain much that is good practice. They have responsibility only for the investigation of accidents which some observers believe gives them a useful degree of independence since they do not have to look over their shoulders at what they have also done by way of regulation and inspection. AIBs have no authority in the prosecution process. The exact processes to be used by the RAIB for rail accidents have yet to develop fully. It is known, however, that the great majority of rail accidents are not major and the areas of responsibility for the RAIB and the HSE in these areas will need to evolve. When AIBs investigate they have the right and duty to seek external expert opinion and they will usually place their findings fully in the public domain. The AIBs will maintain close relationships with the regulatory and inspection bodies but remain independent of them in the conduct and reporting of accident investigations. The AIBs also maintain close but informal relationships with their corresponding organisations in other countries and within the UK Ministry of Defence. These contacts are beneficial in exchanging technical experience and in identifying better practices.

4.7.3 Judicial and Public Inquiries on accidents are set up by the HSE although with the approval of the government of the day and work to no specified pattern. There are guidelines for their conduct but the nature of the circumstances that prompted this form of inquiry will dictate the direction and style of the inquiry. They may be held in public or in camera or a mixture of both. They may have the identification of cause as a primary aim or they may not. Other circumstances will certainly be brought into the inquiry according to the public interest seen to be present. Whilst they are taking place other inquiries are usually prevented from completing their work. In some cases these government appointed inquiries can be extremely influential however. Most notable of these was the Piper Alpha Inquiry under Lord Cullen.

5 Accident Prevention though Feedback from Investigations

For a company and its own and other industries to learn from an accident, or from an incident of high potential, the direct evidence surviving the accident, the witnesses, and the relevant papers must all be available for consideration.

The developing situation at the accident site is often also a chaotic scene with other priorities; for getting the injured treated, making the scene safe, and securing damaged equipment also having a call upon the attention of responsible managers. Setting out an ideal set of accident investigation processes that must apply would be an impractical counsel of perfection to attempt. Nevertheless considering how the interests of investigation can be assisted may be useful.

5.1 Feedback process

5.1.1 The use of feedback from accident and incident investigation is well known. Its essence consists of taking lessons learned from one accident and checking whether these lessons also apply in other situations where, by making changes, similar accidents can thereby be prevented. Similar feed-back can occur in inspection and regulation and in prosecution by feeding into changes in the law. Most inquiries into cause have terms of reference including a call for specific recommendations that allow progress towards implementing these to be checked.

5.1.2 The principle of feed-back is easy to comprehend but its application in real situations is much harder. If an organisation knows that information exists that it wishes to use there are multiple mechanisms for finding it. More difficult is the reverse process that is having information that various, and unknown, organisations might need to see and arranging for them to receive it. This is the common experience after an accident investigation. The holder of the information does not know the range of situations, interests or capabilities of the many possible users. Nevertheless meeting this situation is an essential need if the full value of the investigation is to be gained.

5.1.3 The way in which information is broadcast varies from situation to situation. Investigations are generally very willing to have the results of their deliberations distributed but less often get involved in the process of that distribution. The three stages of using information effectively from an investigation are important:

a) assembling the information in an appropriate form

b) distributing it appropriately, and

c) having recipients motivated to do something with it.

5.2 Assembling Information from the Investigation

5.2.1 Information from an investigation will be assembled in the investigation's report in a manner that makes the conclusions of the investigation into the causes of the accident clear and convincing. It will not usually be the case that information is then re-assembled in a form appropriate to its subsequent use. This places a burden of search and translation upon the reader that results in some of the value being lost.

5.2.2 An important adjunct to the work of the investigation would be either to request the investigation itself to prepare a supplement to the report setting out the recommended actions to be taken in other relevant cases or to provide for this task to be done separately. An ideal arrangement would be for the information to be cross referenced and accessible by different industrial situations seeking to identify the relevant parts of the report's findings.

5.2.3 In some situations the assembly of information is much better. In major accident cases the HSE with its responsibility for regulation and inspection will often extract key messages that should be communicated to

relevant industries without delay, even whilst the investigation still continues. Similar action is taken by the AAIB in the very safety conscious aviation world. In many major accident investigations some sort of interim extract of conclusions is communicated with specific points of concern for other situations highlighted. A key point is for critical and urgent information to be promulgated quickly. However, our view is that the full value of these major investigations, and those that fall into the category that we are concerned with here, could best be obtained with a more rigorous and consistent approach to information assembly being aimed at its eventual user. The best practices are very good and these should be used as templates for improving the performance of the whole.

5.3 Dissemination of information from the Investigation

5.3.1 When the information has been assembled it requires to be distributed. The aim must be to disseminate urgent information quickly and to retain all records of the investigation for easy future access in an appropriate form. Several approaches to this task are in use. The first, easiest and least considered is to broadcast the investigation report to everybody who might have an interest in it. In this respect electronic transmission and especially the Internet has great potential for allowing information to be broadly and readily accessible and yet not to be sent in full to every reader. Broadcast e-mails alerting recipients to the existence of a more comprehensive Internet account are also likely to be helpful. Printed material often joins the mass of circulated material in the bin of the executive who receives it. One large international company based in the UK has become so disenchanted with the indifferent results from broadcasting accident reports that it has stopped this practice and now disseminates only selected reports to specific recipients. It is very demanding of the recipient to assess the quality, relevance and focus of the material and much of its value gets lost at this stage. A much better approach would be to send the material only to those who have an established system for assessing it or who are known to have a relevant interest. The best approach would be to extract generic points and select only those for distribution by way of an abstracted summary that might lead those who wanted to know more of the detail to obtain the full report. More than one channel of communication should be considered – both direct and by providing a searchable Internet database. The selection of the recipient of the information is also an important issue – he should be someone who can appreciate the value of the information and the steps needed to make use of it in the recipient company.

5.3.2 The dissemination of information varies greatly from industry to industry. In the nuclear industry not only is UK information circulated but international information too. There is a culture of seeking out the best ways of doing jobs and an inquiring approach to how others do them. Aviation and OOG are also good and look for international comparisons. The marine industry has a traditionally very technical approach to its investigations especially where these are major in scale and the evidence is available – which is not always the case – and these reports receive wide circulation within the industry.

5.4 In-Company training and learning from investigations

5.4.1 Assuming that relevant information can be extracted from the mass of other data and, assuming that it can be distributed to those who need to know it, the issue of its beneficial use remains. It will not usually be sufficient to arrange that accident reports are sent to the manager most responsible. At best this can often mean that the manager himself learns something but not many others do. The discretion rests with him to read it or not and to act on it or not. The aim is to make good use of the information and this generally requires that there is a culture within the recipient company that wants to do things better. Such a culture is a long and hard task to establish and is a responsibility of the highest managerial group or the Board of the site. The highest level in the company must see the benefits of creating a body of corporate knowledge and establishing systems to create this institutionalised learning. Tackled as a managerial project it is possible to establish a process that will embed knowledge into the corporate structure.

5.4.2 An example of what this means is that in the company or industry database that is generally accessible there should be a record of receiving information about an accident. The source and date should be recorded. An appropriate manager should record his expert analysis of its applicability. Decisions about the areas of plant

to be changed as a consequence should be set out with their rationale. The people involved in the change process should be noted with the process used to inform them of the need. The implications for company process regulations, control processes, training etc should be noted. Such a process requires bringing to a conclusion and the conclusion of the process drives the changes and the collective learning that is looked for.

5.4.3 It is not easy to inculcate a desire to learn from others' misfortunes. The human default position seems to be resistant to this. Many reasons are advanced for not looking at the experience of others – it is perceived to reflect poorly on what has already been done, it hints at lack of knowledge on the part of individuals, its takes time that often does not exist. Most managers would readily agree that if the extra work of learning from accidents would definitely allow an accident to be prevented it would certainly be worthwhile. But the implicit belief is often that taking on this extra work will not prevent anything because nothing was going to happen. This is probably often true and there is certainly a judgement needed to sift the information that is to be taken on board from the irrelevant straw that would absorb time with no result.

5.4.4 The present situation is mixed. There is much that is done that is good and examples of best practice are not hard to find. At the same time there are practices that differ widely from this best practice. One of the areas that have learnt from misfortune best has been the OOG sector. The disaster of Piper Alpha shocked the industry and resulted in a range of fundamental changes to the industry's approach to safety. Three Mile Island had a similar effect in the nuclear industry. Both resulted in fundamental changes; e.g. resulting in the safety case approach for design being adopted. They have embedded an industry-wide concern to learn from experience and to take the view that this kind of learning is not a reflection on the present but a mature route to progress.

6 Making these mechanisms work better

It is certainly the case that there are many examples of good practice. It is not the case that the system of accident investigation and using the results to prevent further accidents has been neglected; many protocols and standards already exist. But it is also true that the application of these good practices is not uniformly good. The improvements to accident prevention through investigation and communication will not be by revolution but by the application of processes that we can already see at work.

6.1 Better statistics?

6.1.1 Sorting through the plethora of European statistics on safety one is struck by the difficulty both of finding the statistics required and making direct comparisons between performance in different EU members. There are many metrics but all seem to miss slightly the target that the reader has in mind. What do we want statistics to tell us that will inspire, inform or challenge us to do better? We can easily find the number of accidents, or the proportion that include deaths, or the number of serious injuries. But it is harder to find subject related statistics – how many people were hurt working on high pressure steam lines, or on electrical wiring? These might be more interesting to users of the statistics and might easily be provided by attaching "markers" to key words in the text during compilation. The problem with different statistics is that they all represent an additional burden of collection and collation. The extra cost of a new statistical series is considerable and there must always be doubt about its utility. The additional value of a data series will often be more in the mind of the originator than in the minds of the intended users and if there is denial of the importance of a safety feature statistics are unlikely to help. In most cases the search for new statistics will not be justified by the results but there should be scope for making more use of those already collected by HSE. In addition it is important that organisations collect proper statistics about their own performance and analyse the causes of incidents and learn from this analysis. Benchmarking with other comparable organisations should be encouraged.

6.2 Immediate Post-accident actions

6.2.1 The actions demanded of the police service in the opening hours after an incident are multiple. The police have many other duties in which to be competent. Company contingency plans can help to bring order to the situation but the police will be in charge. The situation is inevitably a compromise between the possible and the desirable.

6.2.2 Given that this is the situation, improvement of the situation will rest in shifting the borders of the compromise towards the desirable. It is already the case that the HSE (and the AAIB) carry out instructional visits to police forces and we encourage this and other steps to provide understanding of the protocol for work-related deaths. The police FLO operates effectively although there seems to be scope for more understanding of the positive and constructive relationship that can be achieved with the relatives over time.

