Using pictures in training

The impact of pictorial OSH training on migrant worker behaviour and competence

Report submitted to the IOSH Research Committee

Prof Iain Cameron, Dr Billy Hare, Dr Roy Duff and Fiona McNairney
School of the Built and Natural Environment
Glasgow Caledonian University
Cowcaddens Road
Glasgow
G4 0BA
UK

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Mary Ogungbeje
Research and Technical Adviser
mary.ogungbeje@iosh.co.uk

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Abstract

Strategies adopted in construction to communicate with non-English-speaking migrant workers include the use of pictorial aids. However, there have been few construction-specific studies in this area and few validation techniques applied to them. The aim of this research was to establish whether delivering hazard information and instruction using pictorial aids can be linked with an improvement (ie better results than with text-only materials) in targeted competences and behaviours among second-language (migrant) workers.

Four targeted themes were identified for the purpose of the research:

A exclusion zones
B materials storage
C use of hand tools
D personal protective equipment (PPE).

Knowledge was measured via a 24-question multiple choice pictorial test with six questions per theme. Behaviour was measured via eight observational criteria, two per theme. The interventions consisted of pictorial toolbox talks on themes A and B, conducted on two sites (sites 1 and 3, collectively known as group 1). Conversely, themes C and D featured on sites 2 and 4 (group 2). Each group acted as the control for the other by using text-only versions of the corresponding toolbox talks. Sites 1 and 2 were revisited one month later to be tested again.

The main findings were:

- the mean knowledge test scores after using pictorial aids increased in all cases by more than those with text-only versions
- the analysis of variance (ANOVA) of knowledge test scores found very significant interaction effects over all the sites
- one month later, test scores remained high but there was a ceiling effect.

This shows that training with pictorial materials improves knowledge and understanding among second-language migrant workers better than text alone. In addition, the average pre-intervention knowledge test score was 10 per cent higher than previous research. This is probably because all the workers in the sample were European and had attained CSCS competence levels. The scores also agreed with previous findings showing that more experienced workers generally score higher.

The observation scores were not as conclusive. Prima facie, the results were similar as the plotted graphs showed that improvements in safe behaviours were generally greater on intervention sites; however, ANOVA returned no significant differences on virtually all individual measures. Combined scores for behaviour returned significant or very near significant results. This shows that measuring the impact of the images on behaviour is both challenging and unpredictable. Pictorial aids are merely a method of communication and do not ensure compliance. Where scores improved, they remained high one month later for themes A and B, whereas the scores dipped for themes C and D. In the case of A and B, site managers placed posters of the training images beside work areas. This ‘poster effect’ may have been the reason for the longer-term differences.

The benefits of pictorial aids to help improve health and safety knowledge should be disseminated to the construction industry and beyond. The format of ‘hazard–consequences–controls’ should continue to be used. Sketch drawings, pictograms and photos all have different strengths. However, further research is needed to establish how they can be used more efficiently. The use of pictorial toolbox talks in conjunction with a synchronised poster campaign or ‘Trojan horse’ approach may improve the overall impact of pictorial aids in communicating health and safety information. But their long-term efficacy needs to be investigated further.

Executive summary

Introduction

Strategies adopted by construction companies to communicate with non-English-speaking migrant workers include pictorial methods of communication. This strategy is supported by legislation. However, there is an urgent requirement to improve communication and integration throughout the construction industry. Various authors have concluded that there is scope for using pictorial communication in this sector in order to bridge the communication gap, due in large part to the increase in migrant labour. However, there have been few construction-specific studies and, in these, few validation techniques have been applied to gauge the success of the communication methods.

Aim and objectives

The aim of this research was to establish whether there was evidence that the delivery of hazard information and instruction using pictorial aids can be linked with improvement beyond that generated by text-only materials in targeted competences and behaviours among second-language (migrant) workers.

To achieve this aim the following objectives were set:

1 to develop a targeted set of measurable factors for the assessment of second-language workers' health and safety:
   a competence
   b behaviour
2 to record the targeted baseline measures for specific worker competences and behaviours (ie before the pictorial aid interventions)
3 to use pictorial aids for communicating hazard information and instruction, developed by GCU, on a number of construction sites (ie the intervention)
4 to record the targeted measures of worker competences and behaviours after the intervention
5 to investigate anecdotally, graphically and statistically the presence of a causal link between the introduction of pictorial aids to communicate hazard information and instruction and any changes in the targeted competences and behaviours of second-language workers
6 to complete a report on the findings, which will highlight the benefits and limitations of the communication aids and methods of delivery.

Methods

Four targeted themes were identified for the purpose of the research, identified by the letters A–D:

A exclusion zones
B materials storage
C use of hand tools
D personal protective equipment (PPE).

These were chosen in collaboration with site management teams and with the aid of safety audit data. Knowledge was measured via a 24-question multi-choice pictorial test with six questions per theme. Behaviour was measured via eight observational criteria, two per theme. The interventions consisted of pictorial toolbox talks on themes A and B, conducted on two sites (sites 1 and 3, collectively known as group 1). Conversely, themes C and D were presented pictorially on sites 2 and 4 (group 2). Each group acted as the control for the other by using text-only versions of the corresponding toolbox talk. Sites 1 and 2 were revisited one month later to be tested again.

Findings

1 Mean knowledge test scores in relation to the themes increased in all cases where pictorial aids where used. On the other hand, mean scores in relation to text-only themes showed random variation over time, slightly increasing, decreasing or remaining static.
2 Analysis of variance (ANOVA) of knowledge test scores found consistent effects for pictorial intervention over all the sites, with every test for interaction returning very significant results.
3 Test scores taken one month later remained high. Due to a ceiling effect, there was little room for further improvement. Therefore no further testing was undertaken after the second intervention (although further observational data were collected for behaviour measures).
4 Findings 1–3 show that training with pictorial materials improves knowledge and understanding among migrant workers for whom English is a second language to a greater extent than training without pictures.

5 In addition to this, the average pre-intervention score was 10 per cent higher than that observed in previous research. This can probably be attributed to two factors:
   - all the workers in the current sample were European, and there is more synergy between UK standards and working practices and those elsewhere in Europe than there is between the UK and many other non-English-speaking countries
   - all the workers in the sample had attained CSCS competence levels, whereas not all sites in the previous research required this.
6 The pre-intervention scores also agreed with previous findings showing that more experienced workers generally scored higher on the knowledge test than less experienced ones (the scores were < 5 years: 21.89; 5–10 years: 22.13; > 10 years: 22.58); however, the correlation was not statistically significant.

The observation scores were not as conclusive. The results were *prima facie* similar but were not statistically significant, possibly because the group data were pooled.

7 Visual inspection of the plotted graphs showed improvements in safe behaviours to be greater on intervention sites. However, ANOVA returned no significant differences on virtually all individual measures.
8 Mean scores for behaviour returned significant or very near significant results.
9 The improved scores remained high one month later for the intervention on themes A and B (site 1), whereas the scores dipped for C and D (site 2), before rising again after the second intervention.
10 Further investigation into finding 9 showed that the management at site 1 reproduced posters of the training images and placed them beside work areas. This 'poster effect' may be the reason for the longer-term differences between the two sites.
11 However, the longer-term differences between the sites may be due to variation in worker motivation or capability (although it is assumed these differences existed uniformly throughout the sample). Another reason may be possible contamination of data due to a higher turnover of workers at site 2.
12 Findings 7–11 show that measuring the impact of the images on behaviour is both challenging and unpredictable. Pictorial aids are obviously limited by the fact that they are merely a method of communication and do not ensure compliance.

Recommendations

The recommendations are divided into two categories: those for improved industry practice and those for further academic study.

Improved industry practice

1 The benefits of pictorial aids in improving health and safety knowledge should be disseminated to the construction industry and beyond.
2 The format of 'hazard–consequences–controls' should be used to communicate health and safety information, as this was the format used successfully (in terms of improved knowledge scores) in the study.
3 Sketch drawings are useful ways to communicate hazards and consequences without using real people. Pictograms are useful for conveying information about hazards and controls. Photographs help to show controls in context.

Further academic study

4 Sketch drawings, pictograms and photographs all have different strengths (see recommendation 3). However, further research is needed to establish, in detail, how they can be used more efficiently by comparing them in different situations.
5 The use of pictorial toolbox talks in conjunction with a synchronised poster campaign (the 'Trojan horse' approach) may help improve the overall impact and effectiveness of pictorial aids to communicate health and safety information. But their long-term efficacy needs to be investigated.
6 Further research on the interaction of communication method, motivation, capability and other relevant factors would help understand more fully how pictorial aids affect migrant workers' behaviour.

1 Introduction

1.1 General introduction

The number of migrant workers in the UK has grown in recent years, particularly following the expansion of the European Union in 2004 to include Central and Eastern European states, but also with the creation of new work schemes for sectors experiencing labour shortages.

Evidence suggests that migrant workers are exposed to greater safety risks than those born locally.[1] It is reasonable to assume that language could be a contributory factor to the raised incident rates.[2] Consequently, there is an urgent requirement to develop, evaluate, and validate alternative communication strategies, and particularly to create communication methods that will aid the flow of health and safety information from supervisors and managers to employees and *vice versa*.

1.2 Aim and objectives

The aim of this research was to establish whether there was evidence that the delivery of hazard information and instruction using pictorial aids can be linked with improvement beyond that generated by text-only materials in targeted competences and behaviours among second-language (migrant) workers.

To achieve this aim the following objectives were set:

1 to develop a targeted set of measurable factors for the assessment of second-language workers' health and safety:
   a competence
   b behaviour
2 to record the targeted baseline measures for specific worker competences and behaviours (ie before the pictorial aid interventions)
3 to use pictorial aids for communicating hazard information and instruction, developed by GCU, on a number of construction sites (ie the intervention)
4 to record the targeted measures of worker competences and behaviours after the intervention
5 to investigate anecdotally, graphically and statistically the presence of a causal link between the introduction of pictorial aids to communicate hazard information and instruction and any changes in the targeted competences and behaviours of second-language workers
6 to complete a report on the findings, which will highlight the benefits and limitations of the communication aids and methods of delivery.

2 Literature review

2.1 Introduction

There are many programmes and permit schemes that attract migrants to work in the UK, for example the Highly Skilled Migrant Programme, the Sectors Based Scheme, and the Worker Registration Scheme. The construction industry is particularly attractive because of the ease of gaining entry without qualifications. It is widely known that the industry attracts many workers with low or no formal qualifications. For example, a majority of the workforce (55 per cent) have skills below NVQ level 2 and 11 per cent have low or no qualifications; a sector with this kind of profile therefore offers easy access to migrant workers.[3] There are no precise figures available for the size of the migrant population working in the UK because data are collated from various sources, such as the International Passenger Survey, the Labour Force Survey and work permit applications. There is no single comprehensive data collection body. It is estimated that there are approximately 2.8 million construction workers employed in Great Britain, and that migrant workers account for approximately 8 per cent of these.[4] Migrant workers are mostly employed on short-term contracts,[2] with Eastern Europeans dominating.[4] Migrant worker deaths in construction have also climbed in recent years to 17 per cent of the industry total ($n = 12$) for 2007/08.[4] These figures suggest that migrant worker fatalities are twice the expected number. Moreover, the number of undocumented migrants working in the UK is unknown; although estimates have been made, they are thought to be inaccurately low.[5]

Strategies adopted by construction companies to communicate with non-English speaking migrant workers include pictorial methods of communication. This strategy is supported by legislation such as the Health and Safety at Work etc Act 1974,[6] the Management of Health and Safety at Work Regulations 1999[7] and the Construction (Design and Management) Regulations 2007.[8] The associated Approved Codes of Practice (ACoPs) for these regulations include recommendations that information be 'provided in a format that can be understood by the worker', which can include 'providing translation, using interpreters, and replacing written notices with clear symbols or diagrams'.[9,10]

Safety signage in the UK is governed by the Health and Safety (Safety Signs and Signals) Regulations 1996,[11] which encompass information including acoustic alarms, spoken communication, and the use of illuminated signs. Before the introduction of these regulations, many UK businesses had already adopted the use of safety signage developed in line with the British Standard as a means of communication. Therefore safety signage and pictorial displays have been used for a number of years in UK industry in an effort to communicate with the workforce. Despite this, attempts to transcend the language barrier by using symbols have often proved futile, in many cases due to the desire for corporate identity, the *ad hoc* nature of development, and a severe lack of comprehension testing. All of these factors have resulted in a lack of consistency in the signage produced.

2.2 Existing research

Previous studies[12,13] have attempted to improve communication by introducing visual methods, such as images. However, these studies failed to convince because they were not thoroughly evaluated by measuring the success of the pictorial elements in terms of behaviour change or knowledge retention. For example, Brunette[12] documents a construction-specific study that targeted Hispanic workers. She points out that 'well-planned safety training interventions' are required and that in order to achieve this a linguistically and culturally sensitive approach is essential. The research developed a 10-hour safety training programme with additional educational materials, such as a Spanish–English dictionary of construction terms and various audiovisual materials. The materials were developed in consultation with the Hispanic workforce using the participatory approach. This research does seek to target vulnerable workers in construction, but there are a number of limitations: it is specific only to Hispanics and does not encompass other migrant groups or natives with a poor grasp of English; and, despite the fact that an Instructional System Design model, including evaluation, was incorporated into the research, there is no evidence to show the success of the materials. The article states that 'a protocol for testing and evaluating the Spanish language materials among Hispanic workers will be developed', and that questions regarding the usefulness of the language and graphics will constitute part of this, but it is unclear from the research paper whether, and how, this has been achieved. Consequently, despite the requirement for improved health and safety communication methods, there is a notable lack of any evidence-based research with concrete validation techniques.

Jaselskis *et al.*[13] examined the issue of cultural integration and differentiation as well as assessing cultural training programmes. Part of the research involved the development of toolbox integration

courses to facilitate communication between a Hispanic workforce and American supervisors. The toolbox talks used flashcards and survival phrases to meet this objective. The report states that 'flashcards were a crucial element of this course', but neither the content nor design of the flashcards is given. An important point considered by the authors is that the individual conducting the toolbox course must be trained to use the materials and understand the information it contains in order to convey the safety messages effectively. The Hispanic construction workers received 11 toolbox talks and their attitudes to these were recorded through a questionnaire survey. The general conclusion drawn from the survey indicated that using the flashcards was perceived to be good practice by both parties and that they should continue to be used, as this improved the supervisors' understanding of what the workers were thinking. Moreover, the Hispanic workers also believed that their relationship with their supervisor had improved as a result. Unfortunately, this research neither explained the criteria used to develop the flashcards nor indicated their content; it merely listed the modules covered by the toolbox integration course. The research is more focused toward the delivery of the toolbox course and its perceived success, and is less concerned with the actual content of the training materials. Moreover, the findings of the research rely solely on the immediate responses from the workforce and the supervisors; they do not take account of any long-lasting behavioural change or knowledge transfer.

Few studies have evaluated the influence of using pictorial materials on behaviour. The reasons for this are manifold and include:

- time constraints
- the transient nature of the workforce
- the complexity of the relationship between behaviour, knowledge, attitude, and safety culture.

On-site observations can become very complex because of the changing nature of site activity and the impact this has on consistency in the workforce. Tracking and observing a consistent sample of site employees over a period of time is very challenging if individuals are placed on different duties and therefore in different locations from time to time, or if they leave the site. In addition, relatively long-lasting projects are needed if longitudinal observations comprise part of the method, thus excluding many projects. Also, the relationship between behaviour and motivation can be very complex, which may discourage research in this area. Nevertheless, the present research does incorporate this aspect and includes competence and behaviour as measurable factors. In doing so, the research will provide evidence as to whether the materials used can influence knowledge and safe site behaviours, thereby providing validated results on an issue that has been somewhat neglected.

2.3 UK-specific research

Research investigating worker engagement in construction[2,14] has found that the language and communication difficulties of non-English-speaking workers in the industry is a growing problem, with obvious implications for, among other things, the management of health and safety. These studies have made recommendations for further research into communicating with non-English-speaking workers to ascertain how these language barriers can be overcome. An array of research conducted to date has reached similar conclusions. For example, a study examining migrant construction workers in England and Wales concluded that 'migrant workers are at increased risk due to their inability to communicate effectively with supervisors, particularly in relation to their understanding of risk', and that they 'have limited access to health and safety training with difficulties understanding what is being offered where proficiency in English is limited'.[2] Therefore, the study recommended that:

- particular use of non-verbal means of communication be investigated
- employers assess migrant workers' knowledge of English and literacy in order to develop appropriate training materials tailored to the individual
- the award of an English kitemark system be considered to encourage employers to help their workers learn English.[2]

Similar recommendations have been made by Trajkovski & Loosemore[15] and Bust *et al.*[16] Wogalter also summarises the use to which pictorial images could be put:

> Symbols are increasingly being used to communicate to individuals or groups who have limited or no reading skills in a particular language and are unable to read a printed text warning. Well designed symbols serve to facilitate comprehension.[17]

Another piece of research by the Steel Construction Institute[18] introduced the concept of the 'Trojan horse' method of imparting pictorial information to workers, so called because the message is designed to be taken in subconsciously by the workers. The researchers chose four areas of construction in which the materials developed were tested and trials were conducted on messaged and non-messaged sites.* Safety messages related to the four areas were conveyed in cartoon format and placed on posters in conspicuous areas throughout the site. The participants were then tested for awareness and knowledge transfer through a site survey. The conclusions from the study were very positive. For example, site operatives were generally highly aware of the messages and their recall and interpretation was very good. However, an issue of concern with the research is that of habituation. As the Trojan horse messages become established, operatives may become accustomed to seeing the recurring messages, which could then lose their impact. The research proposed several methods of circumventing this problem, recommending that employers 'constantly refresh the messages, rotate the media/format of the messages, and use the messages as part of toolbox talks'. However, these methods were merely suggestions and had not been tested, so it was unknown at this stage whether any longitudinal effects would result from the research. This sentiment is reinforced by Kalsher & Williams,[19] who discuss product familiarity: 'the more familiar people are with a product, the less likely they are to look for, read, and comply with a warning placed on a product.'

Strategies adopted by construction companies to overcome the barriers of communication and integration include:

- bringing workers who speak the same language together in small groups with an English-speaking leader (in some cases identified by a uniquely coloured hard hat) to act as an interpreter
- 'buddy' systems where a foreign worker is paired with a colleague of the same nationality who can speak English
- using external translators
- providing English language courses
- translating risk assessments or method statements into the workers' own language
- using pictorial methods of communication.

However, none of these methods provides a perfect remedy to the communication and worker engagement problem. Using workers as interpreters can have drawbacks, for example when that person is not available. Providing English language courses is expensive even if considered the best long-term investment. English for Speakers of Other Languages (ESOL) courses are available for specific vocations, including construction. These invariably include material on health and safety, which incorporates a glossary of terms and some pictures or diagrams.[20] The Health and Safety Executive (HSE) has recently translated some of its guides into foreign languages to help to communicate risk assessments and method statements; there is a negative side to this, however, as this approach may hinder the integration of foreign workers by discouraging them from learning English. This conclusion is supported by a recent government research report.[21] Trajkovski & Loosemore[15] illustrate how language is often a barrier to communication despite the use of interventions. In the study, almost half of the respondents admitted to misunderstanding work instructions as a result of their level of English proficiency, and 66.7 per cent admitted to having made work-related errors as a result of communication barriers. Therefore, a combination of methods may be required,[16] bearing in mind that pictures should not wholly replace other methods but be used in harmony with them, especially some learning of the English language.

2.4 Comprehension

A comprehension and retention study was conducted by Wogalter & Sojourner,[22] which tested existing pictorial images. The study highlights the importance of careful design in creating the images, but primarily focuses on the influence of training on the comprehension and retention aspects. All respondents were given a pre-training test which involved the participants being shown pictograms and writing down their meaning. The respondents were then given two scenarios: firstly, pictograms with a simple phrase or accompanying statement, and secondly pictograms with a more comprehensive explanatory sentence. Following this, half of the workers were subjected to an immediate post-training test, whereby they were shown the pictograms in a random order and asked to write down their meaning. The other half were asked to return one week later to undergo the same test. Finally, six months later, the participants undertook the same comprehension test once again.

* In the 'Trojan horse' project, 'messaged' sites had safety images attached to materials used on site (eg steel beams, plasterboard sheets) to remind workers of safe practices, while 'non-messaged' sites did not.

The results of the study demonstrate that comprehension and retention can be influenced in several ways. Training has a significant impact on the two factors, as was highlighted by the scores from the pre- and post-training exercises. Furthermore, the increased levels of comprehension were maintained at the one-week post-trial stage; even more reassuringly, there was no significant difference between the weekly and six monthly comprehension results, although the number of respondents available to take the test at the later stage was limited.

Overall findings from the research indicate that long, comprehensive statements accompanying pictograms are not helpful. Instead, only a short description is required. Also, brief training before being introduced to the pictograms (eg by providing an associated verbal label) substantially increased comprehension of those pictograms classed as 'difficult'. Finally, the research selected operational pictograms used in industry where, interestingly, the results of the pre-training test indicate that many of the pictograms achieved a comprehension score of 50 per cent or less. This demonstrates that pictorial design is extremely important in order to facilitate correct communication flow and emphasises the importance of evaluating the designs. Similar final conclusions were obtained by another study conducted by Davies *et al*.,[23] in which established safety signs were tested for comprehension. The study revealed that seven out of 13 signs tested on 325 participants scored less than 29 per cent comprehension, whereas the American National Standards Institute proposes a target of 85 per cent comprehension for safety signs.

The literature suggests that comprehension among migrant workers can also be influenced by culture. Culture is generally defined as:

> ...the shared beliefs and values of a group, the learned way of living. It encompasses what we are taught to think, feel, and do in any given situation by the society in which we were raised. As well as providing content, our cultural conditioning affects how we are to think, feel, and behave.[24]

These shared features have developed over the course of a lifetime and through lifelong interaction with others; this inevitably influences the meaning attributed to a message by its recipient. Thus, communication and culture are inextricably linked. The authors quoted above explain that once an idea has been formulated and communicated, verbally or non-verbally, this communication then passes through a culture filter before being interpreted by the recipient. This highlights the importance that culture plays in communication, and the precarious nature of interpretation if cultural influences are not accounted for. The main cultural variables identified by Victor[25] are:

- attitude
- social organisation
- thought patterns
- roles
- non-verbal behaviour
- language.

These factors should be considered when developing new methods of communication in order to overcome language barriers. Loosemoore & Lee[26] conclude that 'resolving language differences within an organisation requires much more than simply learning another language. It also requires some degree of cultural assimilation.'

2.5 The CHIP model

A Communication–Human Information Processing (CHIP) model has been devised by Wogalter *et al*.[17] (Figure 1). The model is composed of several stages, all of which have emerged from warning research as important factors in information processing. The CHIP model combines communication and information processing into one framework. The model can be divided into two parts. First, it concentrates on the basic communication principle of sender–receiver and second, it highlights how a receiver will process the information.

The model appears to be a linear process, in which all stages are completed in order to achieve success. However, the model is in fact both a stage model and a process model. It can, but does not necessarily always, follow the linear pathway. It features feedback loops that show that some stages are interlinked. For example, a common problem in warning design is that of habituation. Using the CHIP model, a link can be seen between memory and attention switch, indicating that an advanced stage (memory) can influence an earlier stage (attention). This highlights the model's utility in determining problematic areas of design or use.

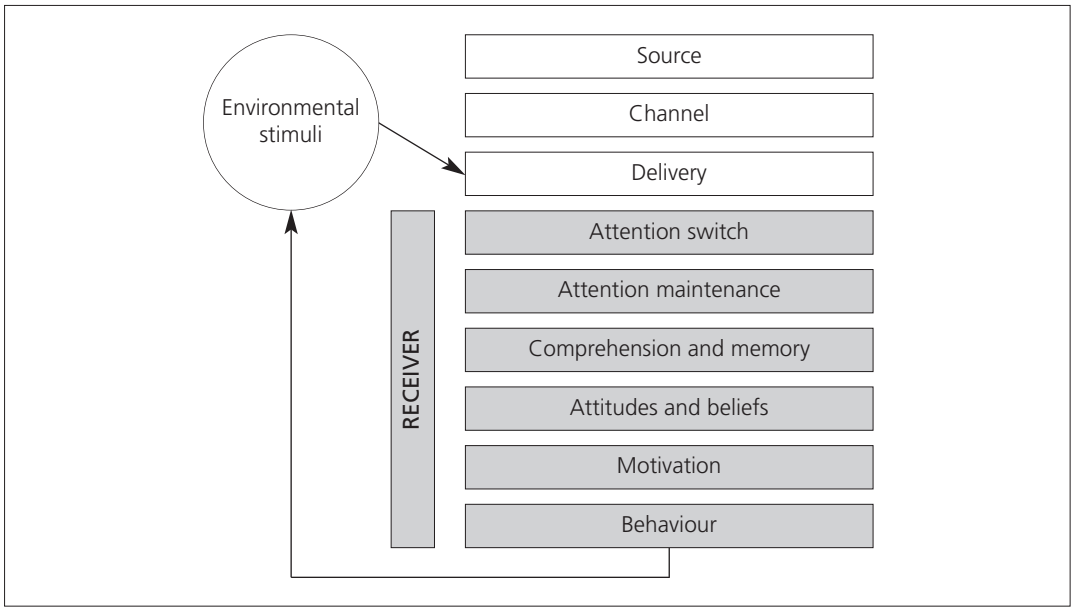

Figure 1
The CHIP model[17]

In order to alter behaviour, all of the preceding stages must be accomplished. However, it may be the case that a warning does not fulfil all of the stages leading to behaviour change; if so, it would fail at that stage. Nevertheless, this does not mean the warning has completely failed. For instance, the attention, comprehension, attitude and belief stages may have been successful in their own right but failed to make an impact at the motivation stage, thereby resulting in a lack of behaviour change. In this way, the warning could be said to be effective in altering attitudes and beliefs and capturing and maintaining attention, but not at altering behaviour. Again, this highlights the utility of the model, as it can be used to detect reasons why warnings failed to take effect. As the exact problem area can be pinpointed using the model, warning designers can modify their blueprint by successfully targeting these zones.

As mentioned, the first portion of the CHIP model is concerned with communication. Three stages are dedicated to this issue – source, channel and delivery. The initial transmitter of the message is defined as the source; the channel encompasses the media used; and delivery refers to how the message arrives at the receiver. If a communication is delivered to an audience in both verbal and visual modes, it is more likely to attract attention, since, regardless of whether the respondent listens to the speaker, the information will still be conveyed visually. This is especially useful for migrant workers whose first language is not English.

The next stages of the model cover attention, comprehension, attitudes and beliefs, motivation and behaviour. The importance of ensuring that a warning gains attention is recognised in the model under ‘attention switch’ – this points out that there may be various other stimuli competing for viewers’ attention, so the design and placement are critical. A warning that puts its message across well but does not attract attention is of limited use. This aspect is referred to in the model as ‘attention maintenance’, which points out that it is essential for a warning to hold attention long enough for the information to be processed. The model also incorporates receiver characteristics, as information processing is also dependent on the cognitive characteristics of the receiver. Three of these characteristics are discussed by Wogalter, namely language level, reading ability and technical knowledge.

The literature review demonstrates that there is an urgent requirement to improve communication and integration throughout the construction industry. Various authors have concluded that there is scope for applying images to toolbox talks in this sector in order to bridge the communication gap, due in large part to the increase in migrant labour. However, as indicated throughout the review, there have been few construction-specific studies and, in these, few validation techniques have been applied to gauge the success of the communication methods. This research aimed to bridge this gap by measuring the impact of carefully designed images on competence and site behaviour.

3 Methods employed

3.1 Introduction

The objectives of the study were to:

1 to develop a targeted set of measurable factors for the assessment of second-language workers' health and safety:
   a competence
   b behaviour
2 to record the targeted baseline measures for specific worker competences and behaviours (ie before the pictorial aid interventions)
3 to use pictorial aids for communicating hazard information and instruction, developed by GCU, on a number of construction sites (ie the intervention)
4 to record the targeted measures of worker competences and behaviours after the intervention
5 to investigate anecdotally, graphically and statistically the presence of a causal link between the introduction of pictorial aids to communicate hazard information and instruction and any changes in the targeted competences and behaviours of second-language workers
6 to complete a report on the findings, which will highlight the benefits and limitations of the communication aids and methods of delivery.

The experimental design required to achieve these objectives involved repeated measures before and after the intervention. To control for extraneous factors, the groups were paired in such a way that each intervention group had a comparable control group.

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3.2 Hypothesis

The hypothesis for the research was that application of the independent variable (pictorial aids) will cause an improvement in the dependent variable (targeted competences and behaviours).

The 'pictorial aids' were a suite of four toolbox talks using a mixture of pictograms, sketches and photographs (see Appendix 1).

The 'targeted competences' were represented through workers' knowledge of the four toolbox talk themes.

The 'targeted behaviours' were represented through observation of safe acts and conditions related to the four toolbox talk themes.

3.3 Experimental design

Correct, or safe, behaviour is commonly accepted as being the result of competence combined with motivation to act safely. However, measuring behaviour alone cannot distinguish between the two. Competence itself requires knowledge and skill. Skills and knowledge need to be tested. Furthermore, a worker could understand and have knowledge of hazards (both crucial to competence) but choose not to follow the controls (ie a lack of motivation). Therefore, a knowledge test and behavioural observation form were developed to test whether specific safety knowledge was understood and whether the motivation was there to implement it as a result of a picture-based intervention.

The dependent variables were 'targeted competences' and 'targeted behaviours'. The word 'targeted' in this context describes specific behaviours or conditions relating to safe activities that can be discretely measured and linked to a specific group of workers. This prevents the possibility of observable measures being attributed to someone other than the workers being tracked. The competence aspect was assessed via a knowledge test. While knowledge is only one element of competence, it is generally accepted as an indicator of competence.

Targeted items (dependent variables) were selected from a menu of possibilities based on common toolbox talk themes. The interventions were implemented on sites belonging to the same construction firm (discussed later). It made sense to collaborate with the site management teams and analyse their occupational safety and health (OSH) performance data, so that the target areas chosen for intervention were relevant and useful to the construction sites involved. The target themes agreed were:

A exclusion zones
B materials storage

C portable tools
D personal protective equipment (PPE).

Knowledge was measured via a pictorial test covering the issues contained in the interventions, showing a specified number of safe and unsafe conditions or behaviours relevant to the themes. The number of correct items identified in the test resulted in a numerical score. Since knowledge is crucial to competence, it can be considered a part measure of competence that can be arrived at without specific knowledge of individual languages. In the event of high knowledge scores combined with low behaviour scores, participant migrant workers were asked to record their level and range of construction experience, to determine whether lack of trade skills was a barrier to implementing the health and safety knowledge. If it is demonstrated that there is not a lack of such skills, it can be assumed that motivation to behave safely is low.

Behavioural observations also avoid any language barrier. This was achieved using a 'percentage safe' approach – eg if four out of five observations are safe, this translates to 80 per cent safe. Table 1 shows how each of the four items were assessed. Each item has six test criteria (knowledge) and two observable criteria (behaviour).

Table 1
Item test and observation criteria

No.	Theme	Test criteria	Observation criteria	Group
1	A: Exclusion zones	Crane lifting operations	A1: Safe exclusion zone A2: PTW armband on	Group 1: Intervention on themes A and B
2		Scaffold being altered		
3		Work at height		
4		Permit to work (PTW)		
5		Pedestrian route		
6		Scaffold stability		
7	B: Materials storage	Stacking pallet loads	B1: Materials stored safely B2: No waste packaging around	
8		Sheet materials		
9		Circular/tubular materials		
10		Storage at height		
11		Waste packaging		
12		Ground conditions		
13	C: Portable tools	Lanyards at height	C1: Lanyards on tools at height C2: Housekeeping of tools	Group 2: Intervention on themes C and D
14		Correct use of chisels		
15		Housekeeping		
16		Cartridge guns		
17		Electrical tool faults		
18		Electrical tool voltage		
19	D: PPE	Mandatory PPE	D1: Wearing mandatory PPE D2: Wearing task-specific PPE	
20		Position of hard hat		
21		Using earplugs		
22		Dust masks		
23		Eye protection		
24		Defects		

Increasing the number of sites tested increases the reliability of any findings. However, this had to be balanced against time and resource limitations. Therefore, four sites were chosen; these were divided into two pairs, with one of each pair being the other's control site. These were sites with over 30 migrant workers of similar national origin. 'Migrant workers' were defined as being domiciled outside the UK (economic migrants) and not speaking English as their first language (the definition therefore excludes workers from the Republic of Ireland). The sites were also all under the control of the same Principal Contractor.* Placing these limits on the study helped to reduce the impact of confounding factors created by sampling workers from different countries and working under different management systems.

The four OSH items were measured across all four sites. At each site, two of the OSH items were interventions and two were the controls as shown in Table 2.

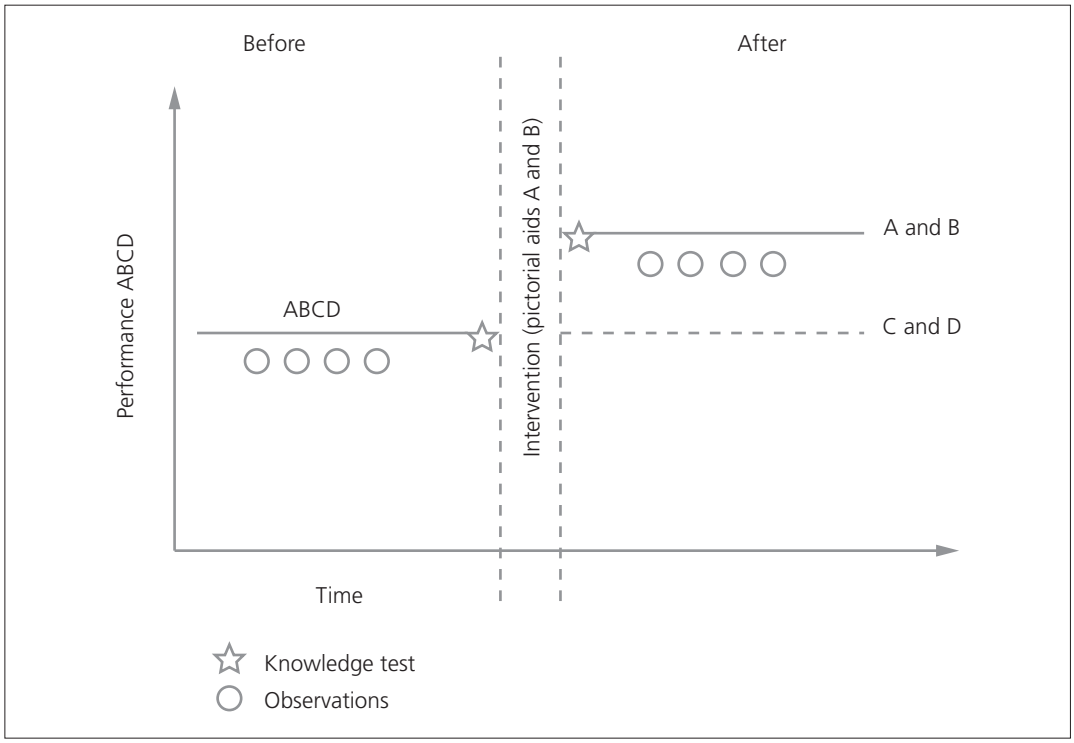
Table 2
Intervention and control sites

Sites	Intervention group	Control group
1 and 3	Themes A and B pictorial	Themes C and D text only
2 and 4	Themes C and D pictorial	Themes A and B text only

The study design had to accommodate the possibility that toolbox talk training, delivered without the aid of any explanatory pictorial material, would result in an equally satisfactory increase in knowledge and behaviour. Therefore, text-only material was delivered for the 'control' OSH items on each site (Table 2).

Thus, if there was an intervention on one set of OSH items, eg A and B, and they improve, but C and D remain unchanged (or only show minor change), then it could be deduced that the improvement was not a result of merely receiving textual information (see Figure 2). The sites were managed by personnel who already undertook behaviour observations as part of their normal site duties. Therefore, the effect of the novelty of such observations (ie the Hawthorne effect) was also minimised.

Figure 2
Theoretical graph: sites 1 and 3 (intervention on themes A and B)



* Under the Construction (Design and Management) Regulations 2007, the Principal Contractor is the organisation in charge of the construction phase of the project.

The performance measures (knowledge test and observations) were used to establish a baseline. Mock observations were done by the full-time researcher accompanied by a member of the site management team on each site. This allowed the site managers to become familiar with the observation scoring and alterations to be made to improve inter-rater reliability.* The 'real' observations were then undertaken by the member of the site management team. The observations were recorded for a succession of days over a two-week period (10 days in total) and averages calculated thus:

$$\frac{\text{sum of safe items} \times 100}{\text{sum of items observed}} = \text{total percentage safe}$$

For example, using the first observation criterion, 'safe exclusion zone' (Table 1: A1), if a total of 50 exclusion zones were observed over the two weeks, and 30 were safe and 20 were unsafe (eg missing a barrier, accessed by unauthorised personnel and so on), then the total percentage safe would be:

$$\frac{30 \times 100}{50} = 60\%$$

The picture-based tests† were administered by the researcher. These consisted of 24 pictorial scenarios with three multi-choice options for each: two options were unsafe and one was safe. The respondent (the migrant worker) was asked in their own language by their supervisor or interpreter to tick the box of the 'safe' choice. Since there were six scenarios for each theme (see Table 1), testing the impact of the intervention on two themes together (eg A and B) meant a maximum score of 12 could be achieved for each measure of knowledge.

The intervention required the images to be printed in colour on A3 size paper, mounted on a ring binder flipped over to create a mini flip-chart. These were complemented by A5 size booklets for each worker, also printed in colour. Speaker packs were printed with additional notes on how to interact with the images when delivering the talks. Text versions of the control toolbox talks were also printed. The procedures for the intervention consisted of:

1 a one-hour training session for the site manager or supervisor on how to use the materials (toolbox talk presentation and worker booklet)
2 use of the materials by the site manager or supervisor during the talk;
3 worker participation during the implementation (the materials supplemented existing procedures for communicating with second language workers, ie buddies or interpreters).

After the interventions the knowledge test was rerun and the observations continued for a further two weeks. A common phenomenon observed in intervention studies is the 'regression to mediocrity'; ie the workers revert to their pre-intervention behaviour despite an increase in knowledge. Therefore monitoring of Sites 1 and 2 continued to assess for this (see Figure 3).

The measurements and interventions took place between January and March 2010 as shown in Table 3. The 'before' measures for each site started with two weeks of observations; followed by the knowledge test at the end of week two. This was designed so that the test itself did not alter behaviour scores before the intervention. The intervention lasted two days, during which time the toolbox talks were delivered. The 'after' measures then started with the same knowledge test, followed by the observations for two weeks. This was designed so that knowledge could be measured first before assessing whether this had translated into improved safe behaviours. The follow-up data collection was performed only on sites 1 and 2 as this issue of longer-term improvements was not the main objective of the research.

The final decision to make in the research design was the number of workers to include in the interventions. There were two different variables to measure: knowledge and behaviour. The knowledge test allowed enough control to ensure the data came from the same workers throughout the experiment: they were identified by matching their occupation, date of birth, length of construction industry experience and time on site. However, the observation data covered the group as a whole. So while this allowed specific work teams to be observed, detailed accounts of individual

* Observation criteria B1 and B2 were changed from measures of area (square metres) to number of storage areas, which improved inter-rater reliability.

