

OCCUPIED BUILDINGS ON CHEMICAL SITES — REVISED CHEMICAL INDUSTRIES ASSOCIATION GUIDANCE AND ASSESSMENT METHOD

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The UK Chemical Industries Association (CIA), working with HSE input, has revised the “Occupied buildings on chemical manufacturing sites” guidance document. The revised document was published in January 2004. The revisions deal with protection against toxic gas releases and suggest how companies can assess the need for protection, in both buildings and plant areas; what steps should be taken to provide protection where it is required; and the standards which should be used in any toxic gas refuges provided.

Since the publication of the original guidance, HSE have used the publication as the standard of good practice against which to judge occupied buildings on chemical sites, especially those to which the COMAH regulations apply. This has caused some concern in some CIA member companies but HSE feel that there is a need to address the risks to, and where necessary provide protection for, personnel in buildings on chemical sites. HSE also consider that the CIA publication, being industry guidance, provides a suitable standard against which to judge company provision.

The paper summarises the contents of the original guidance and discuss the changes made to it and the thinking behind them. In particular the paper discusses the industry view of what is acceptable provision to cope with possible toxic gas releases, the design of toxic gas refuges, and an assessment method that companies can use to determine what provision should be made for toxic gas refuges.

INTRODUCTION

In any chemical accident there are a number of different “targets” which will be at risk: those on-site; those attending site to deal with the incident; the surrounding population; and the environment around the site; these are perhaps the most obviously at-risk. The history of the chemical industry in Western Europe over the last 60 years shows that the list above is generally in the “at-risk” order. Accidents (as opposed to chronic releases) have caused relatively little lasting environmental damage, even from incidents as serious as the Sandoz fire — though there are, of course, some cases of lasting environmental damage, most notably Seveso itself. Even after Enschede (an unlicensed fireworks store) and Toulouse⁽¹⁾, those living around chemical sites seem to be at relatively low risk from chemical accidents — certainly several orders of magnitude less than the risk from (for example) domestic gas explosions.

Emergency teams are at higher risk, but their risks can be substantially lowered if reactions can be made safe, transfers stopped and storage isolated, soon after an accident

has occurred. Those at highest risk are those on-site: attending, controlling or maintaining chemical reactions and process plant; or involved in ancillary functions such as analysis, logistics and management. Even in these cases the risks should not be overstated: in normal circumstances chemical works are — not surprisingly given the efforts the industry puts into safe operation — safe workplaces. The chemical industry is in the forefront of further continuous improvements in safety and safe operation. None the less, in the event of an accident, the safety of those on-site can be significantly affected by the location and type of building they are in; and the capacity of those controlling operations to make the plant as safe as possible after an incident — itself a function of the safety and security offered by the building they are in — can affect the safety of those attending the scene to deal with the emergency

Following the incidents at Hickson & Welch, and the Phillips refinery in Pasadena, USA in 1992, and at the La Mede refinery in France in 1993, HSE asked CIA whether the industry could develop guidance that could be used by operators to prevent similar accidents from occurring elsewhere. CIA and its member companies agreed to do this and a working group of companies of different sizes was set up. HSE worked closely with the group in the production of *Guidance for the location and design of occupied buildings on chemical manufacturing sites*, published by CIA in February 1998⁽²⁾. The guidance was launched with a series of seminars around the UK, with both Industry and HSE speakers giving their interpretation of and advice on implementation of the guidance. Occupied buildings were also a theme at “Hazards XV” in 2000, with five papers being presented on this topic⁽³⁾.

The guidance was rapidly adopted by HSE as “Industry Best Practice” and HSE indicated to chemical companies that they would expect companies to show how they intended to comply with the guidance^(3e). Where significant changes were required, HSE looked for company action plans to show how compliance would be achieved over a period of time. However, the guidance was published at about the same time as industry and the regulators began to deal with the COMAH regulations and attention (on both sides) rapidly became focussed on the need to “demonstrate” compliance with COMAH. Also, questions raised by member companies (and the regulators) on the meaning of some sections especially around toxic gas refuges (somewhat misleadingly referred to as “safe havens” in the original text), pointed the need for some revision and clarification.

