

## OCCUPIED BUILDINGS: BUILDING ON OUR PAST IMPROVEMENTS

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The UK Chemical Industries Association has been going through the process of revising its guidance document on “The location and design of occupied buildings on chemical manufacturing sites”. The document is progressing towards publication at about the time of the Hazards XXI conference.

The revision tackles in greater detail than the original the definition of buildings and their occupancy, and how this relates to the hierarchy of safety controls, when prioritising either hazard, or risk reduction measures. It will also include comment on means to upgrade existing buildings. It reviews topics such as the use of exclusion zones, vulnerability data, assessment methods and mitigation within ALARP, and upgrades the issue of temporary buildings to a full section, based on the learning experiences from Texas City.

This paper summarises the background and content of the original guidance and its 2003 revision; discusses some of the events since 2003 and their influence on the revision and gives more detailed comment on the enhanced and additional sections in this latest version.

### INTRODUCTION

Occupied buildings have been an active subject of discussion and papers at Hazards over the last 10 years or so, certainly since CIA (the UK Chemical Industries Association) published the second version of their guidance on the subject in 1998 (CIA, 1998). This second version significantly changed the focus from control rooms – the subject of the first CIA guidance (CIA, 1979) to all Occupied Buildings (OBs). This change was prompted by the deaths of people not in traditional control rooms, but in other buildings close to operational plant but not intimately involved with the plant. The deaths of five office and other managerial staff in buildings on the Hickson & Welch site in 1992 is perhaps the most obvious example of this and the HSE report into the accident included the recommendation that: “The design and location of control and other buildings near chemical plant . . . should be based on the assessment of potential for fire, explosion and/or toxic releases at these plants. Companies should assess the suitability of existing control buildings and if they are found to be vulnerable practicable mitigating measures should be taken” (HSE 1994).

The publication of the first edition of the revised guidance in 1998 prompted the UK Health & Safety Executive (HSE), who had been involved in the production of the guidance, to indicate to the UK chemical industry that HSE regarded the guidance as setting a standard which HSE would expect the industry to meet over a period of time. Indeed HSE indicated that they would regard the guidance as “enforceable”: that is setting a standard for which HSE would be prepared to use their enforcement powers. Initially HSE approached this as a separate exercise but it rapidly became bound up in the implementation of the 1999 Control of Major Accident Hazards (COMAH) Regulations, with HSE focussing particularly on top-tier sites which needed to submit COMAH safety reports and therefore show that risks on their sites had been reduced to ALARP levels.

### THE SECOND EDITION OF THE CIA GUIDANCE

This adoption by HSE of the guidance and the consequent request to companies to indicate how they intended to meet it, prompted a number of questions about the first edition. These particularly touched on the questions of “what is an Occupied Building?”; how should sites deal with the risks of toxic gas releases?; and how should temporary buildings be managed and their risks assessed? These concerns prompted CIA to re-convene the working group, with some changes in membership, to examine these issues and consider revising the guidance. In the event, the revised guidance which was published in 2003 (CIA 2003) did give significant additional guidance on assessment of and protection against toxic gas releases, gave some help with the question of occupation but left the section on temporary buildings substantially unchanged. The only change of note was the inclusion of a paragraph which recognised that a temporary building could provide protection against toxic gas releases, provided it was assessed and made fit for that purpose.

### TOXIC GAS RELEASES

In dealing with toxic gas releases, the group discarded the term “safe haven” used in the first edition, as it was felt to imply protection against all possible hazards. The group felt that the term “toxic gas refuge” (TGR) more accurately reflected the protection buildings can give against toxic releases even though they may not provide significant protection against blast or fire. In locations further away from operating plant, protection against toxic releases may be all that is required.

The section on toxic gas release was substantially expanded and rewritten to provide operators with considerably more guidance on both how to assess buildings and then how to make them suitable to provide protection against a release. The new Appendix, including a worked

example, was intended to provide operators with relatively easy to use, largely hazard based tools which they could use to first define an action plan for improvement and then an acceptable way of approaching the ALARP question for toxic gas hazards.