† © ConstructionSkills

Figure 3
Theoretical graph: repeat measures

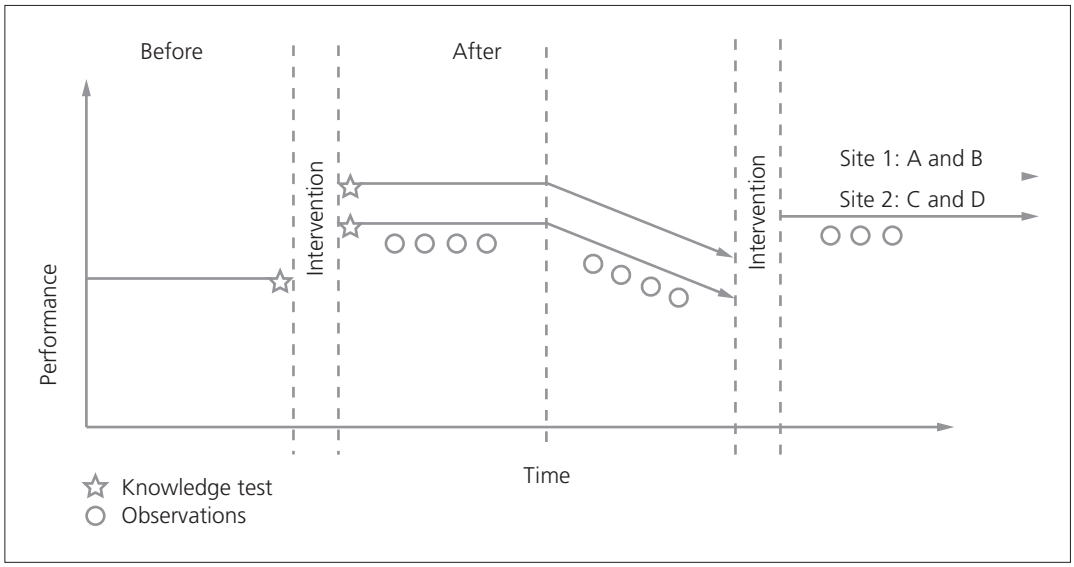


Table 3
Intervention programme

Activities	Dec 2009	January 2010	February 2010	March 2010
Inter-rater testing				
Base measures: sites 1 and 2				
Interventions: sites 1 and 2				
After measures: sites 1 and 2				
Interviews: sites 1 and 2				
Base measures: sites 3 and 4				
Interventions: sites 3 and 4				
After measures: sites 3 and 4				
Interviews: sites 3 and 4				
Repeat measures: sites 1 and 2				

behaviours would have been logistically impractical. Thus, the sample size was based on the requirements of the knowledge test.

The knowledge test had already been developed as part of previous work for ConstructionSkills, during which test sets of 25 questions (from a pool of 83) were used. Results from this previous work returned a mean score of 20.47 (maximum 25) and a standard deviation of 2.45 with migrant workers. Using these data with a desired power of 80 per cent and 5 per cent significance level, it was estimated that a sample of 15 would be able to detect an increase of one standard deviation in the knowledge score. However, the study design involved 24 questions, of which 12 related to each intervention (1–12: A and B; 13–24: C and D; see Table 1). Therefore, the desired minimum was estimated to be 30 workers. It is also good practice to allow for possible drop-off of respondents, so 40 was considered appropriate. Since two sites would be implementing the same intervention (sites 1 and 3 using interventions A and B; sites 2 and 4 using interventions C and D), the numbers could be spread across each pair of sites, ie 20 workers per site, giving 40 between each pair of interventions. For observation purposes the workers needed to be in the same group, working in the same area of the site.

Initial analysis of the data involved plotting graphs of the before and after measures to view the intervention and control results. This was initially done before revisiting sites 1 and 2 (to inform the extent of follow-up work), then again afterwards.

Statistical analysis consisted of a two-factor repeated measures ANOVA. The two factors were 'group' and 'time' (Table 4). The group factor contained two levels: 'intervention' and 'control', depending on whether the workers received the pictorial or text versions of the toolbox talks. The time factor contained two levels for initial analyses: 'before' and 'after' the intervention. Then, when further analysis was performed using only sites 1 and 2 with a third time level of 'later', the time factor required three levels. Table 4 also illustrates how each site was exposed to pictorial methods on one pair of themes as well as text versions of the other pair, thereby acting as intervention and control. For example, site 1 received pictorial training on themes A and B (intervention) but was also subjected to text versions of themes C and D (control). The analysis was undertaken using the knowledge test results as the dependent variable (marks out of 12), then duplicated using behaviour scores (percentage safe) for each condition.

Table 4
Factor analysis design

Group	Time		
	Before	After	Later
Themes A and B			
Pictorial (intervention)	Sites 1 and 3	Sites 1 and 3	Site 1
Text (control)	Sites 2 and 4	Sites 2 and 4	Site 2
Themes C and D			
Pictorial (intervention)	Sites 2 and 4	Sites 2 and 4	Site 2
Text (control)	Sites 1 and 3	Sites 1 and 3	Site 1

In summary, a repeated measures design was used with four sites (two pairs of intervention and control) to test the hypothesis that pictorial aids will cause an improvement in the targeted competences and behaviour among migrant construction workers. The pictorial aids were used in toolbox talks on four themes: exclusion zones, materials storage, portable tools and PPE. Competence was measured via a pictorial test of 24 questions (six on each theme). Behaviour was measured via 'percentage safe' scores for eight observational criteria (two per theme). Data were collected over a three-month period starting with before and after measures for sites 1 and 2, then 3 and 4, before returning to 1 and 2 one month later. The interventions were delivered by site supervisors after receiving instruction and with the help of speaker notes. The interventions were delivered to 20 workers on each site (80 in total). Each received pictorial training on two themes and text-only training on the other two (acting as controls). Analysis of the data consisted of a two-factor repeated measures ANOVA (factors: group (intervention and control); time (before, after, later)).

4 Findings

4.1 Introduction

The findings are presented in four sections:

- overview of sites and workers
- findings: knowledge test
- findings: behaviour observations
- findings: other data.

4.2 Overview of sites and workers

4.2.1 Demographic data per site

The four sites chosen for the study were under the control of the same Principal Contractor. This provided some confidence that there was a uniformity of approach to management practices on each site, including for health and safety. All four sites needed to be large enough to employ at least 20 migrant workers operating within a designated area of the site (for observation data collection requirements). Migrant workers were identified by the site management teams (using criteria from Section 3.3). Finding suitable groups was made easier by the practice of employing homogenous groups of workers for entire subcontract packages. Work at the sites also needed to be long enough in duration to allow data to be collected over the three-month period of field work (no other interventions were planned during the study period). These criteria resulted in the following sites being chosen:

Site 1 London; retail and office development; cost £200 million; duration 120 weeks; completion due late 2010
Site 2 Manchester; broadcasting and media development; cost £415 million; duration three years; completion due mid-2010
Site 3 London; office development; cost £50 million; duration 40 weeks; completion due mid-2010
Site 4 London; media development and refurbishment; cost £400 million; duration five years; completion due 2012.

The occupation of the workers chosen for the study needed to be similar or involve tasks of a similar nature. They also needed to provide the opportunity to measure the four toolbox talk themes; therefore they needed to include exclusion zones, have storage areas, involve work with hand tools at height and require PPE. The occupations per site were as follows:

Site 1 partition wall installers and block layers
Site 2 cladding and partition wall installers
Site 3 cladding installers
Site 4 partition wall installers and block layers.

Homogeneity between the sites was desirable to allow valid comparisons. Previous studies have shown country of origin, age and experience to be important factors in relation to non-English - peaking workers being able to understand pictorial images.[27] All workers were from Eastern European countries. The other demographics are summarised in Table 5. These data are also illustrated in Figures 4–6, along with commentary and the results of independent Mann-Whitney U-tests to assess statistical difference between the sites. Only sites 1 and 2 were compared individually because they were subject to extended data collection. The main data collected for 'before' and 'after' analysis were combined into two groups: 'group 1' and 'group 2' (see Table 2). Sites 1 and 3 (group 1) were compared with sites 2 and 4 (group 2) for statistical differences.

Figure 4 shows the variation in age through the sample by site. Sites 1 and 2 have medians close to the total median (37), slightly below and above respectively. However, sites 3 and 4 have a greater detraction from the total median. The most notable detractor was site 3, where the median age was notably lower than the rest, lying at 30.5. However, only the differences between sites 1 and 2 needed to be statistically tested (the others were tested as part of the wider group; see section 4.2.2).

The average age (in years) of workers at site 1 was 34.5, compared to 37.5 for site 2. This was not statistically different at the 5 per cent level of significance (Mann-Whitney $U = 160.5$; $p = 0.285$).

Site ($n = 20$ each)	Age (years)		Construction experience (years)		Time on site (months)	
	Median	Min/Max	Median	Min/Max	Median	Min/Max
1	34.5	17 / 64	6.3	1.5 / 49	1.5	0.5 / 12
2	37.5	24 / 57	4.1	1 / 15	8.0	6 / 12
3	30.5	20 / 58	3.0	2 / 11	2.5	1 / 11
4	41.5	22 / 65	12.5	1 / 48	6.0	1 / 9
Total	37.0	17 / 65	4.1	1 / 49	6.0	0.5 / 12

Table 5
Demographic data for each site

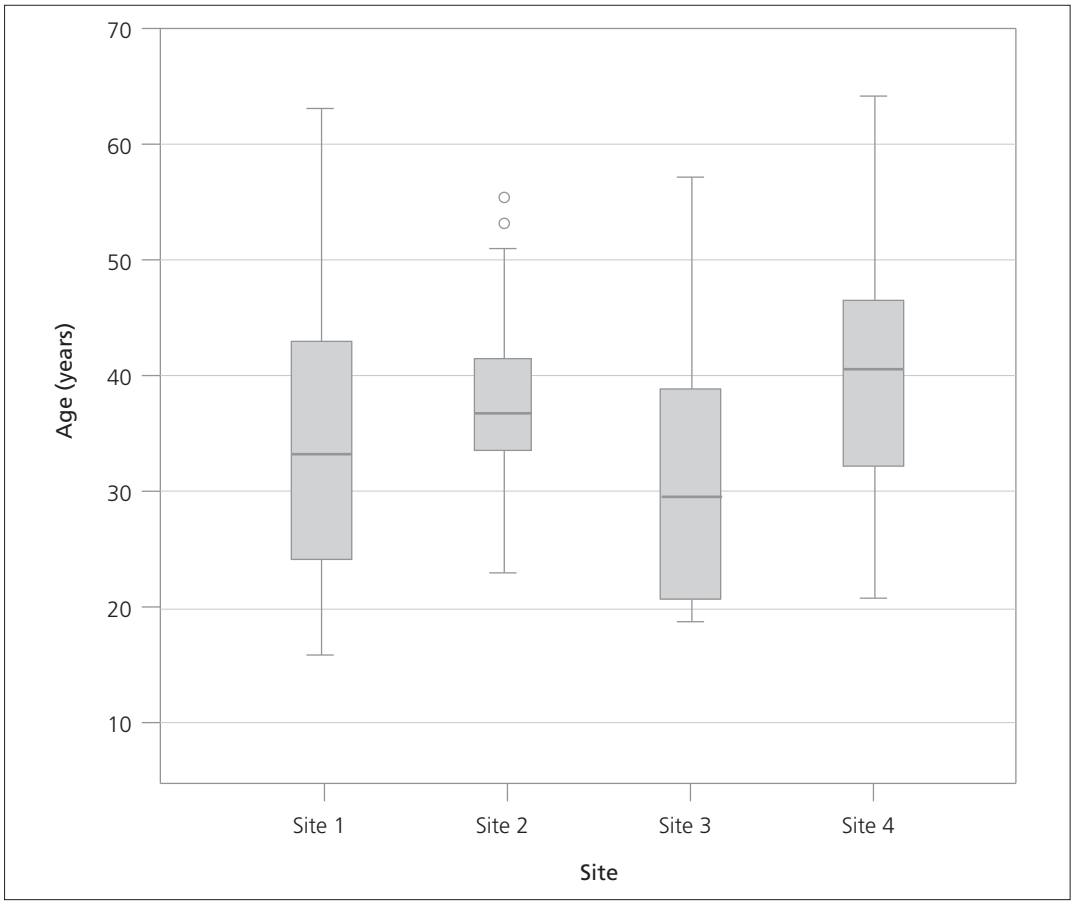


Figure 4
Demographic data: age for each site

Figure 5 shows the variability of relevant construction experience across the sites. There is considerable variation around the total median of 4.1 years. While sites 1 and 2 displayed some similarity, sites 3 and 4 were notably different. Site 4 had a far higher average level of worker experience than site 3. The average length of construction experience for workers on site 4 was 12.5 years, while the corresponding average for site 3 was 3 years.

The average length of construction experience (in years) at site 1 was 6.3, compared to 4.1 for Site 2. This was not significantly different at the 5 per cent level ($U = 145.5$, $p = 0.14$).

Figure 6 shows the variability of time spent on site at each of the four sites. These data were measured in months as opposed to years as shown in Figures 4 and 5. Site 2 stands out as the workers here had been on site longer than the rest.

The average length of time on site (months) in Site 1 was 1.5 compared to 8 for Site 2. This was significantly different at the 5 per cent level ($U = 44.5$, $p < 0.01$). However, the difference between medians is only 6.5 months (see Figure 6).

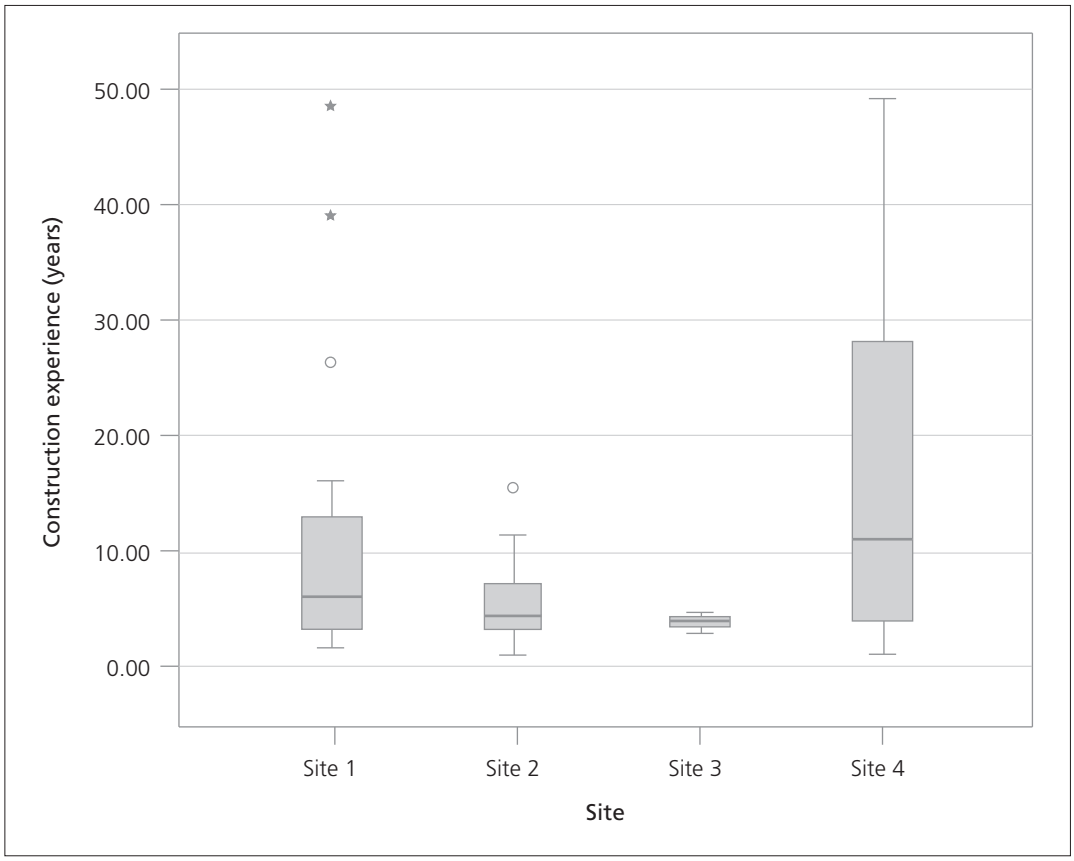


Figure 5
Demographic data: construction experience for each site

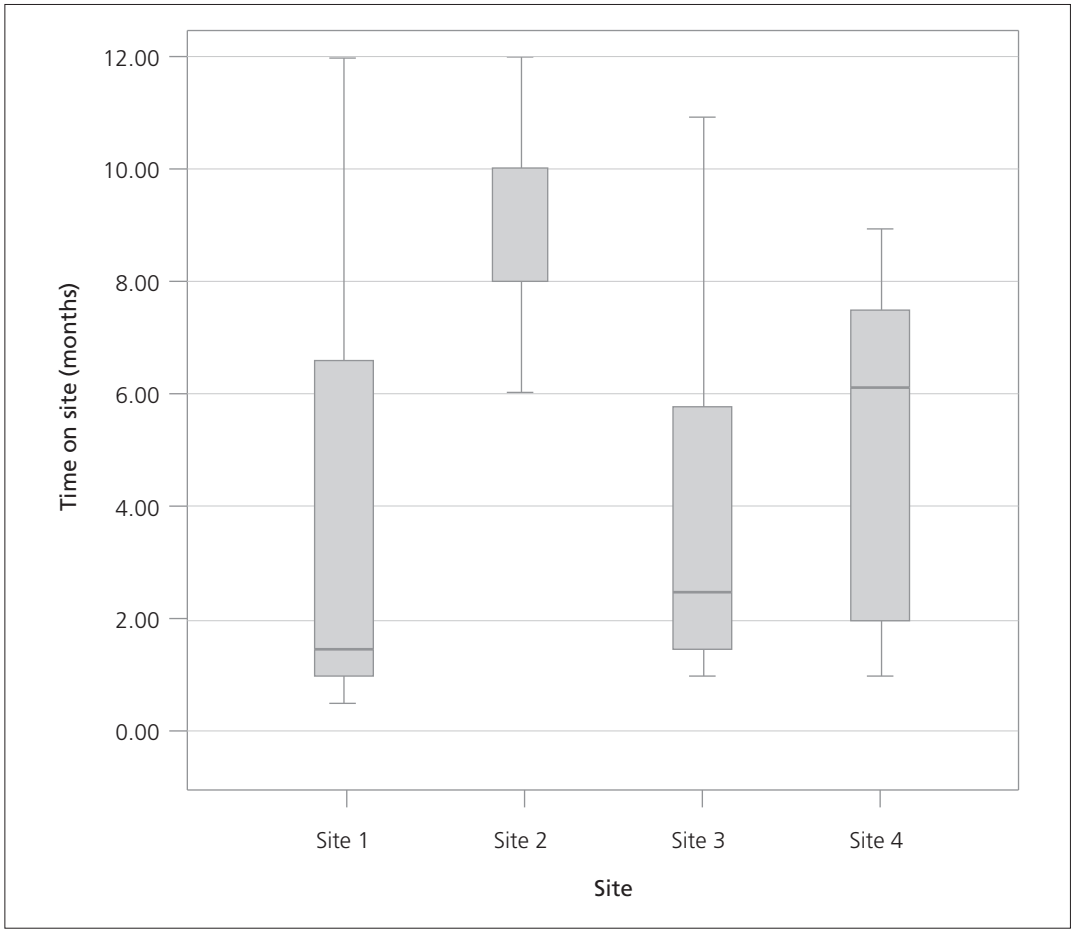


Figure 6
Demographic data: time on site for each site

4.2.2 Demographic data per group

Sites 1 and 3 were subject to the same conditions. Likewise, sites 2 and 4 were subject to the opposite conditions (see Table 2). Therefore, the demographic data was also analysed within these groups:

- group 1: sites 1 and 3
- group 2: sites 2 and 4.

Table 6 shows the demographic data commensurate with those in Table 5, but for the two consolidated groups. An initial inspection shows far more parity than in Table 5, with the spreads of variation being more equal among all three measures.

Group ($n = 40$ each)	Age (years)		Construction experience (years)		Time on site (months)	
	Median	Min/Max	Median	Min/Max	Median	Min/Max
1	32	17 / 64	3.2	1.5 / 49	2	0.5 / 12
2	40	22 / 65	5.2	1 / 48	8	1 / 12
Total	37	17 / 65	4.1	1 / 49	6	0.5 / 12

Table 6
Demographic data for each group

Figure 7 shows the variation in ages between the groups. The consolidated groups were more closely aligned than the individual sites were (Figure 4). The average age (in years) of workers in group 1 was 32, compared to 40 for group 2. This was significant at the 5 per cent level ($U = 532$; $p = 0.01$).

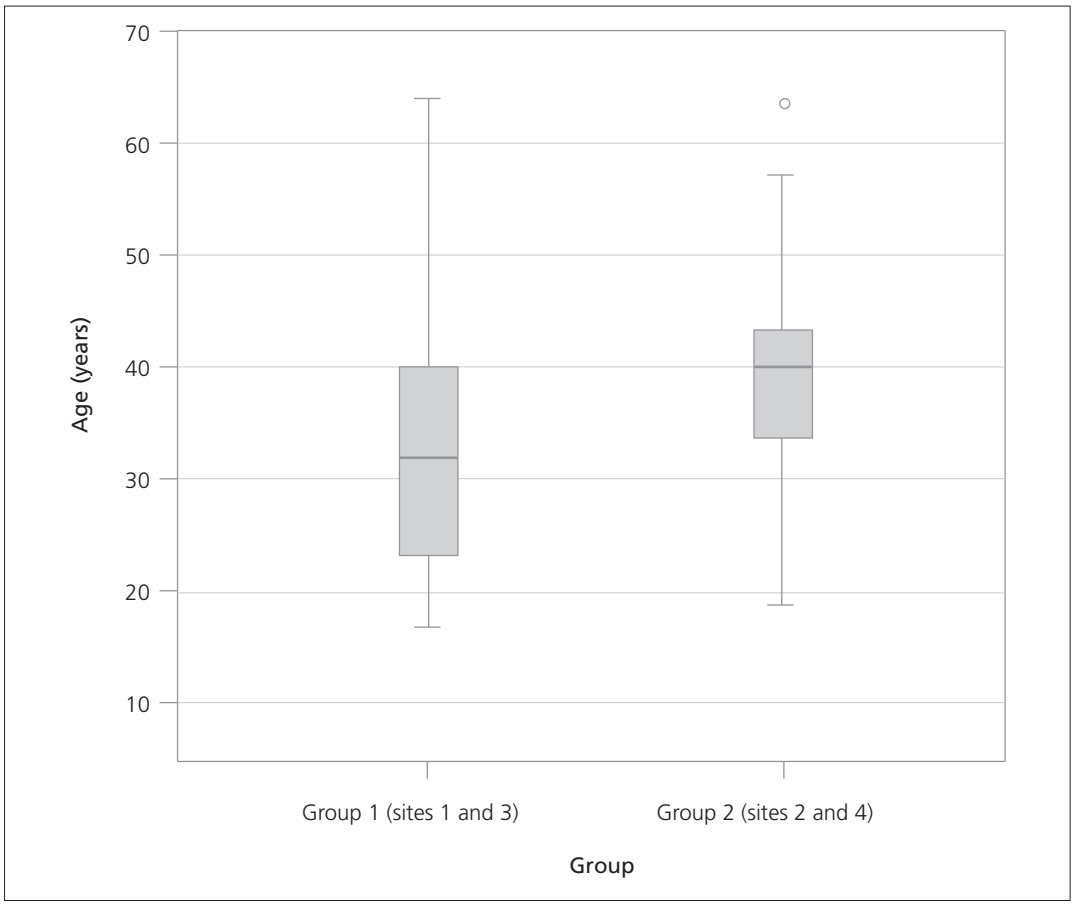


Figure 7
Demographic data: age for each group

Figure 8 shows the variation in relevant construction experience between the two groups. The large differences between Sites 3 and 4 (Figure 5) have been smoothed out with the means far closer together and each box plot resembling the other.

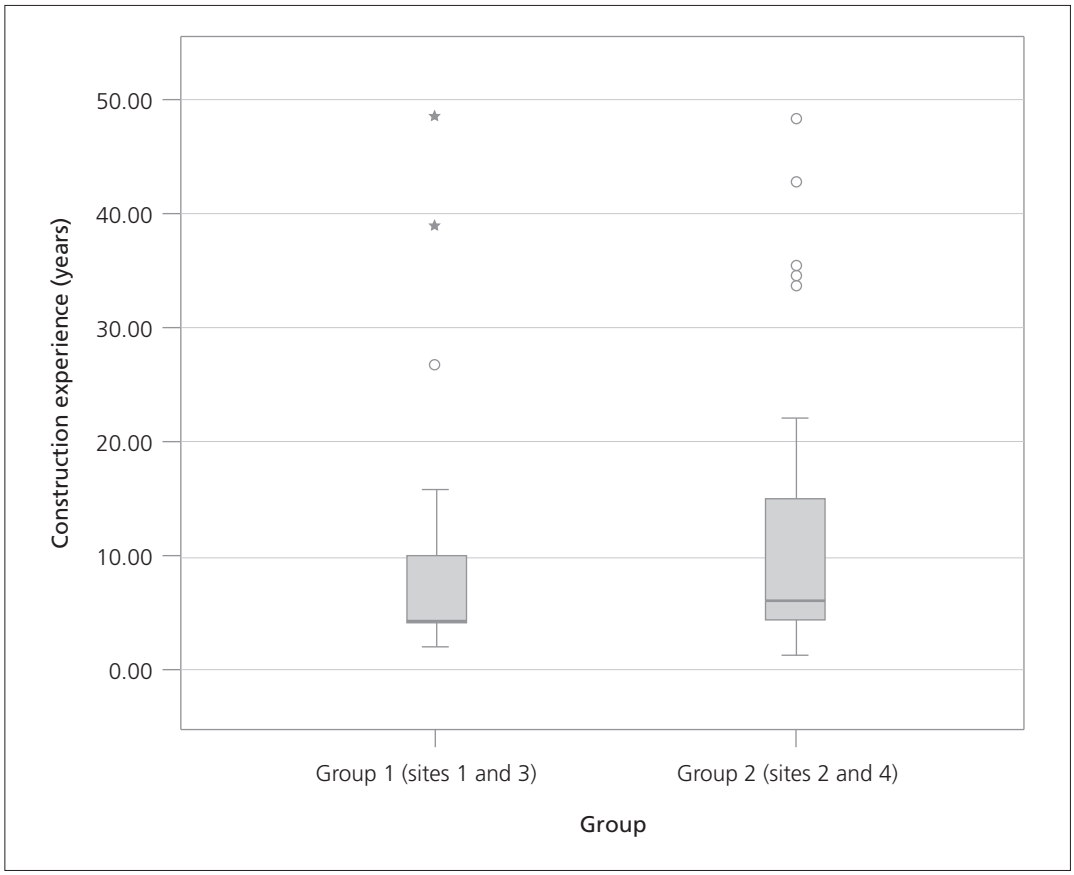


Figure 8
Demographic data: construction experience for each group

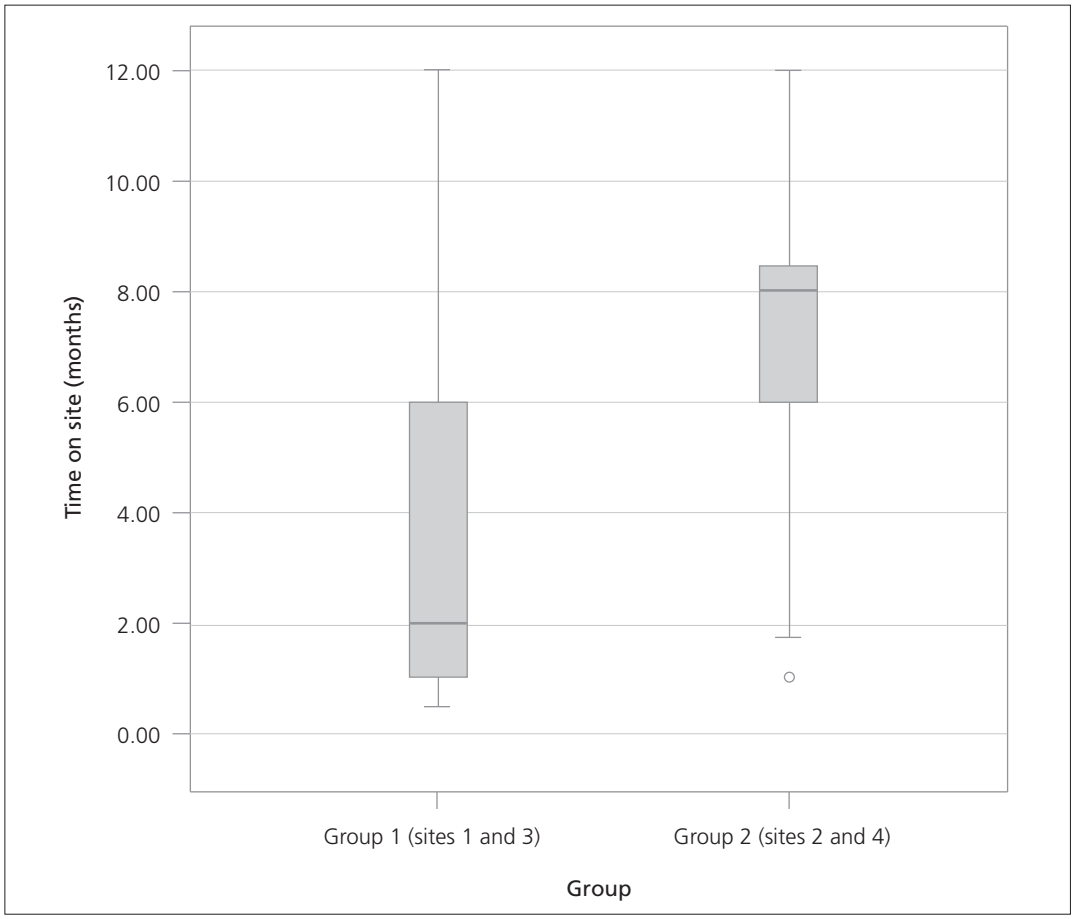


Figure 9
Demographic data: time on site for each group

The average length of construction experience (in years) in group 1 was 3.2, compared to 5.2 for group 2. This was not significantly different at the 5 per cent level ($U = 574.5$, $p = 0.29$).

Figure 9 shows the variation in 'time on site' by group. There is still a disparity between the two groups. However, as mentioned previously, this measure is calculated in months and not years.

The average length of time on site (in months) in group 1 was 2, compared to 8 for group 2. This was significantly different at the 5 per cent level ($U = -395.5$; $p < 0.01$). However, the difference between medians is only six months (see Figure 9).

Overall, the findings from this portion of the analysis show that the groups identified for comparison are homogenous in several areas of identified importance. The only statistically significant difference across both sites and groups is the length of time the workers were on site. In real terms this amounts to only a few months' variation, with 98.7 per cent (79 out of 80) of the workers being on site at least one month.

4.3 Findings: Knowledge test

4.3.1 Knowledge test scores: before and after

The knowledge test consisted of 24 pictorial multi-choice questions – six questions per theme (see Table 1). The themes were:

A exclusion zones
B materials storage
C portable tools
D PPE.

Sites 1 and 3 received toolbox talks on themes A and B in pictorial form and C and D in text only. Sites 2 and 4 had the opposite arrangement (see Table 2, Section 3.3).

Table 7 shows mean test results before and after the interventions on themes A and B. ANOVA found a very significant interaction effect between group and time ($p < 0.001$). This is important as it indicates a difference in group results over time. Figure 10 illustrates this difference as the intervention group gradually increases over time, while the control group shows a gradual decrease.

Group		Time		
		Before	After	Overall
Control (group 2)	mean	11.75	11.55	11.65
	sd	0.54	0.60	0.58
	n	40	40	80
Intervention (group 1)	mean	11.35	11.95	11.65
	sd	1.08	0.22	0.83
	n	40	40	80
Overall	mean	11.55	11.75	11.65
	sd	0.87	0.49	0.71
	n	80	80	160

Table 7
Knowledge test scores: before and after intervention on themes A and B

Table 8 shows mean test results before and after the interventions on themes C and D. ANOVA found a very significant effect for the interaction of group and time ($p = 0.008$). Separate results for group and time were also significant (group $p < 0.001$; time $p = 0.001$). Figure 11 shows the intervention group increasing in mean test score over time. The control also shows a gradual increase, but not to the same extent.

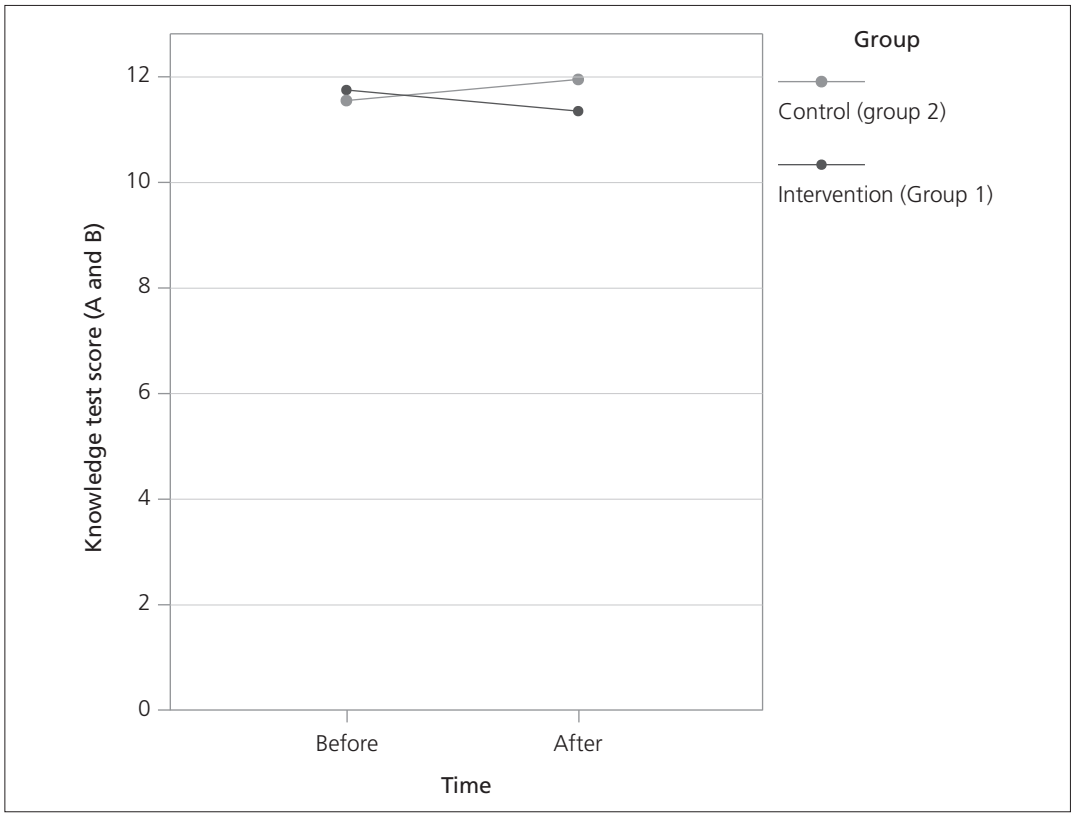


Figure 10
Knowledge test scores: before and after intervention on themes A and B

Table 8
Knowledge test scores: before and after intervention on themes C and D

Group		Time		
		Before	After	Overall
Control (group 1)	mean	10.07	10.20	10.14
	sd	1.47	1.52	1.49
	n	40	40	80
Intervention (group 2)	mean	11.03	11.95	11.49
	sd	0.86	0.22	0.78
	n	40	40	80
Overall	mean	10.55	11.08	11.65
	sd	1.29	1.52	0.71
	n	80	80	160

4.3.2 Knowledge test scores: before, after and later

Additional data were collected for sites 1 and 2 one month after the original interventions. Tables 9 and 10 and Figures 12 and 13 incorporate the findings from the repeat visits for these sites.

Table 9 shows the mean test results before, after and (one month) later for site 1 (intervention) and site 2 (control) on themes A and B. ANOVA found very significant effects for the interaction of site and time ($p = 0.002$). Site was also significant ($p < 0.001$). Figure 12 shows that Site 1 follows the general trend of group 1 (Figure 10), with a gradual increase after intervention. One month later, the mean test scores remain steady at 12.00. There has been a ceiling effect as 12 is the maximum score achievable (6 per theme). The site 2 score drops slightly over the same period.

Table 10 shows the mean test results before, after and (one month) later for interventions on themes C and D. This time site 1 is the control, while site 2 is the intervention. ANOVA found a very

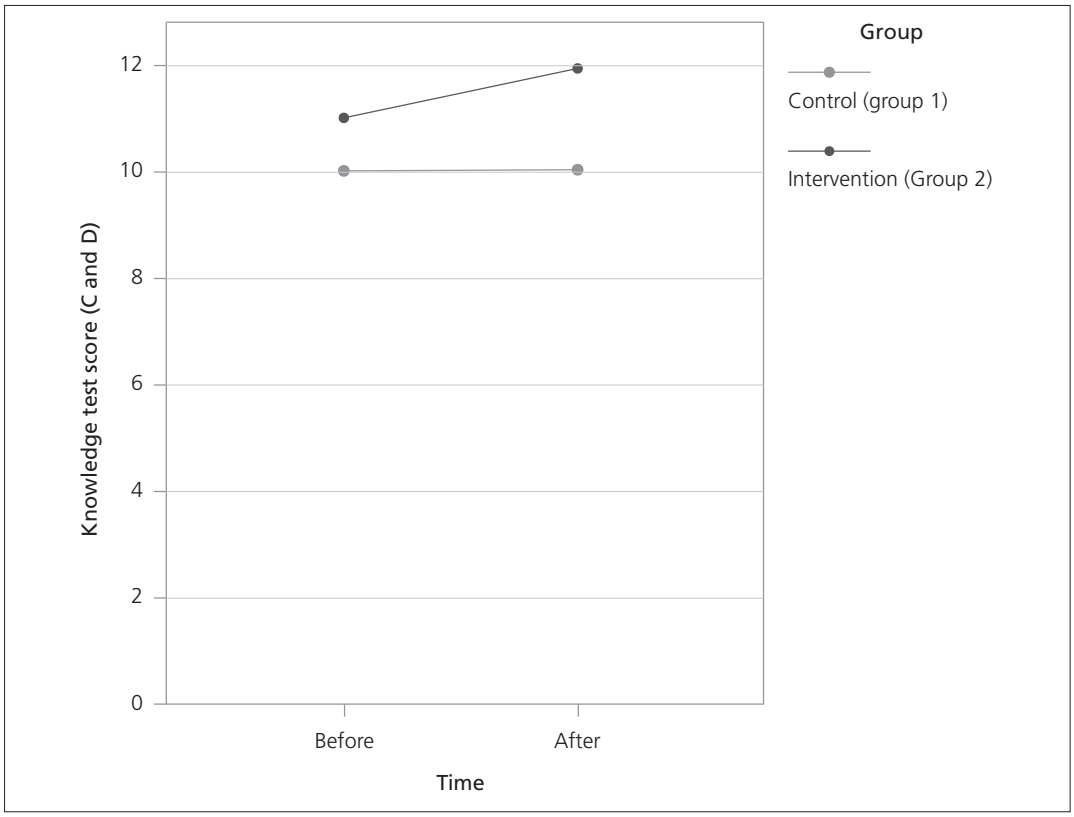


Figure 11
Knowledge test scores: before and after intervention on themes C and D

Group		Time			
		Before	After	Later	Overall
Control (site 2)	mean	11.75	11.40	11.33	11.51
	sd	0.64	0.68	0.72	0.69
	n	20	20	15	55
Intervention (site 1)	mean	11.70	12.00	12.00	11.88
	sd	0.47	0.00	0.00	0.32
	n	20	20	12	52
Overall	mean	11.73	11.70	11.63	11.69
	sd	0.55	0.56	0.63	0.57
	n	40	40	27	107

Table 9
Knowledge test scores: before, after and later than intervention on themes A and B

significant effect for the interaction of site and time ($p < 0.001$). Site and time were also individually significant (site $p < 0.001$; time $p < 0.001$). Figure 13 shows that site 2 follows the general trend of its group (Figure 11) by climbing after intervention, then holds at 12.00 (because of the ceiling effect) one month later. Site 1 remains virtually unchanged over the same period.
The knowledge test findings all show a similar pattern, depending on which themes were delivered using pictorial aids. Where pictorial aids were used, mean test scores in relation to the themes increased in all cases. On the other hand, mean scores in relation to text-only themes showed random variation over time: increasing, decreasing or remaining static.

