SUMMARY

This paper details the background, rationale, and extent of current national and international legislation aimed at controlling the risks from hazardous installations, and outlines further current initiatives.

1. Introduction

Man-made major hazards are not new. They form but one aspect of ever-present threats to mankind, dwarfed by those arising from natural disasters such as earthquakes, floods, and volcanic eruptions. Nor are major industrial hazards very significant, statistically, when set against the continuing toll of non-occupational catastrophes. But all 'major hazards', in the sense that they carry the seeds of catastrophe and sensation, are media-worthy; and major industrial hazards, where public perception of benefit is at best indirect, carry an additional 'aversion' factor. Neither is this aversion factor tempered by relative familiarity. The sky-line totems of chemical engineering provide a dominant reminder of the potential of the artefacts they proclaim.

In chemical engineering terms, the realisation of such hazards and risks was, however, relatively recent. It has become a commonplace to cite the first official recognition of significance as that in the 1967 Report of HM Chief Inspector of Factories (1). But without tangible realisation of perceived threats, the impetus for the legislator was not great (2) despite further written manifestations of official or public concern (3) (4). It took Flixborough (5) in 1974, and Manfredonia and Seveso in 1976, to concentrate the political will, in the UK and Europe respectively, with the aim of erecting a system of controls to counter the threats posed by, or perceived from, hazardous industrial installations. Development of those controls was relatively rapid in Western Europe; slower in the rest of the so-called 'developed' world; and until recently, even slower in the developing countries. This development was punctuated by a continuing series of events,
such as those at Bantry Bay and San Carlos Potosi, and ultimately brought to a
head by the 1984 tragedies of San Juan Ixuatepec and Bhopal. Basle (1986) may
well prove a watershed in more than one sense; certainly a further dimension
has been added to the arena for control; and the Sandoz incident added further
proof, if indeed further proof were needed, that major chemical incidents have
significant economic as well as social and human implications, which may well
be transnational.

2. Development of Controls

The Flixborough explosion triggered, or produced, several outcomes. Of
central importance was the decision by the UK government to set up a widely
based Committee of Experts to consider in depth the problem of major
industrial hazards. This Committee, the Advisory Committee on Major Hazards
(ACMH) produced three reports of great significance (6). Most importantly,
they outlined 4 basic principles - identification, recognition, elimination
(or reduction of probability) and assessment, which have become the
cornerstones of first the UK, then the European, and now the wider
international approach to the control of major industrial hazards. In the UK
the framework of legislative control has been formalised into an
interdependent trinity of areas of approach (7) incorporating the following
concepts:

- identification - via the NIHHS Regulations (8)
- assessment and control - via HASAWA (9) and the CIMAH
  Regulations (10)
- mitigation - via CIMAH (involving on site and off-site emergency
  planning and the provision of appropriate information to the
  public) and land use planning control.

This involves a risk related approach, and embodies European requirements
(11).

3. Identification

Identification is, of course, a precondition of control. Competent
authorities and enforcement agencies need to know where the hazards and risks
are located. But a requirement to notify the competent authorities of the
existence of a hazardous site as defined is a trigger mechanism only; it
prioritizes the attention of the enforcing agency certainly, but it goes
further than that. It permits identification of such sites to land use and
emergency planners and to emergency services; and hopefully, and most
importantly, it stimulates a greater self-awareness of the hazards and risks
amongst those who are required to notify - that is to say, those who are
responsible for both the creation and the control of the risks.

In the UK, notification requirements are based on a substance/threshold
approach (12). There are currently some 1700 sites notified under NIHHS, with
several hundred more notified under CIMAH, many of the latter presenting
environmental as well as human risk. These numbers will change when current
European initiatives are carried forward, and may well involve the more
general application of generic indicative criteria.

Appropriate identification of the site then permits the application of the
next increment in the control regime, that of:
4. Assessment and Control

It is a general and fundamental precept of UK employment law, that the hazards and risks resulting from work activities are appropriately controlled, so far as is reasonably practicable (and the latter concept denotes a computation to set off the quantum of risk against the effort involved in the control measures (13)). This requirement applies equally to the risks to the public from work activities as to those risks which affect those directly involved in the work activities. In the case of major industrial accident hazards as defined (14), it is supplemented by further general and specific requirements.