The rest of this paper briefly describes the contents of the original document, proceeds to deal in some detail with the recent amendment that expands the text dealing with toxic gas refuges, and finally discusses possible future developments.

THE ORIGINAL GUIDANCE

In considering the original guidance it is worth noting two things: firstly that the guidance covers all occupied building on a chemical manufacturing site. Initially, the guidance was read by many as applying to control rooms on chemical sites — perhaps not entirely surprising as much of the guidance does discuss control rooms close to operating plant. However, as companies realised once they started their consideration of the guidance, the major concentrations of people are often in offices, laboratories, warehouses and work-

shops rather than on plant. Proper protection of these buildings is often more important and gives a better safety return (i.e. risk reduction) for the time and capital invested, than work on plant control rooms.

Secondly, it should be remembered that the guidance deals with secondary protection, after an accident. As the guidance notes: “The major effort of operating companies should be directed to the prevention of events which could lead to (major) accidents”. It is hard to overstate the importance of this. Whilst good design and appropriate location of buildings on chemical sites is important, it is much less important than the primary duty to prevent accidents. It is essential that dealing with the guidance is not allowed to divert resources — of either people or capital — which should properly be applied to a company’s primary duty to ensure safe operation, for example by proper Process Safety Management.

The publication was divided into the following sections:

- Purpose and scope of the guidance
- Flowcharts for applying the guidance
- Discussion of various hazards e.g.:
 - Vapour cloud explosion
 - Exothermic reactions
 - Toxic gas release
 - Fire/pool fire/jet fire
 - etc
- Application to new permanent buildings
- Application to existing buildings — an overview of risk assessment
- Individual risk tolerability
- Appendices
 - Explosion hazards
 - Vulnerability
 - Thermal radiation hazards
 - Toxic gas
 - Temporary buildings

Most of these sections are relatively self-explanatory, though implementation of the guidance on existing sites has not been easy. The guidance was founded on the principle that people inside buildings should not be placed at greater risk by virtue of their occupancy of the building, and should be protected to as low a risk as is reasonably practicable. In order to achieve this, the guidance recommends all companies to prepare a policy which covers the location and design of occupied buildings and which sets criteria against which the acceptability of the risks faced by people in buildings can be judged.

EXPERIENCE WITH THE EXISTING GUIDANCE

When preparing the document, CIA’s aim was to produce something that was genuinely useful to companies in providing protection against the effects of an accident. The

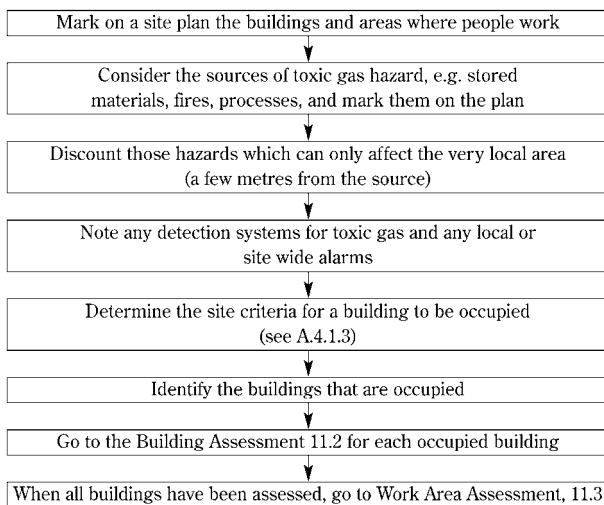
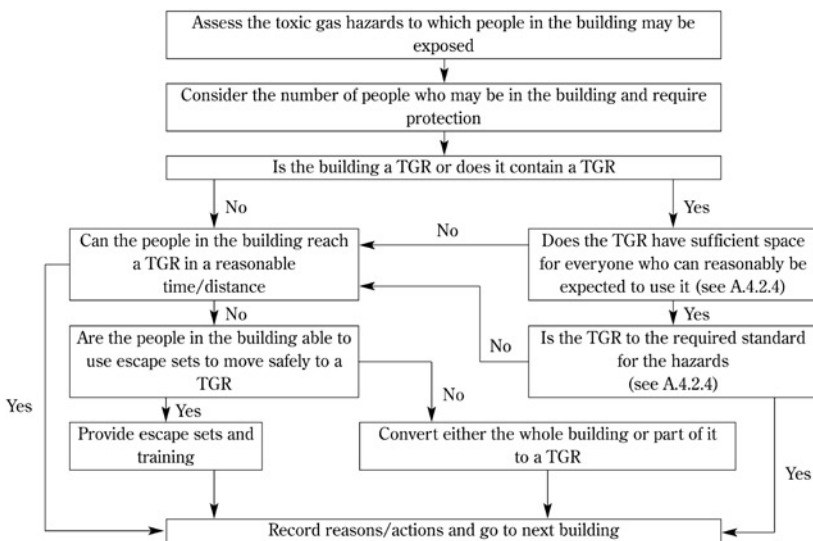