ANOVA found consistent effects over all the sites. While there was some variation between group/site and time effects, every test for the important 'interaction' effect returned very significant results. These very significant interaction effects clearly show that the two groups' knowledge test results were statistically different over time.

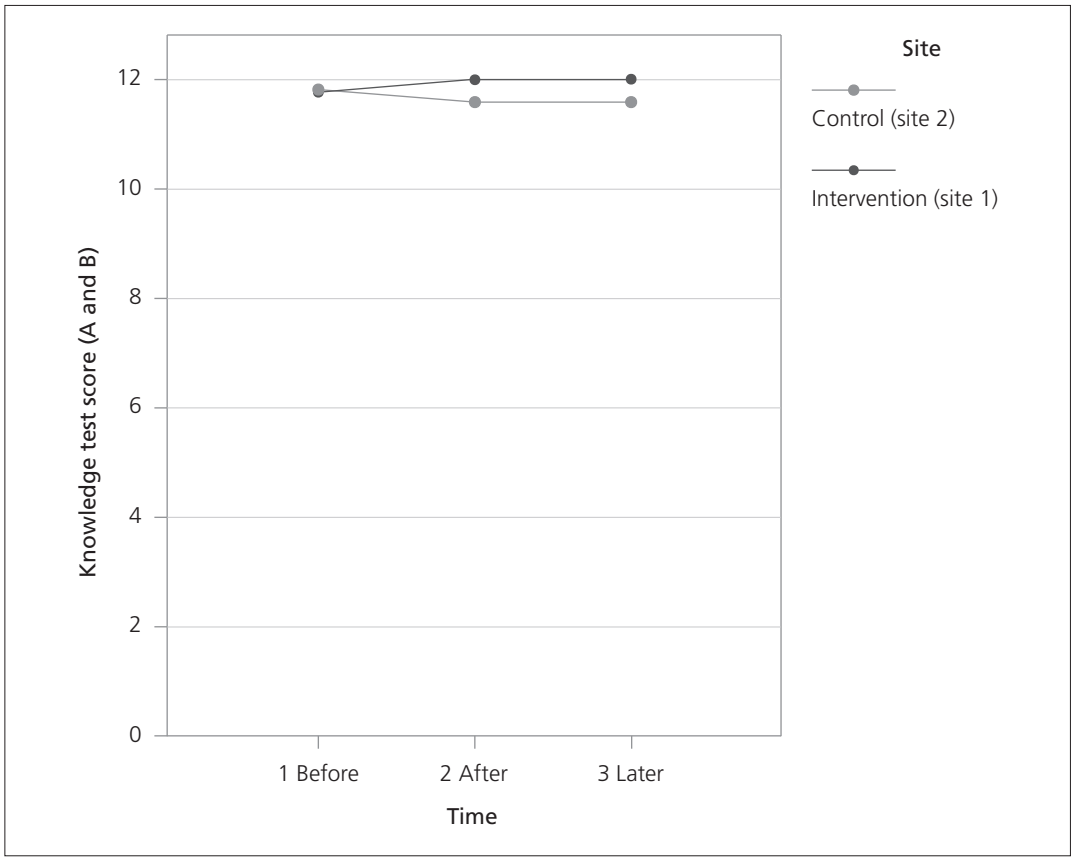


Figure 12
Knowledge test scores: before, after and later than intervention on themes A and B

Table 10
Knowledge test scores: before, after and later than intervention on themes C and D

Group		Time			
		Before	After	Later	Overall
Intervention (site 2)	mean	10.90	12.00	12.00	11.60
	sd	0.72	0.00	0.00	0.68
	n	20	20	15	55
Control (site 1)	mean	10.80	10.90	10.92	10.87
	sd	0.83	0.85	0.90	0.84
	n	20	20	12	52
Overall	mean	10.85	11.45	11.52	11.24
	sd	0.77	0.81	0.80	0.84
	n	40	40	27	107

However, it should be noted that the results one month later were not as robust, since there was some drop-out of participants by this time. Tables 9 and 10 show that the number of original workers on sites 1 and 2 reduced from 20 on each site to 15 and 12 respectively at the one-month point. These workers were exposed to refresher toolbox talks (repeats of the original ones) after their third knowledge test. This was to measure behaviour after refresher training (see section 4.4). Knowledge tests could have been repeated after these second interventions, but the ceiling effect meant no further meaningful analysis could be undertaken. Therefore, a fourth knowledge test was not administered one week later.

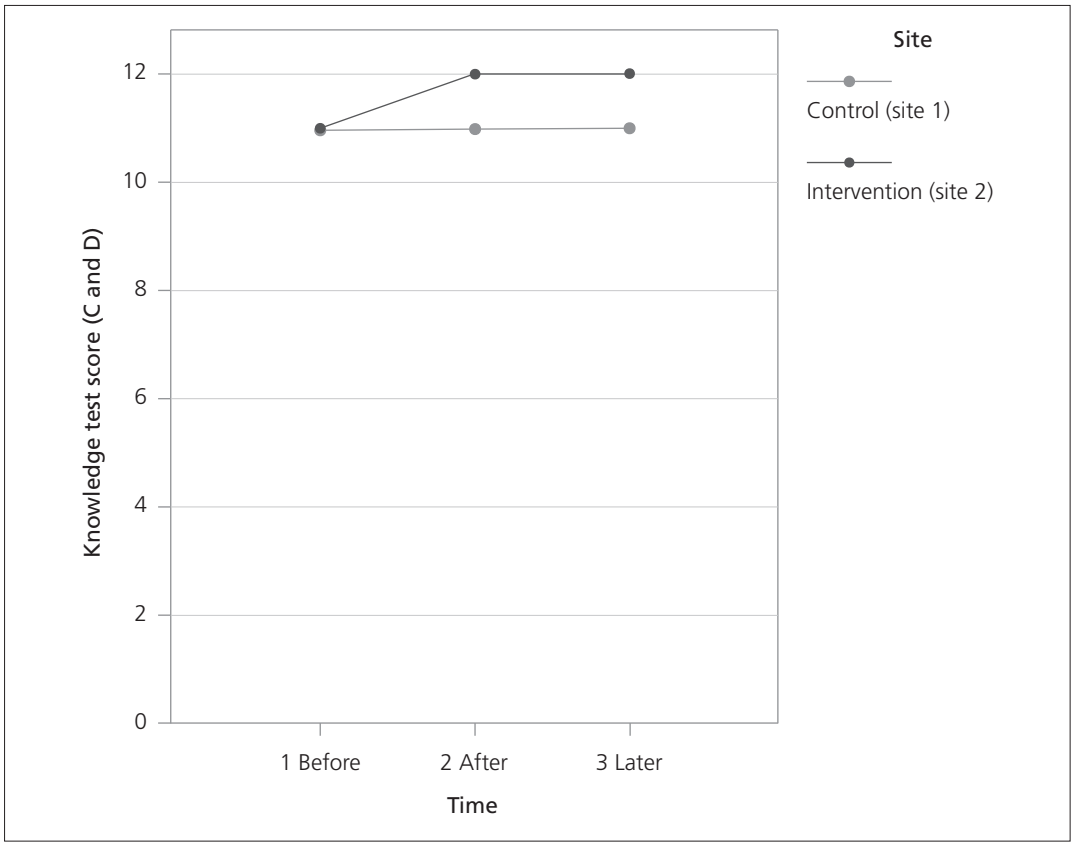


Figure 13
Knowledge test scores: before, after and later than intervention on themes C and D

4.4 Findings: observation scores

4.4.1 Observation scores: before and after

The observation scores consisted of eight observable criteria: two criteria per theme (see Table 1).

Table 11 and Figure 14 show the mean percentage safe scores for observation criterion A1 (safe exclusion zone). The intervention group increased from 70.46 per cent to 95.12 per cent after intervention. The control site showed a slight increase from 78.79 per cent to 81.04 per cent over the same period. Visually, Group 1's increase is greater than Group 2's, but ANOVA found no significant effects (interaction $p = 0.322$).

Table 11
Observation scores: before and after intervention on observation A1

Group		Time		
		Before	After	Overall
Control (group 2)	mean	78.79	81.04	79.91
	sd	19.91	17.38	15.31
	n	2	2	4
Intervention (group 1)	mean	70.46	95.12	82.79
	sd	6.43	6.90	15.25
	n	2	2	4
Overall	mean	74.62	88.08	81.35
	sd	13.00	13.51	14.23
	n	4	4	8

Figure 14
Observation scores: before and after intervention on observation A1

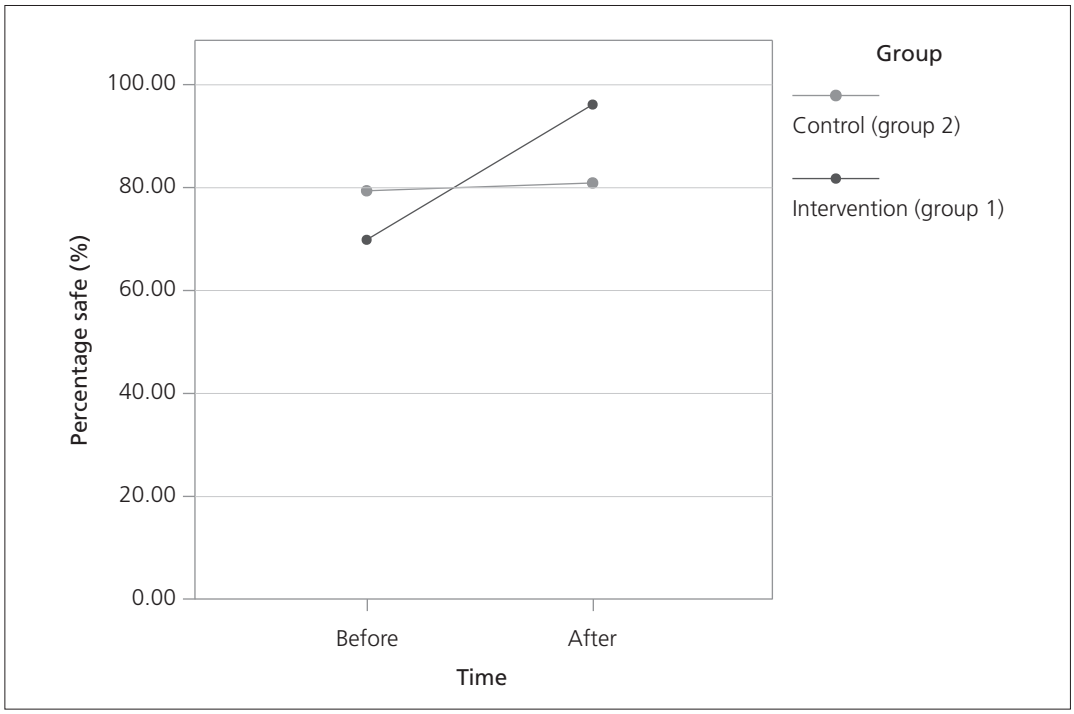


Table 12 shows the mean percentage safe scores for observation criterion A2 (permit-to-work armband on). Data collection for this criterion became problematic as site 4 recorded no instances of permit-to-work activities among the participant workers. This is illustrated in Table 12 under 'control' where there is no standard deviation (only one site's data is included). However, this is the only instance where this problem occurred.

Despite the problems with data collection for this criterion, visual inspection of Figure 15 shows the mean percentage scores increased from 91.67 per cent to 100 per cent (ie all observations were safe) for the intervention group (sites 1 and 3). The smaller control group (consisting of only site 2) remained relatively unchanged over the same period. No ANOVA was possible for this criterion due to the lack of data at site 4.

Group		Time		
		Before	After	Overall
Control (group 2)	mean	85.71	84.62	85.17
	sd	–	–	0.77
	n	1	1	2
Intervention (group 1)	mean	91.67	100.0	95.83
	sd	11.79	0.0	8.34
	n	2	2	4
Overall	mean	89.68	94.87	92.28
	sd	9.02	8.88	8.49
	n	3	3	6

Table 12
Observation scores: before and after intervention on observation A2

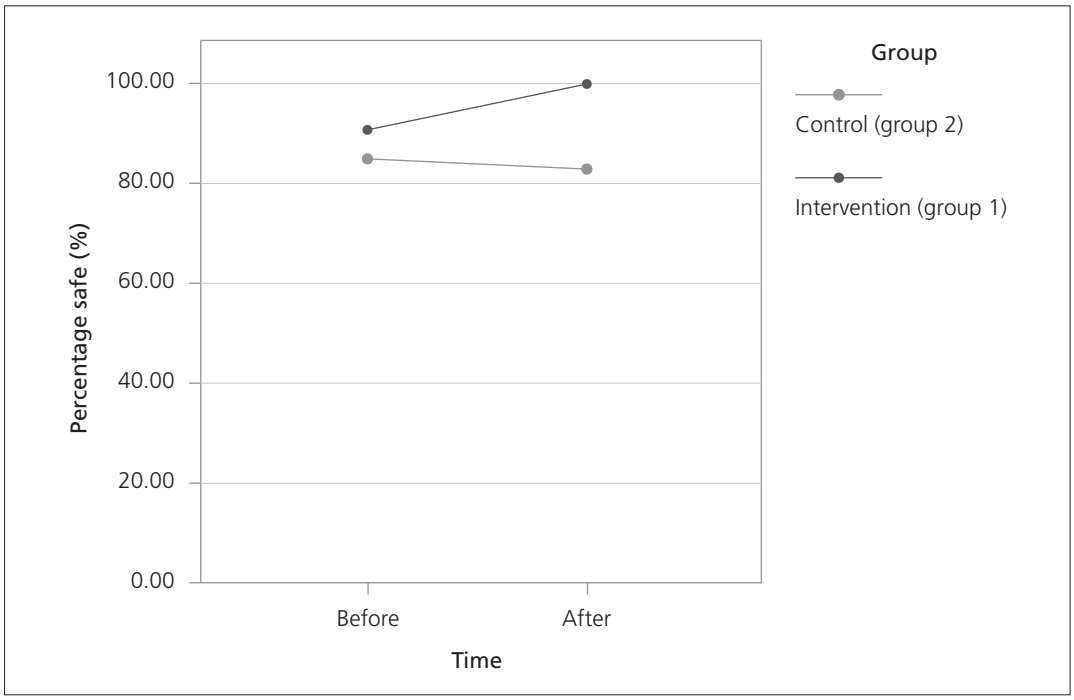


Figure 15
Observation scores: before and after intervention on observation A2

Table 13 and Figure 16 show the mean percentage safe scores for observation criterion B1 (materials stored safely). The intervention group increased from 68.98 per cent to 93.15 per cent after intervention. The control group showed virtually no change over the same period at just over 92 per cent. ANOVA found near-significant effects for the interaction of group and time ($p = 0.05$) and time alone ($p = 0.05$). Both these p-values were exactly on the cut-off point for significance of 0.05, rather than below it, hence the use of the term near-significant. However, Figure 16 shows the 'before' scores to be 33 percentage points apart. Therefore, the groups did not start on similar scores and it is difficult to make comparisons on this criterion.

Table 13
Observation scores: before and after intervention on observation B1

Group		Time		
		Before	After	Overall
Control (group 2)	mean	92.20	92.17	92.18
	sd	6.33	5.64	4.89
	n	2	2	4
Intervention (group 1)	mean	68.98	93.15	81.07
	sd	8.51	2.62	14.87
	n	2	2	4
Overall	mean	80.59	92.66	86.62
	sd	14.74	3.63	11.85
	n	4	4	8

Figure 16
Observation scores: before and after intervention on observation B1

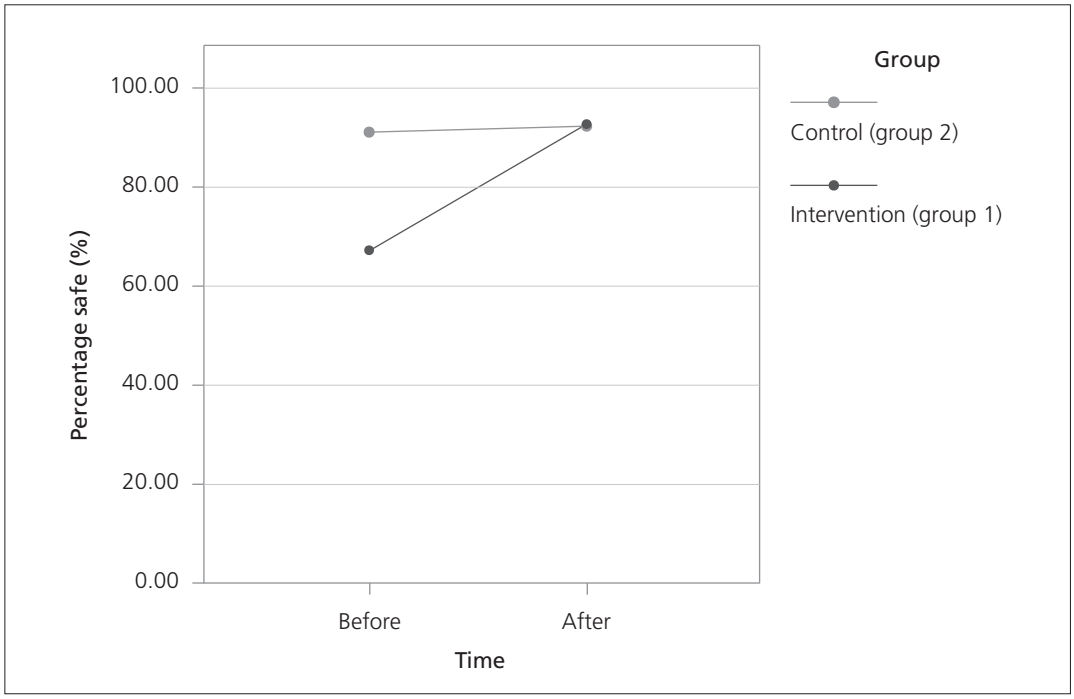


Table 14 and Figure 17 show the mean percentage safe scores for observation criterion B2 (no waste packaging around). The intervention group increased from 67.99 per cent to 85.39 per cent after intervention. There was also a slight increase from 77.38 per cent to 80.91 per cent for the control group. Visually, Group 1's increase is greater than Group 2's, but ANOVA found no significant effects (interaction $p = 0.502$).

Table 14
Observation scores: before and after intervention on observation B2

Group		Time		
		Before	After	Overall
Control (group 2)	mean	77.38	80.91	79.14
	sd	8.41	7.71	6.90
	n	2	2	4
Intervention (group 1)	mean	67.99	85.39	76.69
	sd	19.01	14.69	17.12
	n	2	2	4
Overall	mean	72.69	83.15	77.92
	sd	13.17	9.92	12.16
	n	4	4	8

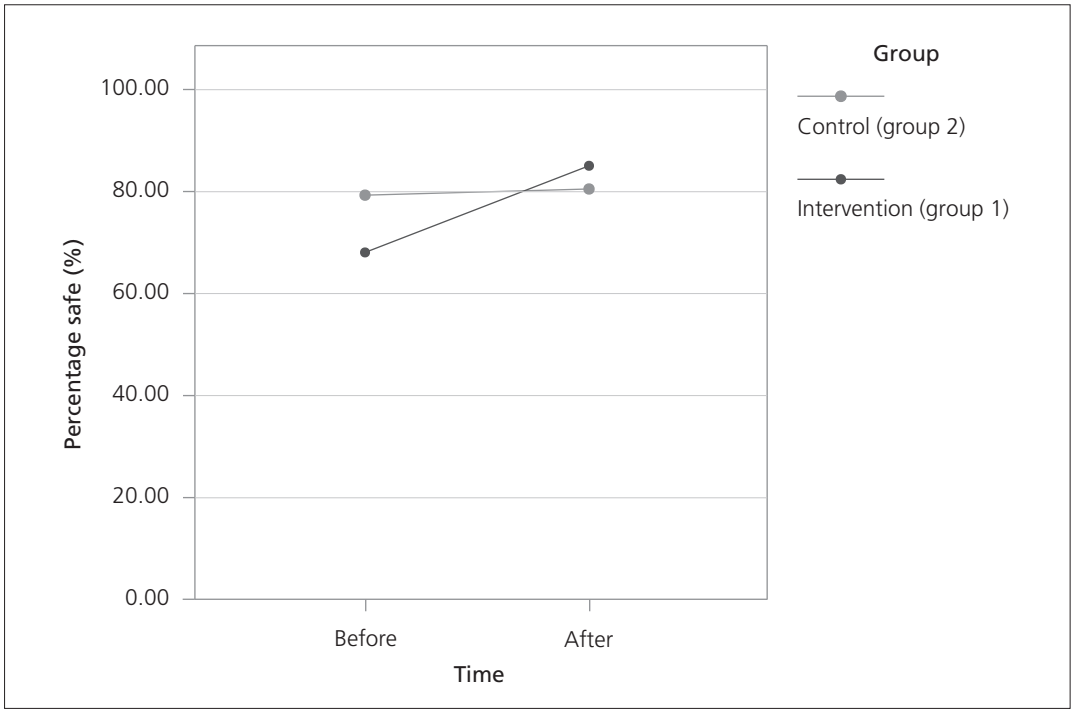


Figure 17
Observation scores: before and after intervention on observation B2

`Table 15 and Figure 18 show the mean percentage safe scores for observation criterion C1 (lanyards on tools at height). The intervention group (group 2) increased from 85.23 per cent to 96.09 per cent after intervention. The control group showed virtually no change over the same period at just over 60 per cent. Visually, group 2's increase is greater than group 1's, but ANOVA found no significant effects (interaction $p = 0.867$). The gap of 25 percentage points between the 'before' scores also made comparisons difficult.

Table 15
Observation scores: before and after intervention on observation C1

Group		Time		
		Before	After	Overall
Intervention (group 2)	mean	85.23	96.09	90.66
	sd	4.26	1.99	6.83
	n	2	2	4
Control (group 1)	mean	60.00	60.87	60.44
	sd	56.57	55.34	45.69
	n	2	2	4
Overall	mean	72.62	78.48	75.55
	sd	35.85	37.89	34.29
	n	4	4	8

Figure 18
Observation scores: before and after intervention on observation C1

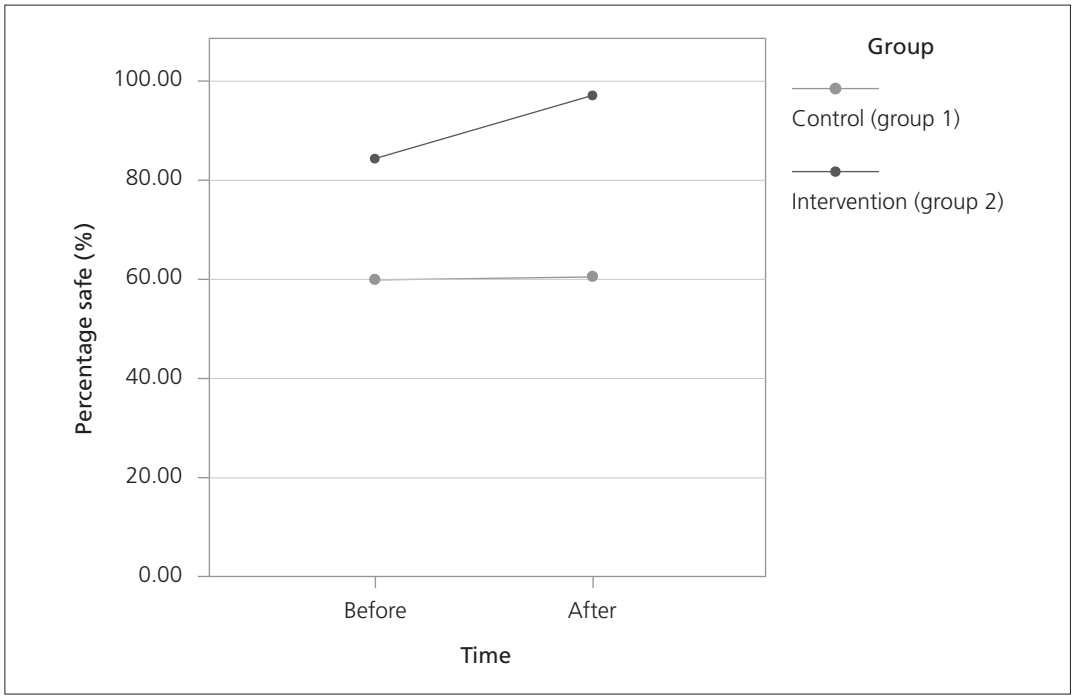


Table 16 and Figure 19 show the mean percentage safe scores for observation criterion C2 (housekeeping of tools). The intervention group increased from 82.77 per cent to 93.82 per cent after intervention. There was also a slight increase from 76.82 per cent to 82.21 per cent for the control group. Visually, group 2's increase is greater than group 1's, but ANOVA found no significant effects (interaction $p = 0.512$).

Table 16
Observation scores: before and after intervention on observation C2

Group		Time		
		Before	After	Overall
Intervention (group 2)	mean	82.77	93.82	88.29
	sd	4.40	2.57	7.02
	n	2	2	4
Control (group 1)	mean	76.82	82.21	79.51
	sd	6.81	7.16	6.50
	n	2	2	4
Overall	mean	79.79	88.01	83.90
	sd	5.81	8.01	7.83
	n	4	4	8

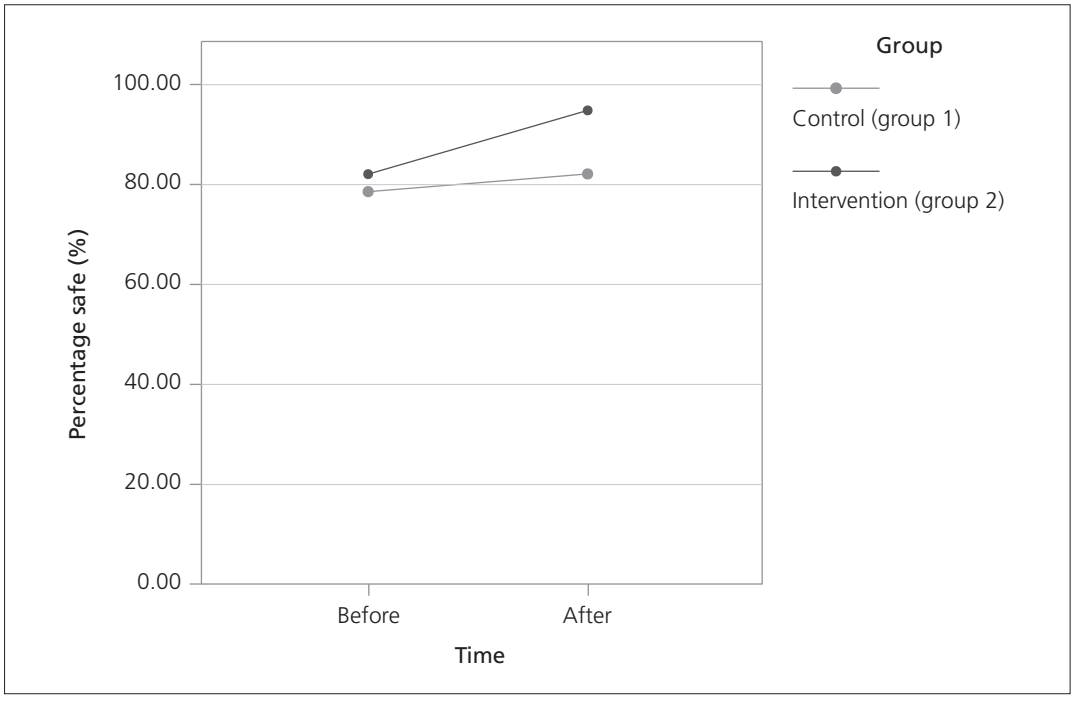


Figure 19
Observation scores: before and after intervention on observation C2

Table 17 and Figure 20 show the mean percentage safe scores for observation criterion D1 (wearing mandatory PPE). The intervention group increased from 92.50 per cent to 98.25 per cent after intervention. There was also a slight increase from 86.67 per cent to 88.83 per cent for the control group. Visually, group 2's increase is greater than group 1's, but ANOVA found no significant effects (interaction $p = 0.603$).

Table 17
Observation scores: before and after intervention on observation D1

Group		Time		
		Before	After	Overall
Intervention (group 2)	mean	92.50	98.25	95.38
	sd	4.95	0.35	4.39
	n	2	2	4
Control (group 1)	mean	86.67	88.83	87.75
	sd	4.72	5.81	4.50
	n	2	2	4
Overall	mean	89.58	93.54	91.56
	sd	5.19	6.39	5.79
	n	4	4	8

Figure 20
Observation scores: before and after intervention on observation D1

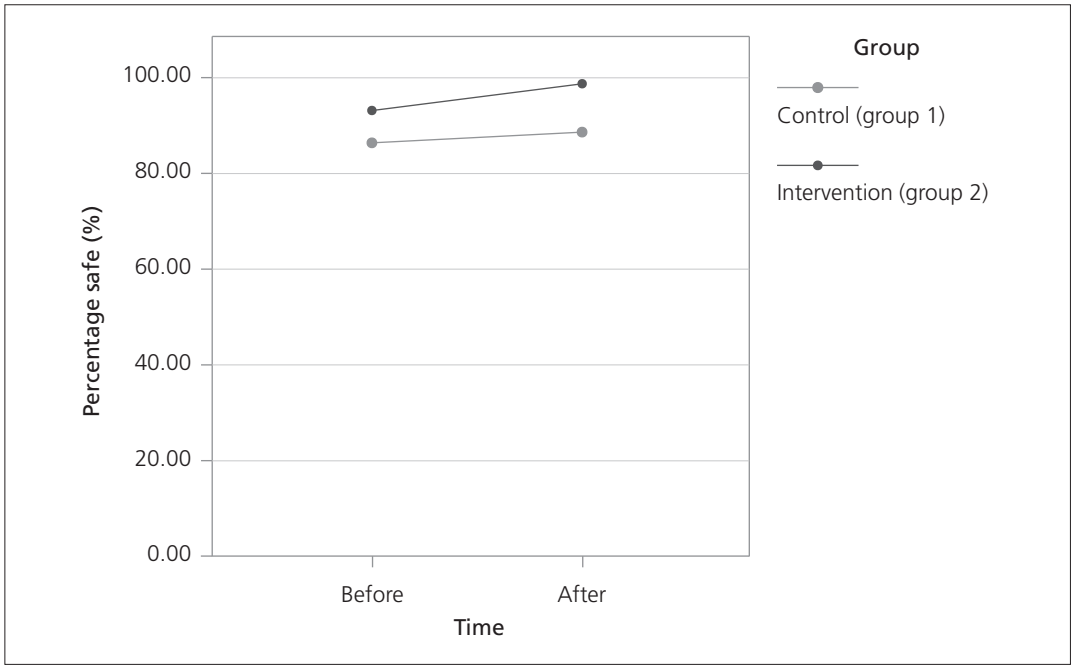


Table 18 and Figure 21 show the mean percentage safe scores for observation criterion D2 (wearing task-specific PPE). The intervention group increased from 62.50 per cent to 81.67 per cent after intervention. There was also a slight increase from 93.12 per cent to 95.36 per cent for the control group. Visually, group 2's increase is greater than group 1's, but ANOVA found only one significant effect: group by itself ($p = 0.029$). This result can be attributed to the large gap in 'before' scores, which makes like with like comparisons difficult.

Group		Time		
		Before	After	Overall
Intervention (group 2)	mean	62.50	81.67	72.09
	sd	17.68	2.35	15.11
	n	2	2	4
Control (group 1)	mean	93.12	95.36	94.24
	sd	5.27	3.25	3.80
	n	2	2	4
Overall	mean	77.81	88.51	83.16
	sd	20.64	8.24	15.63
	n	4	4	8

Table 18
Observation scores: before and after intervention on observation D2

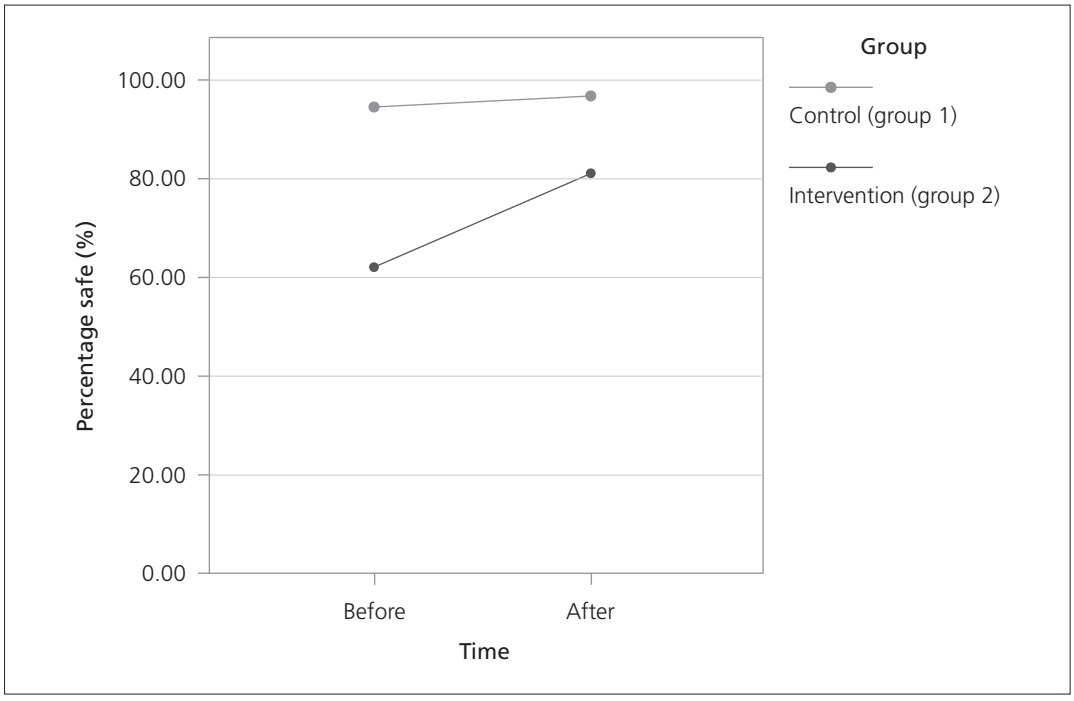


Figure 21
Observation scores: before and after intervention on observation D2

4.4.2 Observation scores: before, after and later

Data were also collected for sites 1 and 2 one month later. This consisted of two more weeks of observations: one before and one after a second (repeat) intervention. The purpose of this was to test the impact of refresher toolbox talks and their ability to prevent behaviour returning to pre-intervention levels. The findings are shown in Figures 22–29 and Tables 19–26 with 4 time points:

1 before original intervention
2 after original intervention
3 one month after original intervention but before the repeat intervention
4 after the repeat intervention.

Table 19 and Figure 22 show the original and repeat scores for criterion A1 (safe exclusion zone). The intervention site climbs and maintains a 100 per cent safe record through to the end of the period measured. The control site increases slightly after intervention 1 but then drops, with a very slight increase after intervention 2.

Table 19
Observation scores: before, after and later than intervention on observation A1

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 2)	mean	64.71	68.75	55.56	57.14	11.60
	sd	–	–	–	–	6.25
	n	1	1	1	1	4
Intervention (site 1)	mean	75.00	100.00	100.00	100.00	93.75
	sd	–	–	–	–	12.50
	n	1	1	1	1	4
Overall	mean	69.86	84.38	77.78	78.57	77.65
	sd	7.28	22.10	31.42	30.31	19.50
	n	2	2	2	2	8

Figure 22
Observation scores: before, after and later than intervention on observation A1

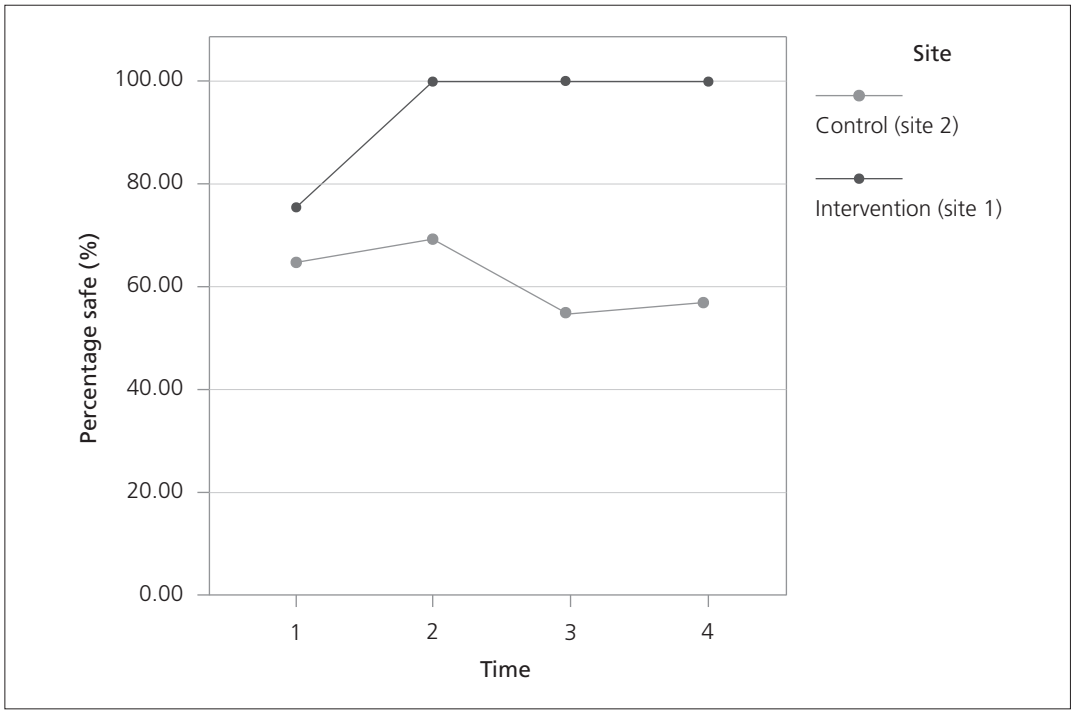


Table 20 and Figure 23 show the original and repeat scores for criterion A2 (permit-to-work armband on). A ceiling effect occurs, with the intervention site remaining 100 per cent safe for the entire duration of measurement. The control site shows little movement at around 85 per cent safe.