The general requirements of the CIMAH Regulations apply to sites which storing or using hazardous substances which satisfy criteria related to toxicity, flammability, reactivity or explosibility. Several thousand such substances have been identified as being in regular use in UK industry. No threshold quantity is involved. In such cases, the operator of the site must:

- notify the HSE of any major accident which has occurred on his site, with details of steps taken to prevent its recurrence; (note - a major accident need only have the potential for harm).
- be prepared to demonstrate to an Inspector, on request, (and produce documentary evidence as appropriate) that he has considered the potential for major accidents from his operations, and has taken all appropriate steps both to prevent their occurrence and to mitigate the consequences of any which may occur.

Further, more specific duties under the Regulations apply to sites on which are stored or used certain substances in excess of specified threshold quantities. These sites have become known as large inventory top tier sites (LITTS) - which store large quantities of flammable toxic or explosive materials - and small inventory top tier sites (SITTS), - which store or use materials which are considered particularly toxic, and for which more lower thresholds (1 tonne or less) are prescribed. In the UK there are over 200 LITTS, and several hundred SITTS notified to HSE. Again, changes proposed in Europe will result in changes to these national statistics.

The additional duties which fall to the occupiers of such sites are:
- the preparation of on and off-site emergency plans
- the provision of appropriate information to the public
- the submission to HSE of a 'safety case'

The safety case.

Emergency planning and information to the public are measures primarily designed to mitigate the consequences of any major incident, should it occur (the probability of a major accident should, however, be remote) or, in the case of some aspects of emergency planning, to intervene in the escalation process. This latter approach apart, however, such questions should be concerned with the residual risk after all appropriate, reasonably practicable precautions have been taken. In other words, they are concerned with the mitigation aspect of control. The 'safety case' however is, in concept at least, central to assessment and control; the 'written report' format merely formalizes the approach.

The Safety case should
- identify the nature and scale of use of dangerous substances
- place the installation in its geographical and social context
identify the type, consequences, and relative likelihood of potential major accidents.

- identify the control regimes and systems on the site, and in so doing demonstrate that the operator of the site has considered and (presumably) is satisfied with the adequacy of his controls, and that any residual risks are at an acceptable level.

Essentially, the case consists of facts about the site, and reasoned arguments and conclusions about the risks from the site. It is a mixture of fact and prediction, leading to informed judgements (both technical and social) about the acceptability of the site in its physical location. But it is not licensing, nor is it, despite the role of HSE as a European competent authority, one of approval. It is, however a quintessential management approach (15), applying relevant management techniques to major hazard control. It identifies the critical areas, which can then be addressed on a concentrated and continuing basis; and the hazard analysis carried out an early stage of the assessment process highlights, inter alia, the relevant areas for potential mitigation.

5. Mitigation

The main elements of mitigation are emergency planning, information to the public, and location.

a) Emergency Planning

CIMAH requires effective arrangements for on and off-site emergency plans, involving close cooperation between the site operator, the local authority, the county authority and the emergency services.

General advice on emergency planning has been published in the UK by both the HSE (16) and industry (17) (18). The recent SIESO booklet is a significant addition to this corpus of advice (19). Similar guidance is being produced in other countries, eg the USA (20). General principles for the preparation of such plans (and examples) are outlined in another Conference Paper (21).

b) Information to the Public

Any emergency planning depends for its success on an appropriate response from those covered by the plan, and this necessitates adequate briefing of those liable to be affected. On site personnel should receive this briefing (and training, as appropriate) as part of the preparation and realisation of the site emergency plan. Off-site, however, such detailed briefing and preparation will rarely be possible. For this reason the UK CIMAH Regulations impose an additional duty to inform persons who are within an area which it is for the HSE to define (often the land-use planning consultation distance). The minimum information to be given is:

- that the hazardous installation is notifiable, and has been notified to HSE;

- a description of the operations on site, and of the hazards and risks which might affect the recipient of the information; and
of any emergency measures (including appropriate personal behaviour) to be taken in the event of an incident.