6.3 Responsibility assignment

6.3.1 It is already the case that the HSE try to get the decisions on the responsibility for the investigation made as early as possible. We would like this to take a positive step towards making it a duty of the HSE (AIB accidents already make this assumption). This would not prevent it from changing later if the further consideration of the case for prosecution indicated such a change. But we believe that the HSE should assume investigative command (and therefore of the evidence, the witness programme, media contact and care of the bereaved relatives) from their arrival on site.

6.3.2 The HSE inspector who is first to arrive should act as an agent of the investigator in setting up the required processes of consultation and data collection.

6.4 Transparency of investigation process

We believe that the process of investigating cause should be a transparent one. We think it important for the process to continue to build confidence among the general public and to remain highly regarded by them.

Investigations should therefore be aware of the dangers of working behind closed doors and feeding any perceptions of deals or whitewashes that the processes of rumour and speculation can initiate. The inquiries of the prosecution services will inevitably have greater confidentiality attached to them.

6.4.2 There will be limits on the amount of specific information that can be made public. Guidelines will need to be prepared setting these down. They will need to be discussed. They may include information that has commercial confidentiality applied to it, to information that may affect individuals' rights, to data that are unconfirmed and unreliable. But this leaves most areas of an investigation open and able to be reported on by the investigator.

6.4.3 A particular group who should benefit from greater transparency is the bereaved relatives. They will be anxious to obtain as much information as possible and will be more likely to support the investigatory process if they are kept fully informed.

6.5 The human dimension

6.5.1 The importance of the human factor is acknowledged but is sometimes given less attention during an investigation than it warrants. (We recognise that the term "Human Factors" has a more precise specialist meaning and when this is meant we place it in quotation marks). Humans are undoubtedly concerned with all accidents, in their cause, in their effects and in their assessment, and throughout the whole accident cycle.

6.5.2 The high power systems that we have examined all work through the performance of complex systems. None of them are automatic in that they require intervention by humans for their conception, management and operation. All of our systems have human involvement from their earliest days until the accident. They are conceived, designed, assembled, programmed, tested, managed, maintained and operated by humans and in this sequence of activities, that continues over many years, there is ample opportunity for error, doubtful judgement, misconception or misunderstanding, as well as for mistakes due to lack of knowledge. Consideration of the human dimensions of an accident can, and probably should, extend to the highest levels in an organisation for it is there that the human decisions that set the framework for the installation are first made and are most influential.

6.5.3 There is in the literature a vast amount of data that examines how the incidence of these instances of human fallibility can be reduced or eliminated; that is the area of work of "Human Factors". The case is made by Prof Muir (see also Annex 4 para 4.3.7) that the examination of the human factors in an investigation into the sequence from conception to operation should be made by professionals in the field far more often than is currently the case.

6.5.4 Even when the skills of "Human Factors" practitioners are used in investigations there is much more about human behaviour that will have an impact upon the course and outcome of an investigation. Many investigations seek to establish their credentials by making it clear they are called upon to establish cause not blame but it is clear from many of the accounts that this is often not wholly successful if blame hangs in the air. Sympathetic consultation, perhaps in an informal setting, with those who have suffered in the accident, or their surviving relatives and friends, is identified as a behavioural pattern that is likely in many cases to ease subsequent demands for more open or judicial forms of inquiry.

6.5.5 Human behaviour is not only the preserve of those that may have been involved in the accident but is a factor in those who inquire into its causes. History is littered with the errors that can arise from departure from objective, auditable, justifiable and independent technical evidence. The Derbyshire inquiries were marred by false and unsubstantiated opinions that could only slowly be discounted by fact. The quality of the investigation, that is the aggregate effect of it in terms of relevance, truth and credibility, is clearly very dependent upon the nature of the expertise or lack of it that is brought into play. This is not merely a matter of increasing the 'grade' of the investigation but of ensuring that the expert witnesses are expert, are independent wherever possible and can devote sufficient of their time to the investigation's purposes.

6.5.6 The Derbyshire case, and others, raises the question of the independence of experts. We believe that it is axiomatic that inquiries should be as independent as feasible. At the more serious end of the scale this should be mandatory. The alternative treatments for dealing with experts are further dealt with at 6.9.5.

6.5.7 Criminal proceedings, with the attendant drama of seeking to hold persons or companies liable for the consequences of accidents, tend to attract the press and other media to a greater extent than the methodical processes of inquiry. It is important for those involved, particularly the prosecuting team, to avoid exaggerated or emotive language which can be misinterpreted by the press and used by pressure groups in a manner which the facts do not justify.

6.5.8 In this area of public perception the railways in particular have suffered from the lack of any homogenous and stable public opinion. Surveys of the priorities for railways usually put safety high on the list. Different surveys about what should be done first on the railways put rail safety very much lower. Passengers when asked what they want often address service issues of timetables, cleanliness and staff. This no doubt occurs to a lesser extent in other industries less in the public eye. We cannot expect it to be resolved but more information and education of a more consistent kind can alleviate the situation. Such variability also underlines the dangers of taking the views of any one group as a guide to action.

6.5.9 From all of the above it is clear to us that the subtle, difficult, somewhat unpredictable, and above all natural variation in human behaviour as contributions to the causes of accidents must be regarded as a vital element to be taken into account by any investigation.

6.5.10 We find it surprising that given the widespread importance of human behaviour in so many ways and in so many accidents there is so little expertise employed in examining its contribution. One aspect of this is the degree of formality decided upon for interviews. Formality in investigations makes it harder to find out what happened. People are over-awed and while they may answer questions correctly they are less likely to volunteer information. They are more likely to do so if questioned in their workplace than in the head office.

6.5.11 This embraces the professional expertise in Human Factors that should be applied in appropriate cases and which in many of these cases is not. We believe that the employment of Human Factors professionals should be considered in all major investigations where it is possible that these issues will be important.

6.5.12 Additionally we think it is likely that the human behaviours represented by senior and middle management in the panoply of actions, decisions, training, policies and rules that together represent the safety culture of the industry or company should feature more strongly in investigations. We are concerned that there are still instances in which the existence of written rules is put forward as evidence that management has done all that is needed whereas the actual culture is one that discounts these rules in favour of better operational results. We accept that there must be a balance between the two priorities but we believe that behaviours often build an unintended situation. We think that the actual process involved in establishing cultural and behavioural norms should be addressed in all major investigations.

6.5.13 There is considerable variation across the sectors in the interest and engagement in post-incident behaviours. Concerning those who may have been involved to some degree in the accident it is important to recognise the often-conflicting emotions, and pressures, felt by individuals. Alternately they may experience feelings of guilt or responsibility and feelings of self-protection and denial. We believe that it will often be important to recognise these conflicts during the investigation.

6.5.14 Human responses are, of course, to be expected from survivors or relatives after a fatal accident. Their motivations may change with time and in response to the behaviour of others. Many relatives may be disposed to search for 'the truth', others for 'justice', and others for 'making sure it will never happen again'. Relatives may seek to use these issues to influence the investigation, sometimes through the media. What is

clear from the sector reports is that these positions need not remain static and the relationship between relatives and the investigation can be a dynamic one that, if not sympathetically managed, can become an issue of its own. Experience in the aviation sector has been that substantial benefits to the victims and/or relatives and the investigation are gathered by early and constant engagement with and of the relations. We suggest that the practices of the AAIB, and other areas of good practice, are developed in other sectors. We believe that this will better address the concerns of relations and give them as much information as the investigation holds at any time. It will often be as much as the families need or want and will lead in fewer cases to dissatisfied militant pressure groups being set up that often cannot be satisfied at all.

6.5.15 There is a great deal that concerns human behaviour to be examined in the post-investigation stage of an accident. It is in this stage that the lessons learnt by the investigation (at whatever level this happens) are translated into an improved understanding and a more appropriate behavioural norm. As remarked above this learning process is often deficient; either because information is not easily accessible or when accessible is not consulted. Many accidents happen where the proper behaviour is either known to those concerned but not practised or is known but not to those concerned. Any general improvement in accident performance should address these weaknesses.

6.6 The penetration of the investigation

6.6.1 It is clearly a responsibility of an inquiry into a major accident or incident with similar potential to get at the root causes. In our discussions we found that the understanding of "cause" could be variable.

6.6.2 At one level the differences are illustrated by the attitude of some police officers at accidents. In looking for evidence they can be inclined to take a "scene of crime" view of the site in which the key evidence is assumed to lie at the wreckage site. An investigative approach may take this view or may take the view that the greater evidence is likely to lie in a set of offices somewhere where the plant or equipment was designed, or in a company safety statement that was inconsistent with its training policy.

6.6.3 There will usually be a set of direct, immediate and adjacent causes for an accident. Something was done there that actually caused the disaster. It is very appropriate that the inquiry should examine this level of cause and most of the evidence for it will usually lie at the scene.

6.6.4 There will be other causes that will be subtler, less easy to be clear about, contributory rather than decisive but nevertheless collectively being vital parts of creating the situation of the accident. It will be important for the inquiry to delve into these sometimes difficult areas where they think that they have contributed to the accident or incident. They need to look at the concept, design, building or manufacture, testing and use in service with maintenance and support and the training and instruction of those who used the equipment.

6.6.5 It is easy to cite extreme cases: where the accident was wholly concerned with some immediate, local and direct cause or where the reverse was true that some error existed in the concept of the enterprise that could only have manifest itself at this juncture. What is more difficult is to penetrate the cases between, where there may have been several types of deficiency each contributing in part to the whole. Turning these strands into definite findings and being specific about the shortcomings, whether they were rational but erroneous decisions or whether they were negligent failures to take responsible precautions will often be difficult and time consuming. Nevertheless if the maximum benefit is to be obtained from the investigation the more that these areas are penetrated the greater the chance that similar deficiencies can be prevented in future.

6.6.6 One of the most difficult areas of this background to an accident to get to grips with is in those companies where there is a difference between the official policies of the company and the reality of its operations. Policies that are supported by numerous files full of consistent papers setting out the way in which safety is to be achieved may be at variance from life on the ground. Sometimes this borders on the deliberate but more commonly it will be an evolved situation. It occurs because the demonstrated priorities of the bosses

are seen to be giving different messages to their workforce, at all levels, from the printed words of guides and instructions. In the most evolved plants these differences are dismissed as "old Spanish customs" – things that are neither disapproved of nor approved of. They can be dangerous and they are subtle. They embrace the human willingness to take short cuts, to assume that things will be OK, to devote less time to precautions than to the urgencies of output. Given that the UK is safer than most European countries we should not believe that these possibilities are the normal behaviour – but they can exist and investigations need to look out for them. The *de facto* culture of a company is created not by policies and papers but by the day-to-day behaviour of influential figures whose example penetrates through an organisation slowly but inexorably.