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 2)	mean	85.71	84.62	85.71	85.71	85.44
	sd	–	–	–	–	0.55
	n	1	1	1	1	4
Intervention (site 1)	mean	100.00	100.00	100.00	100.00	100.00
	sd	–	–	–	–	0.00
	n	1	1	1	1	4
Overall	mean	92.86	92.31	92.86	92.86	92.72
	sd	10.10	10.88	10.10	10.10	7.79
	n	2	2	2	2	8

Table 20
Observation scores: before, after and later than intervention on observation A2

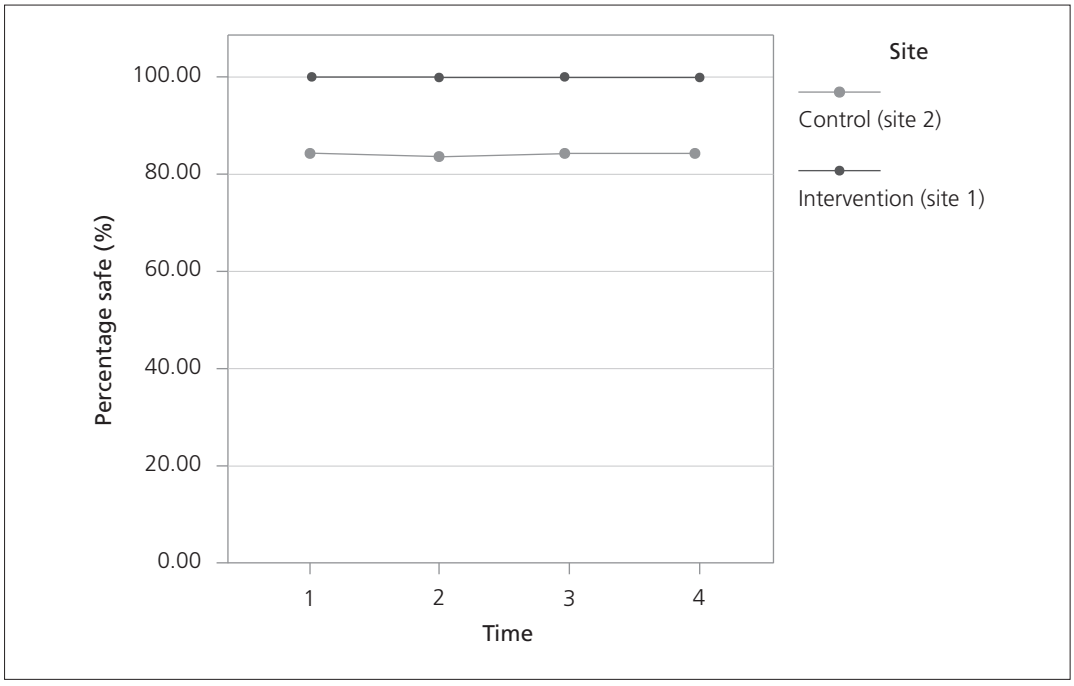


Figure 23
Observation scores: before, after and later than intervention on observation A2

Table 21 and Figure 24 show the original and repeat scores for criterion B1 (materials stored safely). The intervention site climbs from 62.96 per cent to 91.3 per cent and maintains this score through to the end of the period measured. The control site remains static at around 88 per cent safe. The gap between the two sites before intervention makes it difficult to make comparisons.

Table 21
Observation scores: before, after and later than intervention on observation B1

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 2)	mean	87.72	88.18	88.89	89.09	88.47
	sd	–	–	–	–	0.63
	n	1	1	1	1	4
Intervention (site 1)	mean	62.96	91.30	90.00	90.00	83.57
	sd	–	–	–	–	13.75
	n	1	1	1	1	4
Overall	mean	75.34	89.74	89.45	89.55	86.02
	sd	17.51	2.21	0.78	0.64	9.38
	n	2	2	2	2	8

Figure 24
Observation scores: before, after and later than intervention on observation B1

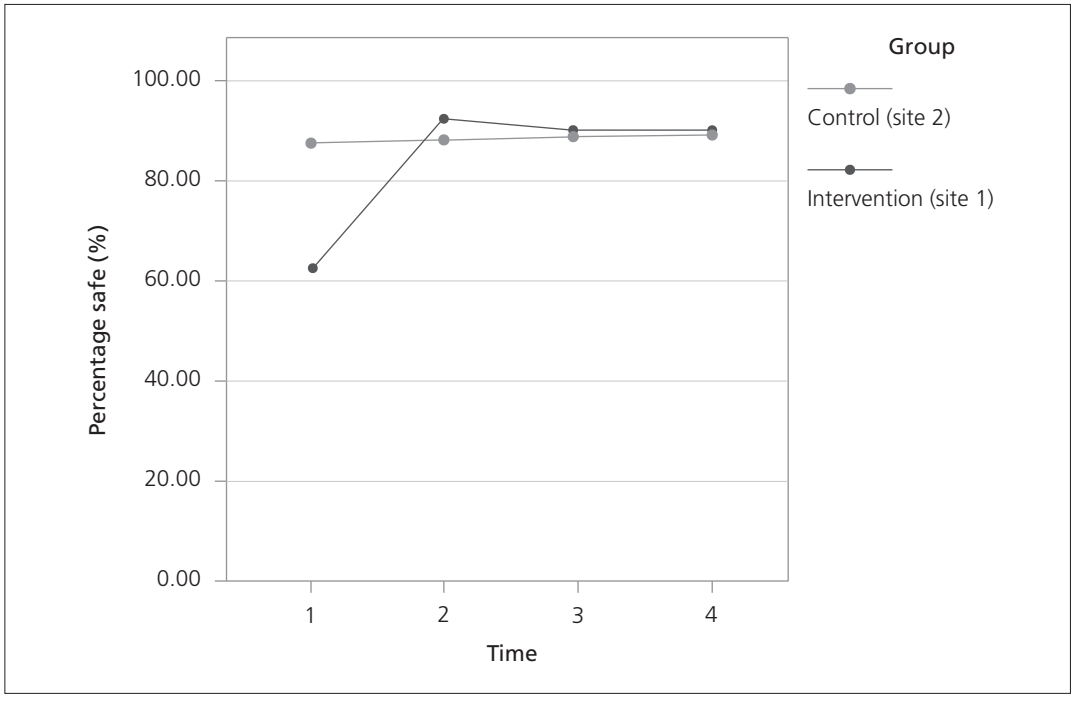


Table 22 and Figure 25 show the original and repeat scores for criterion B2 (no waste packaging around). The intervention site climbs from 54.55 per cent to 75 per cent after the first intervention, before dropping back slightly to 71.43 per cent, but climbing again to 87.5 per cent after the second intervention. The control site follows a similar trend but to a lesser extent: the intervention site improves overall by 33 percentage points, whereas the improvement for the control site is only 6.5 percentage points.

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 2)	mean	71.43	75.45	72.86	78.00	74.44
	sd	–	–	–	–	2.90
	n	1	1	1	1	4
Intervention (site 1)	mean	54.55	75.00	71.43	87.50	72.12
	sd	–	–	–	–	13.59
	n	1	1	1	1	4
Overall	mean	62.99	75.23	72.15	82.75	73.28
	sd	11.94	0.32	1.01	6.72	9.18
	n	2	2	2	2	8

Table 22
Observation scores: before, after and later than intervention on observation B2

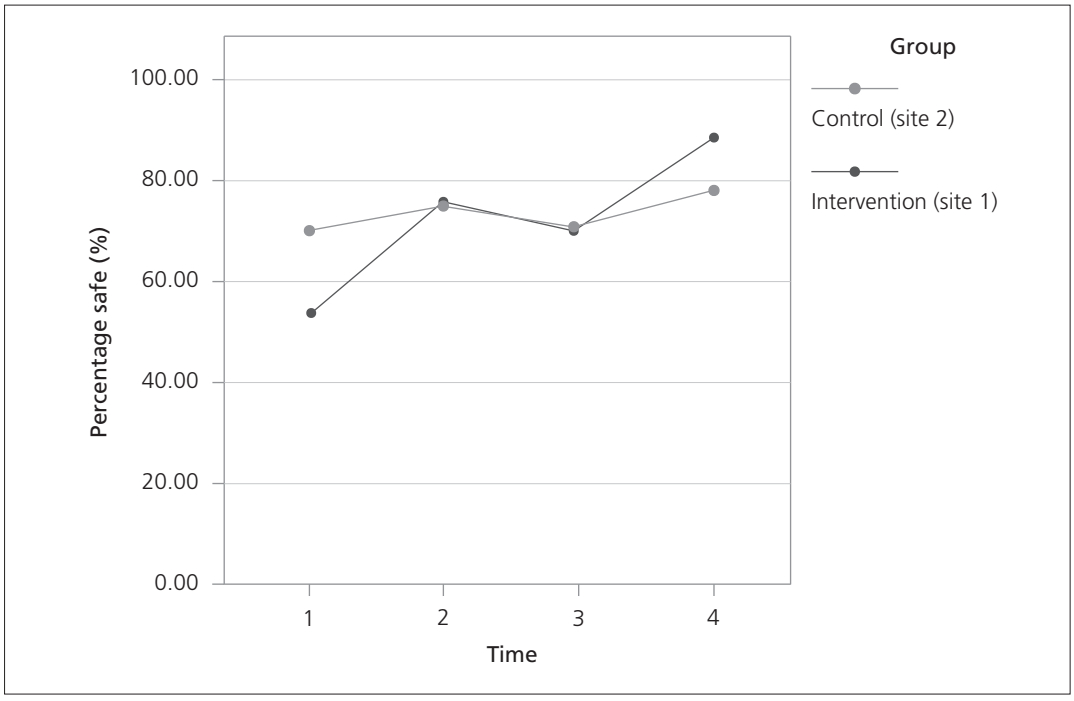


Figure 25
Observation scores: before, after and later than intervention on observation B2

Table 23 and Figure 26 show the original and repeat scores for criterion C1 (lanyards on tools at height). The intervention site climbs from 88.24 per cent to 97.5 per cent after the first intervention, before dropping back slightly to 87.78 per cent, but then climbs again to 97.14 per cent after the second intervention. There is a considerable difference in the scores for this criterion between the two sites. The control site began at only 20 per cent safe and follows a similar trend, but finishes at only 25 per cent safe. This difference in 'before' scores makes comparing the two sites virtually impossible.

Table 23
Observation scores: before, after and later than intervention on observation C1

Group		Time				
		Before	After	Later 1	Later 2	Overall
Intervention (site 2)	mean	88.24	97.50	87.78	97.14	92.67
	sd	–	–	–	–	5.38
	n	1	1	1	1	4
Control (site 1)	mean	20.00	21.74	20.00	25.00	21.69
	sd	–	–	–	–	2.36
	n	1	1	1	1	4
Overall	mean	54.12	59.62	53.89	61.07	57.18
	sd	48.25	53.57	47.93	51.01	38.13
	n	2	2	2	2	8

Figure 26
Observation scores: before, after and later than intervention on observation C1

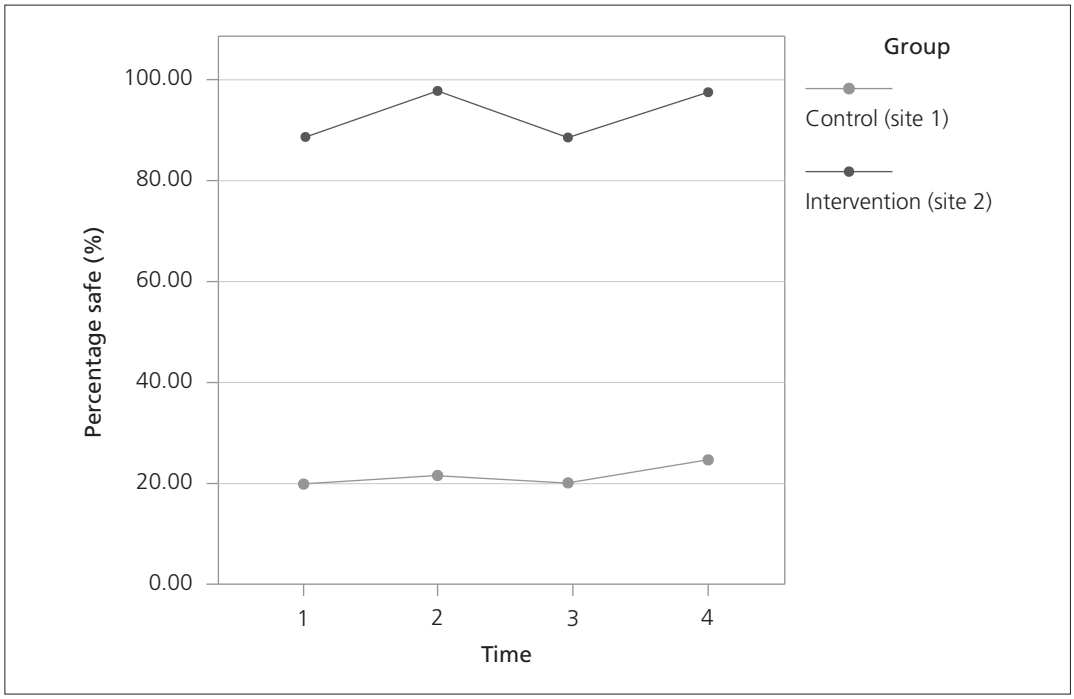


Table 24 and Figure 27 show the original and repeat scores for criterion C2 (housekeeping of tools). The intervention site climbs from 85.88 per cent to 95.63 per cent after the first intervention, before dropping back slightly to 83.33 per cent, but climbing again to 88.89 per cent after the second intervention. The control site follows a similar trend but it is less pronounced.

Group		Time				
		Before	After	Later 1	Later 2	Overall
Intervention (site 2)	mean	85.88	95.63	83.33	88.89	88.43
	sd	–	–	–	–	5.31
	n	1	1	1	1	4
Control (site 1)	mean	72.00	77.14	73.68	75.00	74.46
	sd	–	–	–	–	2.17
	n	1	1	1	1	4
Overall	mean	78.94	86.39	78.51	81.95	81.44
	sd	9.81	13.07	6.82	9.82	8.36
	n	2	2	2	2	8

Table 24
Observation scores: before, after and later than intervention on observation C2

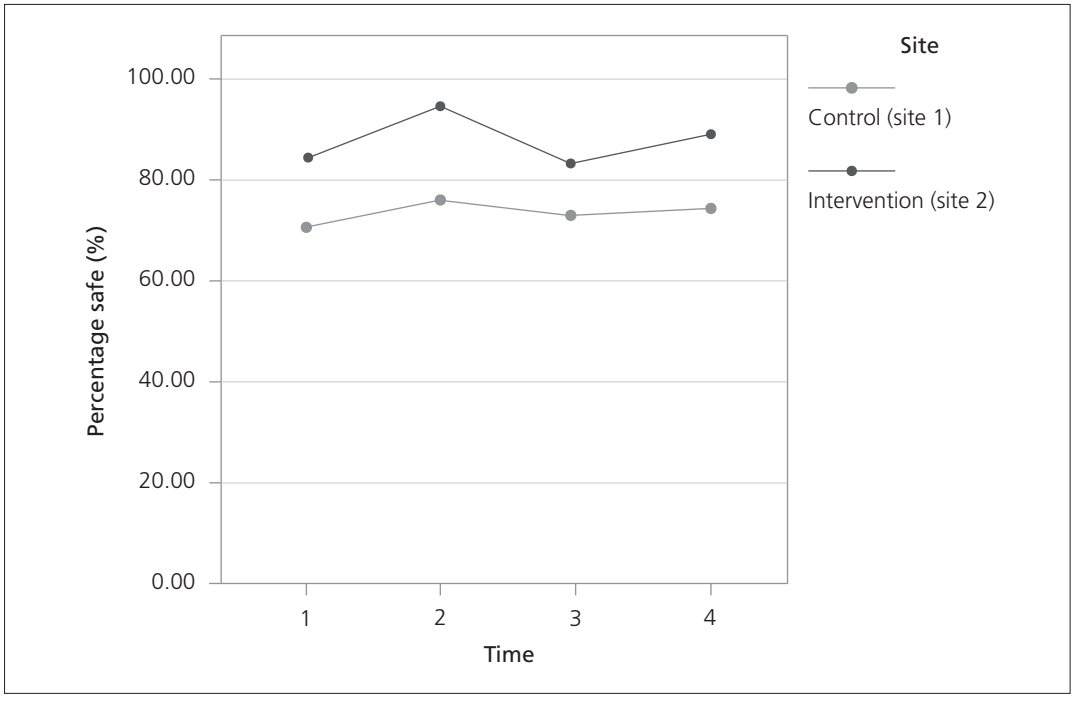


Figure 27
Observation scores: before, after and later than intervention on observation C2

Table 25 and Figure 28 show the original and repeat scores for criterion D1 (wearing mandatory PPE). The intervention site climbs from 89 per cent to 98 per cent after the first intervention, before dropping back slightly to 87 per cent, but climbing again to 95 per cent after the second intervention. The control site remains relatively unchanged.

Table 25
Observation scores: before, after and later than intervention on observation D1

Group		Time				
		Before	After	Later 1	Later 2	Overall
Intervention (site 2)	mean	89.00	98.00	87.00	95.00	92.25
	sd	–	–	–	–	5.12
	n	1	1	1	1	4
Control (site 1)	mean	83.33	84.72	83.33	83.33	83.68
	sd	–	–	–	–	0.70
	n	1	1	1	1	4
Overall	mean	86.17	91.36	85.17	89.17	87.96
	sd	4.01	9.39	2.60	8.25	5.70
	n	2	2	2	2	8

Figure 28
Observation scores: before, after and later than intervention on observation D1

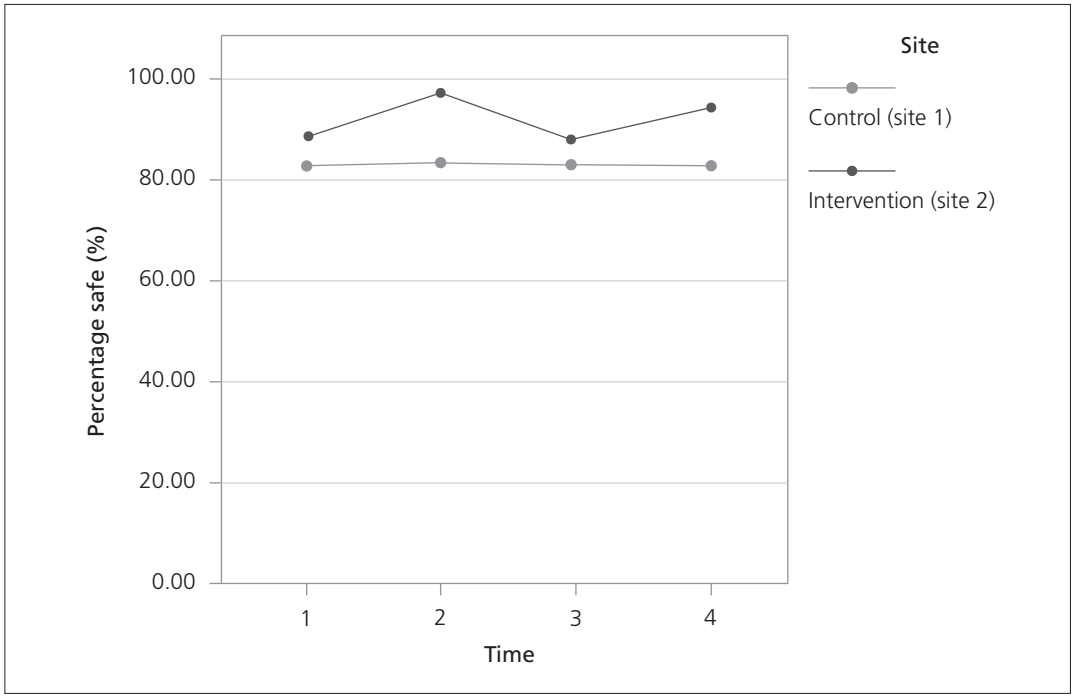


Table 26 and Figure 29 show the original and repeat scores for criterion D2 (wearing task-specific PPE). The intervention site climbs from 75 per cent to 83.33 per cent after the first intervention, before dropping back considerably to 60 per cent, but climbing again to 80 per cent after the second intervention. The control site follows a similar trend but is less pronounced. The control site seems to have actually performed better than the intervention site.

Group		Time				
		Before	After	Later 1	Later 2	Overall
Intervention (site 2)	mean	75.00	83.33	60.00	80.00	74.58
	sd	–	–	–	–	10.31
	n	1	1	1	1	4
Control (site 1)	mean	89.39	93.06	86.67	90.48	89.90
	sd	–	–	–	–	2.65
	n	1	1	1	1	4
Overall	mean	82.20	88.20	73.34	85.24	82.24
	sd	10.18	6.88	18.86	7.41	10.75
	n	2	2	2	2	8

Table 26
Observation scores: before, after and later than intervention on observation D2

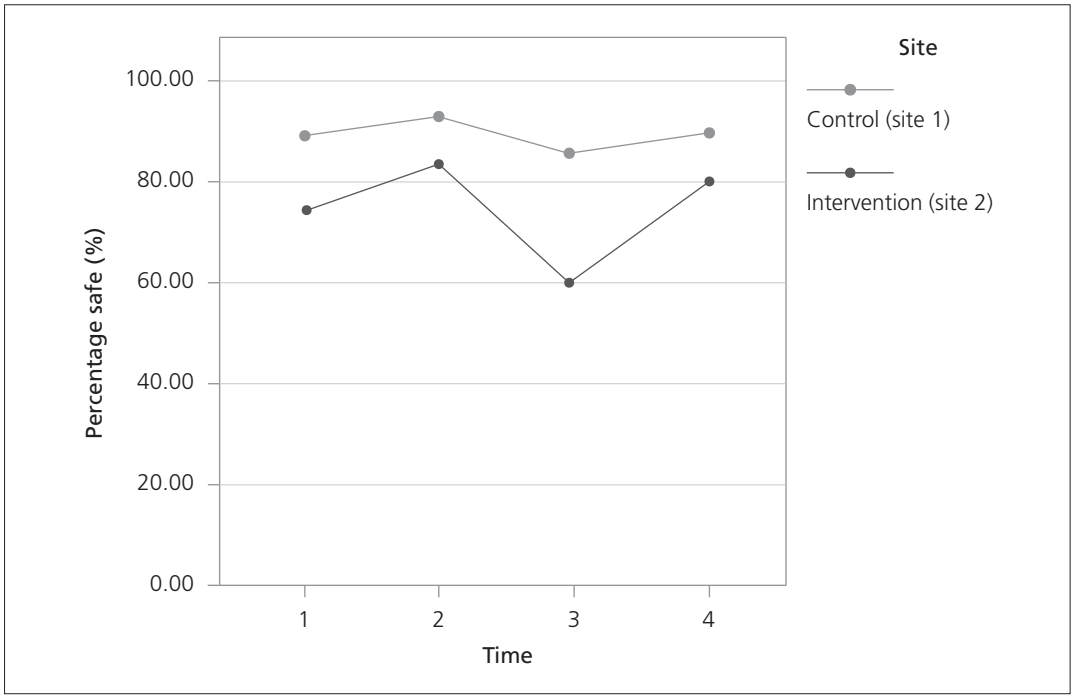


Figure 29
Observation scores: before, after and later than intervention on observation D2

4.4.3 Mean observation scores

ANOVA can be performed if each of the four criteria are grouped together. For example, the first A and B observation scores for site 1 can be presented for analysis as follows:

A1 (Table 19)	75.00%
A2 (Table 20)	100.00%
B1 (Table 21)	2.96%
B2 (Table 22)	54.55%
Mean % for A and B (Table 29)	73.13%

Table 27 and Figure 30 show the mean observation criteria scores for themes A and B. The intervention group increases after intervention and the control group increases to a lesser extent. ANOVA found a near significant effect for the interaction of group and time (p = 0.054) and a significant effect for time ($p = 0.01$).

Table 27
Observation scores: before and after intervention on themes A and B

Group		Time		
		Before	After	Overall
Control (group 2)	mean	83.20	85.97	84.59
	sd	11.42	7.59	9.42
	n	7	7	14
Intervention (group 1)	mean	74.77	93.41	84.09
	sd	14.05	8.38	14.75
	n	8	8	16
Overall	mean	78.71	89.94	84.32
	sd	13.17	8.64	12.34
	n	15	15	30

Figure 30
Observation scores: before and after intervention on themes A and B

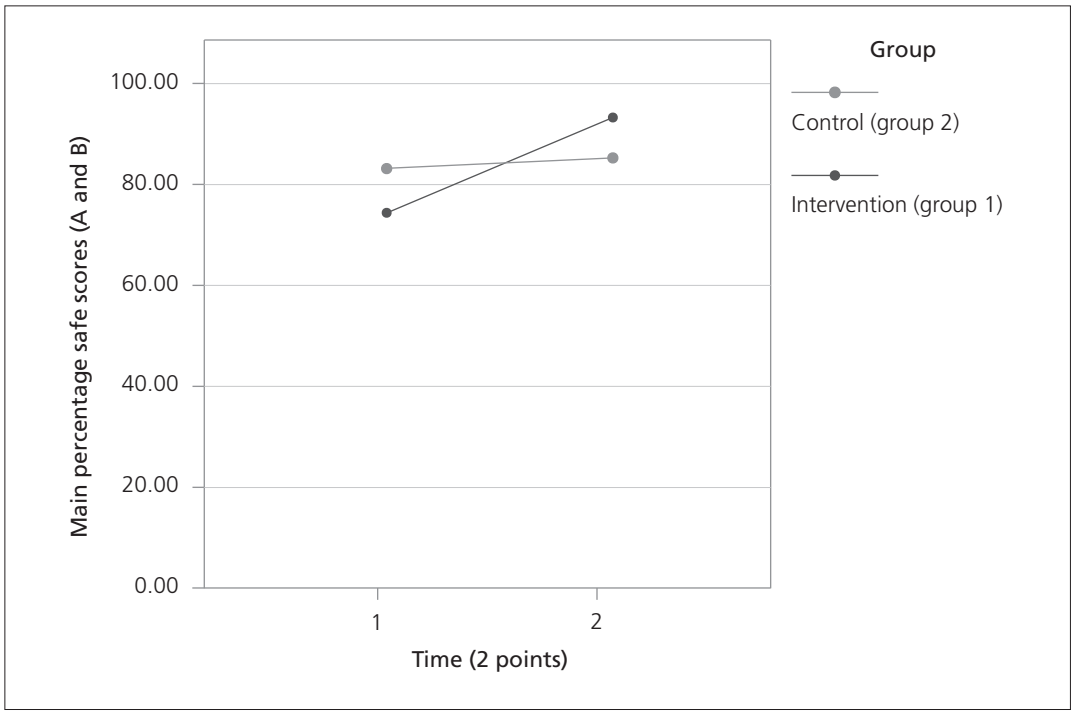


Table 28 and Figure 31 show the mean observation criteria scores for themes C and D. The intervention group increases after intervention and the control group increases to a lesser extent. However, ANOVA found no significant effects (interaction $p = 0.647$).

Group		Time		
		Before	After	Overall
Control (group 2)	mean	79.15	82.90	81.03
	sd	25.48	22.43	23.27
	n	8	8	16
Intervention (group 1)	mean	82.83	92.46	87.64
	sd	9.13	7.03	9.31
	n	8	8	16
Overall	mean	80.99	87.68	84.33
	sd	18.58	16.80	17.76
	n	16	16	32

Table 28
Observation scores: before and after intervention on themes C and D

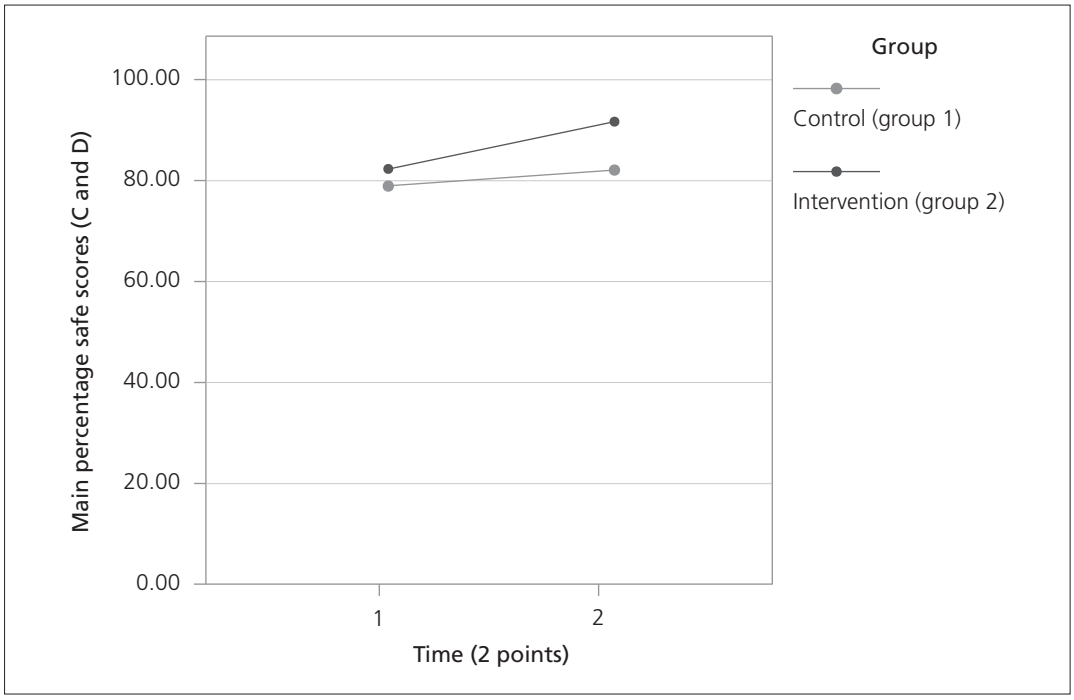


Figure 31
Observation scores: before and after intervention on themes C and D

Table 29 and Figure 32 show the mean observation criteria scores for themes A and B over four time points. The mean scores for the intervention site climb after the first intervention, then remain relatively steady after one month, before climbing slightly again after the second intervention. The control site sees a slight increase after the first intervention but this falls back after one month, with a very slight increase after the second intervention. ANOVA found only a near-significant site effect ($p = 0.053$) due to the scores running parallel apart.

Table 29
Observation scores: before, after and later than intervention on themes A and B

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 2)	mean	77.39	81.50	75.76	77.49	78.03
	sd	11.14	5.99	15.14	14.34	11.12
	n	4	4	4	4	16
Intervention (site 1)	mean	73.13	91.58	90.36	94.38	87.36
	sd	19.78	11.79	13.47	6.57	15.01
	n	4	4	4	4	16
Overall	mean	75.26	86.54	83.06	85.93	82.70
	sd	15.04	10.20	15.39	13.72	13.83
	n	8	8	8	8	32

Figure 32
Observation scores: before, after and later than intervention on themes A and B

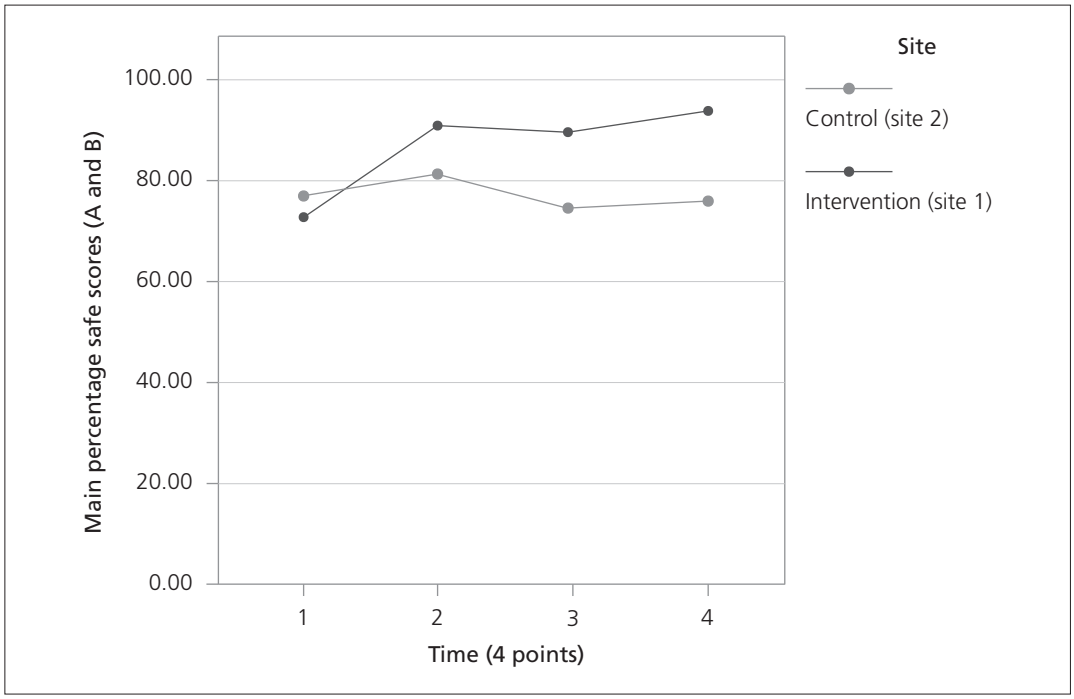


Table 30 and Figure 33 show the mean observation criteria scores for themes C and D over four time points. The mean scores for the intervention site climb after the first intervention, but fall back to below the starting mean one month later, before climbing again after the second intervention. The control site increases but does not fall as much one month later, before increasing slightly once more after the second intervention. ANOVA found only a significant site effect ($p = 0.026$) due to the gap in scores.

Group		Time				
		Before	After	Later 1	Later 2	Overall
Control (site 1)	mean	66.18	71.34	70.57	73.14	70.31
	sd	31.62	28.04	25.03	20.59	23.96
	n	4	4	4	4	16
Intervention (site 2)	mean	84.53	93.62	79.53	90.26	86.98
	sd	6.49	6.93	13.16	7.68	9.77
	n	4	4	4	4	16
Overall	mean	75.36	82.48	75.05	81.70	78.64
	sd	23.30	22.34	19.12	17.05	19.89
	n	8	8	8	8	32

Table 30
Observation scores: before, after and later than intervention on themes C and D

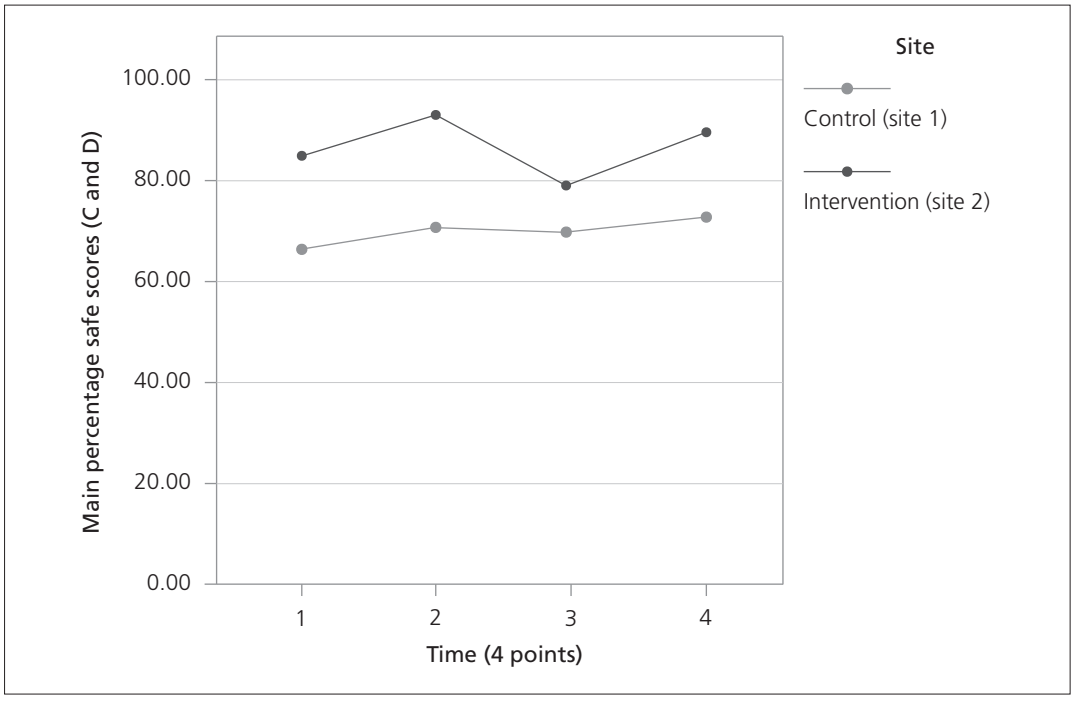


Figure 33
Observation scores: before, after and later than intervention on themes C and D

Overall, the observation scores showed similar trends to the test scores. However, the findings were less conclusive. This was, in part, due to the difficulties relating to identification of observational data that could be attributed to the participants. Unlike the knowledge tests, the data had to be collected on a group basis. Therefore individual scores could not be analysed, which hindered ANOVA.

Having said this, some useful findings emerged. Visual inspection of the plotted graphs showed improvements in safe behaviours to be greater on intervention sites virtually every time. However, for one criterion, the control site appeared to perform better. In addition to this, some baseline scores were quite far apart, making like with like comparisons difficult.

It was interesting to note that the improved scores remained high one month later for the intervention on themes A and B (site 1), whereas the scores dipped for themes C and D (Site 2), before rising again after the second intervention. This prompted further investigation.

In most cases ANOVA was either not possible or returned no significant interaction effect. There were a few instances of near significant effects (on or just over 5 per cent significance) but, on balance, these results did not outweigh the non-significant results.

4.5 Findings: Other data

Some of the findings in sections 4.2–4.4 prompted further investigation to help explain why certain results were produced. This involved follow-up questions to members of the site management team and contractors' supervisors.

4.5.1 The CSCS effect

The research design in relation to the pictorial knowledge test was based on findings from previous work for ConstructionSkills in which average test scores among migrant workers was 20.47 (82 per cent) from a maximum of 25. However, the mean for the 24-question test used on the current study was 22.1 (92 per cent) before the intervention – ie 10 per cent higher. This increased the ceiling effect in the data. In the end the number of participants in the study allowed a statistically significant increase to be detected. However, the reason for this increase in initial scores needed further investigation.

One possible reason for the difference was the origin of the workers: Eastern Europe. Previous research found European workers scored an average of 87 per cent, compared to African and Indian workers who scored an average of 73 per cent.[27] However, this does not fully explain the mean score of 92 per cent. A further influencing factor may have been the site competence requirements of the Principal Contractor in charge of the sample sites. Further investigation found that all workers, including the migrant workers, were required to possess a ConstructionSkills Certification Scheme (CSCS) card. This is an industry competence scheme which includes the ConstructionSkills Health and Safety Test. The samples used in previous research included sites where this was not required. Therefore, it is conceivable that the difference in mean test scores between the previous samples and the current study may have been due to the underlying knowledge that workers had gained in attaining their CSCS cards. This would be consistent with Wogalter's CHIP model (Section 2.5) where attitudes, beliefs and technical knowledge can improve success.

4.5.2 Experience vs existing knowledge

Care was taken to ensure that an even spread of experience existed throughout the four sites in the sample. However, visual inspection of the knowledge test scores indicated a possible link between overall construction-related experience and test scores. Therefore, the entire sample was stratified into groups based on experience: less than five years; 5–10 years; and over 10 years. This was cross-tabulated with mean test scores. The result is shown in Figure 34, which agrees with previous findings on the impact of relevant experience on the knowledge test scores – ie increased experience is associated with higher scores. However, tests for correlation did not prove significant.

4.5.3 Poster effect

The findings in section 4.4.3 show that observation scores reduced after one month for the intervention on themes C and D. However, they remained high after one month for the intervention on themes A and B. During the return visits to sites 1 and 2, possible reasons for this were investigated.