Methods of information giving will of course vary, as will frequency. Advance and regular information can be given to those resident or working in the area; those in control of public amenities can be similarly informed. Transients may well, however, only receive the information in an emergency situation.

Adequate and relevant information is, therefore, a prerequisite for control and response in an emergency situation.

This requirement for limited openness in the provision of information about risks to those who might be affected, is, of course, part of a much wider initiative in respect of freedom of information. HSE has already published a discussion document relating to the industrial context (22). Discussion documents on risk are in the course of preparation. Freedom of information is a cornerstone of the approach in some other countries (eg Canada(23) and the USA(24)).

c) Location

Adequate mitigation of major hazard risks is best achieved by planning control of incompatible land uses. In the UK, land use and development is controlled by planning law (25). ACMH confirmed that such controls remained appropriate for the location of hazardous installations and for developments in their vicinity. Despite the setting up administratively of liaison and advice arrangements in 1972, planning law as it then stood was not capable of dealing with all aspects of the risks from such installations, and there have been more recent developments, both in the law (26) and in liaison (27), which have closed some of loopholes. Further developments are imminent - The Housing and Planning Act (28), introduced to Parliament early in 1986, contains proposals for 'consent' procedures for hazardous installations control, operated by planning authorities advised by HSE. Regulations will soon introduce this enabling Act, on the basis of application to NTHHS and (perhaps some) CIMAH sites. Such 'consent' will relate to description of the land, and of the substance(s), the maximum quantity permitted of each substance, and may include conditions as to how and where any hazardous substance is to be kept or used. The imposition of such conditions will involve statutory consultation with the HSE.

These are planning controls, and proposals for control, for the present and future. What of the present legacy of past mistakes? It is clear that in the UK not all hazardous installations are ideally located; indeed some locations are far from ideal. The costs to society of preventing incompatible developments in advance of their taking place are generally relatively small; whereas the cost of intervention to relocate from existing incompatibility may be enormous. Where the risk warrants it such action may be justified; but in most cases, the expense involved would not justify the costs. This explains the apparent paradox in some HSE advice, against further development at a range greater than developments currently existing. Consent will assist in mitigating any problems where this paradox is real, rather than apparent.
Current European standards do not include any such siting elements, explicitly.

6. Environmental Risks

The overall strategy outlined above was developed on the basis of incidents which, in general, had direct effects on humans, and where any environmental effects were secondary. Indeed, where environmental risks from major chemical hazards (i.e., the uncovenanted rather than the covenanted release) were perceived, they tended to be approached as the vector for indirect human risk rather than damage to other flora and fauna. The 'Seveso' Directive and the CIMAH Regulations have, however, an environmental dimension; indeed the risk nature of some SITT substances may be dominantly ecotoxic. The transfrontier consequences of fire water run-off pollution at Basle in 1986 has concentrated international attention on such risks (some implications of this are discussed later in this paper), and supplements more local effort. In the UK, the HSE has carried out substantial investigative work on CIMAH environmental risks, though its research agreement with the Safety and Reliability Directorate of UKAEA, and has done other work in collaboration with other government departments, and water authorities(29). Arrangements are in place in the UK to ensure appropriate liaison and cooperation between relevant government departments and other enforcing authorities in respect of CIMAH environmental risks.

7. The European Response to the 'Seveso' Directive

Earlier parts of this paper have outlined the UK input to a European strategy, and the application of the European strategy to the domestic scene. Although member states of the EC are required to conform to Directive standards, there is, currently, some variation in approach and response. Not all member states have yet in place the legislative and enforcement framework to put the requirements of the Directive into effect; and where such frameworks are in place, implementation dates vary. Enforcement and compliance approaches also vary, as does the scale of any problems.