6.6.7 One of the issues that investigators need to face in getting deeper into situations is sustaining among the full-time staff the experience, skills and competence that are necessary. There is a balance to be struck, and no doubt has been struck, between having enough work on investigations to sustain a person's competence and not being able to do the work as deeply as one might. External resources can be employed but there will no doubt be considerations of maintaining an adequate continuity of experience as well. There will also be cost issues associated but the cost returns on accidents prevented are good and cost considerations alone should not prevent proper investigation.

6.7 The impact of public or other national inquiries

6.7.1 The scope for improvement discussed here may be limited to areas not concerned with the law but are nevertheless positive. Public and Judicial Inquiries are mounted by the HSE at the behest of the Government in consideration of its perspective of the overall public interest. The investigation into causes may be important but may not, in the Government's judgement, be the most important issue to be dealt with. Whatever the reasons for mounting such an inquiry it will take its own course.

6.7.2 From the perspective of the investigation we may conclude that the impact of these kinds of inquiries will usually be poor. They are expensive, they take a long time and generally do not create a useful substitute for a focused technical inquiry into the cause although there are notable examples where this has been the case[6].

6.7.3 In terms of improving the situation one route is the long term possibility of building a slow but progressive appreciation of the issues in government. We emphasise that the benefits of a technical inquiry will often be blunted by calling for a public or judicial inquiry – although the efficacy of such soft influence is far from certain. In parallel with this it will also be helpful if the general standard of technical investigative inquiries is sustained at a high level. If government can see that the "cycle" leading from an inquiry through to things happening in companies around the country is working well and that there is a good evidential basis for assuming that this cycle does prevent accidents they may be more inclined to place trust in it.

6.8 The impact of prosecution

6.8.1 The prosecution service will take action where it regards the public interest as best served by doing so. The considerations in their minds will embrace the severity of the possible offences, the consequences of the accident and the likelihood of obtaining a conviction. The decision to prosecute should be taken by someone independent of the investigation.

6.8.2 A decision to prosecute is, however, an important one, not only for those being prosecuted but also for the investigation of cause. In many cases there is not likely to be a sound case for prosecution. As long ago as 1972 the Robens Report said "Relatively few offences are clear cut, few arise from reckless indifference to the possibility of causing injury, few can be laid without qualification at the door of a single individual. The typical infringement or combination of infringements arises rather through carelessness, lack of knowledge or means, inadequate supervision or oversight, or sheer inefficiency. In such circumstances the process of prosecution and punishment by the criminal courts is largely an irrelevancy". The impounding of evidence

6 The Cullen Inquiry into Piper Alpha was particularly noteworthy.

and its selective release, the differing treatment of witnesses and the introduction of a fear of becoming involved in the prosecution all serve to change the tone of the situation. This does nothing to assist the investigators of cause that will usually work best in a more relaxed and less formal atmosphere.

6.8.3 The Government are alive to the dangers of prosecutions holding up the work of the investigations of cause. In the particular case of public inquires the Lord Chancellor gave an opinion in a memorandum "Disasters and the Law – Deciding the form of Inquiry". In this Memorandum the Lord Chancellor states that:

6.8.4 "It would require firm indications of serious criminality to justify a criminal investigation taking precedence over an inquiry held in public (or at least whose results are to be made public) where otherwise the public interest requires that such an inquiry be held. Colleagues will wish to bear in mind that the holding of such an inquiry in advance of criminal proceedings may adversely affect the ultimate prospects of a successful prosecution, but nevertheless, unless the criterion mentioned in the previous sentence is met, this is likely to be justified."

6.8.5 To a considerable extent the manner of prosecution and investigation are separate although both rely upon determining facts and establishing the truth of the situation. Prosecution is decided upon by the prosecution agencies; the Police, CPS and HSE and we can add little to that here. But prosecution and investigation do inter-relate as the Lord Chancellor says. The one is to some degree a hindrance to the other, sometimes seriously so. Relatively few major accidents result in successful prosecution. Given that it is important to the prospects for success in either investigation or prosecution that a lead agency should be selected soon after the accident we believe that two recommendations are called for. First that the Attorney General should consider ways in which a quick initial decision could be made on whether or not to prosecute. Secondly, in the light of the relatively low numbers of successful prosecutions that occur, that the HSE (or AIB) should be held to be the lead agency unless and until the prosecution agencies decide upon a prosecution. We believe that these two measures would allow investigations to get off to a better start in cases that they will run and that prosecution will not be held out as a possibility to the detriment of investigation for longer than is necessary.

6.9 Perceptions of independence

6.9.1 It seemed in our deliberations a good starting point that any inquiry in to the causes of any major accident or incident of high potential should be independent. It turns out, as it so often does, that the varied, complex and unpredictable world makes simple and polarised views difficult to apply. We debated whether there should be a complete separation between the investigators and those concerned with inspection, regulation and prosecution. For major accidents this is achieved now by the AAIB and the MAIB and will shortly be achieved by the RAIB. We wondered why, if it works well for them it should not work better for more sectors.

6.9.2 There were arguments for each approach. Those in favour of keeping the status quo saw its main advantages as:

- The ability for the HSE to decide where the demarcation line should be drawn between lesser accidents and major accidents of the type we were discussing in industries where this was a substantial issue.
- The high cost of maintaining independent bodies for more industries and the related issue of sustaining their expertise.
- Maintaining the value of integrated experience across several sectors having some common problems and also across the spectrum of accidents. Protagonists believed that this would be easier to ensure within the HSE than in and between separate bodies.
- That the type of accidents experienced in the "HSE sectors" was more varied in their nature than those in the transport sectors which tended to a similarity at least in the gross circumstances of the accident, for example an aircraft or train crashing.

6.9.3 On the other hand there were arguments put with equal force for an extension of the AIB system on the grounds that:

- An AIB carries no baggage, either real or perceived, associated with the other roles of regulation, inspection and prosecution but is seen to be wholly concerned with investigation. This allowed the AIBs to be perceived as independent in a way that the HSE cannot always achieve.

- An AIB does not have to consider implementation difficulties in coming to its conclusions about what happened and what should be changed in the way that the HSE might be seen. This is the forward-looking variant of the previous point about perceived independence.

6.9.4 There was a clear division between these among the group with each adhering to what they knew best. In seeking to explain this division we discussed the background to transport accidents and the ways in which they differed from a more diverse and mixed set of accidents in other industrial sectors, and the way in which transport vehicles were controlled (typically by one responsible person assisted by others) in contrast to the more "process" oriented accidents of the wider industry (see also para 3.2.7). We concluded that neither system was best for every situation but should be kept under review. We were encouraged that the move of rail to the AIB system showed a willingness to make changes where these were justified by the likely outcome.

6.9.5 One other aspect of independence occupied us – the status of independent experts. It is generally desirable that those experts who are helping the inquiry on points of technical detail should be independent of any party to the accident and should not act for them. But this aspiration ignores the common fact that those with the greatest, most relevant and up-to-date knowledge may well be employed in the industry or by the firm that had the accident. We believe that the inquiry should have access to the best expertise available even if this is not wholly independent. Our belief is, however, that inquiries should be particularly careful in requiring such experts to define their role. This may be as "independent expert" – meaning employed by the inquiry alone. It may be as "Expert Advisor to Firm X" meaning that the expert is working for the company. The aims of complete independence may be antagonistic to the aims of technical competence but we believe that openness about roles and responsibilities of experts is essential.

6.10 Effective dissemination of knowledge

6.10.1 The information generated by an accident investigation is often more valuable if it is timely. Progressive dissemination is advocated where it is possible to do this in an appropriate way having regard to the whole case. This is usually the case now with major accidents but it should become a routine consideration.

6.10.2 Broadcast dissemination of a wave of "raw" data is generally unhelpful. We believe that the extra cost to the investigation of re-assembling the information into a more user-related form will usually be more than justified. The full report of the investigation should, of course, be referenced and can be made available to those who want to read it. For other purposes an abstracted version of the key findings and recommendations will be more useful. Electronic data systems, especially the internet, provide for readily accessible information to be provided that can be accessed quickly and fully around the world without the need to broadcast it all. The constructive and positive use of the Internet and the re-structuring of the data could help to overcome many of the problems of information overload of failure to communicate especially if combined with selective e-mail alerts to known areas of interest.

6.10.3 The cost of re-assembling information and disseminating it progressively, in different forms and often repeatedly, will need to be recognised as a cost for the investigation and should be allowed for in every investigation of one of the major accidents that are the subject of this report.

6.10.4 The design and periodic review of a distribution network for information should be undertaken in consultation with the relevant industries. This could be designed in a layered form so that each layer of the

network had some decisions to make about onward distribution. This would need to be a balance between the speed and immediacy of a "one-to-all" distribution against the slower but more selective "one-to-some" cascade process. In either case there will be a cost associated with improving the distribution process but we think that this will be small when compared with the cost of investigations and the cost burden of accidents.

6.11 Effective and consistent learning

6.11.1 The key to improving performance as a company that fosters collective learning, about safety as about much else, rests in looking for better practices to adopt. It is rarely possible for a company in isolation to devise a suite of excellent practices in isolation. Nor is it desirable, the cost of the trials and errors would be significant and demoralising for those engaged in the learning. Better usually to adapt and improve the practices of others. The adoption and adaptation of best practice requires to be treated as a project, with objectives, metrics and results. The needs of the recipient organisation should be studied and set out and broken down into sections for management action. One of the sections will be finding better practice although this is usually not too difficult. The sections dealing with creating better safety policies, ensuring feed-back of results, allocating time for training, identifying role models, installing information systems and other internal actions will often be the more difficult obstacles to overcome. But these sections dealing with the internal response of the company are crucial. Without work on them seeking out better practices will be nearly wasted effort. Once the improved practices inside the company are established and generating improved results then more imaginative sources of external data will be sought and improved processes will be devised making the company not only a better learner but an exporter of best practice.

6.11.2 It is worth stressing here the value of learning from any source of information. UK companies are not limited to UK experience and many firms used to working in the global market (OOG, nuclear, some parts of construction) already understand the value that can be gained from looking at international experience. We believe that many more companies could benefit from this source of information.