Figure 1. Identification of hazard sources, buildings and work areas



TGR = toxic gas refuge

Figure 2. Building assessment

working group was mindful of the fact that chemical companies' operations are all different, and therefore the document – from a CIA viewpoint – needed to be phrased so as to allow companies a degree of flexibility in its interpretation. The need to preserve a balance between good utility and reasonable rigour is reflected in the wording used throughout the document.

To make the guidance easier to apply by all sizes of company, the guidance specifically accepts either a hazard or a risk based approach to compliance. The working group producing the document had representatives from five large and one small companies on it. They recognised that a large company might well have access to complex, quantified risk assessment (both experienced risk assessors and supporting software), which meant that a detailed assessment would be both practical and beneficial. For many small companies the costs of carrying out the detailed risk assessment could be more effort (in time and money) than it would be worth. Using a hazard based approach enables their efforts to go into making real improvements, using the guidance as a guide on acceptable approaches to dealing with the hazards identified on their site. For this reason, the guidance contained much good advice and a number of checklists to enable reasonable standards to be achieved.

THE TREATMENT OF TOXIC GAS REFUGES

Once published, the guidance, perhaps inevitably, generated a number of questions. The most persistent of these were around the treatment of buildings to cope with toxic gas releases. While some sites had a well developed arrangements to deal with toxic gas releases, for others this was a new area. The original guidance simply stated that any decision to apply 'mitigation measures' is usually based on an assessment of the consequences of toxic gas release, recommending that dispersion calculations be carried out to determine whether any occupied buildings are within the toxic gas concentration contour which could limit escape. There was a general summary of these mitigation measures which could be used, for example: the provision of a Toxic Gas Refuge (TGR) itself; the provision of gas alarms; and the provision of secondary containment or bunding. This was accompanied by recommendations on the volume of air needed in a toxic gas refuge to protect an individual for a range of times. Finally, there was a summary of the factors that need to be considered in the construction of a "safe haven", together with a number of recommendations relating to any mechanical ventilation system that might be fitted to a TGR.

In short, the text dealt with toxic gas refuges by listing factors which needed to be taken into account rather than giving guidance on how an appropriate standard of protection could be achieved. There was also no guidance on which, or how many, buildings should be made, in whole or in part, toxic gas refuges. Sources in HSE asked CIA whether the guidance could be revised to provide more usable, specific and extensive guidance. A working party was set up, with HSE participation, to consider these points and their work is behind the revision.

THE REVISED PUBLICATION — TOXIC GAS REFUGES

The new guidance document was published in 2003⁽⁴⁾ and most of the guidance is unchanged from the first edition, apart from correction of textual errors and bringing some references up to date. However, the section dealing with toxic gas refuges has been expanded considerably in the revised text; three flow charts have been included, helping the operator to assess all buildings which may be occupied and enabling operators to decide whether each needs to be treated as a toxic gas refuge; and a hypothetical site has been considered showing how the guidance might be realised in practice. The revised guidance also does away with the term “safe haven” which was used in the first edition. The working group felt that the term safe haven has a wider meaning; implying protection against all foreseeable hazards including VCEs and fires. A toxic gas refuge may not provide protection against these other hazards, but will still be fit for purpose as a TGR where other risks are at a suitably low level.