A potential reason was identified which can only be described as an external factor. The site management team and contractor's supervisors were so keen to make use of the pictorial images used

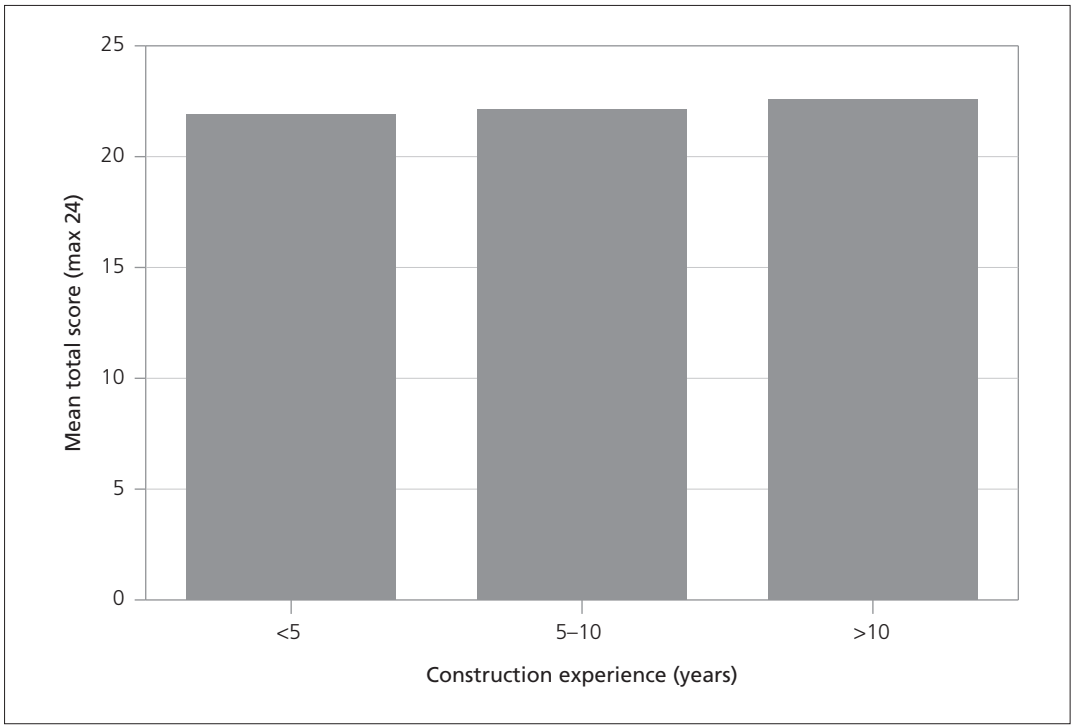


Figure 34
Construction experience *vs* knowledge test scores

in the toolbox talks that they began printing off A3-size versions and placed them in strategic parts of the site for the themes they were targeting: exclusion zones and materials storage areas. This was done during the period between the second and third observations. This could explain why the observation scores remained high after one month. Poster campaigns can typically be effective in the short to medium term before they become 'wallpaper'.[17] Therefore, the combined effect of the pictorial toolbox talks co-ordinated with similar 'reinforcing' posters would probably result in sustained higher performance for at least one month. This can be considered multi-mode delivery (Section 2.5), which reinforces Wogalter's model and expands its applicability.

5 Discussion and conclusions

5.1 Discussion on findings

5.1.1 The sample

The sites chosen for the interventions were a sample of convenience. The sites needed to be large enough to employ a suitable number of migrant workers and to involve projects that would last for long enough to allow data collection. They also needed to be managed by the same Principal Contractor and employ similar types of worker (in terms of nationality, occupation, age and experience) to ensure, as far as possible, homogeneity among them. These factors were considered more important than the requirement for a representative sample of migrant workers by nationality. In any case, government estimates place European workers as the dominant group of migrant construction workers.[2] However, the reported figures vary greatly. Therefore, attempting to develop a stratified sample based on nationality would be futile. Three of the four sites were in London and one was in Manchester. HSE data show that London accommodates at least 40 per cent of the migrant construction workforce.[2] Other areas outside London where migrant labour is high include Manchester.[2] Therefore, the sample was representative of most migrant construction workers in the UK construction industry in terms of location.

The average age of the sample was 37 years. Previous studies have placed the average age of migrant construction workers anywhere between late 20s and mid-30s.[2,27] The sample is therefore at the upper end of this scale. The average length of relevant experience in the sample was 4.1 years. There is lack of data on this subject in the literature for comparison. However, one previous research project used a sample with average experience of 7.4 years.[27] Therefore, the current sample is a little less experienced overall.

The average time on the current site for each worker varied considerably. However, this was counted in months rather than years. Analysis showed that 98.7 per cent (79 out of 80) of the workers had been on site for at least one month. The remaining worker had been on site for two weeks. HSE statistics show workers are most vulnerable in their first few days on site.[28] All the workers had been on site for longer than the minimum first few days where the risk is highest. In this case, it is safe to assume that they would have had an induction and would have been well aware of site-specific hazards and practices.

5.1.2 The knowledge test

The knowledge test findings all show a similar pattern in relation to the themes where pictorial aids where used. In all cases the scores increased. On the other hand, mean scores in relation to text-only themes showed random variation over time, increasing, decreasing or remaining static. ANOVA found consistent interaction effects over all the sites. While there was some variation between group/site and time effects, the interaction results were the most important.

This confirms that the pictorial aids improve knowledge of targeted themes when compared with text-only toolbox talks. Further, the knowledge has been retained one month later, whereas text-only training resulted in little change in knowledge scores.

The pictorial aids used were a combination of sketch drawings, pictograms and photographs. All followed a consistent format: hazards and consequences were shown as sketch drawings (which allowed specific injuries to be depicted without using real people); then controls were presented, first with pictograms to explain the concept, then photographs to demonstrate the context. This framework of hazard–consequences–controls is commonly used[29] and, based on the findings, is effective and should continue to be used for communicating basic health and safety information to migrant constriction workers. It is also reasonable to assume that this would be true for all types of construction worker.

Many of the pictograms used in the knowledge test also featured in the corresponding toolbox talks. Therefore, it could be argued that it was easier for the workers to improve their test scores purely as a result of recalling the images from their pictorial toolbox talks. This would mean the test was merely measuring short-term recall rather than understanding. In actual fact, the pictograms were variations of those used in the toolbox talks. For example, in the toolbox talks, the ‘correct’ stick man was always coloured black, while the ‘incorrect’ one was red. In the test images, however, they were all black with multiple variations on the original theme, only one of which was correct. The sustained high scores one month later indicate understanding rather than short-term recall.

Having said this, other forms of testing, such as hazard-spotting photographs, could have been used. This was not considered due to time and cost restraints (the pictogram tests had already been developed and validated). However, it is acknowledged that a more varied form of assessment could be considered for any future studies.

5.1.3 The observation scores

Establishing the improvement of migrant worker knowledge satisfied one element of overall competence. However, the next step was to investigate whether this translated to safer behaviours, ie observational proof of their competence and motivation.

Overall, the observation scores showed similar trends to the knowledge test scores, ie improvement after intervention. However, the findings were less conclusive. This was, in part, due to the difficulties relating to the identification of observational data (section 4.4.3) and the fact that individual scores could not be analysed, which hindered ANOVA analysis. On the other hand, visual inspection of the plotted graphs showed that improvements in safe behaviours were greater in the intervention groups than the control groups.

There are clearly a number of factors that can influence behaviour that are independent of merely acquiring the correct knowledge. These are collectively described as motivation and capability. Workers may know how a task can be completed safely but choose not to because, for example, they wish to increase productivity at the expense of a safety-specific procedure. Or they may be hindered by not having the necessary skills or equipment. Both of these reduce workers' capability to physically implement a safe system of work. Therefore, the variation in performance from knowledge to behaviour may be expected, as discussed by Wogalter *et al*. (Section 2.5).

Regardless of this, these limitations exist across all of the workers, whether exposed to the pictorial materials or the text-only ones. The research design assumed this, with each site acting as both intervention and control to ensure any differences were genuine and not the result of a more motivated or capable workforce. However, motivation may have been affected by the interventions, as the workers would attach some importance to the subject matter and acted accordingly (ie 'The boss must think this is important enough to have an elaborate toolbox talk, so I'd better do it').

Instances where baseline measures were far apart presented problems for analysis. Ideally, they should have been close together to make 'like with like' comparisons. But each site's management team helped to choose their criteria, based on problems identified in safety audits. Therefore, one site could have had a specific problem with, for example, storage of materials, but the other did not, making some baseline scores far apart.

The sustained improvement in behaviour seen on site 1 added a new dimension to the research design (section 4.5.3). This 'poster effect' was unintentional but very interesting, with obvious implications for worker motivation. It implies the possibility of a co-ordinated approach of training with poster reinforcement through the same images. The 'Trojan horse' project[17] has used the poster approach (by placing posters strategically on materials and equipment), and combining the methods of both studies could improve the overall impact of safety communication and inform the Wogalter model (section 2.5).

The repeat measures for site 2 looked quite different from site 1. One month later, observation performance dipped considerably, below the starting point in all cases (C1; C2; D1; D2: Figures 26–29). Difficulties in data collection may have played a part. The level of drop-out after one month at site 2 was eight workers (from 20 to 12), whereas at site 1 the figure was five. At both sites this was due to natural turnover of workers. This is a common phenomenon, particularly on larger construction sites. The research design for observational data collection attempted to control for this by asking site managers to follow up on unsafe scores one month later to ascertain whether they were due to original group members or newly arrived workers. However, the figures may have been contaminated at site 2 by new workers being erroneously included in the group observation scores. This would account for the pronounced drop in performance one month later. Interestingly, the same drop was seen in site 2 control scores for themes A1 and B2, but not A2 and B1. Therefore, the anomaly can be explained on six out of the eight observation criteria using this rationale. The remaining two may have been slightly easier to maintain or may have been enforced more vigorously at site 2.

Although not statistically significant, the results of the observation analysis were both interesting and useful. An initial effect can be seen and possible methods to improve the longevity of this effect were

identified. However, the purpose of the analysis was to test the general effect of pictorial materials on competence and behaviour. They are obviously limited by the fact that they are merely a method of communication and do not ensure compliance.

5.2 Conclusions and recommendations

5.2.1 Conclusions

The aim of this research was to establish whether there was evidence that delivering hazard information and instruction using pictorial aids can be linked with improvement, beyond that related to the use of text-only materials, in targeted competences and behaviours among second language (migrant) workers.

The main conclusions in relation to worker knowledge were as follows:

1 Mean knowledge test scores in relation to the themes increased in all cases where pictorial aids were used. On the other hand, mean scores in relation to text-only themes showed random variation over time – slightly increasing, decreasing or remaining static.
2 ANOVA of knowledge test scores found consistent effects over all the sites with every test for interaction returning very significant results.
3 One month later test scores remained high. Due to a ceiling effect there was little room for further improvement. Therefore no further testing was undertaken after the second intervention (although further observation data were collected for behaviour measures).
4 Findings 1–3 show that training with pictorial materials improves knowledge and understanding among migrant workers for whom English is their second language, better than training without pictures.
5 In addition to this, the average pre-intervention score was 10 per cent higher than that for previous research. This is probably attributable to two factors. Firstly, all of the workers in the sample were from European countries, where there is more synergy with the UK on health and safety issues than there is in other non-English-speaking countries. Secondly, all the workers in the sample had attained CSCS competence levels, which was not true of all sites mentioned in previous research.
6 The pre-intervention scores also agreed with previous findings showing that more experienced workers generally scored higher on the knowledge test than less experienced ones (< 5 years = 21.89; 5–10 years = 22.13; > 10 years = 22.58). However, the correlation was not statistically significant.

The observation scores were not as conclusive. The results were prima facie similar but were not statistically significant, possibly because the group data had been pooled.

7 Visual inspection of the plotted graphs showed that improvements in safe behaviours were greater on intervention sites. However, ANOVA analysis returned no significant differences on virtually all individual measures.
8 Mean scores for behaviour returned significant or very near significant results.
9 The improved scores remained high one month later for the intervention on themes A and B (site 1), whereas the scores dipped for themes C and D (site 2), before rising again after the second intervention.
10 Further investigation into finding 9 showed that management on site 1 had reproduced posters of the training images and placed them beside work areas. This ‘poster effect’ may have been the reason for the longer-term differences between the two sites.
11 However, the longer-term differences between the sites may have been due to variation in worker motivation or capability (although it is assumed these differences existed uniformly throughout the sample). Another reason may have been possible contamination of data due to a higher turnover of workers on site 2.
12 Findings 7–11 show that measuring the impact of the images on behaviour is both challenging and unpredictable. Pictorial aids are obviously limited by the fact that they are merely a method of communication and do not ensure compliance.

5.2.2 Limitations of the study

The research described in this study has been as robust as possible, taking into account that the interventions took place at ‘real world’ sites and the uniformity desired by the research design was somewhat artificial. The mere fact these were not ‘laboratory conditions’ causes obvious limitations of control. For example, the decision by management on site 1 to reproduce the images in poster

form was outside the control of the research design. However, ethically it was difficult to prevent this from occurring. Besides, the implications of this decision for the longevity of the intervention proved to be very interesting and useful.

Some behaviour baseline scores were excessively different. This may have been due to some target criteria being too site-specific and therefore not corresponding with the control site. However, this problem only occurred with a few of the criteria.

Behaviour and motivation is clearly interlinked. However, the purpose of the analysis was to identify general links with pictorial materials and behaviour, as part of the wider measurement of competence. As such, detailed interactions of behaviour and motivation were not measured. This is an area that needs further study.

The results one month later were not as robust, since there was some drop-out of participants by this time. The number of original workers on sites 1 and 2 was reduced from 20 on each site to 15 and 12 respectively. This may have caused some contamination of the follow-up observation data. However, *prima facie* improvements were still detected.

5.2.3 Recommendations

The recommendations are divided into two categories: those for improved industry practice and those for further academic study.

Improved industry practice

1 The benefits of pictorial aids in helping to improve health and safety knowledge and comprehension should be disseminated to the construction industry and beyond.
2 The format of 'hazard–consequences–controls' should be used to communicate health and safety information, as this was the format used successfully (in terms of improved knowledge scores) in the study.
3 Sketch drawings are useful ways to communicate hazards and consequences without using real people. Pictograms are useful for conveying hazards and controls. Photographs help to show controls in context.

Further academic study

4 Sketch drawings, pictograms and photos all have different strengths (see recommendation 3). However, further research is needed to establish, in detail, how they can be used more efficiently by comparing them in different situations.
5 The use of pictorial toolbox talks in conjunction with a synchronised poster campaign or the 'Trojan horse' approach may help improve the overall impact and effectiveness of pictorial aids in communicating health and safety information. But their long-term efficacy needs to be investigated.
6 Further research on the interaction between communication methods, motivation, capability, experience and other relevant factors would help greater understanding of how pictorial aids affect migrant worker behaviour.

This study sought to establish whether there was evidence that the delivery of hazard information and instruction using pictorial aids can be linked to improvement in targeted competences and behaviours among second language (migrant) workers. It is hoped that these findings will be of use to industry practitioners and academic scholars alike.

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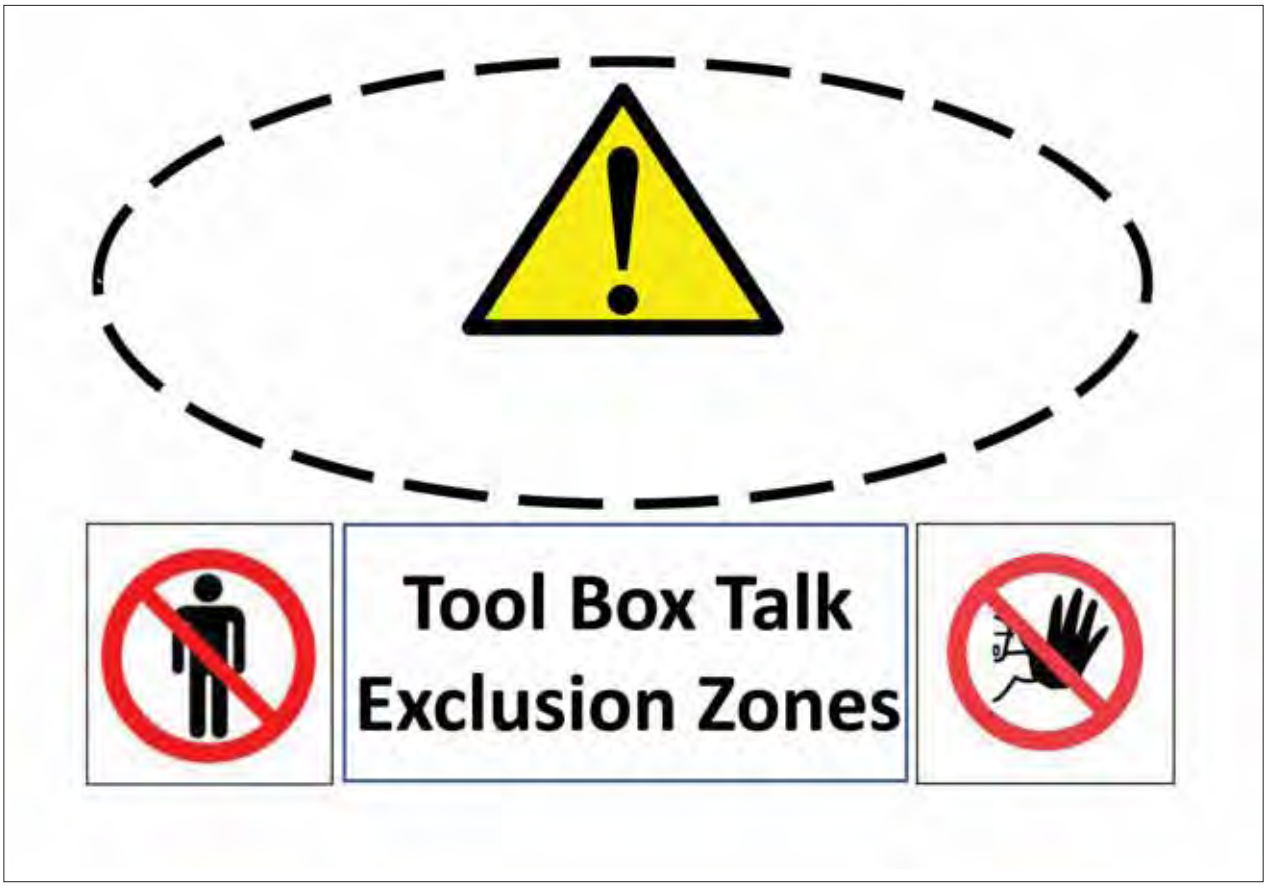
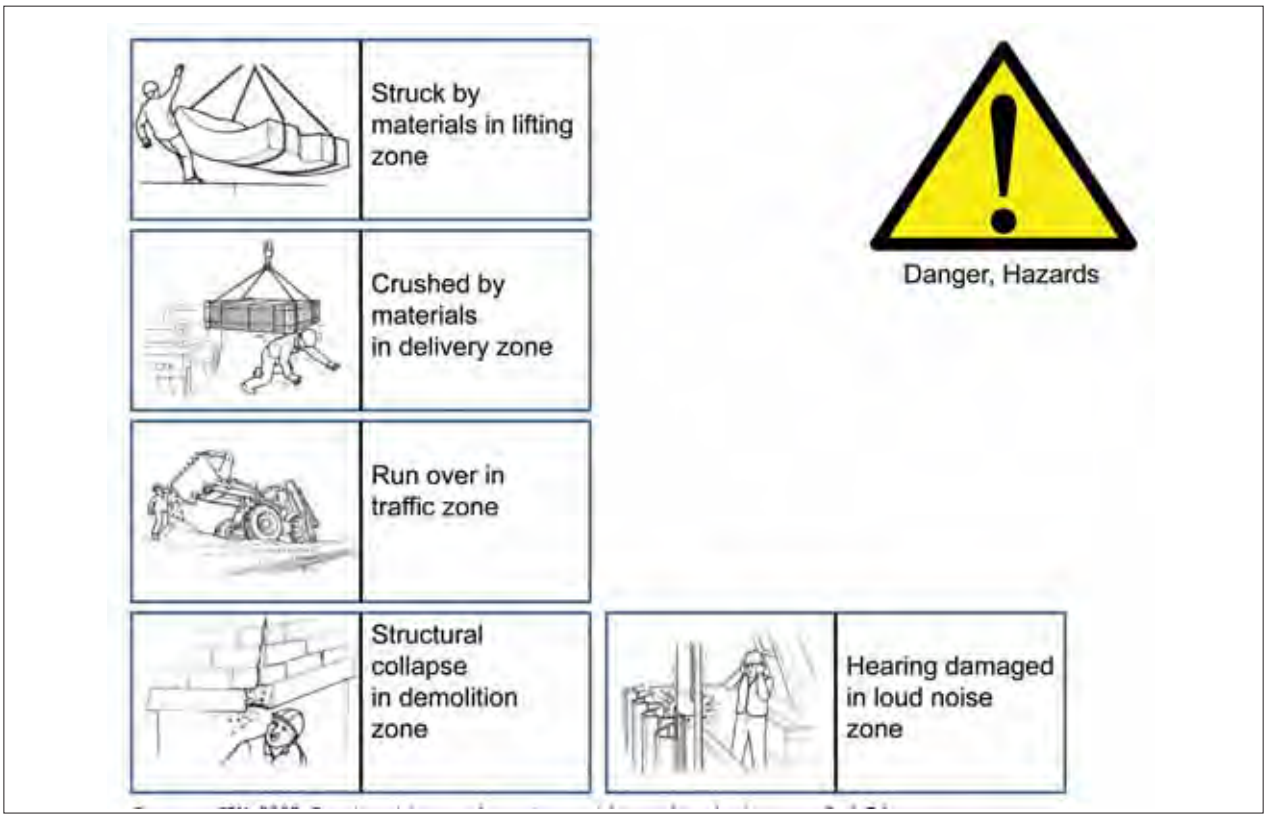
Appendix 1: Toolbox talks used in the study

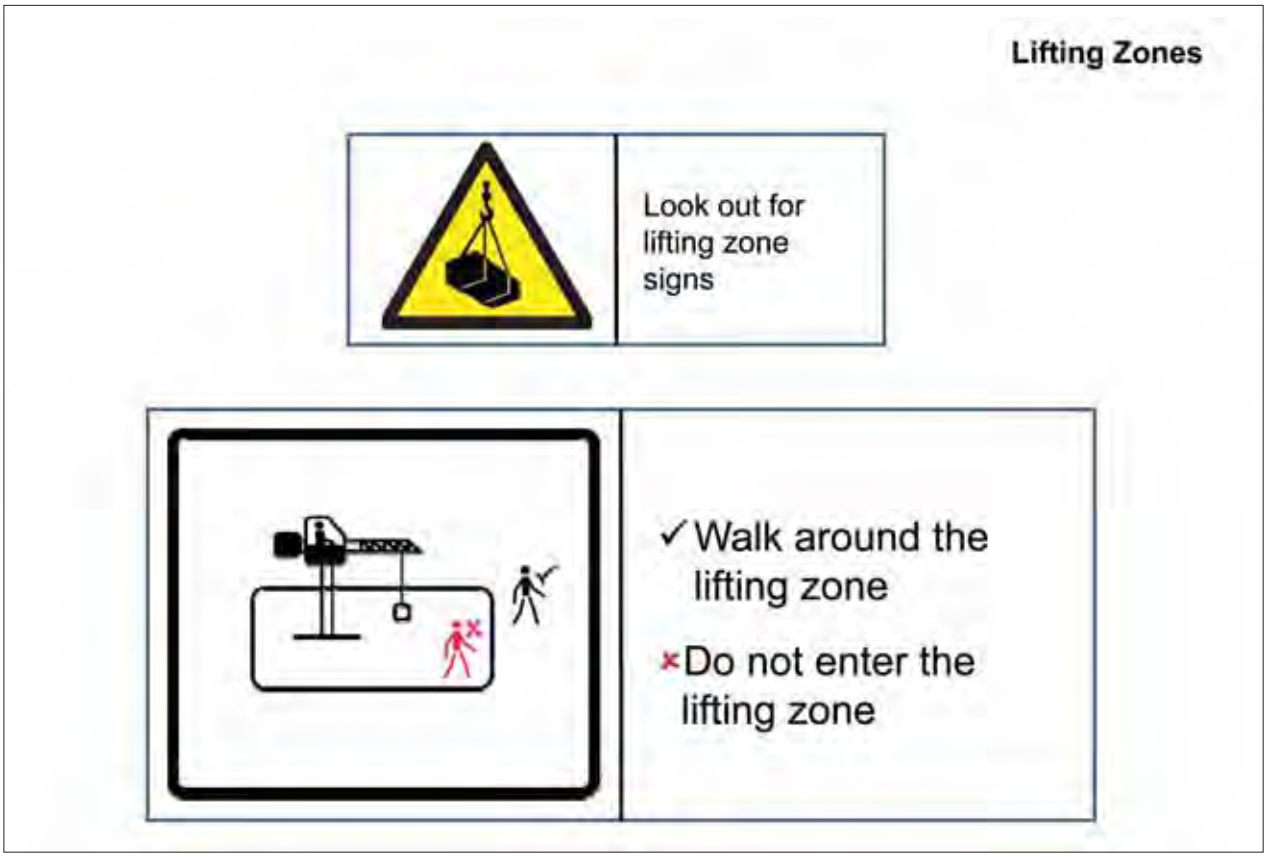
The sources of materials are as follows:

- Sketch drawings: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London.
- Pictograms: Developed as part of a contract for ConstructionSkills entitled ‘Critical safety images: the development of products to support the communication of health and safety knowledge between non/low English speaking construction workers and English speaking site managers’, November 2008.
- Photographs: Bovis Lend Lease toolbox talks and site audit photographs.





Source: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London



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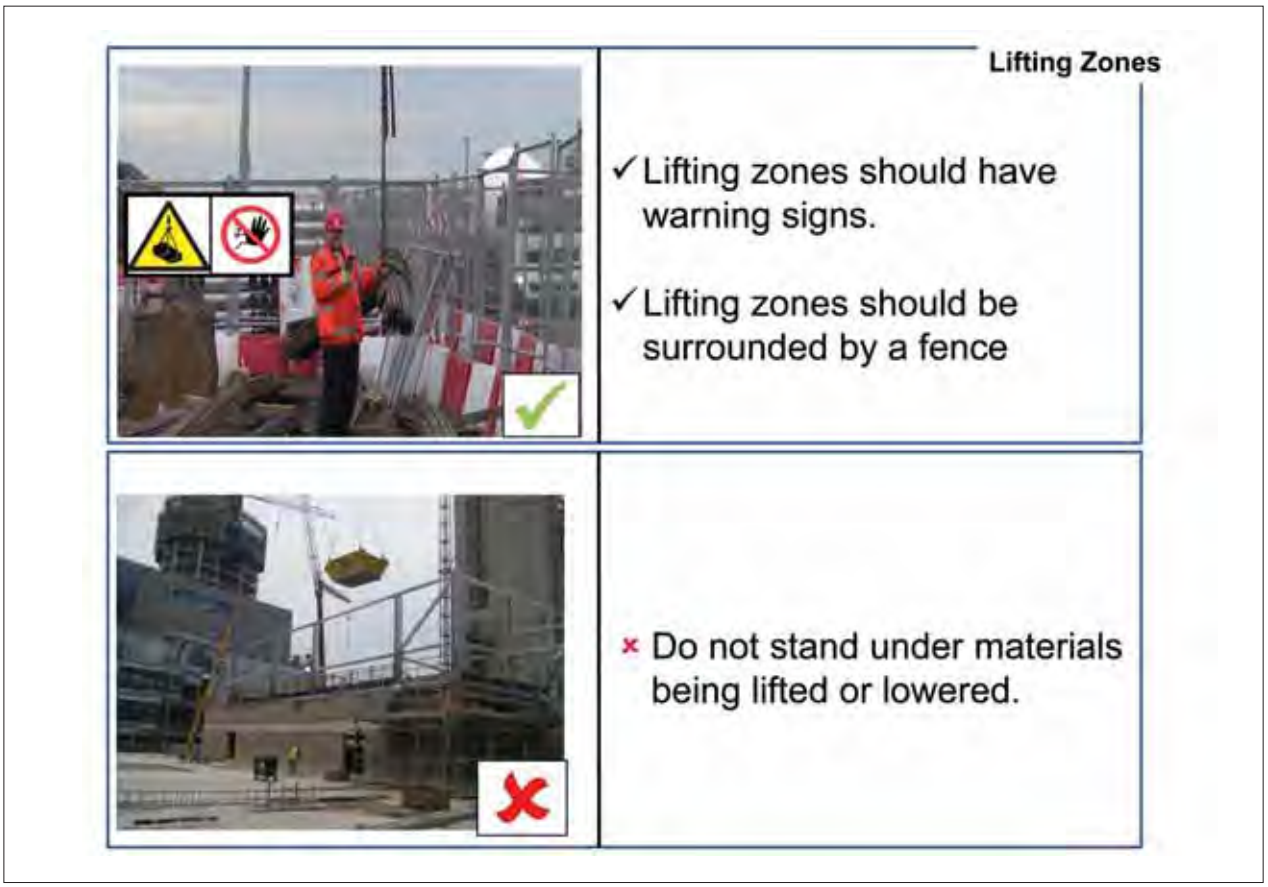

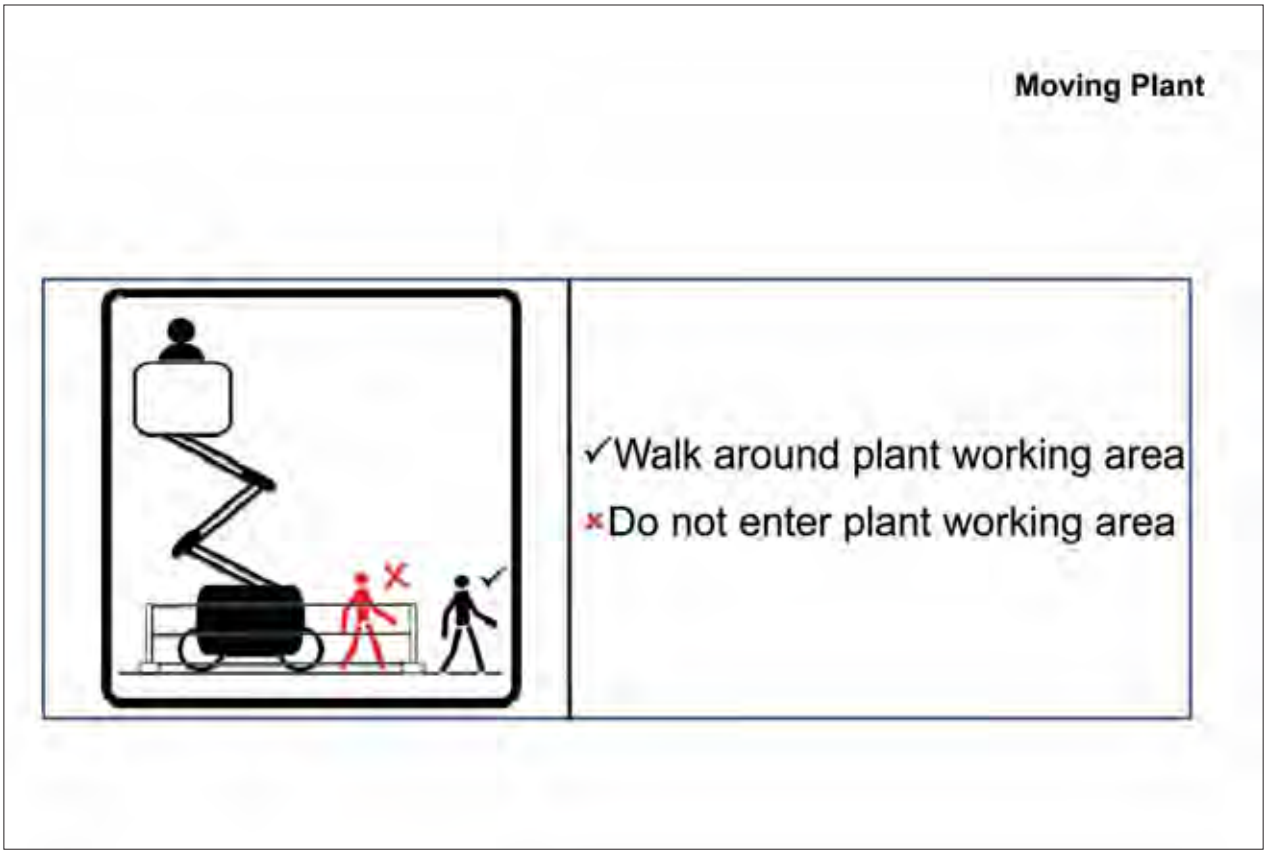

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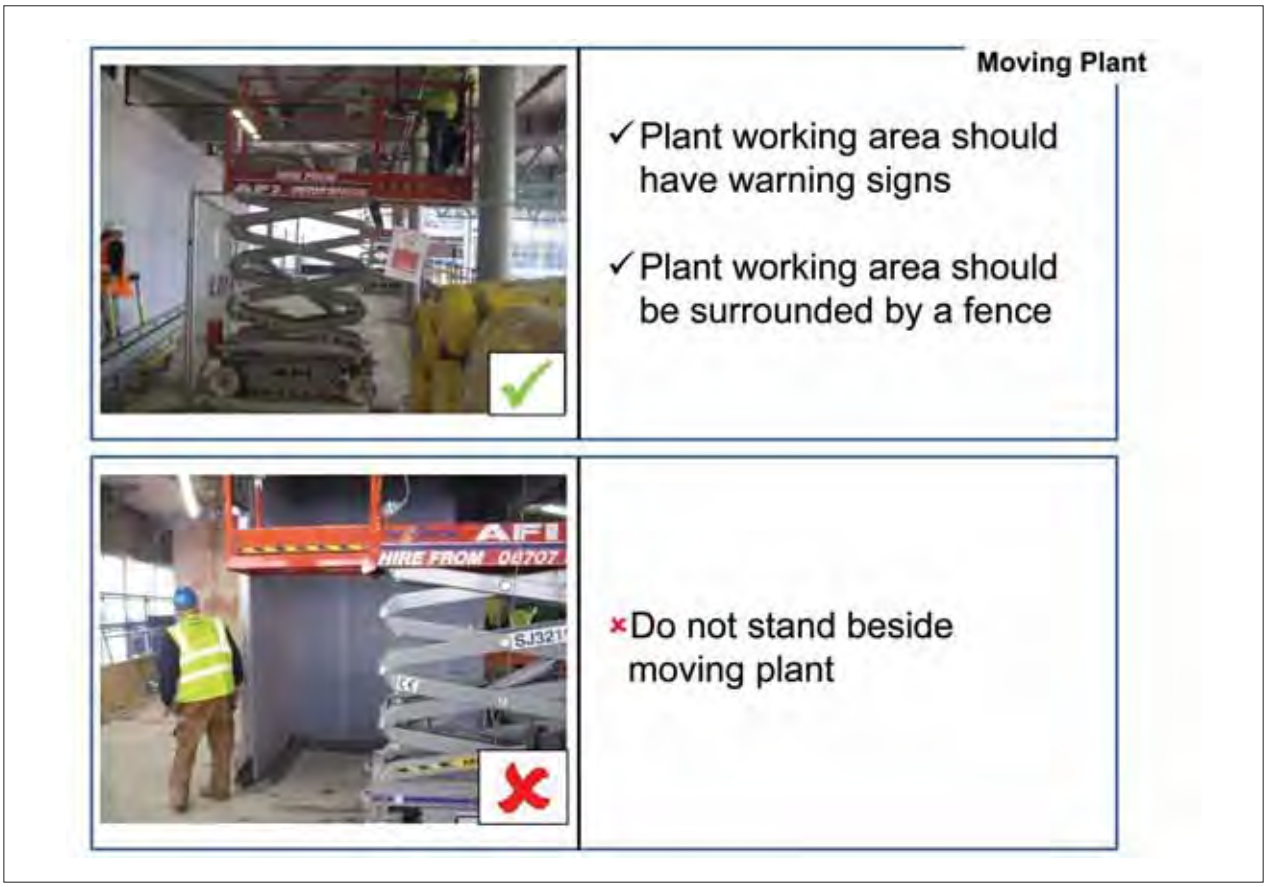

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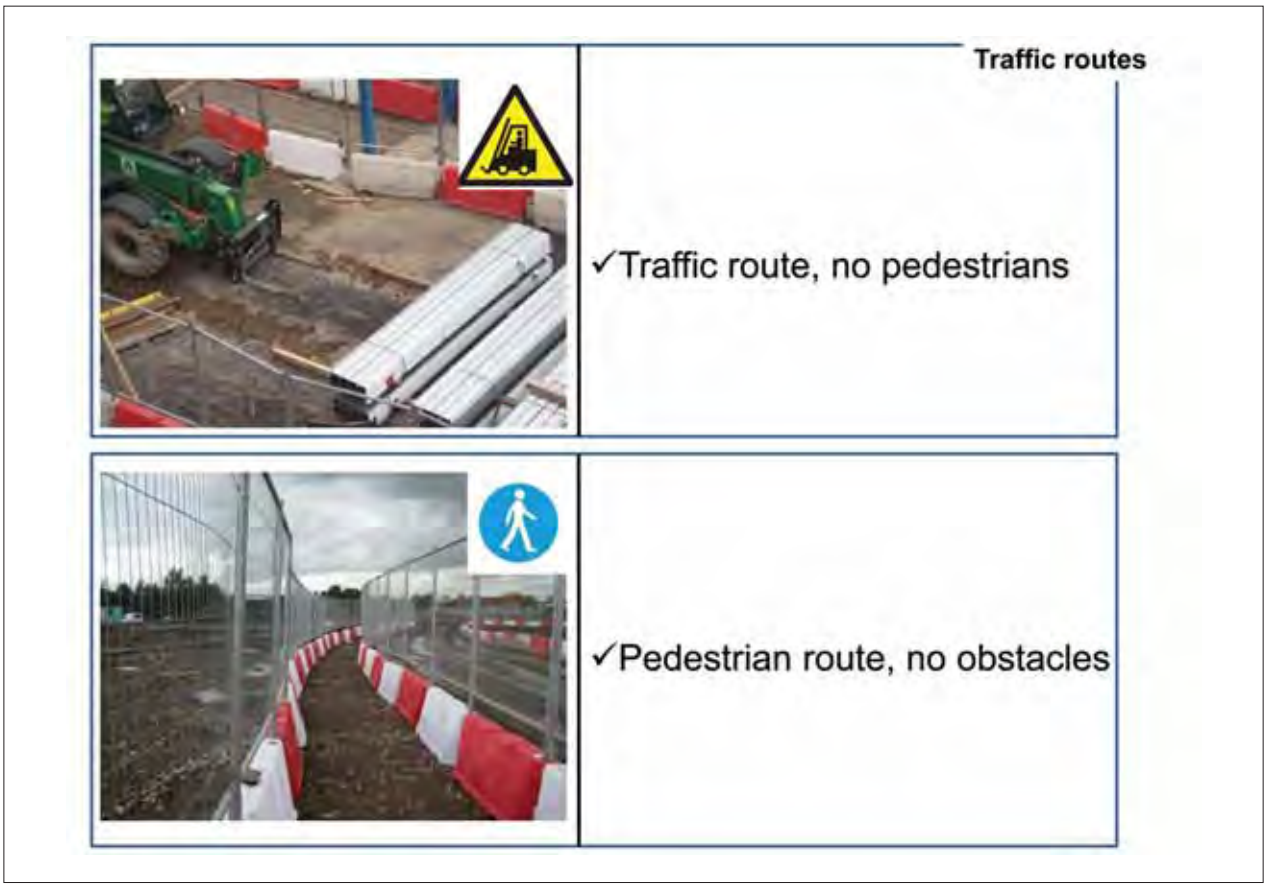