A particular example of variety of approach is that of the use of quantification in hazard and risk assessments (either per se or as part of 'reasonable practicability' or cost benefit considerations). The UK occupies something of the middle ground on this issue between the highly quantified approach of the Netherlands (30,31) and the standard-meeting approach of West Germany, with the implicit assumptions that conformity to detailed engineering and other technical, performance related standards is sufficient to reduce the probability/frequency of a major accident hazard to an 'acceptable' level.

8. Developments in Europe

It is perhaps an overstatement to suggest that the 'Seveso' Directive was introduced in haste; but certainly the political response to initiating incidents brooked no leisurely contemplation. It is not surprising, therefore, that ongoing developments and deeper consideration suggest a need for revision and reconsideration. In the EC, the vehicle for this is in the shape of both short term and long term reviews of the Directive.
a) Short Term Reviews

One amendment to the Directive has already been adopted (32) and drafting of Regulations amending CIMAH consequentially is already under way in the UK (there are also implications for the Hazardous Substances 'Consent' Regulations). The changes introduced by this amendment:-

(i) tidy up the situation re ammonium nitrate  
(ii) reduce the threshold quantities for certain substances (eg chlorine, phosgene and methyl isocyanate).  
(iii) increase the threshold quantities for certain substances (eg cobalt and nickel metal, oxides, carbonates, sulphides, as powders) and  
(iv) add certain substances (eg liquid oxygen, sulphur trioxide).

Probably the most important changes are to clarify that the definition of industrial undertaking in Article 1 of the Directive (Schedule 4 of CIMAH) is inclusive, not exclusive, and to add 'treatment' to the production and processing of energy gases.

A second amendment is also under consideration clarifying the Directive article dealing with information to the public. It may well be that future European requirements will be modelled closely on current UK advice on this subject. If so, information requirements may include:

a) name and address of site  
b) name and position of informant  
c) confirmation that the site is notifiable and has been so notified  
d) a simple explanation of the site activities  
e) the common names (where possible) of the 'major accident' substances on site, with an indication of their principal harmful characteristics  
f) details of how the population will be informed in the event of an accident  
g) general advice on the actions and behaviour appropriate to warning situations  
h) an assurance that adequate arrangements (including liaison with the emergency services) exist to deal with foreseeable accidents and to minimise their effects  
i) a reference to the off-site emergency plan, including advice on cooperation with emergency services  
j) details of sources of further information.

A much more fundamental short term review of the Directive is currently in progress. The Basle incident in 1986 amply demonstrated that previously voiced doubts about the validity of the distinction between isolated storage and process risks were well founded, particularly in emergency situations, and especially in the context of environmental hazards. A far reaching amendment to the Directive is therefore proposed. Details of this proposed amendment (33) are still, at the date of writing, under discussion although the impetus is such that any relevant amendment may well be in place by the time of publication of this paper. On the assumption that the thrust, if not the detail of the current proposals are adopted, the following principles may well need to be carried forward into amendments of UK legislation:-
(i) the substantial extension of the list of named substances held in 'isolated storage' or in process

(ii) the reduction in thresholds of certain named substances held in 'isolated storage' or in process

(iii) the application of generic categories of substances and preparations to both 'isolated storage' and process (the categorisation based perhaps on the so called 'Sixth Amendment' (34))

(iv) the aggregation of partial fractions of generic categories.

b) Long Term Review

The EC has already commissioned numerous investigations into various aspects of the 'Seveso Directive' both on the content of the Directive, and its implementation and effects, generally and locally, in terms of emergency planning, information to the public, and safety reports. A number of concepts are being debated, including hazard equivalence (eg 35), research into major technological risks, information to the public (36), detail (37), pipeline risks, transportation, and non-acute risks, including carcinogenicity and teratogenicity from major accident hazard incidents. Problems associated with criteria are also being investigated. It is perhaps too early to anticipate the effects these and other reviews will have on the future content and form of any fundamentally revised Directive.