#### ... AND THE QUESTION OF "OCCUPATION"

The second edition did not attempt in the main text to answer the question "what is an Occupied Building", or perhaps more explicitly for the purpose of the exercise "Which structures on site are occupied, and which are not occupied and can therefore be ignored". The section on toxic gas releases does give some thoughts on the matter, mentioning a lower limit of 2 hours occupancy per day, below which some sites had decided that buildings could be ignored. Most importantly the guidance suggests that each site's policy on Occupied Buildings should specify their criteria for regarding a building as Occupied.

However the approach adopted by this section of the guidance does suggest that, for toxic risks at least, this is not an issue which is actually of primary importance. The guidance asks site operators to consider each area of the site in turn, whether the area is inside a building or outside, and determine what protection should be provided for the people in that area. This approach changes the problem to a consideration of the risk a person in an area is exposed to and how best they should be protected. Because all areas of the site should be considered this will automatically include all structures, making the question "Is this building occupied so little I can ignore it?" largely irrelevant.

This approach does make it quite clear that all buildings on a site do not have to be toxic gas refuges, provided people can be reasonably protected, usually by gaining access to a toxic gas refuge in a reasonable time. Clearly, buildings occupied nearly all the time by a significant number of people will almost always need to be (or contain) a TGR. But low occupancy buildings are of no more – or less – consequence than any other work area with a similar occupancy. In each case the questions are about provision of adequate protection, via alarms, reasonable travel distances, and if required Respiratory Protective Equipment (RPE), rather than an exhaustive consideration of individual buildings.

#### EVENTS SINCE 2003

There have been two very major events since 2003 which are often considered to have an influence on Occupied Buildings policy: the explosion at Buncefield which caused major destruction but no deaths; and the fire/vapour cloud explosion at BP's refinery at Texas City, which caused 15 deaths and severe damage to plant including a large number of temporary buildings. It is worth reflecting on each of these in turn and teasing out the pointers they give to the future direction of occupied buildings policy.

#### BUNCEFIELD

At Buncefield there was extensive damage to off-site buildings but, from the publicly available reports (Buncefield 2006–8) the site buildings, including the control room, seem to have been largely unaffected. Indeed the Buncefield Task Group's Final report (Buncefield 2008) does not make any recommendation about occupied buildings, neither does it give any references to the subject, nor even mentions them as an issue in the final report text. It can be argued that Buncefield was a low probability event.

This is not to suggest we should be complacent about such a massive event or fail to learn the lessons from it. The unexpectedly large destruction from such a vapour release has been widely studied and our models of what is possible need to be modified to account for the new events we are coming to understand. API 752 (API, 2003) is being revised to take account of the new knowledge, though for smaller chemical sites the relevance may be much lower: it is hard to see how a 50 m<sup>3</sup> storage filled by a 25 m<sup>3</sup> tanker, a situation typical of many chemical sites, could possible cause such an event. The CIA guidance, aimed at the generality of chemical manufacturing sites, may only need to provide a pointer to this via API 752. Perhaps Buncefield reminds us most strongly that we should learn the relevant lessons and ensure that we apply them in a proportionate manner, taking care to focus on those safety improvements with the greatest return in the removal of risks to people, the environment and property.

#### TEMPORARY BUILDINGS AND TEXAS CITY

Texas City does not ask us to speculate on "what might have been", the reality of 15 dead is quite bad enough. The deaths at Texas City were in and around a significant number of temporary buildings installed to deal with two different pieces of work being done on the refinery (Baker 2007). The Texas City refinery operators (BP) did have guidelines, inherited from the refinery's previous owners Amoco, on the use and placement of temporary buildings on the refinery thought these had not been revised for some time and their use seems to have been less than perfect. The event and the problems which led up to it have been widely discussed – BP's openness in its dealings with the investigation is notable as an example to the rest of industry in ensuring that the lessons from such an event are available to anyone affected – and it is clear that different decisions on placement and type of temporary buildings would have led to a very different outcome, in terms of human life at least.