6.11.3 The emphasis above on a systematic approach to improvement will strike many smaller companies as beyond them and possibly irrelevant because they are not open to causing a major accident as discussed here. These are both appropriate considerations. The creation of an effective safety culture should be adapted to the role of the company and its exposure to accidents. There might well be a wider consideration of the benefits of a learning culture but that is not pursued further here. Notwithstanding this balance of effort against a company role there may be things that companies can do to ease the burden – these might include forming an area "club" of companies for self help on a combined basis. At whatever scale company learning about safety is addressed specific efforts should be made to embed the learning –in the processes of the company that form part of its corporate knowledge, as part of the generally accessible database of the company network, and as part of the development of individuals.

6.11.4 One of the practices that will translate to many other sectors and companies is the use of metrics for safety and learning. The OOG sector and the nuclear industry are probably the leaders in using performance indicators to assess the robust use of established process controls during periods of safe operation. This allows the continuous evaluation of these processes and the introduction of safer approaches before an accident or incident develops. Although these sectors are not alone in the use of these techniques there is also clear scope for the extension of the principles they have adopted of active learning, from other sectors and internationally.

6.12 Applying the Learning

6.12.1 Perhaps the acid test of all of the above is whether we prevent future accidents by applying what we have learnt. Technically, of course, we shall never know but we can make qualitative judgements about this. The evidence that we do learn is strong – in aviation a constant stream of innovations traces much of its back-ground to accidents around the world and the community's aims to eradicate one cause after the other. In OOG the disaster of the Piper Alpha and its subsequent inquiry brought fundamental changes to that industry with the effect that we must still look back to Piper Alpha for the last major accident. In the nuclear industry

there is an embedded culture of seeking out weakness and correcting it before any accident strikes. In this industry too most recent experience of accidents comes from abroad. So we see that we have experience that clearly says that we have the means and the will to prevent accidents by learning from the past.

6.12.2 But this good performance does not shield the much less than satisfactory contrary evidence that accompanies it, in which accidents happen to people who know how to do the jobs in question, and know why they should but choose to take risks with themselves and others by not doing what they should. This is not about helping people to read about accident prevention for they already know it. What is needed is to convince them that the time and trouble that they save is not worth the risk and will not be tolerated by their company.

6.12.3 Nor does the good performance hide the vast amount of indifference to learning and improvement that persists. Accidents happen time and again for reasons that we have already seen explained and understood. Only rarely, anyway in the vast majority of lesser accidents, does an accident happen for hitherto unknown reasons. Very often an accident occurs not because those concerned did not know what was right but did not do it. For every accident that actually results in people being hurt and property damaged many are saved from doing so by merest chance. However examples of "new causes" are more likely to occur in complex situations such as we have described here and it is in these areas that new learning is especially important.

6.12.4 The main avenue of accident prevention rests within companies. It rests with their top management establishing practical learning and safety cultures that do not rely on printed documents or company procedures alone but on the interest and concern evidenced by managers of all levels in their everyday management activities. In a practical safety culture learning from accidents and going on to think about the local implications of this knowledge becomes part of an attitude to the job and is more successful than paying lip service to company procedures.

6.12.5 Even in companies that seek to learn from the misfortunes of others there are difficulties. One that we identified is in exposing the weaknesses of an organisation under emergency conditions. It is rarely possible or practicable to simulate the stresses of a real emergency but without those pressures the strength of an organisation, its people and its processes may go untested. This will be especially the case in those sectors where the "team" dealing with any real emergency will include levels of sub-contractors and the strength of the interfaces that have been built up between them. The response to these challenges must rest with individual sectors and companies but we note that the stress of emergency operation should be tested to some level and should embrace the whole contractor network involved in the work.

6.13 Directions for the Future

6.13.1 We are no better able to predict the future than many others who have tried in the past. There will be many aspects of the future that we shall find take on characteristics we cannot predict today. But there are some features that we can expect to be a feature of the future with special reference to the kinds of incidents we have studied. The rise of computer controlled equipment will continue, whether in aircraft systems, plant controllers or in the design of large structures. They will offer the possibility of far safer plants with many decisions that would take humans too long to make being made in an instant. However, understanding the levels of assurance that these systems should offer us is difficult, impossible by ordinary observation. The average person, even those who use these systems, is incapable of knowing how close they are taking the system towards danger if they have not been personally engaged in the appropriate calculations. The system designers will have calculated the actions needed in a variety of specific situations but they are also constrained by their lack of knowledge of the emergent properties of the system. Emergent properties include those which determine that the system may do all that is asked of it but with an unknown level of confidence that it will only do that which is asked. Difficulties may also exist in situations that have not been specifically assessed for their impact. Naturally there are established ways of treating these difficulties and they need not be insuperable problems when correctly designed and built. We see, however, that engineers of the future will

need to be aware of the principles that have been used, to be able to ask the right questions and to be aware which are potentially dangerous practices in the use of the systems. In former times it was perceived to be almost sufficient for engineers to receive one burst of formal education and then to rely on experience. This is not now the case, if it ever was. Experience still has its own value but the design, application and management of complex computer systems require focused education. A recent survey of management handbooks shows that few of them devote more that a fleeting reference to avoiding accidents. We believe that all engineers who aspire to professional qualifications should receive formal safety management and accident prevention training before they become professionally qualified and should receive formal education in the safety aspects of particular systems before they are expected to use them operationally.

6.13.2 A feature of greater globalisation is the procurement of elements of an operation from an enormous breadth and diversity of sources. In the context of avoiding accidents this will pose increasing problems for the managers of the future especially in software management and preventing accidents. Not only will it be advisable to understand how the code has been designed and structured but to ensure that it has had appropriate protection from malicious insertions of code at all stages of its development. This activity may not be confined to the merely malicious but may extend to terrorist activity via the software. The physical installation may, of course, also be subject to terrorist attack or, perhaps worse to sabotage in a less than obvious manner. The implicit assumption that danger can only stem from misjudgement or ignorance that was a feature of former times cannot be assumed to apply in the future. There are established mechanisms for dealing with these risks and we can expect to see these deployed more widely. They include the use of independent and separately procured computing systems work in duplex or triplex formats to provide very low risks of corrupt code.

6.13.3 One of the other consequences of increasing complexity and impenetrability of control systems is that the public attributes to them either unjustified weaknesses or equally unjustified infallibility. Neither is likely to be true but confidence in these systems by people with no real opportunity to understand them will be a matter of informed public relations that is based upon a higher level of understanding and comprehension. The degree of public confidence in the safety of operations that obviously have at least the potential for catastrophe will in good measure depend on skilled and experienced conveying something of the depth of understanding that the engineers have applied to reduce the risk of failure.

6.13.4 This greater understanding must start at the design concept stage and address all potentially credible operational circumstances – which might include issues in commissioning or building plant or structures and in de-commissioning it. Careful analysis using the best tools available will be a great contribution to the safety of the installation providing that experienced and knowledgeable people apply them. There will be many more opportunities to exchange ideas between sectors as the issue becomes how to make control and analytical systems more effective and more dependable.

7 The Terms of Reference and the Report

7.1 The Terms of Reference [TOR] asked for seven points to be considered

- The extent to which the generically desirable aims are achieved by different processes across sectors dealing with the containment or manipulation of high levels of energy.

The Group found that the generic aims were achieved by different approaches although these had many common features. The anomaly of the rail sector is being removed by its alignment under a Rail AIB similar to the precedents of the AAIB and MAIB.

- The process elements that appear to work effectively toward the public good in either accidents or incidents of significance by virtue of their sequence, authority, resource, application or design.

The list of good practices that was exposed by the discussions of the Group is listed at Annex 7 of the Report.

- Recommendations for any procedures that seem to the group to have the best overall chance of achieving the desirable aims or a greater part of them.

The Conclusions and Recommendations below at Section 8 form the Group's response to this action.

- The identification and illumination of the choices that may be necessary when some of the desirable aims are incompatible in a given situation.

The situations where incompatible aims may arise focused upon the choice between investigation of cause and prosecution. This is mainly dealt with in Section 6 of the Report and forms the crux of one of the principal recommendations of the Report.

- To record the histories and outcomes of the accidents studied.

The histories and outcomes of the accidents studied in the various sectors are described in the full reports of their authors on the accompanying CD-ROM and are summarised at Annex 3. The accidents where particularly valuable lessons have been learnt that are of general applicability are also referenced in the main body of the Report.

- To record the nature and main thrust of the evidence given to the group by individuals.

The Group has not sought contributions from individuals other than those who have become members of the Group listed at Annex 1. The contributions of these individuals have not been separately identified except insofar as they have submitted sector or transverse reports.

8 Conclusions and Recommendations

8.1 Introduction

8.1.1 The studies and discussions of the Group have served to question but ultimately to endorse a number of aspects of the post-accident processes that are used in the UK. We do not think that there is presently any need for a radical change in the way we proceed. Some aspects of the industrial scene are changing, most notably in the change to place the railways under a Rail Accident Investigation Branch. We recognise that this is currently a transitional situation and there seemed no great purpose either in criticism of the past or in pronouncing about a future that has not yet become established. We have some concerns and recognise that the changes will be difficult to manage smoothly. But it is best, in our view, that we give those charged with making this change time to do so.

8.1.2 Our view that there is no need for radical change should not be taken to indicate that we see no room for improvement. We are sure that improvement must be constantly sought and believe that this can be achieved in two main areas: firstly in the relationship between prosecution and investigation of cause and secondly in the way in which the value of investigation of cause is extracted and deployed across industry. We also believe that constant attention to this subject is necessary when we look to the future where we see the impact of ever more complex control systems as having important implications and challenges for safety management.

8.1.3 The management of safety in industrial situations cannot be seen only within the context of a single nation as most of our great industries operate in a global market competing with companies all over the world. The UK safety record is good; better than the great majority of countries, and we see no reason to think that this should or will be allowed to slip back in the interests of becoming more globally competitive. In the short term, however, it may be that adherence to our present high standards will make for competitive difficulties in specific situations but in the longer term it is clear to us that effective business practices will demand that global standards should rise. In any case, there is ample evidence that good management of health and safety brings substantial benefits to the business. The UK should therefore be in a good position for future operations and be globally competitive if it continues to develop and evolve its safety practices. Furthermore, we expect the growing internationalism of industries to result in a parallel internationalisation of safety management and codes. The European Aviation Safety Agency (EASA) has already been formed with the view that it will eventually replace the wholly national regulators like the Civil Aviation Authority (CAA). We expect that this trend will be mirrored in other industries.