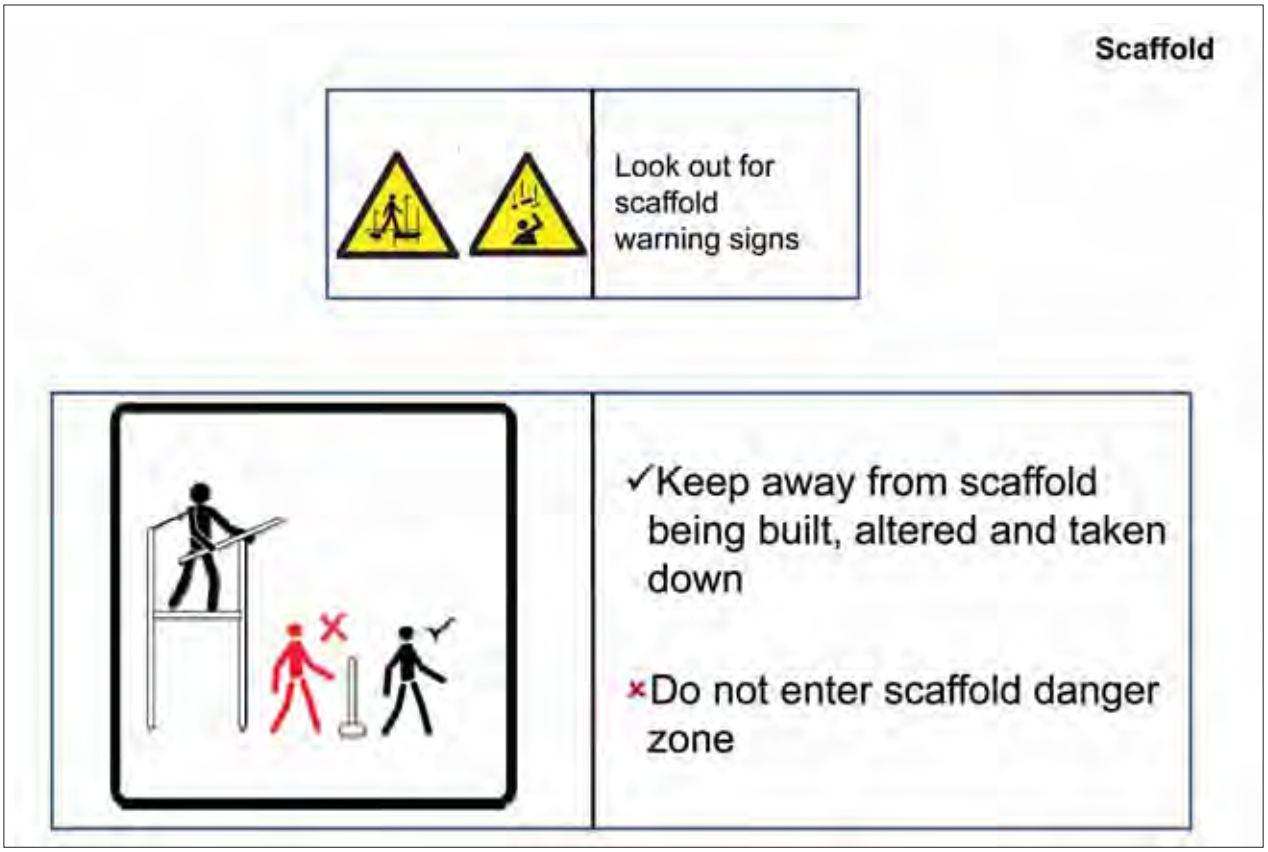

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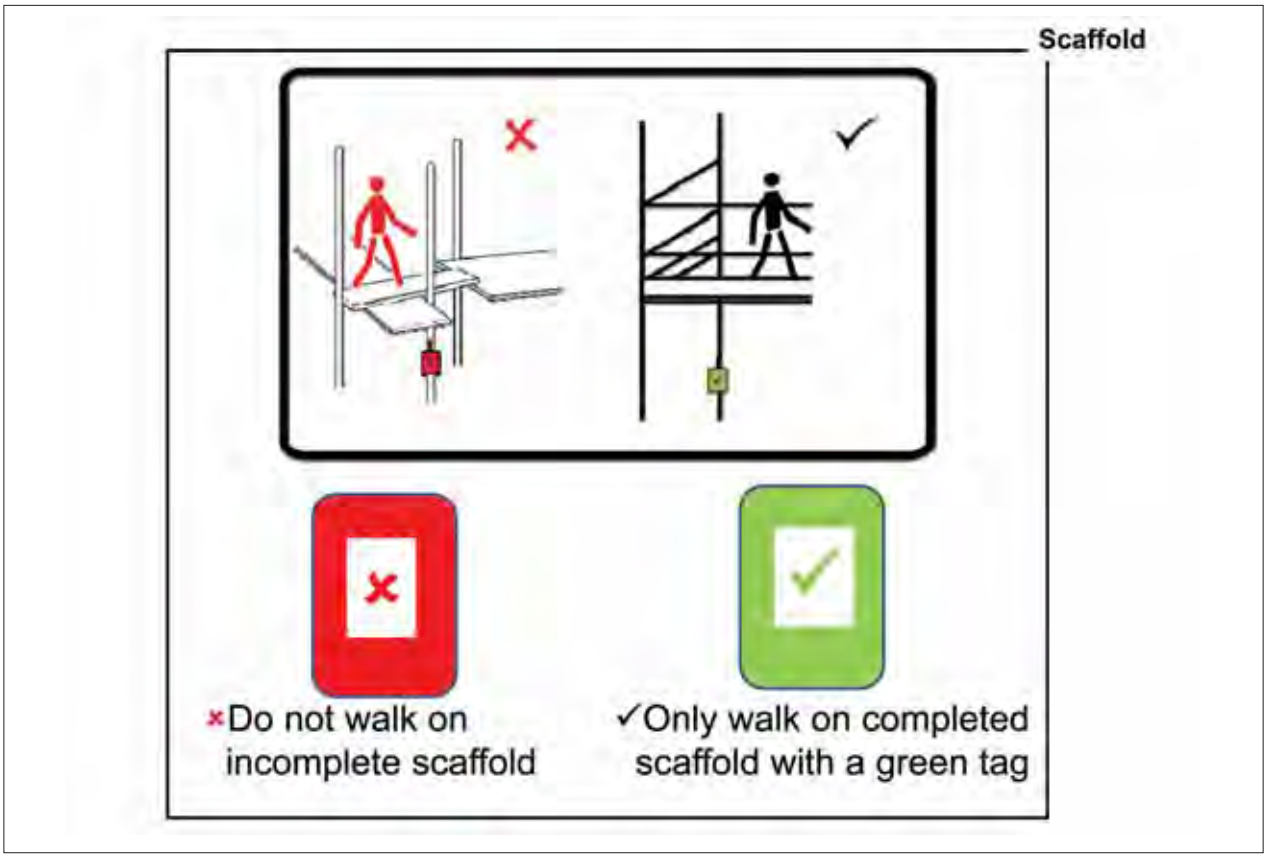

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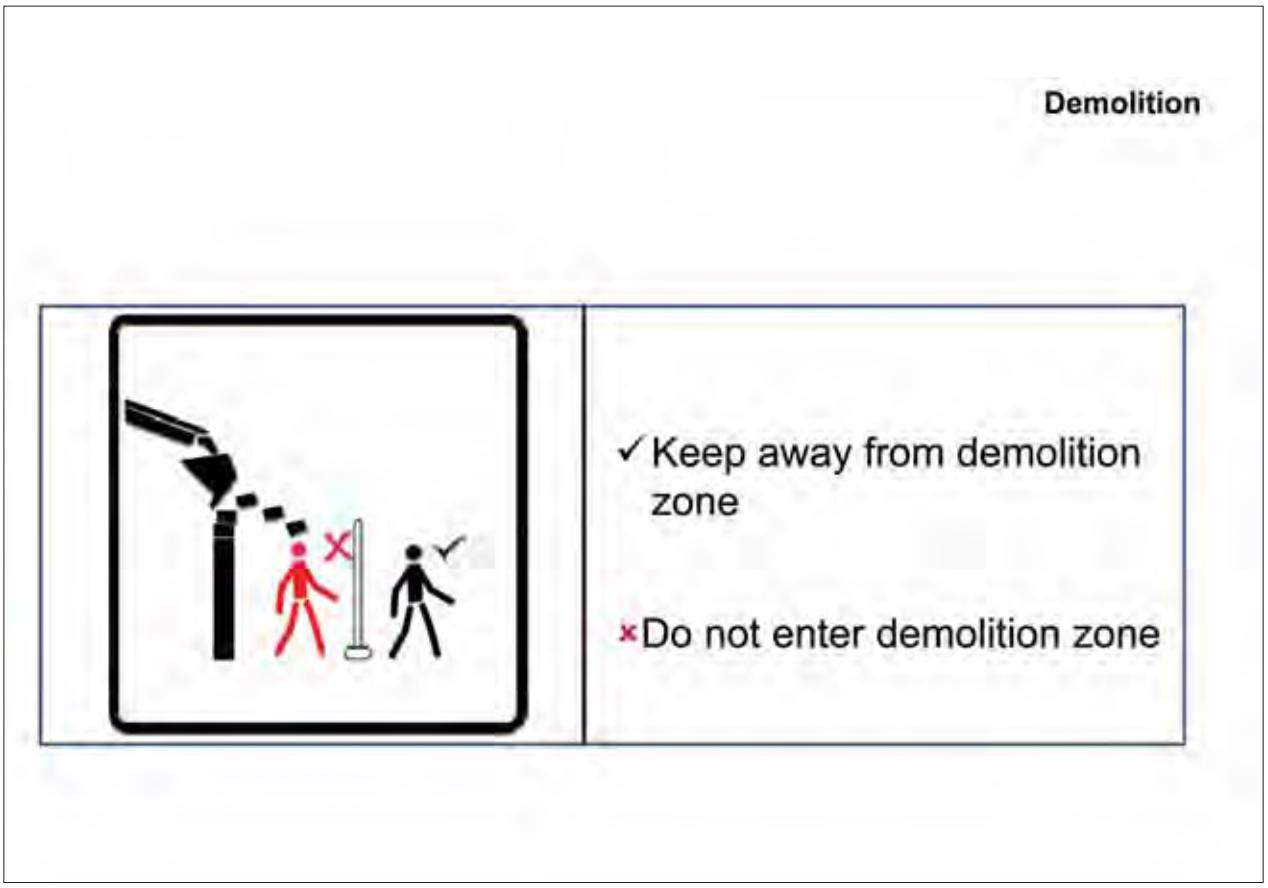

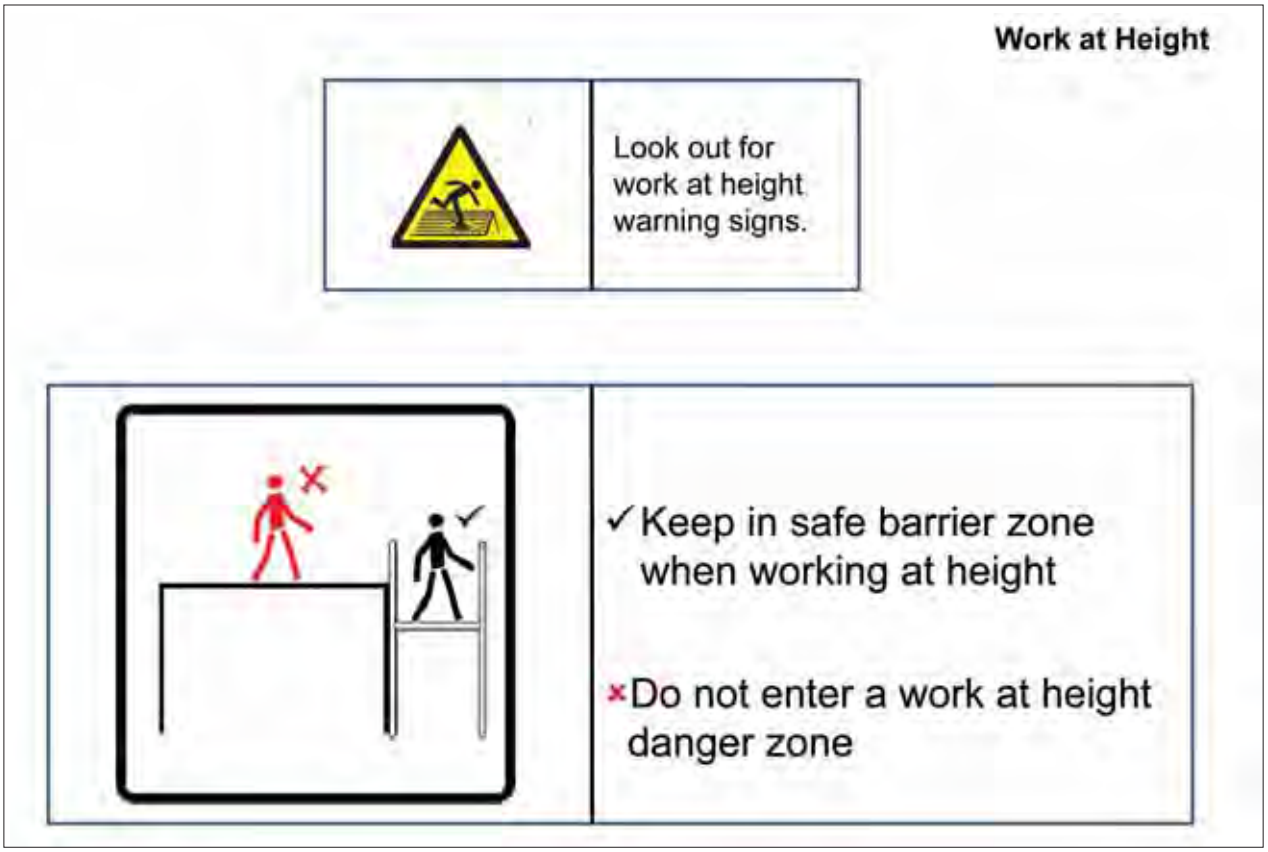

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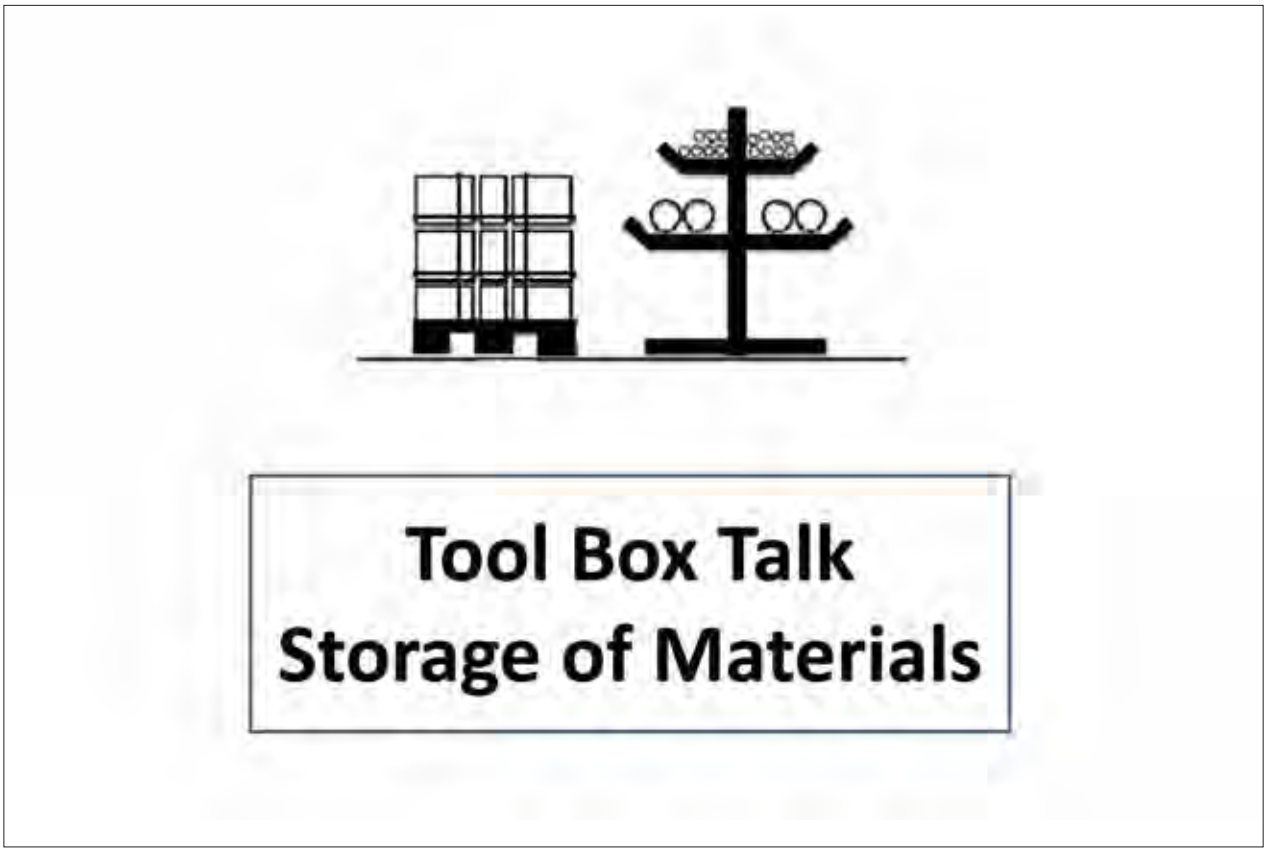
Permit to Work

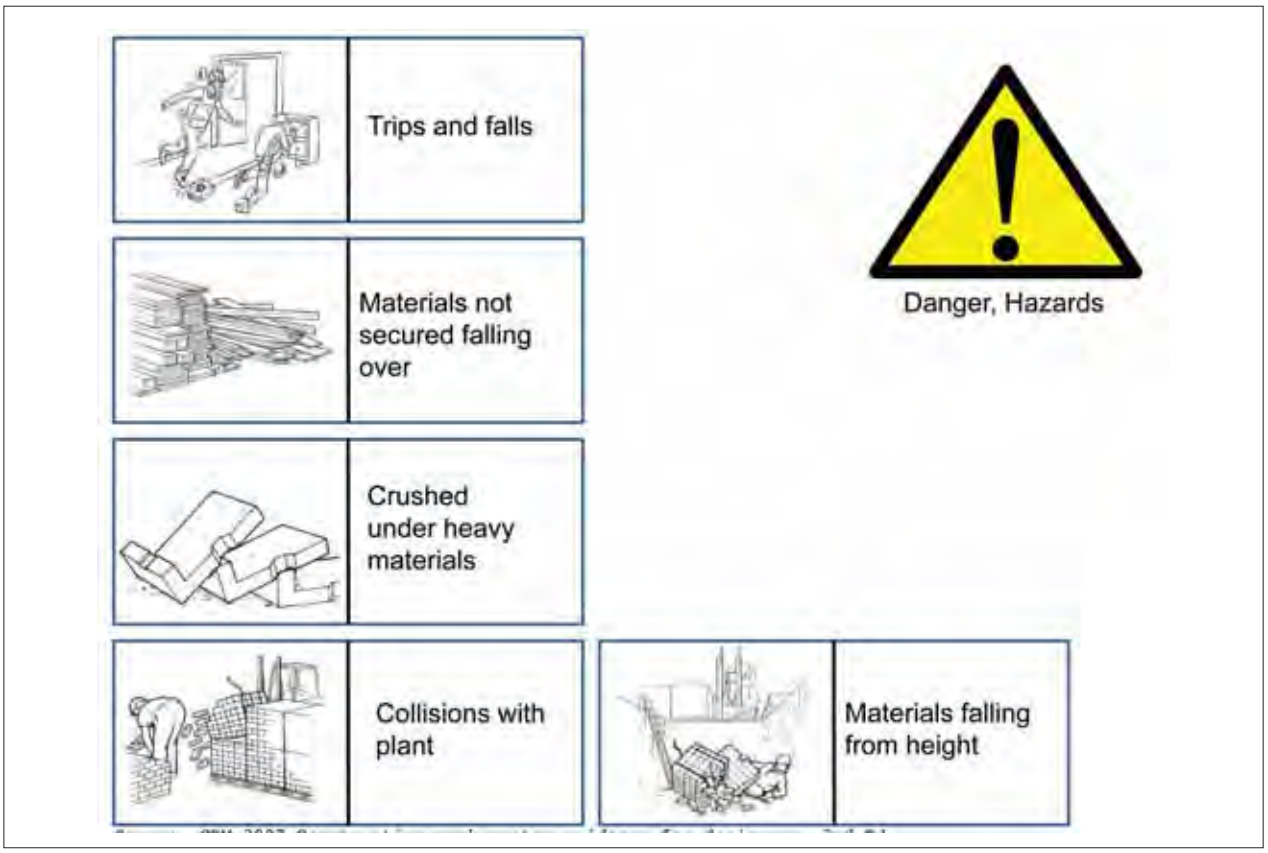
✓Wear your permit to work in your armband

Permit to Work

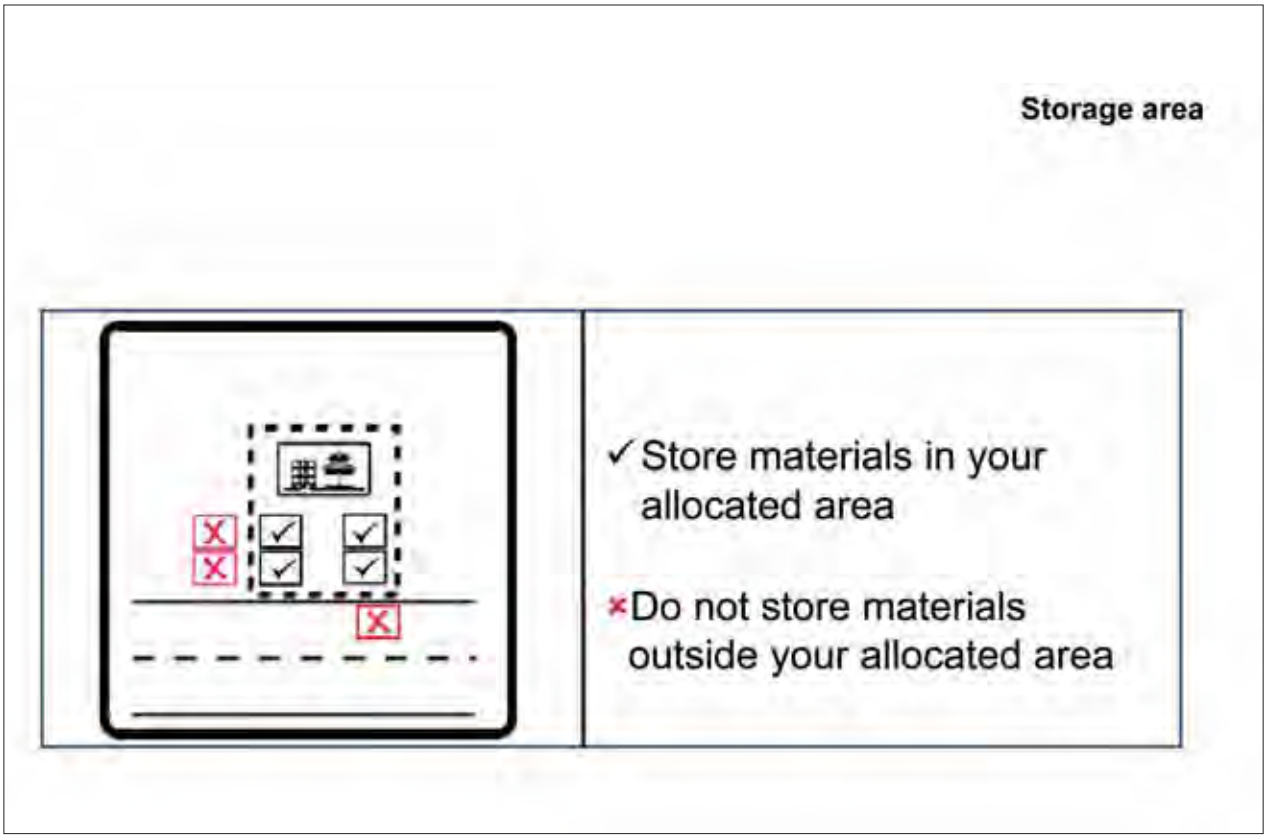
✓Permit to work zones should be clearly marked


Keep out of
Exclusion Zones





Source: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London



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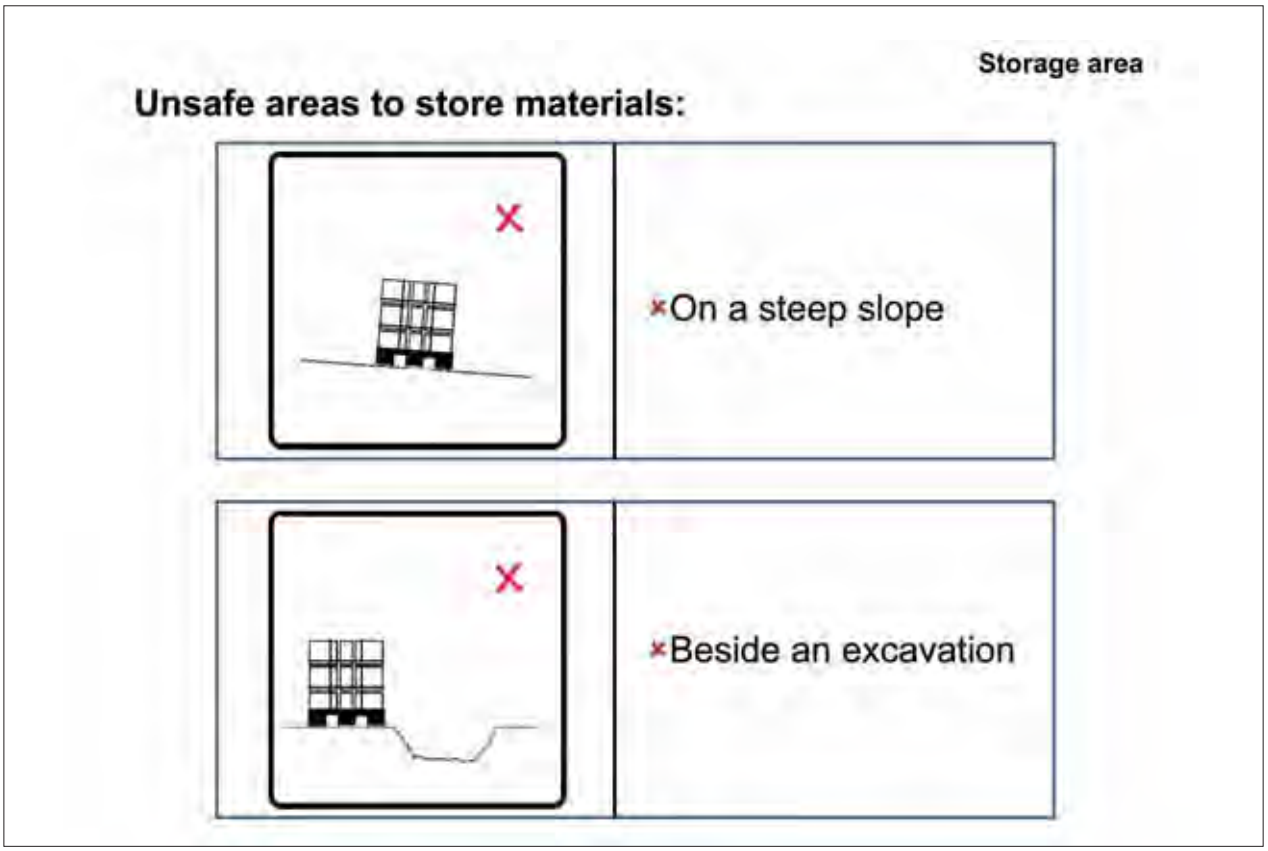

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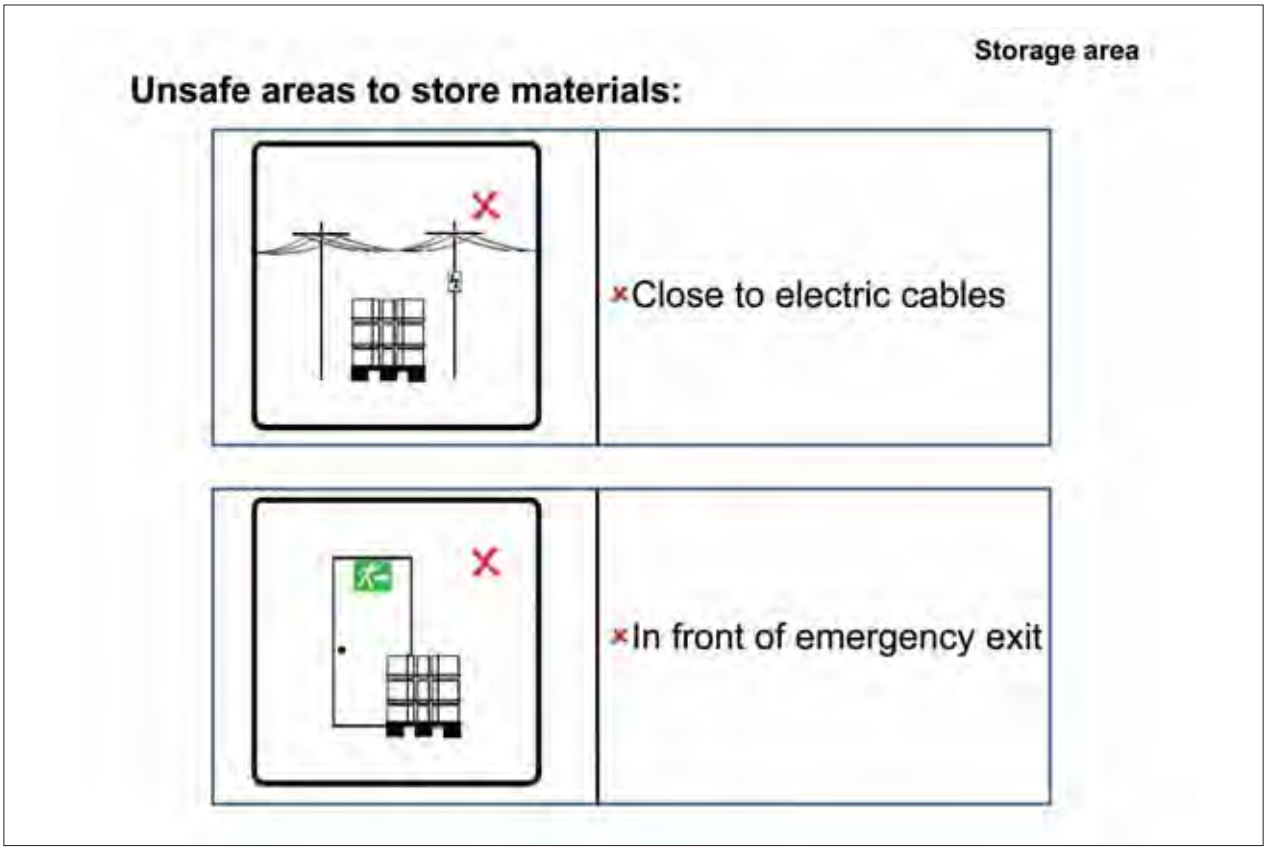

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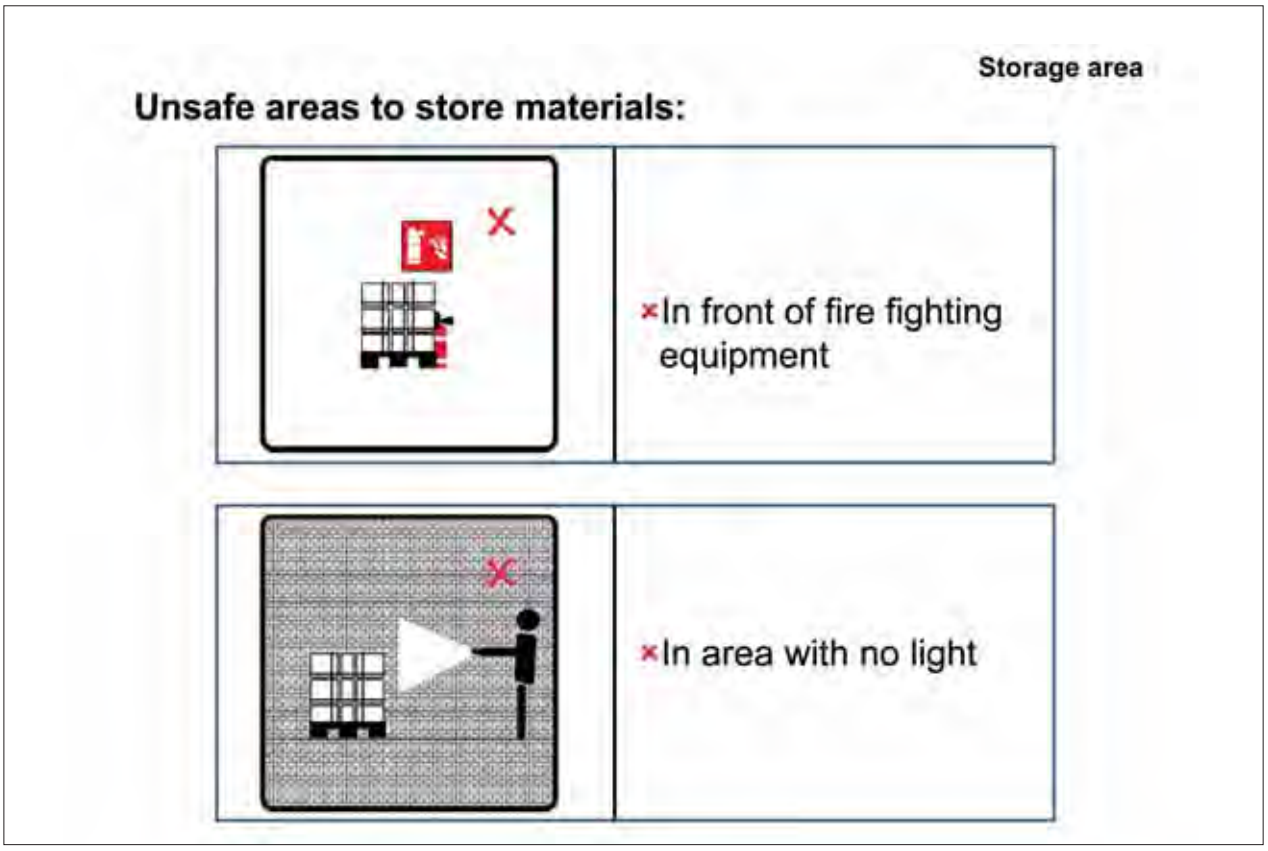

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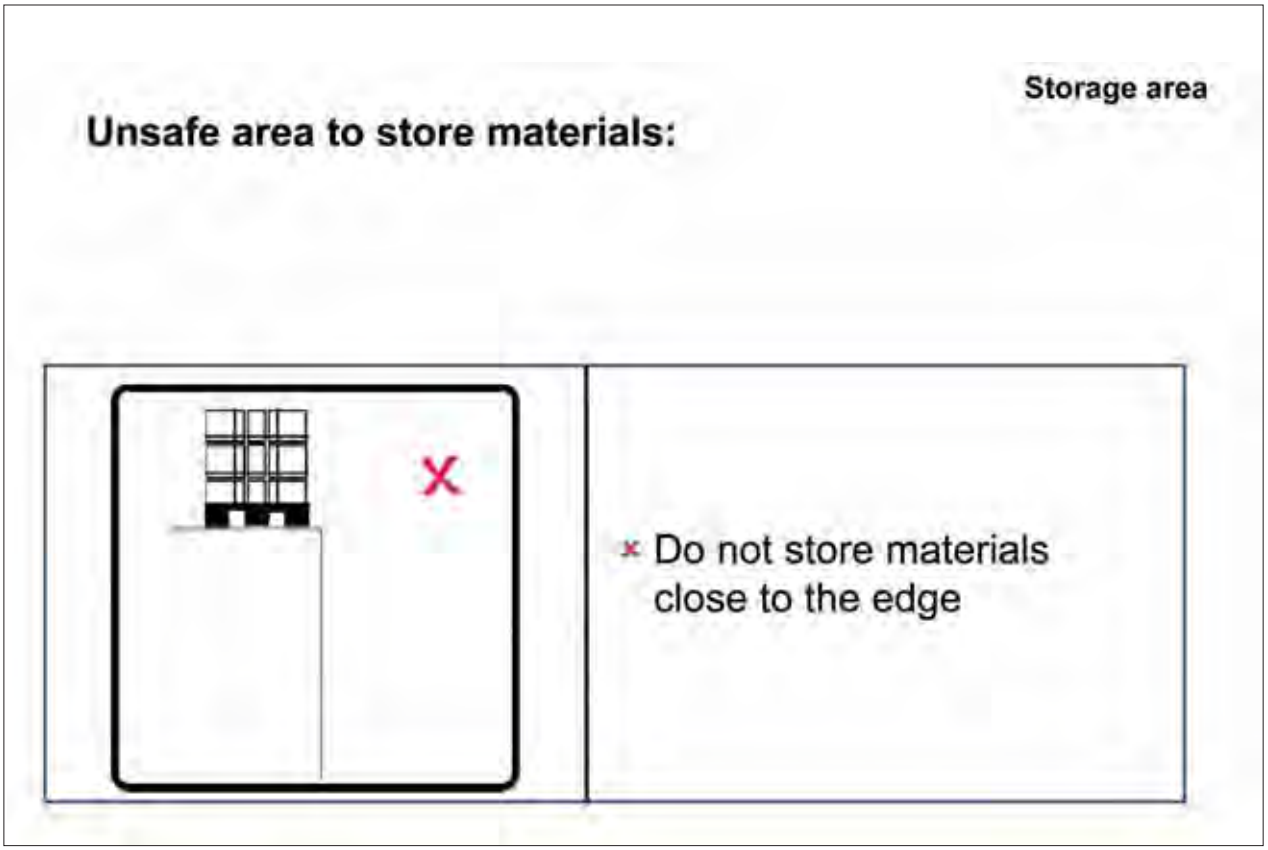