A great deal of work has been done, both before the accident at the Texas City refinery but very intensively since, on how temporary buildings can be designed to withstand overpressure and flame impingement (FABIG 2008). Designs have been developed, and are reasonably readily available, which will cope with quite severe blast loadings, certainly up to the 0.5 bar level, as well as protecting the occupants against fire and other events such as missile impact. The designs can either be sacrificial, that is able to

cope with a single event by deformation and energy absorption, or be robust and designed to be reusable after a pressure event. However, it is clear that these solutions have a significant cost attached.

A great deal of thought has also been given to the question of where temporary buildings should be sited. API RP 753 (API, 2007) has now superseded API RP 752 in its coverage of the management of personnel in temporary buildings, and recommendations on their location. Sensible decisions on siting can remove the need for other forms of protection but the site needs to know both the worst credible accident they should be protecting against and the protection, if any, the proposed temporary buildings will offer. For large petrochemical sites this type of information may be available or obtainable from internal expert sources. For smaller sites with fewer staff and a likely lack of expertise in this area, simpler rules are likely to be more helpful, probably leading to the use of exclusion zones around plant and the generation of designated safe (or safer) areas even if these do entail a larger separation from the work area.

#### THE NUMBERS AND TYPE OF PEOPLE ON SITE

The distance of buildings from plant also raises the further point: who should be allowed to occupy temporary buildings - or indeed any buildings - close to chemical plant? Probably the fastest way for most plant to significantly reduce the overall risk to people on chemical manufacturing sites is to re-locate staff further from operating plant. Quite simply, those not present will not be hurt whatever happens; distance is a great moderator of risk. This process has been followed by many sites in recent years, being facilitated by the severe reductions in staffing levels in many companies. Initially such re-location often raises objections from non-essential staff who like to be "close to the action", that is close to the plant they manage or maintain, and who claim they will spend too much time walking to and from their plant. However, when challenged it usually becomes clear that much of what a modern manager does is not tied to the plant, indeed some separation between the office and the plant, coupled to regular walks between the

two, could well be beneficial to their short and long term health!

This separation of people and plant is, of course, the first step in the classic 6-step risk reduction hierarchy often used with hazardous materials: remove, replace, reduce, enclose, engineer, provide personal protection (HSE, 2005). This comparison is demonstrated for the two cases in Table 1.

This list of protection measures emphasises that the first duty is to keep people away from the hazards; then to use all the Process Safety Management techniques we have to provide a safer process; and only finally to provide protection by using the buildings which remain on site. However, it also makes it clear that, even though it should be seen as a last resort, just like PPE, Occupied Buildings protection is a subject we will always be dealing in the future.

#### HSE INSPECTION GUIDANCE AND PRACTICE

In 2006 HSE produced inspection guidance for COMAH sites (HSE, 2006) which reviewed the CIA industry guidance, recognising that its aims were to protect people through the application of risk assessment and goal-setting principles, rather than prescriptive standards. Also, that in some instances operators may need to take further actions beyond this guidance to demonstrate ALARP.

Inspection practice in recent years for both regulator and operator has relied heavily on the CIA guidance; where there is the possibility of explosion and overpressure, additional risk assessment methodology has been required, which will be reviewed in more detail in the revised CIA guidance document.

The HSE Guidance attempts to put additional definition on the interpretation of an occupied building, and its occupancy, given that this is lightly covered in the current CIA guidance document. This topic has provoked further discussion both in the reviews of the API texts, and the CIA's latest revision, and is mentioned further below.