8.2 Five Principal Conclusions and Recommendations

8.2.1 We conclude that the primary aim of any post accident investigation into causes should be to enable the prevention of future accidents that could have similar causes. The UK safety record is very good on an international comparison. We believe that this has been possible only by consistent attention to investigating the causes of accidents and taking appropriate steps to prevent their repetition. This emphasises the accident prevention aims of an investigation and underlines the need for such investigations to be penetrating, comprehensive and to be completed with despatch. Only when the investigation reports on the cause, whether all at once or in stages, can action begin to be taken by those having a concern for their own operations. Only if the investigations continue to be impartial, objective and thorough can those operators be sure that they have all the information on which to base necessary changes.

8.2.2 After a serious accident it is important to the quality of the appropriate investigation that a decision on the agency to lead it should be reached quickly. The Report discusses the twin paths of prosecution and investigation into cause. They are managed separately but can continue to influence each other. A process stream that starts with investigating cause involving the police, HSE, AIBs and other authorities is the backbone of accident prevention. Sometimes, although in a minority of cases, the relevance and importance

of prosecution will need to take precedence. The style of each form of inquiry is different and places different demands on the situation in terms of witnesses, evidence, timing etc. We do not seek to influence the prosecution process when it is judged necessary but **recommend** that the Attorney General should consider how the process of deciding whether to prosecute and whether the police or another agency should lead the investigation could be made faster and more transparently and how this might be set out in the Work Related Death Protocol. (In Scotland the Procurator Fiscal manages the overall direction of the investigation). Given that prosecution is decided upon only in a minority of cases we **recommend** that the default situation pending any decision as to prosecution should be that the HSE (or the appropriate AIB where they do not already have this position) should be the lead investigative agency in all major accident situations.

8.2.3 We **conclude** that the current UK accident rate should not be regarded as a given or as a stable state. There are significant challenges ahead in sustaining low accident rates in powerful plants and equipment as control systems become more complex. The increasing use of software to control plants and equipment makes understanding their risks and dangers more difficult. It raises the possibility of properties emerging that have not been foreseen. It places a greater responsibility upon the design phase of the work. It makes the interfaces between contractors potentially more difficult. For all of these reasons we think the future will place more demands on individuals and companies if they are to maintain current accident rates or improve upon them. We **recommend** that safety management, safety engineering and accident prevention should form a part of the formal and informal training of all engineers as a requirement to becoming professionally qualified and this should be reinforced by Continued Professional Development. We also **recommend** that companies should be encouraged to devote more energy to the creation of cultures that are conducive to more effective learning by both individuals and by the corporate group.

8.2.4 We **recommend** that incidents that by chance fall short of developing into major accidents should, depending on their circumstances, be regarded as equally appropriate to be the subject of an investigation. As sources of insights to enable the prevention of future accidents they are just as valuable for learning from as major accidents (Para 3.1). In any specific case judgements will be necessary about the potential the incident had for a more serious accident. There are also other processes that are useful in this regard. Confidential and mandatory reporting systems (e.g. of Signals Passed At Danger (SPADs), air near misses etc) also serve to assist in making these judgements. Companies operating relevant plants should all have internal procedures for reporting dangerous incidents and it is also important that any judgement should be made quickly so that any evidence that is appropriate to an inquiry can be secured.

8.2.5 Accidents are only prevented when the findings of investigations are taken into companies and effectively embedded in their processes: in design, management, training, operations, maintenance and decommissioning. We **recommend** that further publicity should be given to promoting the concept of "Best Practice" being adopted by all companies with special reference to the benefits for accident prevention. "Best Practice" in this context should be very broadly interpreted and industrial sectors should look outside their own special fields for new and more effective techniques being used in other sectors world-wide. This requires the achievement of a culture within companies that encourages learning by both the individual and by the company as a group. It is tolerant of mistakes if they are used as learning opportunities but intolerant of mistakes being covered up and denying the company the knowledge of the incident. A best practice company is accustomed to measuring its own performance against others, to using information to amend its processes and to looking to other companies, industries and sectors for useful information from which it can learn and improve its own operation. (para 5.4).

8.3 Other Conclusions and Recommendations

8.3.1 The most promising areas for improving our accident rate still further rests in the better dissemination and application of relevant information and in an improved quality of learning from its messages including learning from other sectors. By far the most common reason that accidents recur is ignorance of what has happened in the past even though reports have been disseminated. We **recommend** that abstracted

information circulated about accidents should be such as to relate to the interests of the recipient and sufficiently detailed to allow the reader to determine whether the full report should be obtained. (para 5.2 & 5.3)

8.3.2 We **recommend** that the best practices of existing investigations should be used more commonly including those set out at Annex 7. Other measures include devoting adequate time to considering when and how to present and disseminate details of their findings and whether to the public or to industrial audiences and to taking appropriate time to looking beyond the superficial. In general we believe that investigations into cause should be as transparent to the public as possible. It is **recommended** that consideration be given by the HSE and by AIBs to the production of a guide for chairmen of investigations setting out elements of best practice that they should consider. (para. 4.5)

8.3.3 We **recommend** that the successful protocols used by the HSE and AIBs should be extended to other areas of inter-agency co-operation including the handling of evidence, selection of witnesses, care of bereaved relatives, and developing the investigation strategy.

8.3.4 We **recommend** the wider use of metrics and statistics to illuminate safety performance and establish credible standards of performance. The need for particular statistics, especially new ones, should be established with care that the effort to produce them will bring corresponding value to those who provide the information and use the data.

Accidents and Agenda

An examination of the processes that follow from accidents or incidents of high potential in several industries and their effectiveness in preventing further accidents

Annexes

Annex 1 – Working Group and Secretariat Members

The Report would not have been feasible without the efforts of the sector and transverse contributors and the Academy is grateful to the following:

Mr Trevor Truman OBE FREng (Chairman) – Director, SEA (Group) Ltd (non-exec)

Professor Douglas Faulkner FREng – Emeritus Professor of Naval Architecture & Ocean Engineering, University of Glasgow

Dr Paul A. Frieze – Managing Director, PAFA Consulting Engineers

Mr Norman Haste OBE FREng – Chairman Severn River Crossing PLC

Vice Admiral Sir Robert Hill KBE FREng – Independent Director of British Energy plc and Chairman of the Safety, Health and Environment Committee (1999-2003)

Mr Jeffrey Jupp FREng – Technical Director, Airbus UK (retired 2001); Visiting Professor Bath University; Chairman, Environment, Safety and Security WG - UK Aviation Innovation and Growth Team

Professor Trevor Kletz OBE FREng – Visiting Professor, Department of Chemical Engineering, Loughborough University and Adjunct Professor, Department of Chemical Engineering, Texas A&M University

Professor Helen Muir – Professor of Aerospace Psychology and Director of the Cranfield Institute for Safety Risk and Reliability at Cranfield University

Professor David Newland FREng – Independent consultant & Emeritus Professor of Engineering, Cambridge University

Mr Richard Snell FREng – Senior Advisor Structural and Civil Engineering BP Exploration

Dr Peter Watson FREng – Formerly, Chairman, AEA Technology plc

John Uff QC, FREng – Emeritus Professor of Engineering Law, King College, London, Arbitrator and Barrister

Other advice and contribution

The work of the group has been materially assisted by other advice and we should like to mention particularly:

Mr Ken Smart – Chief Inspector, Air Accident Investigation Branch

Mr Timothy Walker – Director General of the Health and Safety Executive

Sir Alan Muir Wood FREng FRS – Consultant, Halcrow Group

Professor Nick Pidgeon – Director Centre for Environmental Risk, University of East Anglia

Mr Philip Smedley – Director, Structural Engineering, PAFA Consulting Engineers

Writing and compiling the Report was led by Mr Trevor Truman assisted by the Academy staff principally Mr Brian Doble and Mr Richard Ploszek.

Annex 2 – Terms of Reference

Terms of Reference

1. The Group task was approved by the Standing Committee on Engineering within the Academy and was tasked to provide a Report that addressed:

2. The extent to which the generically desirable aims are achieved by different processes across sectors dealing with the containment or manipulation of high levels of energy...

3. The process elements that appear to work effectively toward the public good in either accidents or incidents of significance by virtue of their sequence, authority, resource, application or design.

4. Recommendations for any procedures that seem to the group to have the best overall chance of achieving the desirable aims or a greater part of them.

5. The identification and illumination of the choices that may be necessary when some of the desirable aims are incompatible in a given situation.

6. To record the histories and outcomes of the accidents studied.

7. To record the nature and main thrust of the evidence given to the group by individuals.

Annex 3 – Industry summaries

The Sector Reports Summarised

The full text of each submission is on the CD associated with this Report.

a3.1 Aviation by Mr Jeff Jupp

a3.1.1 Aviation is, in relative terms, a young industry which was perceived from the very outset as being potentially dangerous. Because of these factors and its international nature, it has grown up in a highly regulated framework governed by international agreement. In the UK, air transport accidents are investigated by the Air Accident Investigation Branch (AAIB) according to the requirements of the International Civil Aviation Organisation (ICAO). The specific international requirements are contained in Annex 13 of the Chicago Agreement, of which the UK is a signatory.

a3.1.2 The AAIB's investigations are for the sole purpose of establishing the reasons for an accident to ensure the continued safety of the travelling public with the minimum disruption to their ability to continue travelling. Except in exceptional circumstances, they are empowered to take control of the accident site and all evidence. AAIB inspectors do however interface with both Coroners' and Judicial Inquiries as required. There are well established procedures for this, and for determining the level of response according to the severity of the accident.

a3.1.3 Although not in its formal terms of reference, the AAIB puts a very high priority on the interests of the survivors of incidents and the dependants of any fatalities, in terms of their need to be kept informed and rehabilitation. (This is important from the point of view of avoiding pressure for further investigation and Judicial Inquiries and thus enhances the organisation's reputation, as its findings are not subject to further scrutiny. Certain aspects of the Warsaw Convention, which regulates travel by air internationally and is particular to the air transport industry, mean that a carrier is *de facto* responsible for the safety of passengers and will compensate them for damages in the first instance before seeking redress from other responsible parties. The simplification of these legal issues from the point of view of the victims also reduces the pressure for further investigations.)

a3.1.4 As well as both formal and informal means of communicating the progress of an investigation and any preliminary findings, the results of the AAIB's investigations and its recommendations are publicly reported and it is then for appropriate parties, including the CAA as regulator, to take action as necessary. Progress on such recommendations is reviewed between the CAA and the AAIB on an annual basis. In addition, as a recent development the AAIB (as well as the CAA) is open to audit by ICAO representatives to ensure that international standards are adhered to (and so far have been held up as exemplars of good practice).