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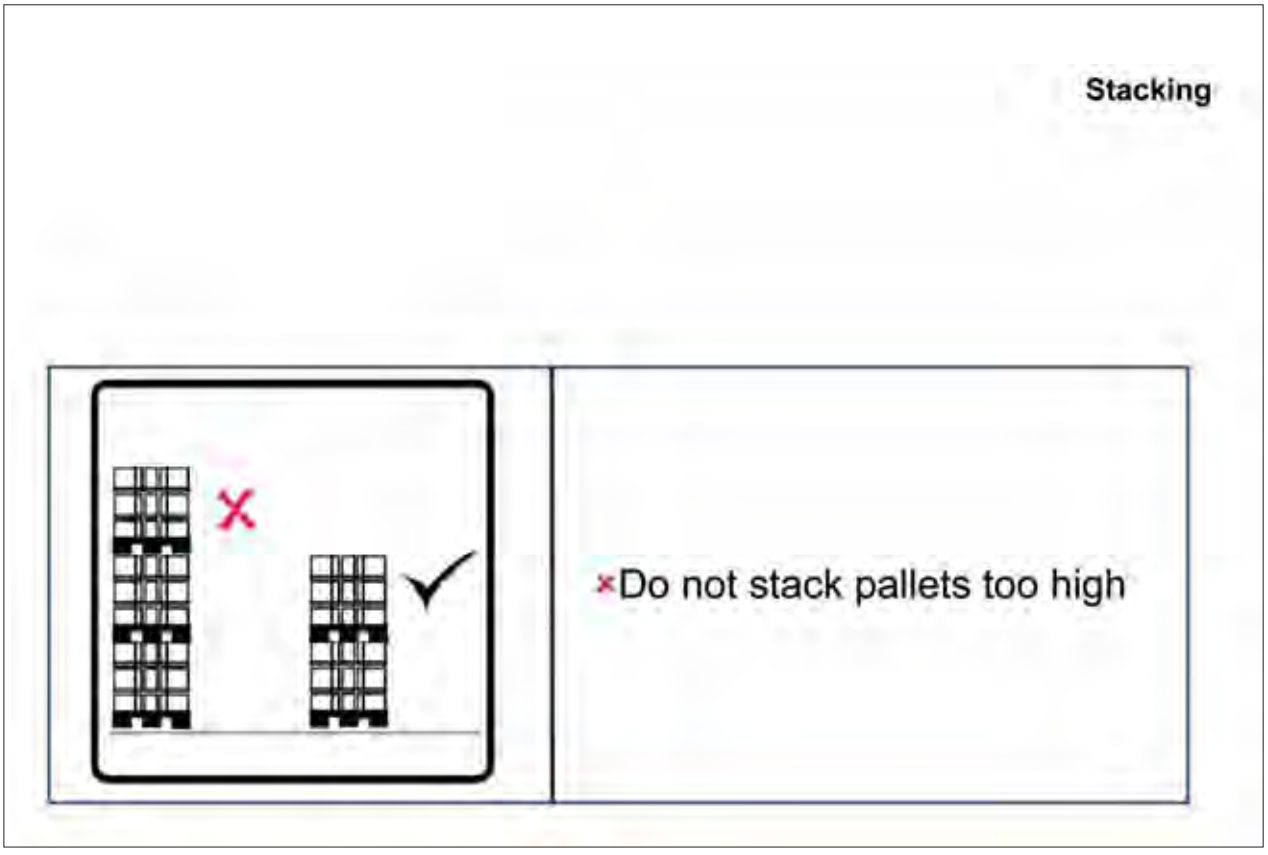

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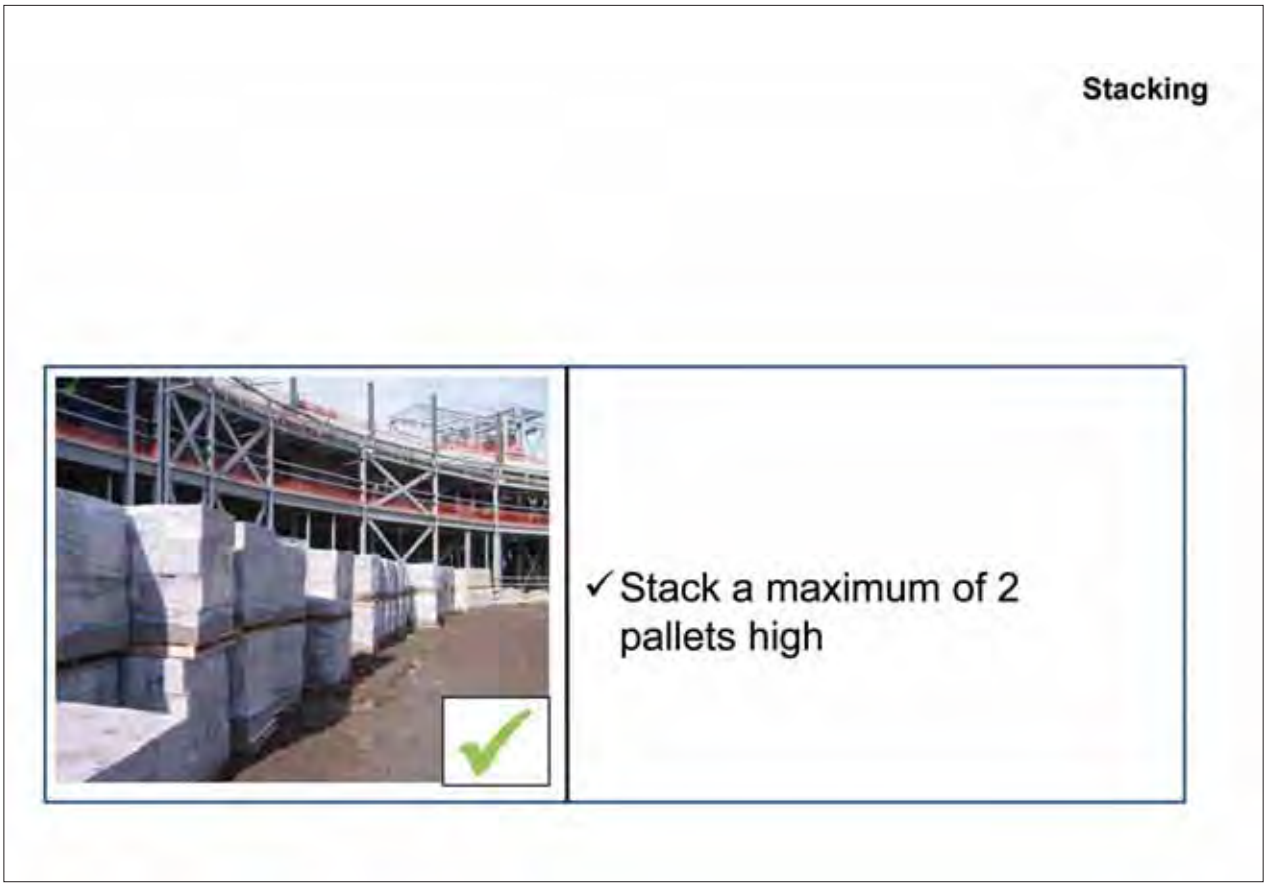

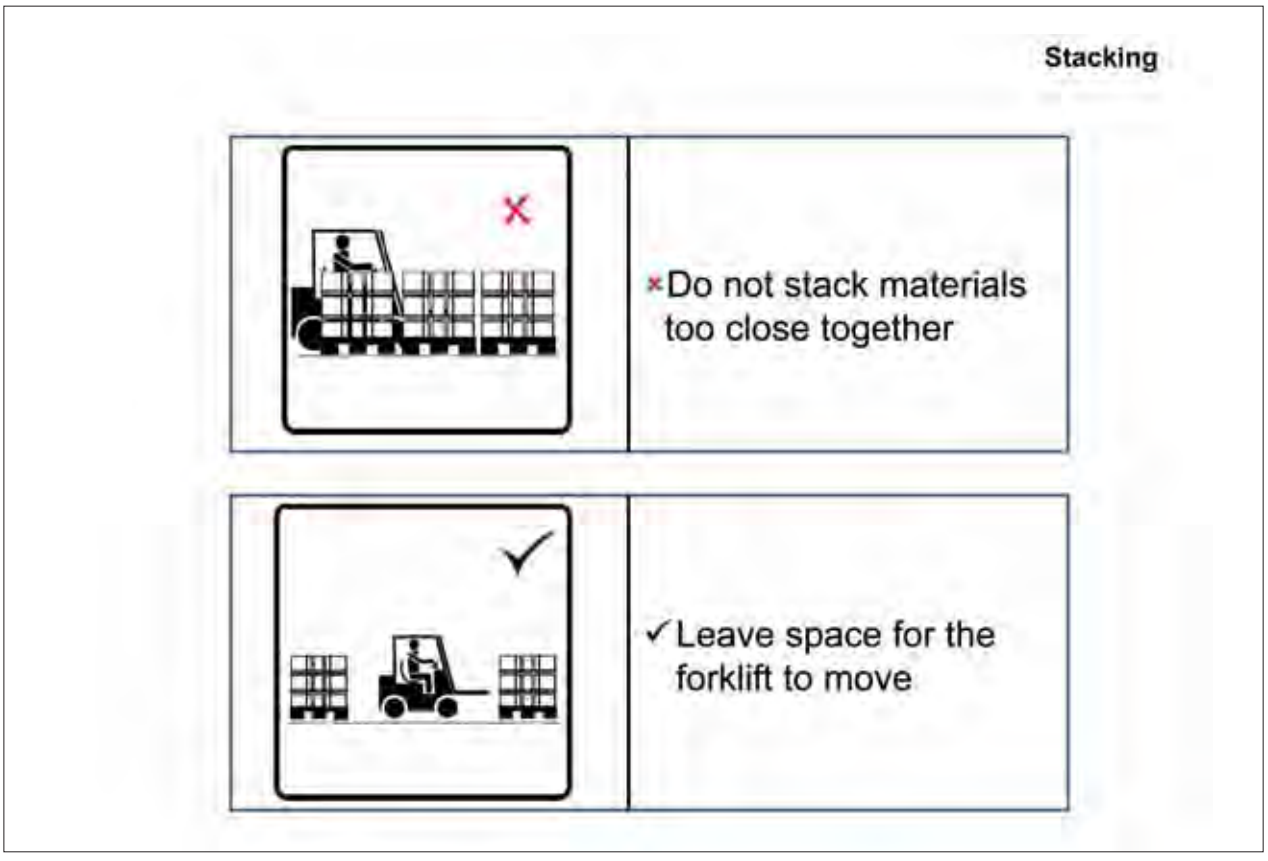

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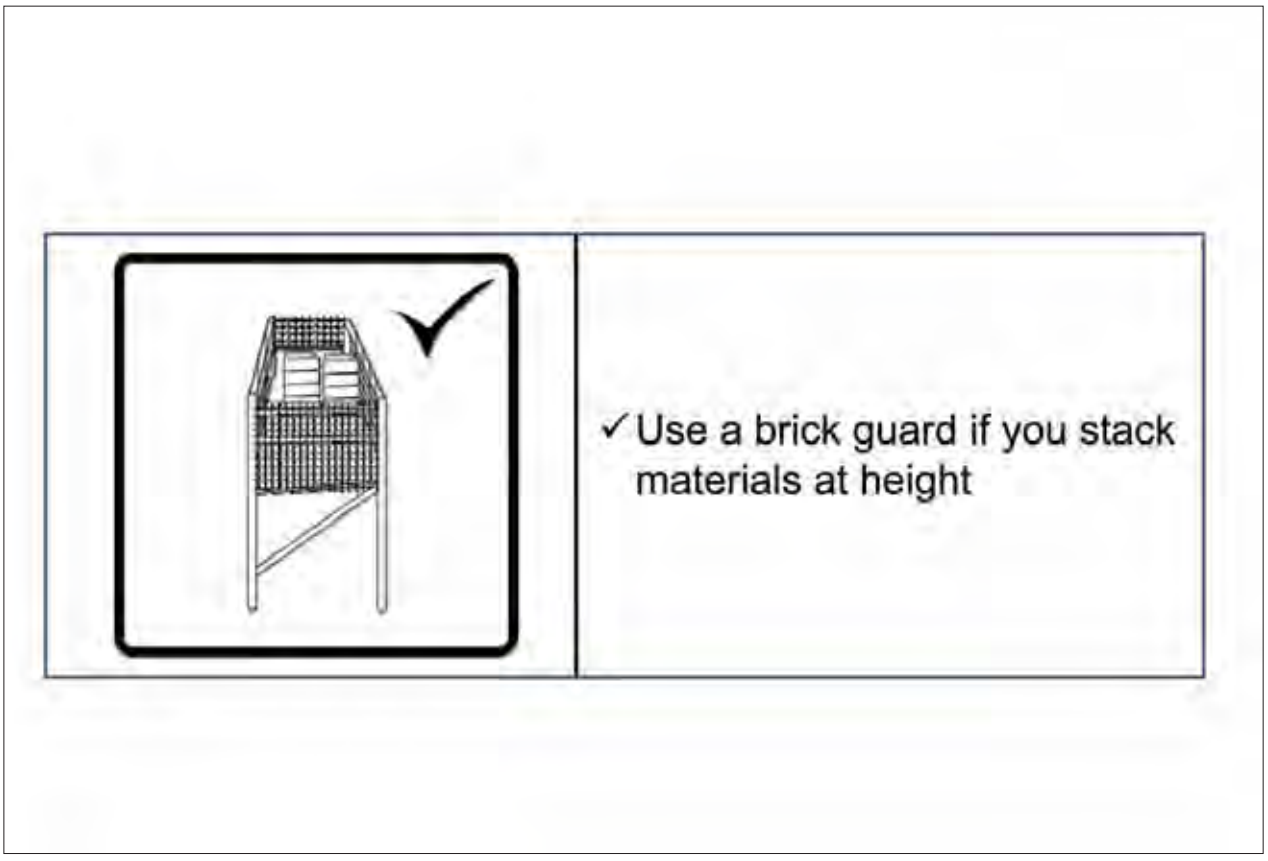

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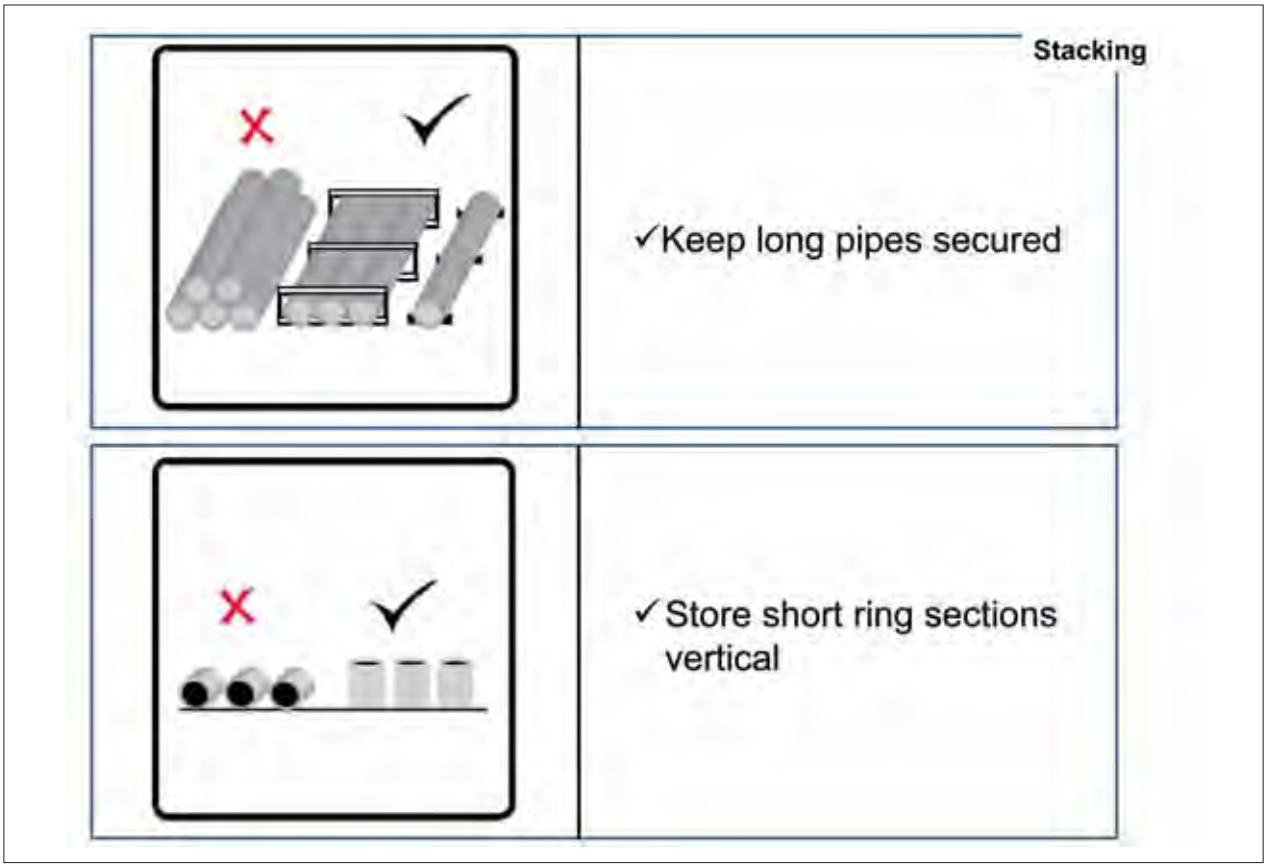

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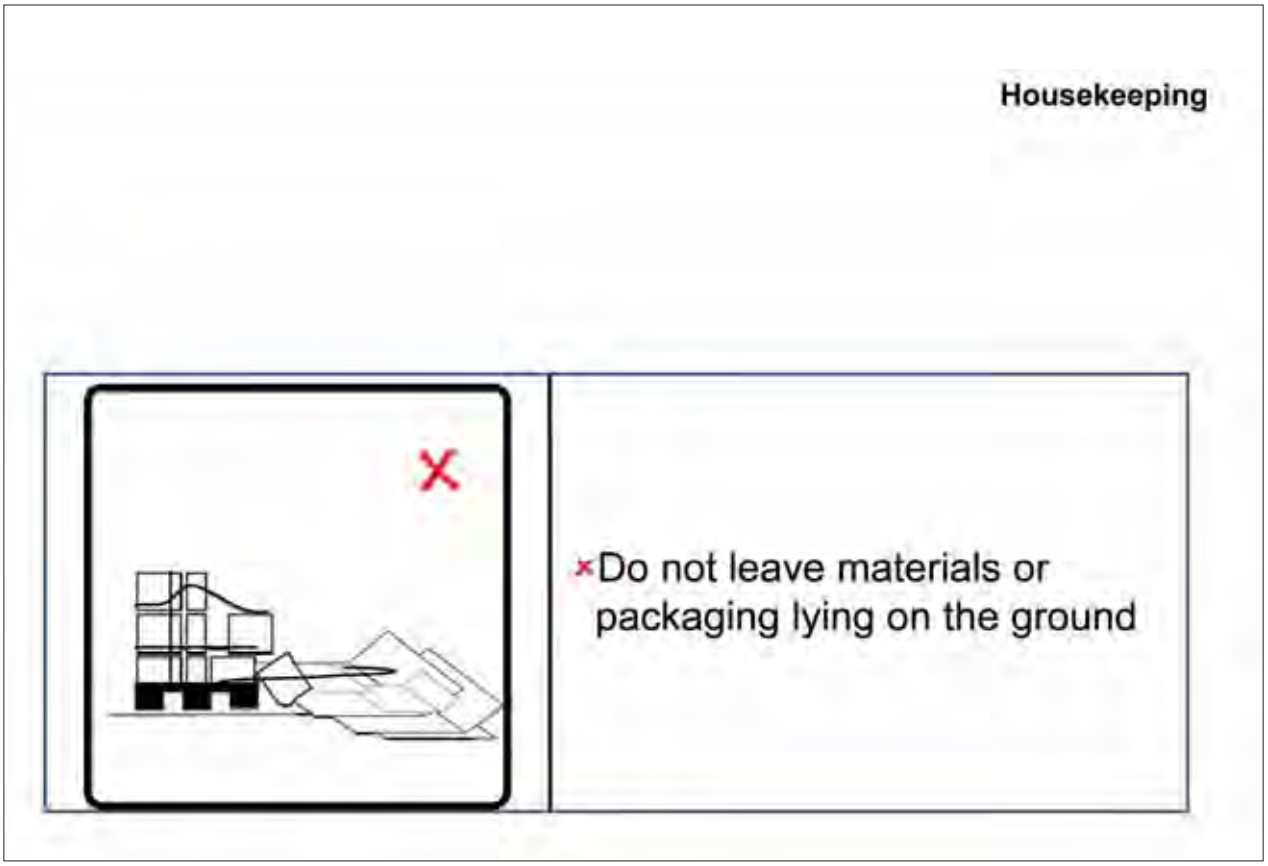

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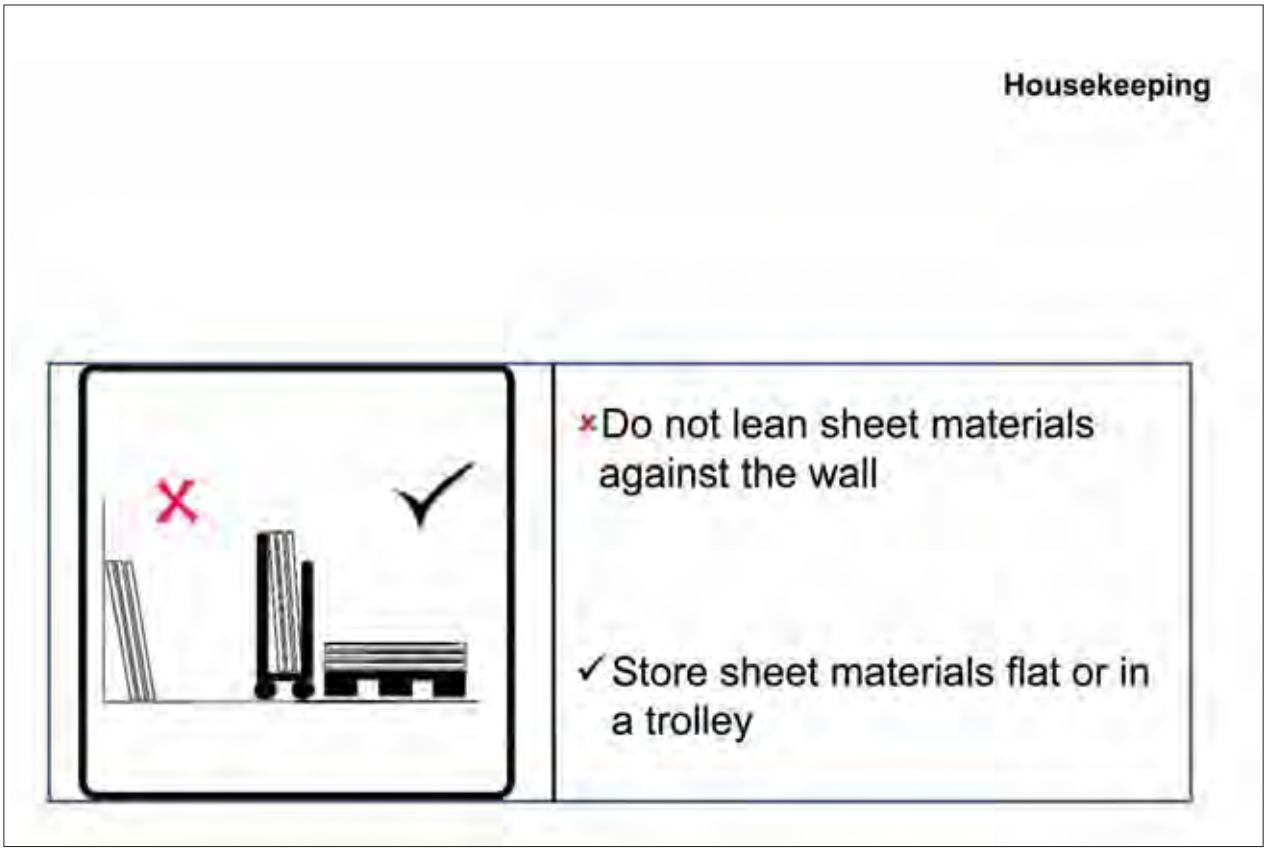

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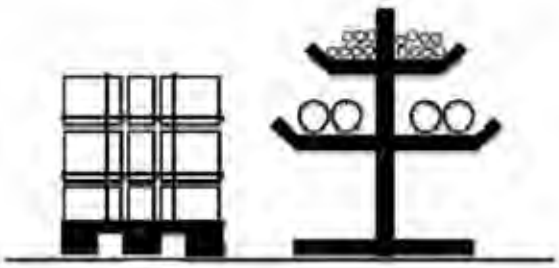
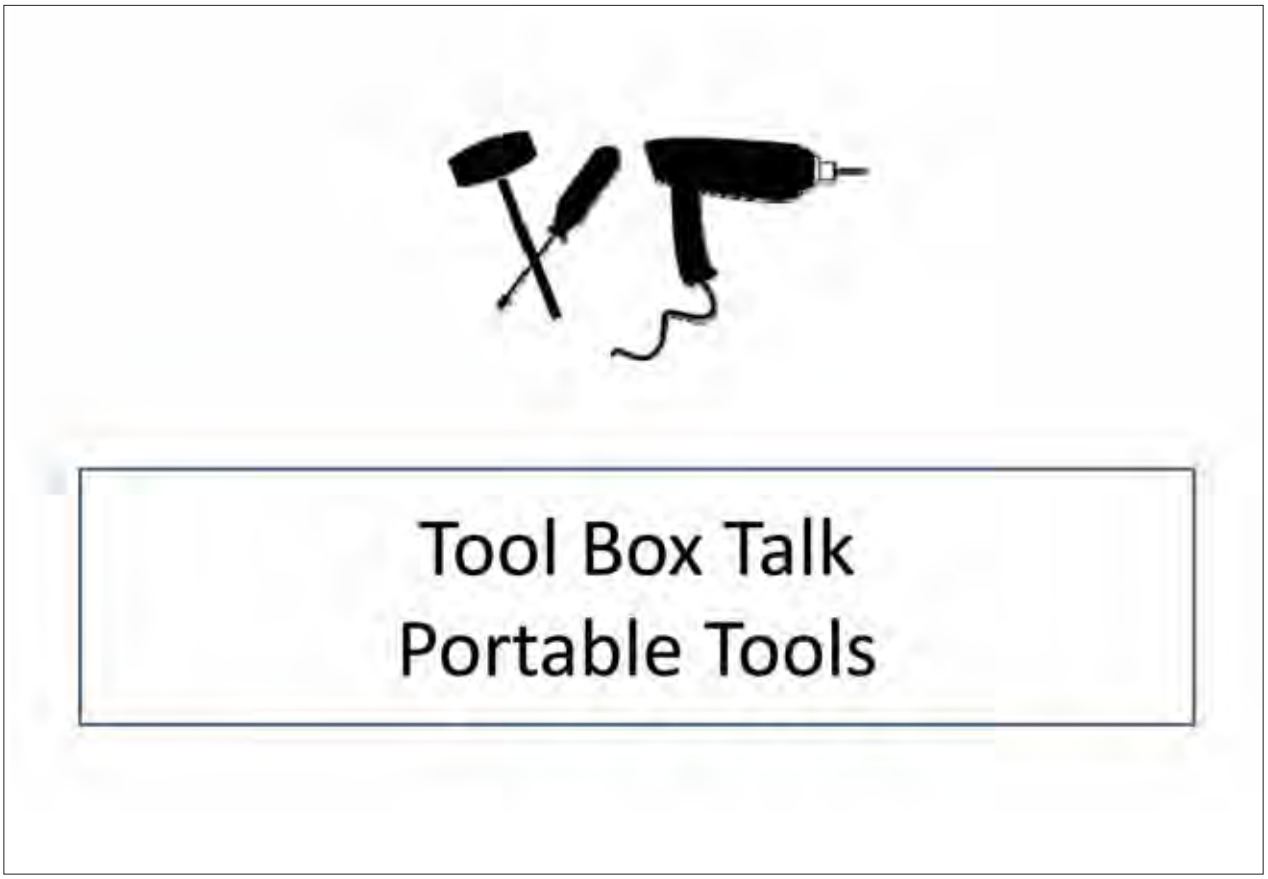
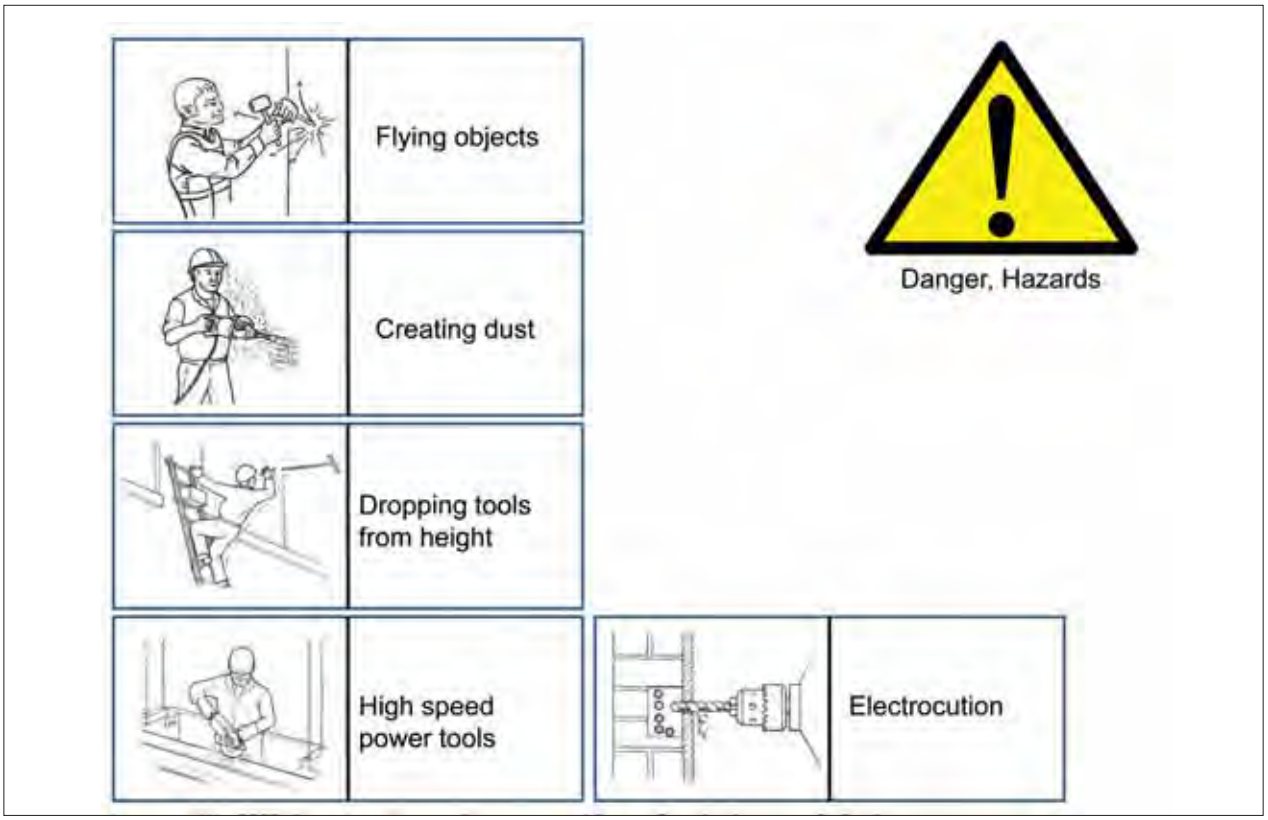
Housekeeping

✓Use storage devices for materials that cannot be easily stacked

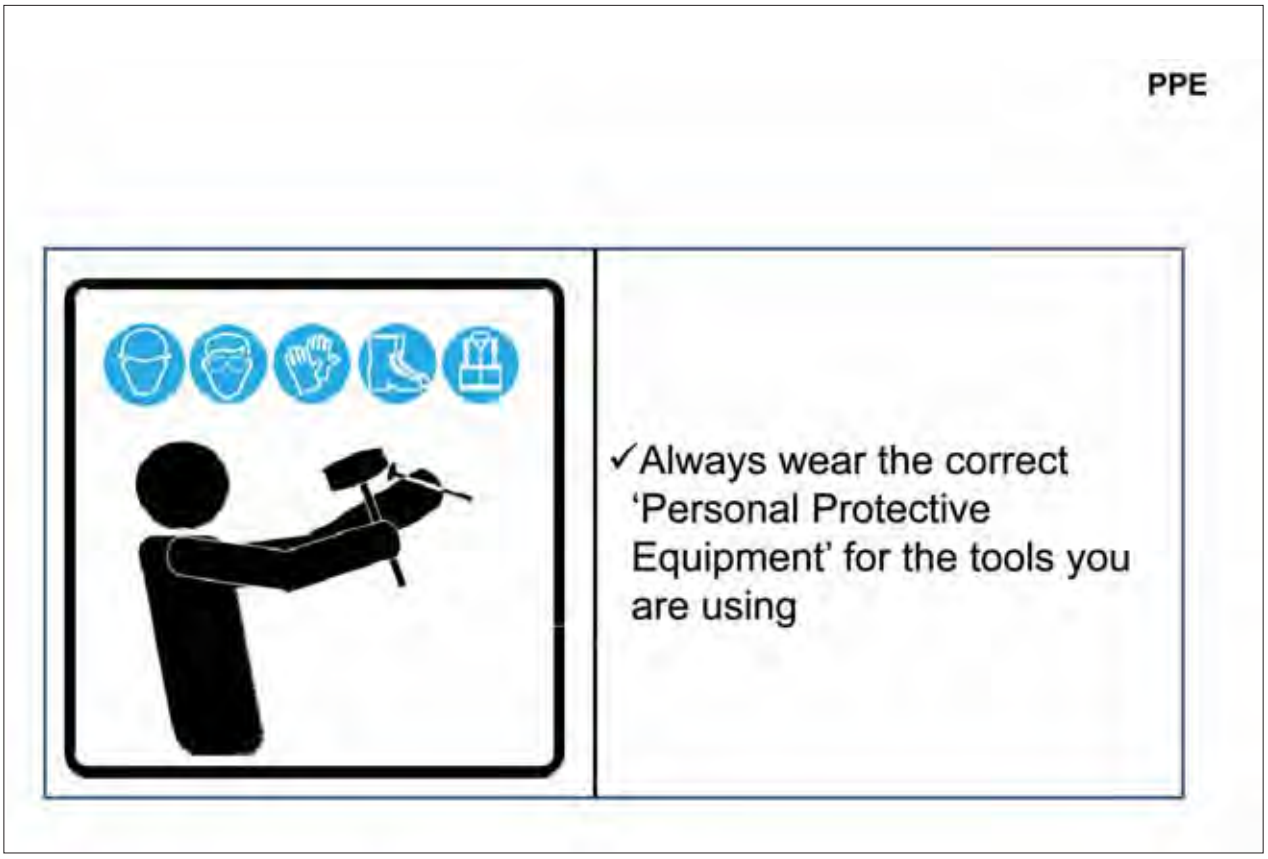


Store materials safely





Source: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London



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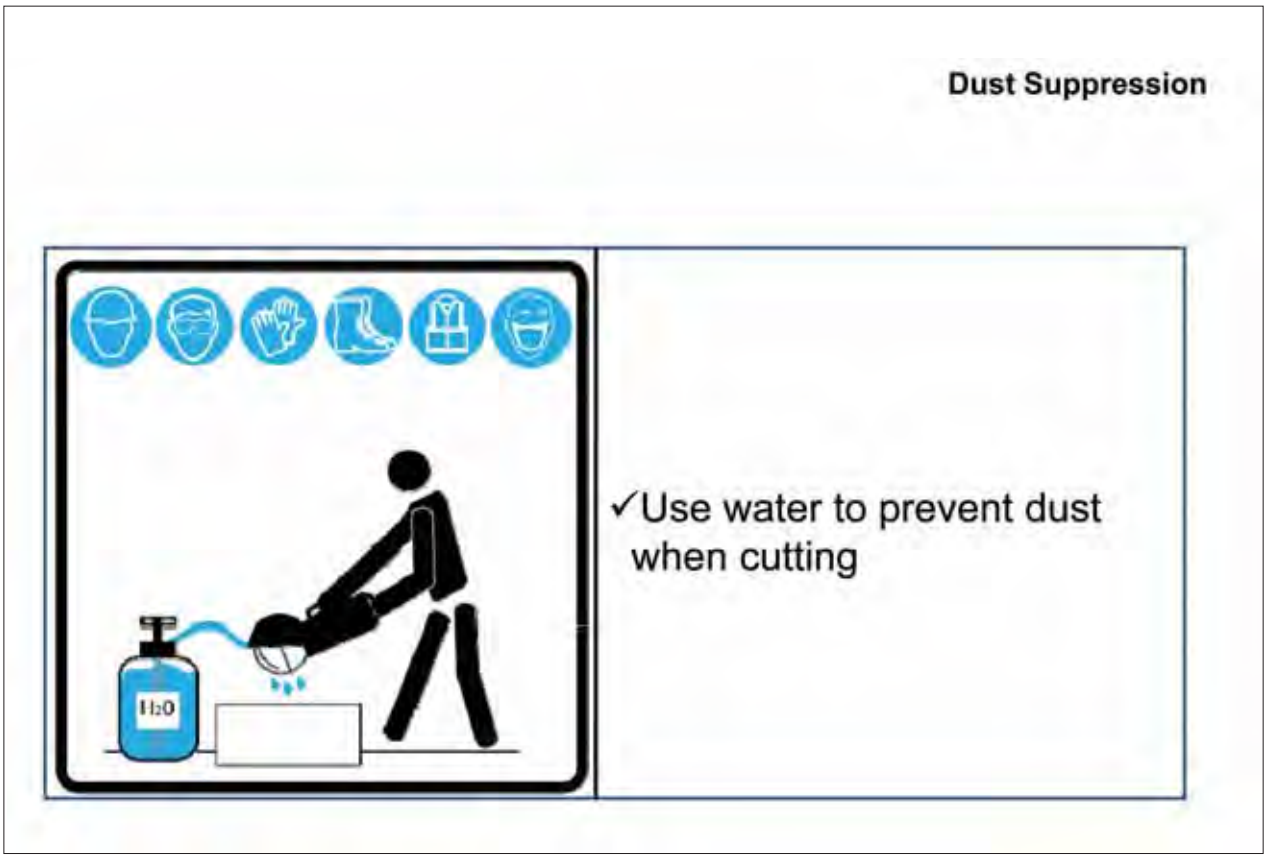

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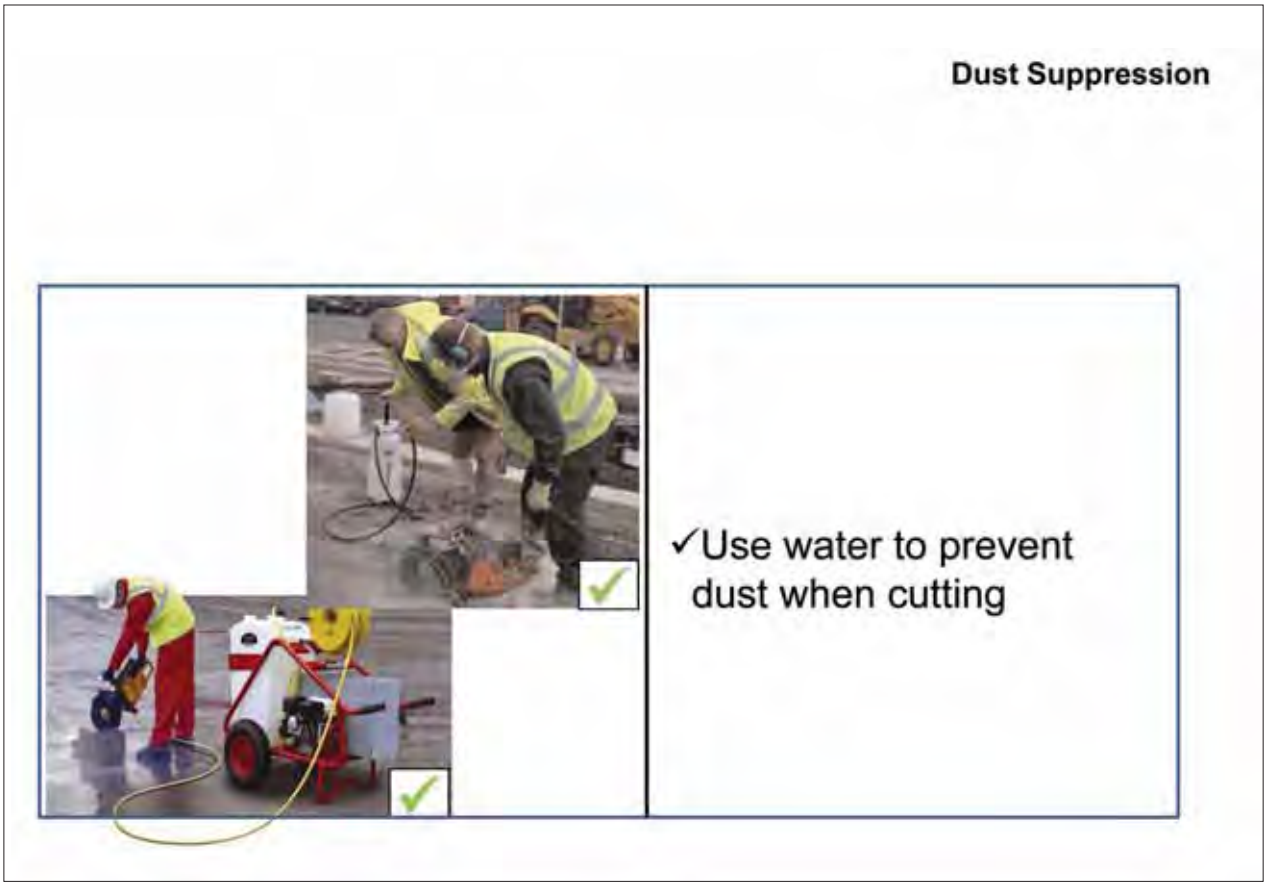