The guidance avoids a strict definition of the term ‘occupied’, to allow users a degree of necessary flexibility in interpreting the guidance. The guidance advises — no doubt obviously — that the proportion of time for which a building is occupied should be taken into account. The frequency of visits, and the number of people who visit a building (both maximum and average) are important considerations. Importantly, the guidance makes it clear that toxic gas refuge status is not needed for low occupancy buildings, provided people in the building or nearby can escape safely to a nearby refuge. The guidance uses — as an example — people being present in a building for more than two hours in any twenty-four hour period as a lower limit of “occupied”. Operators are asked in their policy (or elsewhere) to define their criteria for occupation. This effectively puts an onus on operators to justify any decision not to apply, or not to apply, toxic gas refuge status to a building on the grounds of low occupancy.

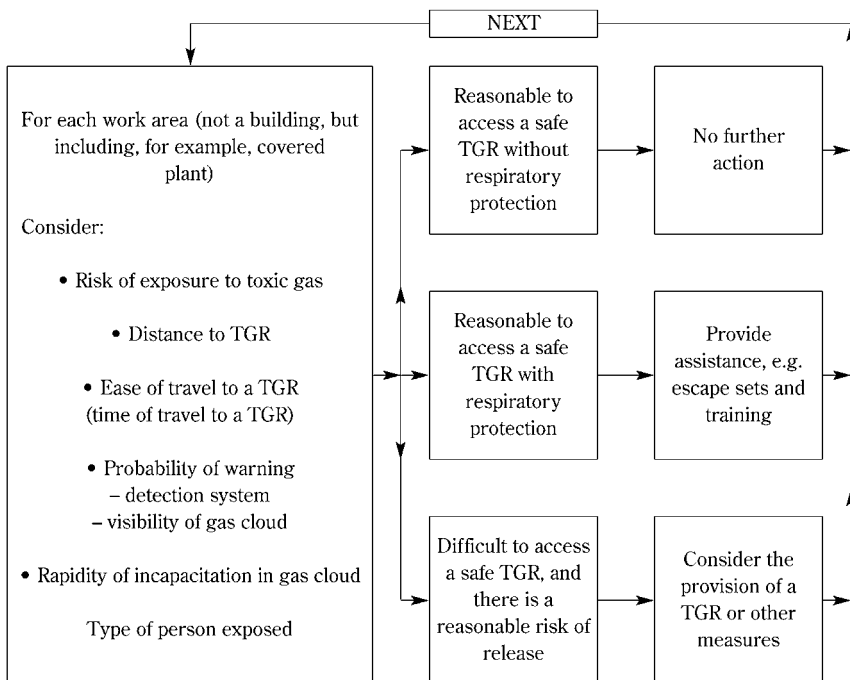
MITIGATION MEASURES

The guidance recognises that the decision to apply mitigatory measures is still usually based on the consequences of a gas release rather than its likelihood (i.e., hazard considerations are primary). This is because of the relatively low cost of most such measures. However, operators may choose to base decisions on the results of a full risk assessment where it can be shown that large parts of the site are so unlikely to be affected that the cost of mitigation measures is not justified.

The guidance clearly states that the number and location of toxic gas refuges should allow anyone on site, whether they are inside or outside, to obtain shelter in a designated refuge. This means that the site assessment should take account of where people are actually likely to be and ensure that they can reach a refuge before they are likely to be incapacitated by the toxic gas. Where a refuge cannot be provided within a reasonable distance — for example for staff working high on a still column or on a gantry — then the site should consider other measures to provide protection: the use of escape sets or canister respirators for example.

Not every building which is occupied needs to be a toxic gas refuge, but the guidance recommends that the following factors need to be taken into account in deciding the number of refuges provided, and their location on the site:

- The distance that people will have to travel to get to the refuge, and the likely speed of dispersion of the toxic gas being considered;
- The means of alert provided for a gas release (e.g. detectors and alarm systems);
- The accessibility of escape route to the nearest refuge;
- Individual capability and knowledge of escape route; level of training; provision of escape route signs; and the consideration that control room operators may need to have easy access to toxic gas refuges and/or be equipped with breathing apparatus to enable safe plant closures in emergencies;
- The nature of the material released — toxicity & physiological effects, detectable odour threshold, visibility within gas cloud;



TGR = toxic gas refuge

Figure 3. Work area assessment

- Personal Protective Equipment available for use during escape;
- Protection provided by buildings during escape.