a3.1.5 Internationally, the AAIB has an enviable reputation and it has been used as a model for the proposed Rail Accident Investigation Branch proposed by the Cullen Inquiry into the Ladbroke Grove Rail Crash. Key to its success are that AAIB inspectors have "ownership" of the accident site (as opposed to the Police whose primary concern is to preserve evidence for the purpose of a criminal investigation), that evidence given to AAIB inspectors will not subsequently be used in a criminal prosecution and the AAIB's independence from the Civil Aviation Authority as regulator, and from any prosecuting agency.

a3.1.6 General Points which emerge from the cases examined may be:

a3.1.7 The need for good co-operation between the AAIB, the police and other agencies (Lockerbie – 747)

a3.1.8 The extent to which complex technical incidents benefit from an independent body able to engage multidisciplinary capabilities in the technical investigation of cause. (Paris – Concorde)

a3.1.9. The importance of a competent and experienced agency taking control of the incident site from the outset. (Paris – Concorde)

a3.2 Chemical by Professor Trevor Kletz

a3.2.1 Investigations in the Industry range from Public Inquiries (which are very rare) to informal hand-notes by a foreman. Some incidents must be reported to HSE or Environmental Agency or both.

a3.2.2 The degree of formality of the investigation varies. In the writer's view more formality does not produce a better result but the reverse.

a3.2.3 The contribution describes an investigation in some detail (see original paper). The investigation revealed a number of issues:

- The direct technical cause of the incident.
- Deficiencies in the management of protective systems.
- The importance of calm, reasoned decision making during the incident.
- The clash between formal authority (vested in the manager) and the real authority (present in the foreman).
- The cultural environment that was perceived to place more emphasis upon output than safety despite formal statements to the contrary.
- In assessing the quality and utility of investigations opportunities for enhanced safety are sometimes, perhaps often, missed through one or more of the following:
- Concentration upon a single cause when there were multiple causal contributions.
- Concentration upon the direct and immediate causes without looking into the background, cultural, systematic issues that created vulnerability.
- A residual temptation to blame human error on someone directly involved without thoroughly analysing which humans made which errors and whether these should also include failures in e.g. training, instruction, management, supervision etc.
- Yielding to the pressures to attach blame rather than thoroughly to establish cause.
- Causes are identified without listing the practical remedies that could have prevented the chain of events developing.
- Focusing upon ostensibly perfect solutions without adequately balancing the risks, costs and benefits of their application.
- A disposition to rely upon procedural change when design changes would offer a more secure remedy.
- Attaching too little importance to the behavioural and cultural environment that conditions how people act both normally and in an emergency.
- If people from other plants, functions or organisations are included in investigation teams or asked to comment on the report they are more likely to see the underlying causes than those who are involved in the details.

a3.3 Construction by Mr Norman Haste

a3.3.1 The construction industry has the worst accident record of all industries in the UK considered in this report. With its thousands of companies, more than 90% of fewer than 6 people, the industry is highly fragmented. Despite this the volume and value of the work completed makes a significant economic impact.

a3.3.2 The nature of the industry is to build new constructions and each of these is the product of knowledge at the time of design and build. Even when new knowledge is obtained it is rarely possible to do more than manage the residual risks in existing buildings.

a3.3.3 Safety is administered by the HSE who set regulations, advise, investigate and prosecute in the safety field. There are moves in hand to introduce more prosecutions of individual directors for safety shortcomings rather than, or as an addition to, the prosecution of the company.

a3.3.4 All accidents involving over 3 days lost time have to be reported and accident frequency is used to generate Accident Frequency Ratios (AFR) which are used mostly by large companies.

a3.3.5 In serious accidents the investigation of cause can be very protracted. Investigation is by the HSE who have powers to preserve evidence by stopping the work. The HSE also consider whether there should be a prosecution under the Act. This has led potentially valuable witnesses to be extremely cautious in giving evidence to the investigation. The HSE seems to give the prosecuting aspect of their work greater weight compared with the investigative processes. All of this causes the determination and the dissemination of the causes and possible avoidance techniques to be long delayed.

3.3.6 Examples are given for the Severn Bridge Gantry accident of 1990 not being communicated to the industry in a prompt and effective manner. In 1998 a somewhat similar accident occurred at Avonmouth which led to a prosecution but which might have been prevented if the outcome of the Severn Bridge accident had been available earlier.

a3.3.7 The possibility of setting up a body like the AAIB or MIAB is discussed but serious problems would be encountered in such a fragmented and diverse industry. An alternative is proposed by which investigation and prosecution could be separated by the appointment of an Investigating Engineer reporting to the DPM who would have no locus to assign blame and who would work in much the same manner as the other bodies like MIAB, AAIB etc. The main benefit of such an approach, with mandatory witness evidence, is seen to be a more rapid and effective identification and dissemination of the causes of the accident.

a3.4 Nuclear by Sir Robert Hill

a3.4.1 While industrial accidents occur and are investigated in a conventional manner by the operator and the HSE, the unique quality of a nuclear accident is the uncovenanted release of radioactivity. Lesser occurrences with nuclear safety or radiological significance are described as incidents, events, or adverse conditions. All are investigated, the nature and level of the investigation being governed by the perceived severity of the event in terms of the threat posed to nuclear and radiological safety.

a3.4.2 The NII has defined the types of event that must be reported, so these are known as Reportable Events. More generally, events are rated from 0 to 7 according to an international nuclear event scale (INES) indicating the risk of, or actual, radioactivity release and the health and environmental effects. At the higher end of the scale, nuclear accidents are extremely rare but attract a very high level of public and political concern.

a3.4.3 The nuclear power industry acts within a highly prescriptive and organised regime of safety management with government regulators and, separately, strong industry self-regulation. All possible lessons having been learnt from the few accidents that have occurred, the prevention of accidents is kept in the forefront of operators' minds by the investigation of all untoward events, by corrective action programmes, and by the world-wide

sharing of operational experience feedback (OEF). Throughout the industry, strong emphasis is placed on open reporting.

a3.4.4 In the unlikely event of a nuclear accident, control of the emergency happens under guidelines prepared by the Nuclear Emergency Planning Liaison Group (NEPLG). Concurrently, for the emergency might develop over a period of hours and last for several days, there is a well defined process that is mobilised to investigate the accident. Once classified as a Major Incident, the primary enquiry is led by the HSE. The Government may also be expected to set up a special enquiry and several forms have been considered. A "1921 Act Enquiry" is probably the most likely form, but no government commits itself in advance to adopt a particular type of enquiry.

a3.4.5 Since the accident at 3-Mile Island in the USA [TMI] a system of performance indicators has been developed and adopted worldwide, covering a range of measurable parameters bearing on nuclear and radiological safety. Constant assessment against best practice has resulted in dramatic increases in safety performance.

a3.4.6 The UK nuclear industry has, despite its good record, suffered from a high level of public suspicion and fear and a corresponding lack of public confidence. This is exacerbated by the use of emotive language in the media when reporting incidents, inquiry and court proceedings.

a3.5 Oil & Gas by Mr Richard Snell

a3.5.1 The Offshore Oil Industry is international in nature and has both world-wide and regional standards and Guidance Notes for safety management. Since the Cullen Inquiry into Piper Alpha was published in 1990 much emphasis has been put onto integrated links between design, operation and maintenance.

a3.5.2 Since Piper Alpha there has been no major incident within the UK jurisdiction. The Industry is therefore focused upon how to design and manage installations that will continue this record. This has led to the development of the Safety Case approach to management.

a3.5.3 The Safety Case approach to safety since 1993 has moved the industry away from prescriptive safety instructions to the use of safety Goals for a specific platform or installation. There is a legal duty upon the Duty Holder to establish the Safety Case and to operate within it.

a3.5.4 The Safety Case approach is based on the ALARP concept (As Low As Reasonably Practicable).

a3.5.5 Following this transition, reviews of existing and planned installations resulted in the expenditure of over $1 billion of modifications and improvements. The oil majors all support the Safety Case approach and have found that when incorporated ab initio the cost burden is not severe.

a3.5.6 The Safety Case system is now to be reviewed by the HSE in the light of 10 years experience to see whether it can be eased or improved in particular ways.

a3.5.7 The Industry also takes very seriously the need for and impact of safety training. The paper comments on the challenge of training to common standards within a variety of national and regional cultures across world-wide operations.

a3.6 Railways by Dr Peter Watson

a3.6.1 There are several agencies involved (soon to be joined by the RAIB) and interaction between them, whilst better than it was, still leaves room for conflicts between their agenda.

a3.6.2 Where criminal prosecution is a possibility the incident site and the contained evidence comes under the authority of the BTP. This can damage the output of the technical investigation and have other conflicting consequences.

a3.6.3 There is an issue to be addressed concerning the freedom (and increasingly the choice) of individuals (even those known to have relevant knowledge) not to give evidence to certain investigations where the force of legal constraint does not apply.

a3.6.4 The management of the processes relevant to the injured and bereaved is not yet at the levels achieved in e.g. the aviation sector.

a3.6.5 Small (5%) proportions of HSE investigations result in prosecution although this independent activity may sometimes be another confusing strand to the overall process.

a3.6.6 Public inquiries are called for more often than they are useful. They are expensive and generally do not add much to the understanding of the accident or its causes. They do not have to make recommendations that are grounded in economic practicality.

a3.6.7 The link from an investigation (of any kind) to future operational choices and economics and their risk assessments is often unclear.

a3.6.8 Public perceptions of rail safety are inconsistent: the public say that safety should come first but place it very low when asked what should be done first.

a3.7 Marine by Mr Paul Frieze (Following work by Prof Douglas Faulkner)

a3.7.1 The investigation of accidents in the marine community is performed by the Marine Accident Investigation Branch of the Department of Transport. The objectives defined in the legislation focus upon the improvement of safety and preventing accidents. Rather than apportioning blame and liability.

a3.7.2 The contribution features the history of one accident in some detail; the sinking of the Bulk Ore Carrier Derbyshire in 1980. The vessel sank without trace in a typhoon off Japan (underlining the global nature of the MIAB remit for UK registered vessels).

a3.7.3 The lack of immediately accessible evidence from the sinking initially prompted no inquiry. But following pressure from the families of the crew studies were commissioned to propose likely scenarios for the loss. The outcome of these studies was controversial.

a3.7.4 Incidents to sister vessels of the Derbyshire finally prompted a formal investigation to be held. The conclusions of this investigation were subject to widespread criticism that could neither be proved nor disproved in the absence of wreckage.

a3.7.5 Some years later a private expedition located the wreck and this led to the reopening of the formal investigation and to a new set of conclusions that were more widely accepted.

a3.7.6 Apart from the detailed review of the application of procedures in the context of the Derbyshire the processes themselves are summarised. Accidents are defined and the process of investigating them followed. The wide responsibilities of the Chief Inspector are set out including the processes for securing evidence and for serving notice of an inquiry.

a3.7.7 There is a short assessment of accident statistics and the conclusion is reached that there has probably been rather little improvement in the safety of large vessels (Bulk Carriers and tankers) in recent decades.

a3.7.8 The section concludes with a survey of possible improvements to the procedures that have been gleaned from recent investigations. Engagement with the families of crew lost at sea is vital if they are to have confidence in the eventual outcome of the investigation findings. Indeed the initial decision as to whether to mount an investigation should take into account the loss of life and the likely reaction of the families.