**Table 1.** Hierarchy of control comparison for hazardous substances and occupied buildings

Hazardous substances	Occupied buildings
Remove the hazardous substance from the process	Remove the hazards from the process OR remove the people from the hazardous zone
Replace the hazardous substance with one offering lower hazards	Re-design the process to reduce its inherent hazards (inherently safe design)
Reduce the quantity of the hazardous substance	Use process intensification to reduce the inventory of flammable or toxic material and hence the hazard/risk range
Totally enclose the hazardous substances and the process	Totally enclose the hazardous substances and the process
Reduce exposure by engineering measures such as exhaust ventilation	Use process safety measures (better control systems, safety shut down, dump tanks, etc.) to mitigate risks arising from process failure
Provide personal protective equipment (PPE)	Provide protected occupied buildings

### THE REVISED CIA GUIDANCE

The CIA guidance document is widely used within the chemical industry in the UK, and indeed widely quoted elsewhere. For many sites the approach outlined in the guidance is now embedded within their site management systems. The latest revision therefore builds on the current document and its past development, maintaining the same overall format but updating the text for current good practice and revising (or removing) out-of date material. It also adds some guidance on additional topics where experience over the last 5 years suggests this would be valuable to industry by indicating current good practice.

The CIA has had an active working group whose members have contributed their experience to the revision and rewriting of the guidance document. The working group has been quite clear that the aim is to retain a comprehensive overview of the subject, which then offers pointers to more detailed or extensive work for those who need this additional information. However a key audience is those smaller chemical manufacturing sites which do not have specialists in detailed risk assessment available in-house. It also aims to provide help to these sites to enable them to be "intelligent customers": understanding when more expert, often consultant, assistance is required; and then ensuring that the help provided is properly focused.

### CHANGES, ADDITIONS AND NEW EMPHASES PRINCIPLES

Basic principles have been included in the introductory section of the document. These are:

- Wherever possible, locate people away from chemical processing and storage unless their presence is required for safe, effective operations;
- Control the risks during storage and all operational phases by efficient and effective process safety management.
- Ensure that the on-site buildings are located and designed to minimise the risks to the occupants by:
  - Carrying out an appropriate risk assessment for the buildings, and
  - Applying the results of the risk assessment to the design and continued operation of the buildings.

### EXISTING BUILDINGS

The 2003 revision covers the requirements for Toxic Gas Refuges at some length, but this does not, of course, cover protection of personnel against fire or explosion risks and a great deal of work has been done on the vulnerability of buildings to, and protection of buildings against, blast loads from vapour cloud explosions (VCEs) especially. A 2009 revision of the ICE's "Blast Effects on Buildings (ICE, 2009) covers much of this. However, existing buildings may not be susceptible to any simple answer; showing that any given building is "ALARP" is not a process susceptible to any simple demonstration. Equally, long and detailed quantified examinations may also add

little to the real safety of personnel on a chemical site. Perhaps the first pass or pragmatic solution to this problem is accept that a chemical site is a place with real hazards (however good the controls and hence low the risks) and to ensure that the site's buildings do not add risks to those within them. This aspect is discussed in greater length in the new revision, along with extent of options available for the upgrading of existing buildings once a risk assessment indicates that a building requires additional protection.

### DEFINITION OF OCCUPIED BUILDINGS

The updated guidance now includes a new section on occupancy to help operators decide on which buildings will be may be considered as occupied and therefore candidates for the process of Occupied Building Risk Assessment (OBRA), and those which are likely to be excluded. There is no definition of what constitutes a building per se, as the group concluded that any structure, (even a lean-to) if adding an additional risk to personnel from an external hazardous event, should be included in the assessment.

There is extended consideration of what constitutes occupancy, the criteria for which operators should decide for themselves. Such criteria should be used to assist the determination of which buildings are in, or out of the OBRA process.

### ASSESSMENT METHODS

It is the intention to include a further case study based on approach taken for an existing plant, in order to consider the various assessment options available. Real life examples can also indicate the often pragmatic approach that is taken for an existing plant, where remedial options are often dictated by the nature of the operations.

### CURRENT STATUS

The CIA working group are actively engaged in the revision to the existing document as this paper is being written. The expectation is that the revisions will be finalised by the early autumn. They will then go to wider consultation amongst CIA members by the time of Hazards XXI in November. The presentation and discussion at Hazards will include discussion of the new text and CIA hopes to formally launch the new document early in 2010.

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