Editorial

From Flixborough to Bhopal: is legislation enough?

New United Kingdom regulations on the control of industrial major accident hazards (CIMAH) were introduced in 1984,1 the year marked by the world's worst industrial disaster at Bhopal on 3 December and the massive liquid petroleum gas (LPG) explosion at Mexico City two weeks earlier. The main impetus in the United Kingdom for legislation was the Flixborough explosion in 1974 in which cyclohexane killed 28 people.2 The philosophy behind the regulations may be seen in the three reports to the Advisory Committee on Major Hazards (ACMH) which was set up after Flixborough.3-5 The CIMAH regulations implement an EEC directive of 1982 and "embrace most of the chemical and petrochemical industries using substances which have dangerous flammable explosive or toxic properties"; the main objectives are "prevention of major accidents arising from industrial activities, the limitation of the effects of such accidents both on man and on the environment, and the harmonisation of the control measures to prevent and limit major accidents in the EEC."1

That there are implications for health workers in these regulations is to be expected, though the uninitiated may have difficulty spotting these at first sight.

In the United Kingdom there has been a requirement since 1983 to identify and notify hazardous sites under the Notification of Installations Handling Hazardous Substances (NIHHS) regulations (1982) and about 1750 sites have been reported to the Health and Safety Executive (HSE), resulting in awareness by local emergency services, more frequent inspections, and greater planning controls. Two hundred and fifty of these sites now come under the CIMAH regulations as "large inventory top-tier sites"6 that undertake the more hazardous activities using dangerous substances or storing certain scheduled substances over specified limits. In addition to the general requirements on safe operations and the reporting of major accidents, there are four main specific duties.1

The manufacturer is obliged to: prepare a safety case—that is, identify the potential for major accidents and the necessary degree of protection and control—to be updated at least every three years; to create an adequate onsite emergency plan; to arrange for the local public to be informed about the risks, and, finally, the local authority has a duty to prepare an offsite emergency plan incorporating the roles of the local emergency services by using adequate information on the hazards which the occupier should provide. Though for existing installations the safety case does not have to be prepared until 1 January 1989, the emergency plans and the supply of information to the public are phased to be completed by 1 January 1986.

At the same time as this legislation was developing, there has been much effort on research towards greater understanding of chemical accidents from a predictive viewpoint. The medical consequences of such catastrophes, however, and the lessons for emergency planning have not been given as much attention so far, even though both on and off site emergency plans must attempt to take these into account. Health professionals are likely to become concerned at this stage but may find themselves with little readily available guidance. In their third report the ACMH recommended that the Employment Medical Advisory Service (EMAS) be concerned in the drawing up of emergency plans,2 and this national team of occupational medicine experts inside the HSE might therefore be expected to help. But what types of issues are involved?