Independent Experts are often summoned to act for inquiries as Marine Accident Inspectors and these should be as impartial and independent as possible. In no case should they have made prior public statements about the probable cause of the accident. In no case should the inquiry depart from the objectives set out in the regulations which do not include apportioning blame. Government should demonstrate its support for the process by ensuring that major findings of formal inquiries are translated into amending regulations whenever appropriate.

Annex 4 – Transverse commentary summaries

a4.1 Procedural constraints and opportunities for Investigations by Professor David Newland

a4.1.1 Conflicts of interest arise when finding the cause of an accident and learning lessons are confused with seeking to punish those responsible.

a4.1.2 For most industries (except for aircraft, ships and, very recently, railways), the HSE (and/or the police) take primacy both for investigating accidents and for initiating prosecutions.

a4.1.3 Considerations of the precedence to be given to investigation over prosecution (or vice versa) will need the greater speed of reaching investigative conclusions to be balanced against the possible disadvantage under which this could place potential defendants. In order to protect those potentially at fault, it is essential that knowledge gained by all accident investigators, including statutory bodies, should be freely and openly available to experts advising defendants in legal proceedings arising from accidents.

a4.1.4 Balancing a potential "scene of crime" investigation with the requirements of an accident-investigating body requires new protocols for the removal, preservation and long-term storage of forensic materials. Establishing the admissibility or otherwise of evidence collected in an accident investigation in any subsequent legal proceedings may prove a very difficult complication.

a4.1.5 If the interests of potential defendants are not to be prejudiced in a prior investigation mechanisms would need to be considered for protecting their identities although this would present formidable problems if it were to be fully secure.

a4.1.6 Once a technical investigation has reached a conclusion it may be extremely difficult, if not impossible, for individuals to challenge these findings because of the huge resources required to do so. Nevertheless to rest a prosecution on the outcome of an engineering investigation and secure a conviction without adequate provision for that investigation's conclusion to be challenged breaches the rules of natural justice.

a4.1.7 The modern trend to assign blame when accidents happen may make insurance to cover legal defence costs as important for engineers as it is for doctors. Whether corporate or individual, potentially huge costs are involved.

a4.2 Legal issues by Professor John Uff

a4.2.1 There are several forms that an investigation might take after an accident. These include the Coroners' Court which may expose evidence not easily accessible by other courts. Civil Court proceedings may be brought by persons either injured or subject to other loss. This will usually only be serious when one Defendant blames another. Criminal proceedings may follow if it is perceived that there is culpability under either the Health & Safety at Work Act or by way of manslaughter charges (or corporate killing) in the event of a death. Internal investigations are provided for in most industries to be conducted by an appointed person. The form and legal standing of these investigations varies. In some cases they can experience conflicting demands for the evidence where the police are also gathering evidence for potential criminal charges. Finally there are public inquiries where the public interest is such to justify the cost and process involved. Public inquiries are always conducted to specific Terms of Reference and are invariably protracted and expensive.

a4.2.2 Whichever form the investigation takes there are some fairly common legal difficulties that emerge in all industries. These are:

a4.2.3 Post accident procedures: Whenever there is the possibility of the police, the HSE or other prosecuting authority needing to take action against persons or companies the gathering of evidence for this purpose will be antagonistic to the gathering of evidence for investigations of cause. Protocols exist to ease these inherent difficulties but these are not always sufficient.

a4.2.4 The Decision to prosecute: Apart from the conflict that occurs over the gathering and custody of evidence there will usually be a temporal impact. It will, for example, not usually be possible for any public inquiry to be held whilst charges are outstanding. The precedence of prosecution over investigation has, however, sometimes been reversed (e.g. Ladbroke Grove) but this gives rise to concerns in the public mind that those responsible have not been brought to book.

a4.2.5 Adequacy of Internal Investigations: Internal investigations will often be suspected, whether fairly or not, of suppressing evidence unfavourable to them and/or of not publishing the full proceedings. It is sometimes not clear when an internal or some more accountable body should run the investigation. Matters in this regard on the railways have been much improved by the recent formation of the Rail Accident Investigation Branch.

a4.2.6 Investigation Procedures: The sharpest division of style is between the adversarial regime of the Criminal and Civil Courts and the inquisitorial approach of investigations. The adversarial style has extended in recent years into the field of public inquiries under regulations which expressly provide for people who are injured or suffered damages to be represented at these. These serve to extend the length and cost of public inquiries.

a4.2.7 The arguments for public inquiries and the benefits that they can bring are set out along with their disadvantages. The needs of prosecuting agencies are also considered and the method of deciding which of these has precedence is not uniform. In the Hatfield rail case prosecution was favoured although this has resulted in a delay already extending to four years in placing the causes of the accident fully before the public.

a4.3 Human Factors by Professor Helen Muir

a4.3.1 Human Factors concerns the interaction between people, their characteristics and abilities, organisation and management – and technology. In the context of accidents it encompasses all of those considerations that affect an individual's ability to perform the expected task.

a4.3.2 Generally estimates agree that in as many as 70% of accidents human factors will have been involved although some put this figure as high as 80% or 90% or "virtually all". Most investigations concentrate on those executing the direct task involved. There is, however, a larger body of people whose decisions on design, layout, construction and operation have set the stage for the accident. It is important to include these in considerations of what caused the accident to happen.

a4.3.3 It is, of course, very easy to attribute almost any accident to 'human failure' and the research in this area seeks to separate out the causal human factors from the contributory ones. Causal factors are necessary to the accident happening, contributory factors will serve to reduce its probability.

a4.3.4 A further division is between primary and secondary safety. Primary safety concerns those things that prevent an accident e.g. good design and training. Secondary safety is concerned with measures that reduce the severity of an accident e.g., evacuation procedures.

a4.3.5 Accident investigation recognises that humans break the rules set for their protection, sometimes they do this consciously and deliberately, other times they make mistakes or they misunderstand the rules. Placing any subsequent blame on the individual alone has the disadvantage that little or nothing may be done about the underlying causes of the departure.

a4.3.6 Each industry has criteria against which the standard of the subsequent investigation or investigation is decided. Often these criteria are set around the number of fatalities or the extent of damage. This approach neglects, however, the important role of chance in accidents where small variations in space, time or actions may make a massive difference to the outcome even when the underlying cause is the same.

a4.3.7 The nature of human behaviour immediately before and after an accident is also examined. Emotional factors, fear, stress or fatigue can alter judgements and the importance of adequate training to counter these

variations is emphasised. After an accident memories may be reduced to snap-shot recollections that become cemented into a personal perception of what happened. This can be distorted either through inadequate awareness of the whole, by lack of understanding or by the pressure of events such as interviews by the police – who are seen as 'crime solvers' and implying criminal activity.

a4.3.8 Because of the enormous range of influences that human, and therefore variable, behaviour can have on and after an accident Prof. Muir recommends that trained psychologists should be in the investigating team. These will be trained interviewers used to looking for some of the common responses of people in these situations and therefore better able to get nearer to the truth.

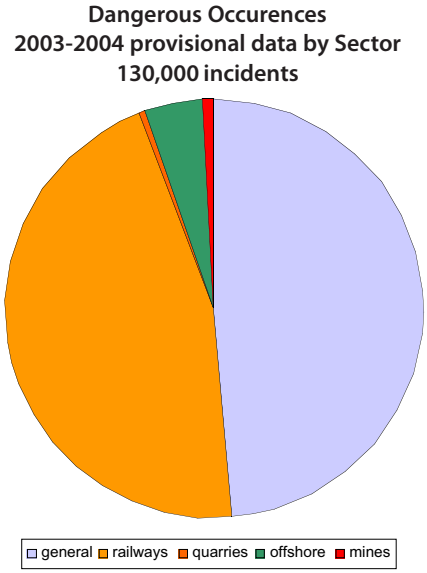
Annex 5 – Statistics.

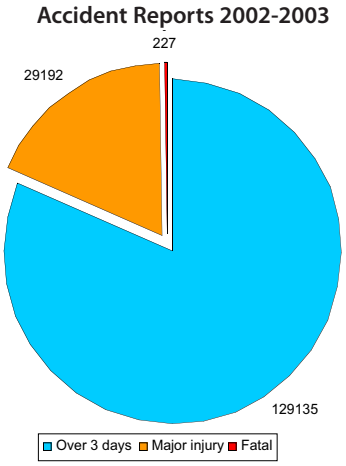
The safety record.

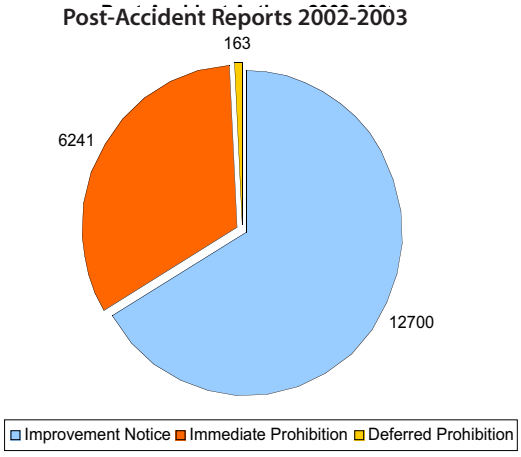
"Eurostat's results and a study by HSE show that the rate of workplace fatal injury in Great Britain is one of the lowest in Europe, and is lower than the USA" (Statistics of workplace fatalities and injuries in Great Britain – 2000).

The statistics below are provided from HSE data kindly supplied by them.

In a highly industrialised society with full employment it is not surprising that there are many injuries each year. With the number in employment at about 20 million the number of accidents per 100,000 workers in the UK was about 1600 as assessed by Eurostat. The number of fatal accidents at work in the UK was 1.7 per 100,000 workers. In both of these categories the UK was in the best 3 countries in Europe.