Using available literature, the guidance recommends a volume of space to be provided per person in a toxic gas refuge, for a given duration of stay.

FACTORS TO BE TAKEN INTO ACCOUNT IN THE CONSTRUCTION OF TOXIC GAS REFUGES

For large buildings, the whole of the building does not need to be, indeed generally should not be, designated as a toxic gas refuge. It is usually more practical to designate certain rooms as refuges. This has the advantages: the roll call is easier; it is nearly always much easier to make specified rooms suitable for use as toxic gas refuges than the whole building; and it is then much easier to keep the specified rooms up to the required standard. Rooms or buildings should be chosen for use as toxic gas refuges taking a number of features into account. The recommendations in the guidance are subdivided into those that are essential for a toxic gas refuge and those that are desirable. Amongst the essential features which must be met are;

- Doors and windows must close properly with an adequate seal;
- Doors and windows must resist any overpressure that might accompany or precede the release of toxic gas from a pressurised source;
- Mechanical ventilation systems must be capable of being shut down rapidly and sealed against gas ingress;
- Service trenches and penetrations for cables must be sealed.

And amongst the desirable features:

- Doors should be of the vestibule design, with an air lock, preferably designed for ingress or egress by people wearing breathing apparatus;
- The number and size of windows should be minimised when close to the source of hazard, and they should preferably be non-opening;
- Openings between the toxic refuge and the roof space should be minimised.

TOXIC GAS REFUGE ASSESSMENT IN PRACTICE

The series of flowcharts referred to earlier consist of a process that a site operator could use in reaching logical decisions about the location of toxic gas refuges. The three flowcharts are shown below as charts 1–3 and clarify the need for an initial identification of toxic hazard sources, buildings and work areas; followed by building and work area assessments for all buildings and areas on the site.

POSSIBLE FUTURE DEVELOPMENTS

Having dealt with the sections which caused most queries in the first edition, it is likely that feedback from both regulators and from users will suggest revision and amplification to other areas. In particular, some smaller sites have found the example assessment for toxic gas refuges useful and the production of similar examples for other hazards could well be beneficial. Feedback on the guidance and on its use in practice would be welcomed by the CIA and the authors.

CIA is not alone in working on the area of occupied buildings on chemical sites. A Paper was presented at “Loss Prevention 2004”⁽⁵⁾ on behalf of the European Process Safety Centre (EPSC) which discussed methods developed to evaluate hazards from fires and explosions and the impact on occupied building design. This work resulted in an EPSC report⁽⁶⁾ and the paper discussed how one company had applied the methods to their occupied buildings. The EPSC report is currently available to members of EPSC and discussions have been started between EPSC and CIA to see if this work, or part of it, could be incorporated into the next revision of the CIA guidance.

There is one other area which is worthy of note. The glossary of the publication defines risk as ‘the likelihood of an effect occurring’, and goes on to state that, in the risk assessment referred to in this guidance, the effect considered is death. It is implicit in this that we are discussing risk to an individual. The Competent Authority for COMAH and especially HSE in their publication “Reducing Risks, Protecting People”⁽⁷⁾, have begun to raise the issue of Societal Risk as well as individual risk. The authors thought about how to deal with societal risk assessment, which would involve calculating the potential for large numbers of casualties on- and off-site. However, this issue is clearly far larger than the issue of on-site buildings and the working group decided to omit such consideration from this revision of the guidance. This decision may need to be revisited as HSE, industry and society’s thinking on societal risk develops.

REFERENCES

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6. European Process Safety Centre, 2002: “Design basis for buildings in hazardous areas”, EPSC report No 25.

In addition, the CIA Guidance document contains a bibliography giving references to fundamental research documents, published standards, and further assessment methods (page 19 of ref 4 above).

The guidance (ref 4) on which this paper is based is available from:

Chemical Industries Association, Kings Buildings, Smith Square, London SW1P 3JJ
Please consult the CIA website (www.CIA.org.UK) for ordering details.