Risk assessments for technological hazards in which statistical probabilities of an accident are compared with risks in other walks of life are by now familiar. The underlying theme is that any reduction in risk to an acceptable level (acceptable to whom?) has to be weighed against the economic consequences. In Britain a watershed in applied risk assessment was the HSE study of Canvey Island, an area in the Thames estuary containing a high concentration of flammable liquids, ammonia, hydrogen fluoride, LPG, and LNG near a populated area. The chance of a resident in the most exposed location being killed or seriously injured as a consequence of a major accident there was estimated to be about 5 in 10 000 a year (the same as the average risk of dying from natural causes for people in the 25–36 age group in England and Wales) but the implementation of numerous safety recommendations, together with refinement of the assessments, eventually reduced this estimate by an order of magnitude.78 The complex scientific consid-
erations that have to be incorporated in a risk equa-
tion for a major industrial accident, together with
t heir deficiencies, have been summarised by Barrell.6
Despite much research on the types of impact
of explosive heat and blast, and the behaviour of gas
clouds, “hardware” failure rate information, on
which probability calculations have to be based, is
still scarce. The importance of human influences on
safety is widely acknowledged but not well under-
stood. Information on human responses to toxic,
heat, and pressure exposures and the ways of miti-
gating these is generally sparse. In addition, we know
that with many of the scheduled chemicals the range
of medical effects of a large release resulting in
exposure of fit adult workers, let alone on the young,
the elderly, and the chronic sick living in the exposed
community, can too frequently only be vaguely sur-
mised. For the scheduled chemical methyl isocyanate,
the first opportunity to study its human toxicology on
any scale was, tragically, at Bhopal. In the December
1985 issue two papers were published which high-
lighted and began to rectify this deficiency; in one
Salmon et al also examine the role of cyanide, a sub-
ject that greatly added to the confusion in treating
casualties at Bhopal.9 Despite the uncertainties, plan-
ers have somehow to arrive at estimates of proba-
bilities for different scales of releases or explosions
and their possible impacts. Merely planning for the
“worst possible scenario” or, even more arbitrarily,
“worst credible” or “worst likely” without regard to
its chance of occurrence and a range of health effects
is unlikely to reflect the real world.
Planning for the different roles of the emergency
services may also face similar difficulties. Flammable
releases can result in fires, vapour cloud explosions,
or BLEVEs (boiling liquid expanding vapour
explosions) which occur if a storage vessel fails sud-
denly in a fire, and the immediate emergency response
to all of these would probably resemble that for other
catastrophic fires and explosions. Medical teams may
need to be sent to the site of the disaster if a large
number of injured require triage or resuscitation, or
both, or trapped victims need surgery. In the Mexico
City incident 5000 injured were seen in provisional
emergency centres after the hospitals became over-
crowded; the 1969 wounded were taken to 33 hospi-
tals where 900 were admitted to hospital; altogether
about 500 died.10 An investigation team sent to Mex-
ico City from the Netherlands Organisation for
Applied Scientific Research (TNO) two weeks after
the disaster studied the validity of mathematical mod-
els of damage effects for risk assessment studies and
found that they stood up reasonably well. The large
toll of dead and injured was clearly due to a densely
populated area having grown up around this large
LPG storage and distribution centre and most of the
damage had been caused by the fire and pressure
effects from several BLEVEs. There were no survivors
within 300 m of the blast and work is continuing on
the locations of the dead and injured.10
There is little information available on disaster
management for toxic releases. It is axiomatic that the
identification of all accidentally released materials is
essential, and whereas this may be rapidly achieved
for materials stored in large amounts, such as ammo-
nia or chlorine, the inventory of a burnt down ware-
house, for example, may take weeks to compile.11
Furthermore, the products of releases from certain
chemical processes, such as occurred at Seveso and
Bhopal, may be unpredictable. It is therefore essential
that expertise is readily available to undertake rapid
testing of areas with known contamination, at least
for such mundane materials as asbestos, poly-
chlorinated biphenyls, and lead which might have been
released incidentally or unexpectedly and which
could cause much public alarm if discovered later in
even small quantities. In addition, chemical samples
should be taken whenever possible from the process
plant by chemical engineering experts, not only for
establishing the cause of the accident but to determine
precisely what chemicals might have been produced in
any reactions that took place. The toxicological infor-
mation for helping in the treatment of the exposed
will most likely be received by doctors over the tele-
phone from a poisons centre. On the spot experts,
however, may well be needed for interpreting these
bare facts in the light of local circumstances, and long
term effects such as carcinogenicity and teratogenicity
may not be adequately considered, even though deci-
sions on urgent evacuation can depend on such issues.
Toxic clouds will remain hazardous over much
larger distances than flammable clouds, exposing peo-
ples sometimes over several kilometres downwind. In
any incident where the toxic release has not been well
contained the entire potentially exposed population
should be surveyed for health effects, not just those
who arrive at hospitals, in order to determine exactly
who has been exposed and require further evaluation
and follow up. Specimens of blood and urine should
be taken if indicated and stored for future analysis to
confirm, whenever possible, the degree of exposure.
In both flammable and toxic releases morbidity and
mortality should be carefully documented, and there
may be a need for long term follow up of survivors.
Such epidemiological information gathering is essen-
tial for the short and long term medical management of
the sufferers as well as for planning preventive mea-
sures at similar sites elsewhere in the world, yet to be
successful it too must be preplanned. The practical
difficulties of rapidly mobilising specialists under
emergency conditions may seem overwhelming, but
delay brings its own insuperable obstacles of sus-
picion and conflict between the helped and the helper as the events at Bhopal have shown under the gaze of the world's media.

Most chemical accidents are minor, with little if any exposure of the public, and may be adequately handled by local emergency services, but there is always the possibility that the uncommon but serious pollution incident will be overlooked or mismanaged unless it is possible to call rapidly on the laboratory, toxicological, and epidemiological expertise which local services do not normally possess. Yet there is currently no provision for such back up to local emergency services in the United Kingdom. Unfortunately, there seems to be a general lack of understanding of the need for such expertise, particularly the value of epidemiological assessment. By contrast, over the past 20 years attempts have been made to rationalise the emergency response to natural disasters such as earthquakes and famine, mainly through the application of epidemiological methods.1213 There is no reason why such methods should not be applied to technological disasters also. Indeed, some concepts arising from natural disaster research might fruitfully be applied to technological disasters. The vulnerability of types of housing or the characterisation of susceptible populations—for example, the concept of "victimisation" as applied by Frears14 to sufferers in the Spanish toxic oil syndrome15—are cases in point.

If recent events have taught us anything it is that catastrophic incidents of pollution of air, food, and water may be relied on to be unpredictable, often with unforeseen implications for human health. Legislative frameworks are invaluable for reducing environmental risks, but can never obviate them. Hand in hand with the new legislation must go the resources to develop a rational approach to the investigation and management of major industrial accidents on both the national and international level if health workers and others are to participate in more than just a paper exercise.

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References

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doi: 10.1136/oem.43.1.1

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