The figures show the number of accidents that contribute to the record (accidents falling into the three classes shown) and the actions that these accidents prompted by way of enforcement notices.

With respect to legal action the HSE and Local Authorities combined laid information before the courts in 1989 cases in 2002/2003 and these secured 1558 convictions (78%).

In the 2003/2004 the average fine per case was £13,947 and the average fine per offence £9,858. At the individual level 17 directors and managers were prosecuted with 11 convictions and 25 employees of whom 19 were convicted.

Major Accidents and Incidents

Major incidents are few in number but in the period between January 1999 and the end of 2004 the following major incidents occurred.

- Avonmouth Bridge – Gantry Collapse
- Ladbroke Grove Rail Collision
- Larkhall gas explosion
- Hull Building Collapse
- Canada Square Crane overturn
- Hatfield Train Derailment
- Corus UK Blast Furnace explosion
- Potters Bar Train Derailment
- Morecombe Bay - cockle picker drownings
- Tebay Rail Incident
- ICL Plastics explosion
- Envirowaste Ltd – confined space incident

In recent years only three Public Inquiries have been held.

- The Southall Rail Accident Inquiry
- The Ladbroke Grove Rail Inquiry
- The Joint Inquiry in to Train Protection Systems

The HSE prosecutes in only about 5% of cases where major injury occurs and in about 33% of cases where there are fatalities.

Annex 6 –Protocols and references

a6.1 Health & Safety Executive

1. Supplementary information on statistics available from HSE's Safety and Enforcement Statistics Unit (SESU), and advice on general quality issues.
2. Statistics of workplace fatalities and injuries in Great Britain – International Comparisons 2000.
3. HSE: Work Related Deaths – Investigators Guide.
4. HSE – Work Related Deaths – A Protocol for Liaison.

a6.2 Air Accident Investigation Branch

Guidance for the Police and Emergency Services in the Aftermath of an Aircraft Accident

Annex 7 – Best practice

a7.1 Good Practice in Different Situations

The sector reports each survey an industrial sector that faces different challenges to its operations as well as to the maintenance of safety. The differences in operating environment may make for some inevitable obstacles in the transfer of good practice from one area to another but this is not universally the case. This Annex examines which good practices exist and the extent to which these may be carried to other industries.

The seven sectors examined in the Report may be characterised as follows:

Sector	Numbers employed in potentially safety critical roles (1)	Level of technology applied to safety critical functions (2)	Number of s employer in the sector	Relative Scale of the average unit operation (3)
Aviation	Low	High	Low	Medium – High
Chemical	Medium	Medium	Low	High
Construction	High	Low	High	Low
Nuclear	Low	High	Low	High
Offshore Oil & Gas	Low	Medium – High	Low	High
Railways	High	Low – Medium	Medium	Medium
Marine	High	Low	High	Low/Medium

Notes:

a7.1.1 The relative number of employees who have the potential for making an operating mistake having serious safety consequences.

a7.1.2 The relative technology applied to the average working unit operation.

a7.1.3 The scale of a typical working unit's safety influence.

a7.1.4 From this simple analysis we can see that the ability of the nuclear industry to achieve its outstanding safety performance in respect of nuclear safety is facilitated by the factors in the table. It has few sites, each with few employees having controlling functions and each unit operation being of such a high safety importance that considerable investment in safety is both necessary and possible. The result of this focused investment in designing good procedures, constantly checking and testing them, and in learning from the international experience of the industry has made for an effective, competent safety culture that can be sustained.

a7.1.5 In contrast the challenge facing the construction industry is that it has almost the opposite conditions to contend with; many employees of many employers, working on many sites, with many workers having safety responsibilities and generally without the technological means to supervise many of these essentially manual tasks remotely. Not surprisingly the number of safety incidents in the construction industry is high although most are of a low level of severity.

a7.1.6 Notwithstanding these extreme positions there is a good deal of what we see as best practice that could be more widely adopted.

a7.1.7 Specifically we identify the following good practices as models of their kind that might be more widely applied in the appropriate circumstances.

Practice	Source Sector(s)	Circumstances where it is applicable	Possible sectors where it might prove useful.
"INES" style grading of incidents and process errors.	Nuclear	Any situation where tight process controls are fundamental, recorded and sustained	Chemical, OOG, Aviation
ALARP analyses	OOG, Nuclear	Where a wide range of technically feasible solutions needs to be assessed for practicability	Chemical, Railways
International experience comparisons	Nuclear, OOG, Chemical, Aviation	Broadens the data base of experience and tests new proposals against it	Railways, Construction, Marine
Safety Case design methods and similar approaches	OOG, Nuclear, Aviation, Chemical	Recognises that the design stage determines safety in many systems	Railways
Pro-active and sensitive handling of bereaved relatives	Aviation, Railways	Recognises that relatives are an interested party and need to be kept fully and consistently informed	All
Performance Indicators and measures	Nuclear. OOG	Establish metrics for performance during safe operations that indicate the robust use of established process controls	All

Annex 8 - Grading Accidents

An approach to a consistent grading of accident investigations

The figure below illustrates a possible generalised and consistent approach to the grading of accidents. The possible advantages of this could be:

- A greater consistency of treatment between industries.
- A measure to ensure that each incident, whether it actually caused and accident or not, should receive its appropriate consideration.
- A measure of constraint upon the unreasonable elevation of accident investigation levels in specific cases.
- A clear, simple and defensible structure to support investigative decisions.

Notwithstanding these possible benefits there are still issues that would remain. Among these would be:

- The number of small companies in some industries (especially construction). It is possible that accidents that would attract a corporate investigation in a large firm, involving executives from outside the site involved, could have industry-wide bodies substituted in the absence of any corporate structure of this kind in small companies. Such industry bodies would need to be empowered by agreements, for example within Trade Associations, that allowed an industry body to examine people and evidence in the same way that would have been possible in a large company. The purpose would always be to bridge the inadequacy of a merely local investigation and the unnecessary deployment of a full HSE or external inquiry.
- The layers of sub-contractors that are often, or perhaps usually, employed in some industries. The danger of layers of sub-contractors lies in the dilution of the ability to take a broad and considered judgement of all of the risks and dangers of a particular course combined with a successively greater preparedness to take risks as the size of the sub-contractor is reduced and his contractual distance from the main contractor increased. This can result in a 'low-level' sub-contractor, often quite small and specialised, taking an action that might have prompted a higher level of decision-making and a greater sophistication of appreciation of the risks in a major contractor. It is not certainly the case that this happens but examples such as the great fire at Windsor Castle and the fire at Uppark House, both of which involved small sub-contractors, illustrate the dangers.

Overcoming this weakness would need a clear definition of responsibility and authority to be used in assigning any accident investigation procedure. For the purposes of such investigations we might say that the main contractor should act as the corporate body for the purposes of accident investigations and be granted the powers and authorities necessary for that purpose.

Level	Type	Situation
1	Local Investigation	Minor infringements of process. Damage to plant in the local area Minor or no injuries No wider implications
2	Local Inquiry	Minor or no injuries No deaths Minor property damage Potential wider implications for operation at that site No public property damage
3	Operating Company or Industry Inquiry	Death or serious Injury of employees and/or Significant property damage Likelihood of wider multi-company or multi-site implications Minor civil property damage
4	External Inquiry by . HSE or relevant investigation authority	Multiple deaths of employees or the public or Major Property damage Damage or risk to the public, public property or public services. Wider and long-term implications likely
5	Public Inquiry	Death or serious injury of multiple members of the public in the context of widespread public concern for the management, operation or safety of the enterprise Widespread concern about public safety.

In the case of the nuclear industry, where release of nuclear radiation is the primary concern, the potential consequences of an accident are such that investigations into root causes are undertaken into untoward events that are relatively minor in themselves, but which indicate some failure of the processes designed to ensure safety.

The following table is indicative of practice in the nuclear industry:

Nuclear Licensee	HSE NSD/NII	INES Level	Event	Example
Technical panel of Investigation →	monitor licensee	0	Below scale. No safety significance.	
	response	1	Anomaly. Variation from permitted procedures.	
	Investigation - possibly prosecution	2	Incident with potential safety consequences on site but with sufficient safety defences remaining. Insignificant release of radioactivity off site.	Wylfa prosecution 1993
		3	Serious Incident. Very small release of radioactivity. Radiation exposure off site a fraction of the prescribed limits. Local protective measures unlikely except for some food monitoring and control. Possible acute health effects to a worker.	
↑ Panel of Enquiry	Major Incident procedure	4	Accident with minor release of radioactivity. Radiation exposure off site of the order of prescribed limits. Local protective measures unlikely except for some food monitoring and control. Significant plant damage. Fatal exposure of a worker.	
		5	Accident with off site risks. Release of radioactivity. Severe plant damage. Partial implementation of local counter measures	Windscale fire 1957 Three Mile Island 1979
		6	Serious accident. Significant release of radioactivity. Full implementation of local counter measures.	Tokaimura 1999
		7	Major accident. Major release of radioactivity. Acute health and long term environment effects	Chernobyl 1986

Annex 9 - Definitions and Acronyms

AAIB	Air Accident Investigation Branch
Accident	An uncovenanted event in which there is injury to personnel, or damage to plant and equipment and/or to the environment.
ALARP	"As Low As Reasonably Practicable". Is defined and expanded by the HSE (SPC/Permissioning/09) revised 03/02/05 available on the web.
BTP	British Transport Police
CAA	Civil Aviation Authority
CPS	Crown Prosecution Service
EA	Environmental Agency
EASA	European Aviation Safety Agency
FLO	Family Liaison Officer
HSC	Health and Safety Commission
HSE	Health and Safety Executive
ICAO	International Civil Aviation Organisation
IHP	Incident of Higher Potential An incident which had higher potential for damage than was realised because: one or several of the planned safeguards of safety has failed and/or chance has played a part in determining that the outcome of the incident is significantly less severe than might have been the case. The judgement that an incident is an IHP will depend on the circumstances of the incident.
Incident	An event that should not have occurred in the expected operation.
INES	International Nuclear Event Scale
INPO	Institute of Nuclear Power Operators
MAIB	Marine Accident Investigation Branch
NEPLG	Nuclear Emergency Planning Liaison Group
NII	Nuclear Installations Inspectorate
NSD	Nuclear Safety Directorate
OOG	Offshore Oil & Gas
RAIB	Rail Accident Investigation Branch
RGM	Rail Group Member
RIO	Rail Incident Officer
RSSB	Rail Safety & Standards Board
TMI	Three Mile Island [incident site]
WAPO	World Association of Nuclear Power Operators

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