9. International Developments

The principles of the European control strategy have been accepted internationally, and are being increasingly adopted, particularly in the so called 'developed' world. A particular initiative has come via the World Bank (38) and similar work has stemmed from the Warren Centre and others, in respect of Australasian and Pacific Basin major industrial hazards (39, 40). In terms of the industrialised world, variations in acceptance and adoption are, in general, of degree and timing rather than type. This is not, however, the case with the developing countries, and it is significant that a number of incidents have recently occurred in such countries.

The problems of developing countries

The predominance of economic factors, the lack of necessary expertise and appropriate training, and the lack of adequate enforcement machinery are all in the forefront of international deliberations on the problems of the transfer of technology to the developing world. There is substantial UN (41) CEFIC (42) and ILO (43) input. All these initiatives may have an effect, subsequently, on control legislation in the industrialised world. The ILO has been particularly active with respect to major hazards in the developing world (44,45) and has produced guidelines on the establishment and organisation of major hazard controls there (46) which take into account the particular problems of the 'Third World'. These controls are based on the European approach, but modified to take account of relevant social and economic features.
Initiatives by the OECD

The Organisation for Economic Cooperation and Development (and in particular the Environmental Directorate) has recently become significantly more involved in industrial major accident hazard issues, and it may well be that OECD initiatives could be combined with current internal European consideration in any fundamental review or changes in the EC Major Hazards Directive.

Topics currently under consideration include (47)

(i) Harmonisation of regulatory controls and procedures for approval of new installations.
(ii) common principles of accident response
(iii) siting policies
(iv) arrangements for handling transfrontier emergencies, and for mutual assistance
(v) exchange of technical information
(vi) harmonised methods of assessment in terms of standards for the safe operation of installations
(vii) exchange of data on past accidents
(viii) setting up of a major accident database
(ix) information to the public
(x) chemicals safety testing
(xi) comprehensive risk management
(xii) enforcement harmonisation.
(xiii) public participation in risk decisions
(xiv) licensing and/or approval regimes

10. Transportation Risks

There is already a substantial corpus of international regulation of the transportation of harmful substances (generally converted into national legislation) by sea, air, road, and rail. Most are based on UN standards (48) modified with mode relevance (49, 50, 51, 52, 53). All such regulation is based on the principles of

- classification of hazard (ie identification)
- identification of dangerous substances (ie labelling)
- containment (ie avoidance/prevention)
- emergency response (ie mitigation)
Many major hazard incidents involving hazardous substances have occurred in the transport mode and one of the valedictory recommendations of the Advisory Committee on Major Hazards involved the assessment of the hazards and risks associated with the transportation (including interchange and marshalling) of major hazard quantities of dangerous substances. This task has been taken up, in the UK, by a sub-committee of the Advisory Committee on Dangerous Substances, who in turn have formed a Technical Working Group whose task is to appraise, and if necessary derive relevant assessment methodology and criteria, for both individual and societal risk, for each major transportation mode. When this task is completed, the ACDS sub-committee will be able to reach informed judgements on the levels of risk(s) and to make appropriate recommendations for further controls (if needed) to government. Members of the sub-committee and working group are aware of the major internationally based effort which is continuing on this subject, and are in contact with many of the workers in the field. It would not be appropriate to anticipate the conclusions of either group, but clearly any necessary controls will relate to quantities, transport mode direction, routeing, and mode prohibition, as well as conventional controls, including siting of interchange and concentration points, and developments in their vicinity.

11. Other Issues

In the longer term, other issues currently being debated, investigated, or even identified, may need resolution. It is not within the scope of this paper to consider these issues. It is clear, however, that issues such as risk criteria, quantification of risk, and risk equivalence, perceived and real, will need to be addressed in due course. Inevitably this will introduce consideration of processes or operations (e.g., handling of pathogens, genetic engineering, etc.) which are perceived to present similar hazards.

12. Conclusions

A fairly comprehensive framework of control for 'static' major accident hazards exists at the UK & European level, which is being extended to other parts of the industrialised world, and, with appropriate modifications, to developing countries. Substantial effort is being deployed in the revision and updating of these controls. Risks from transportation, currently being assessed, may warrant similar controls. The extension of such controls to other hazards and risks remains a matter for future debate.
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