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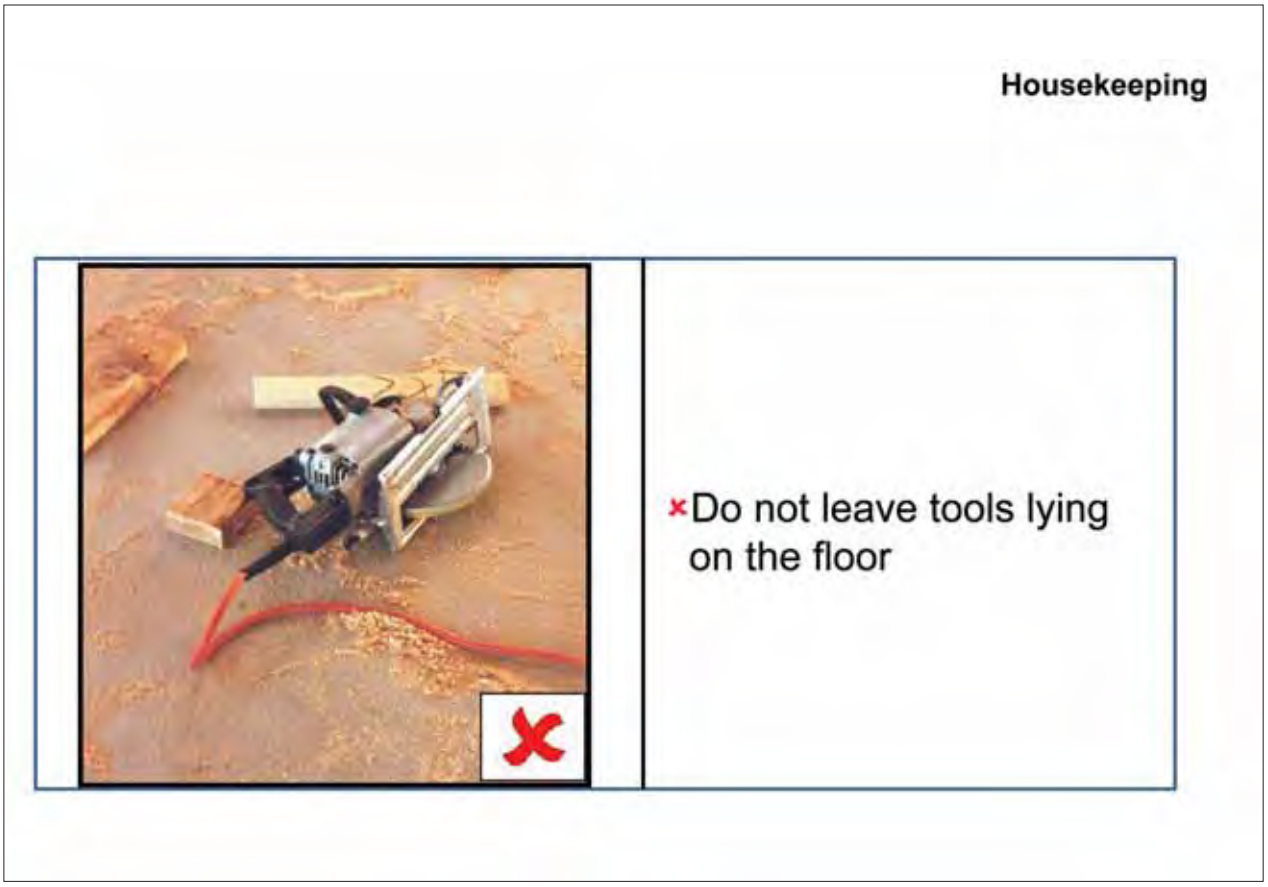

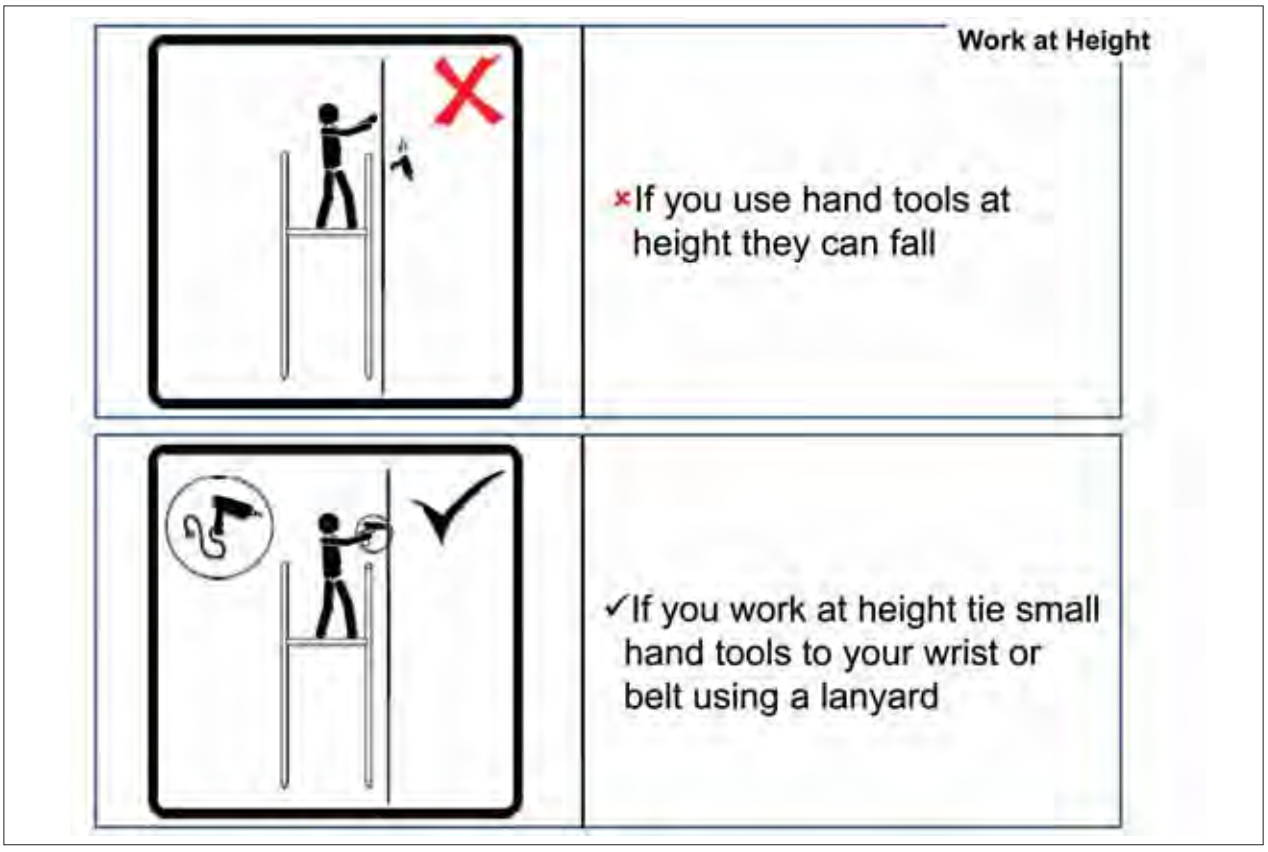

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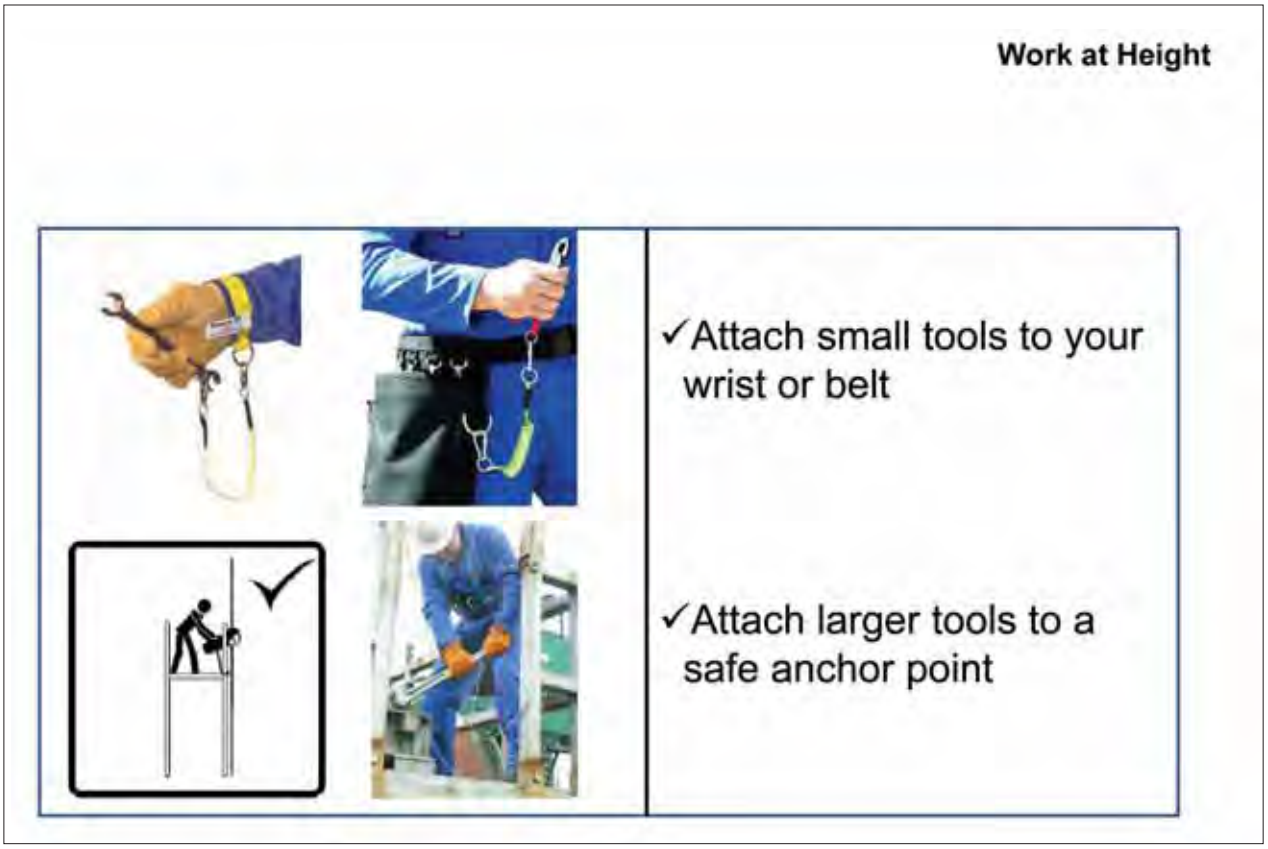

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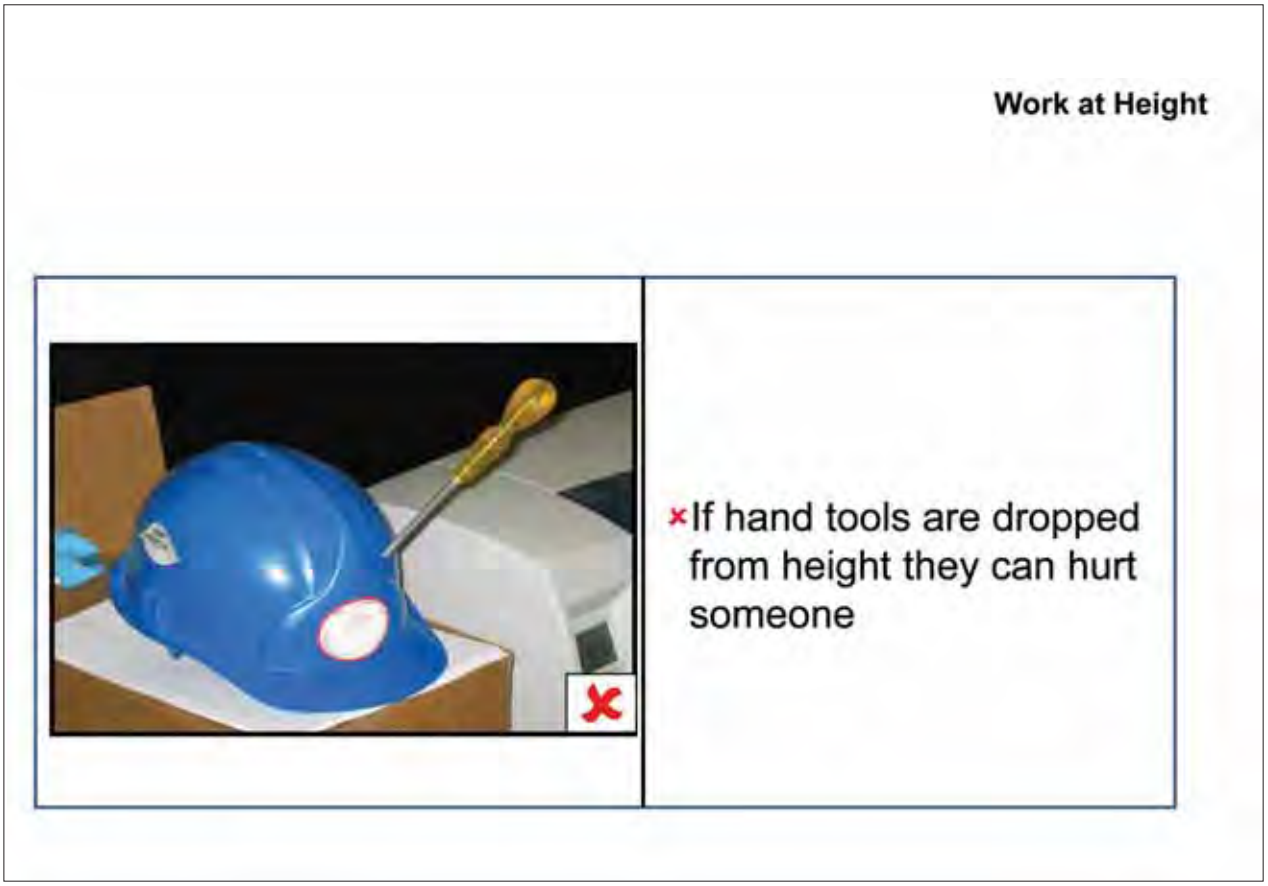

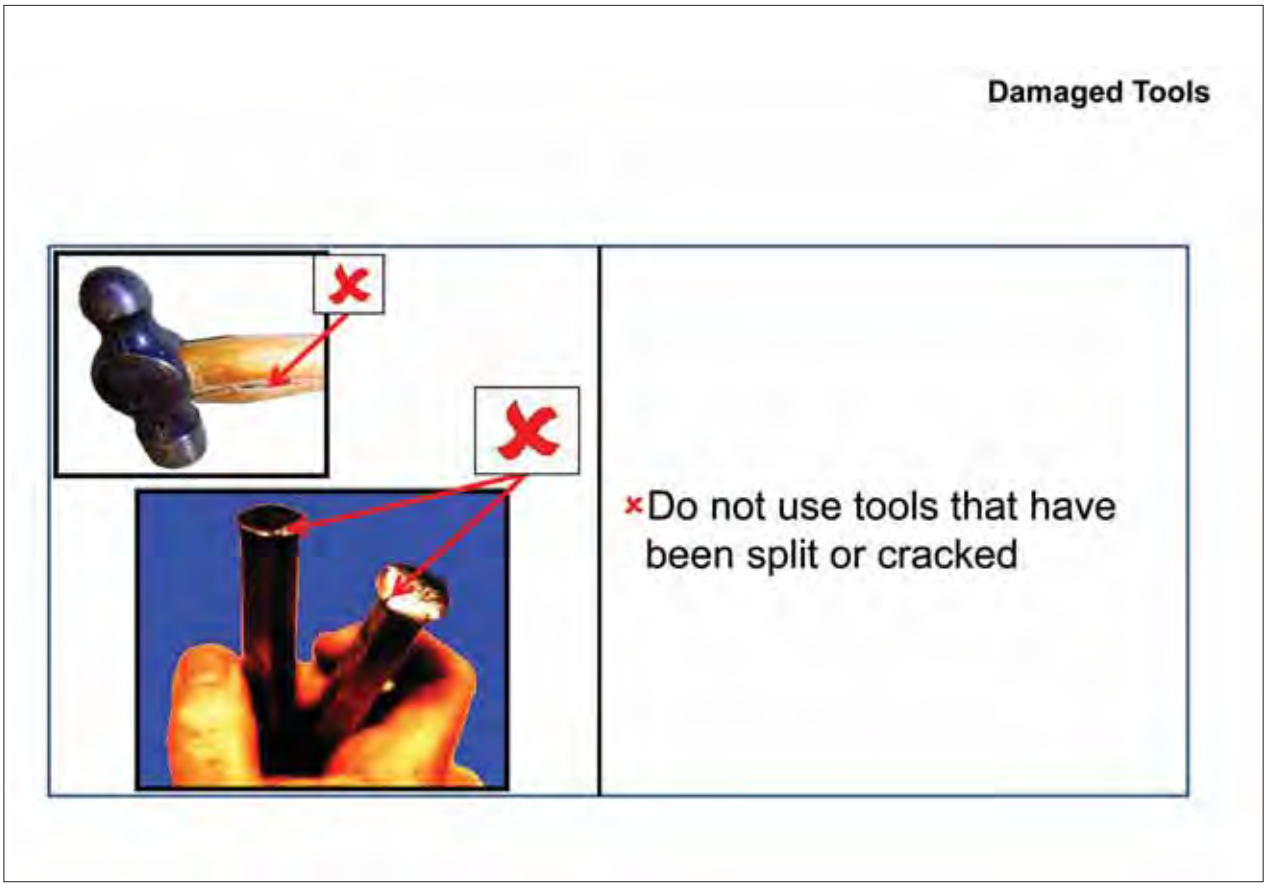

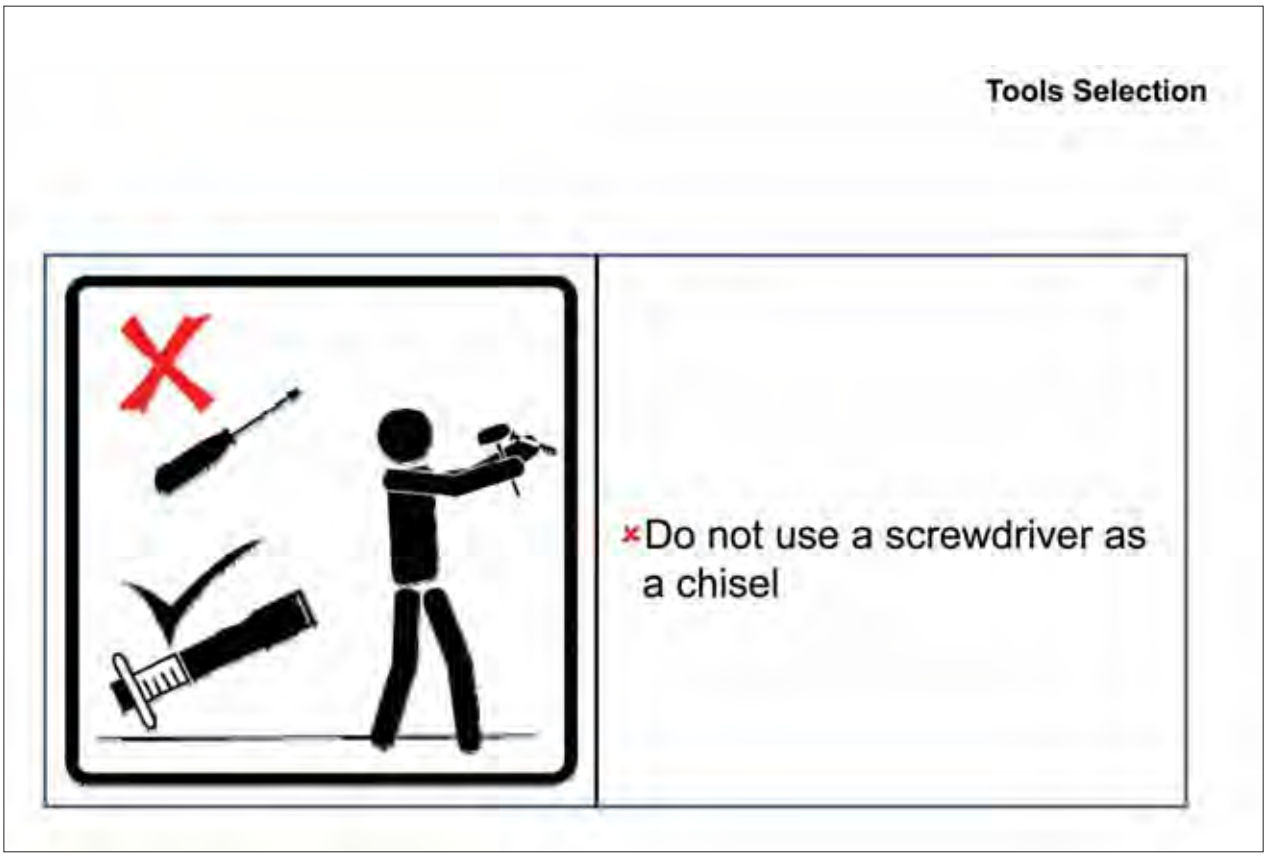

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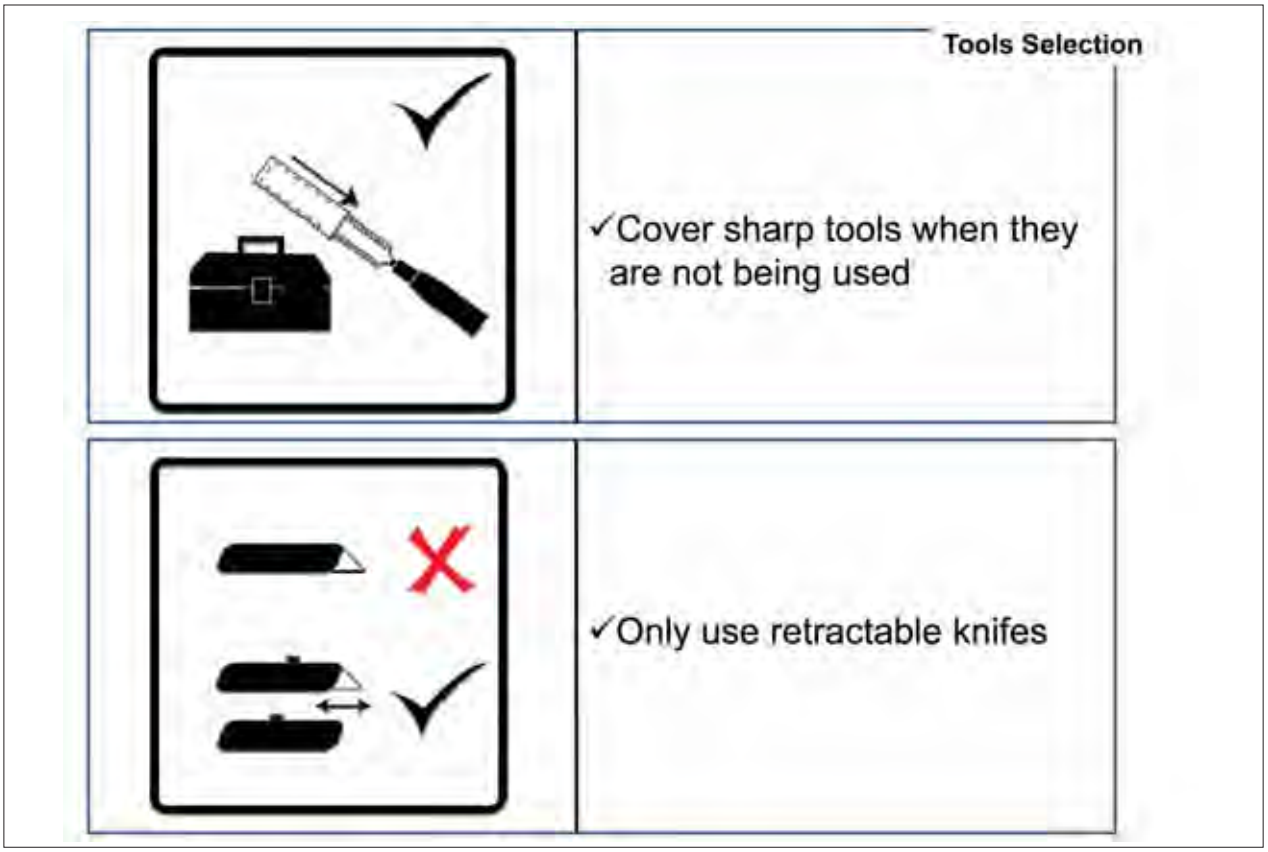

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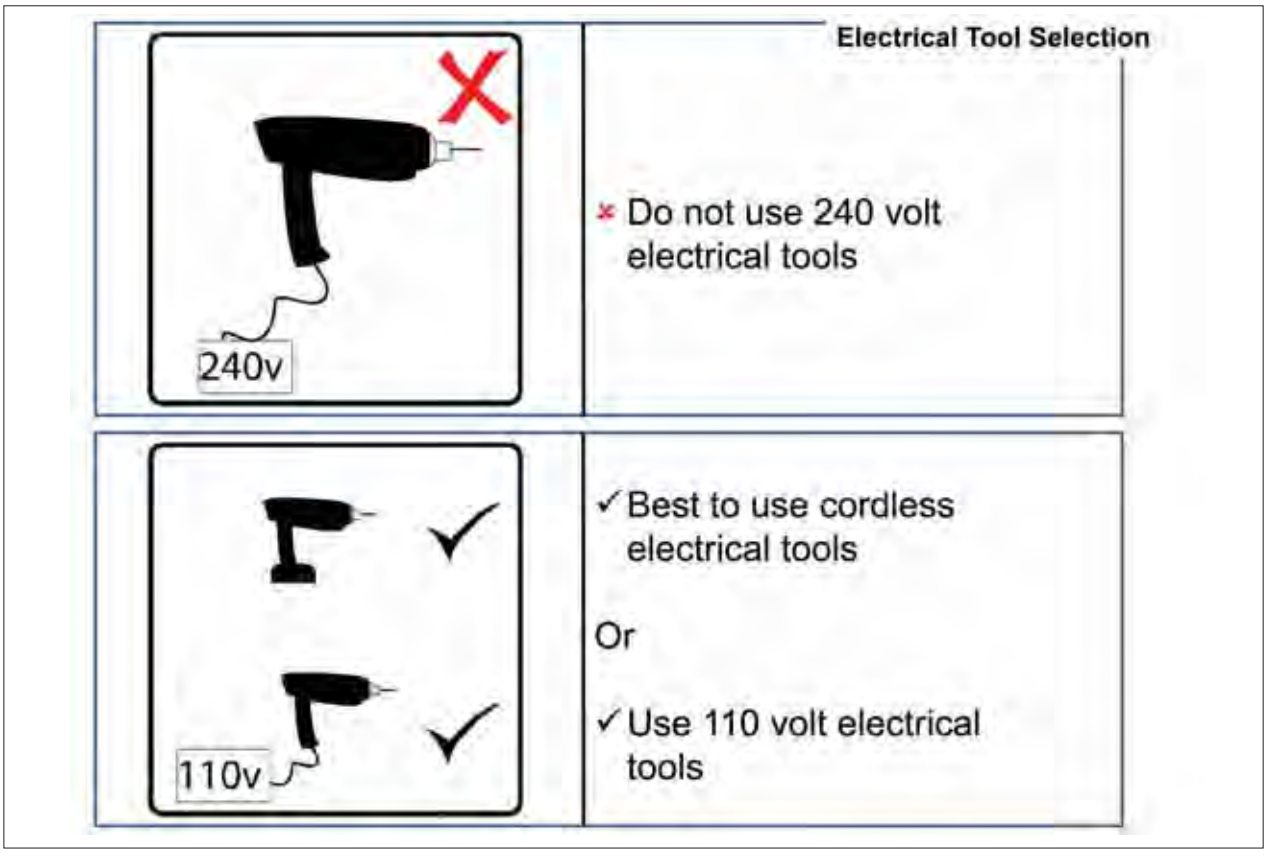

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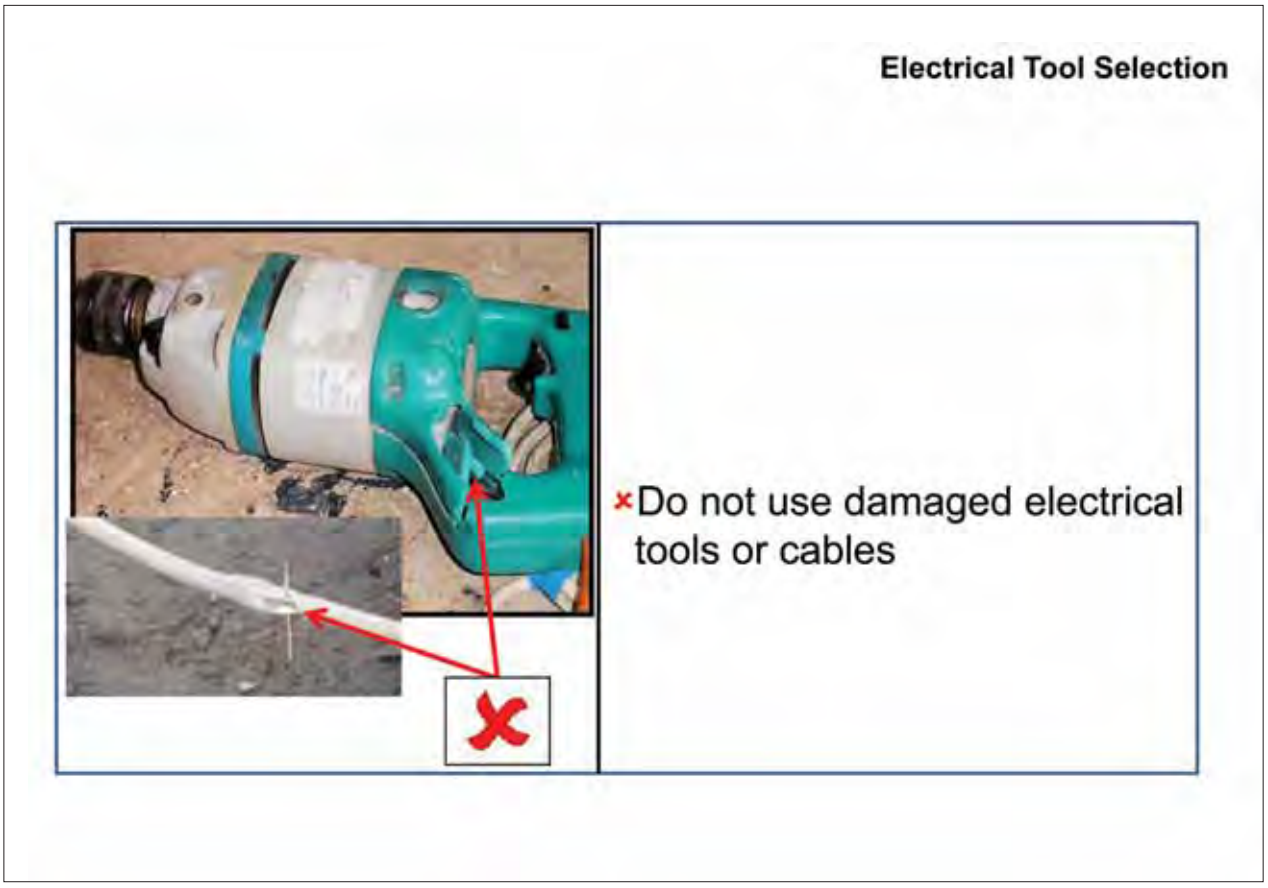

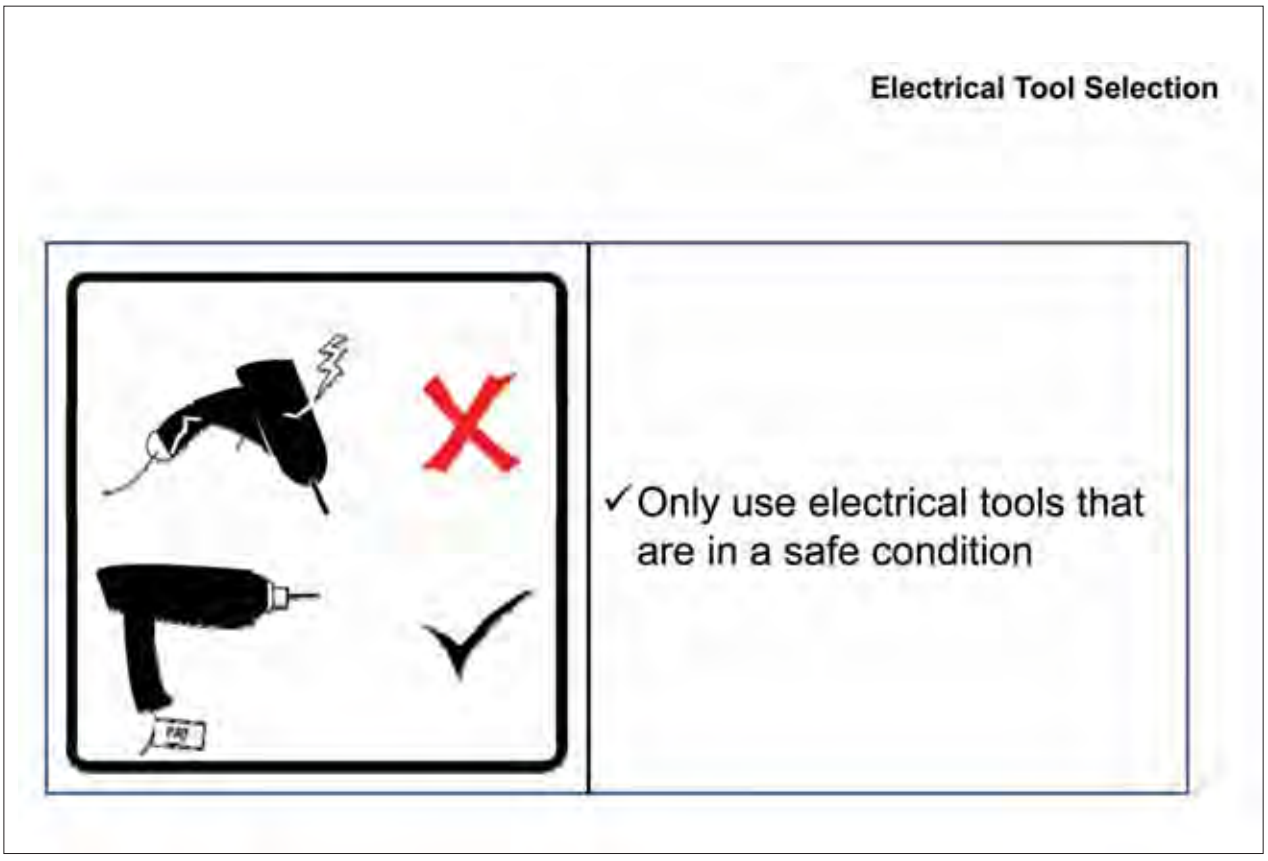

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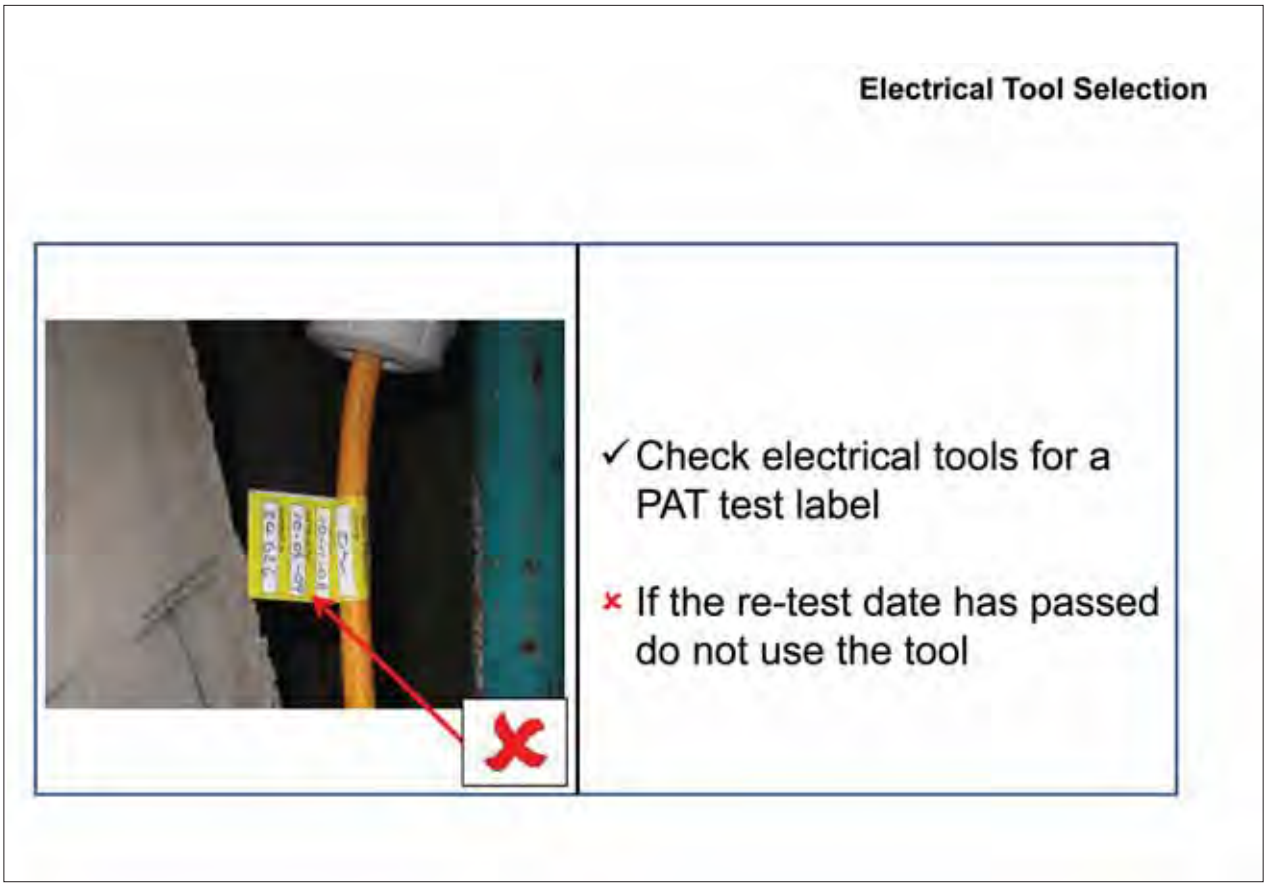

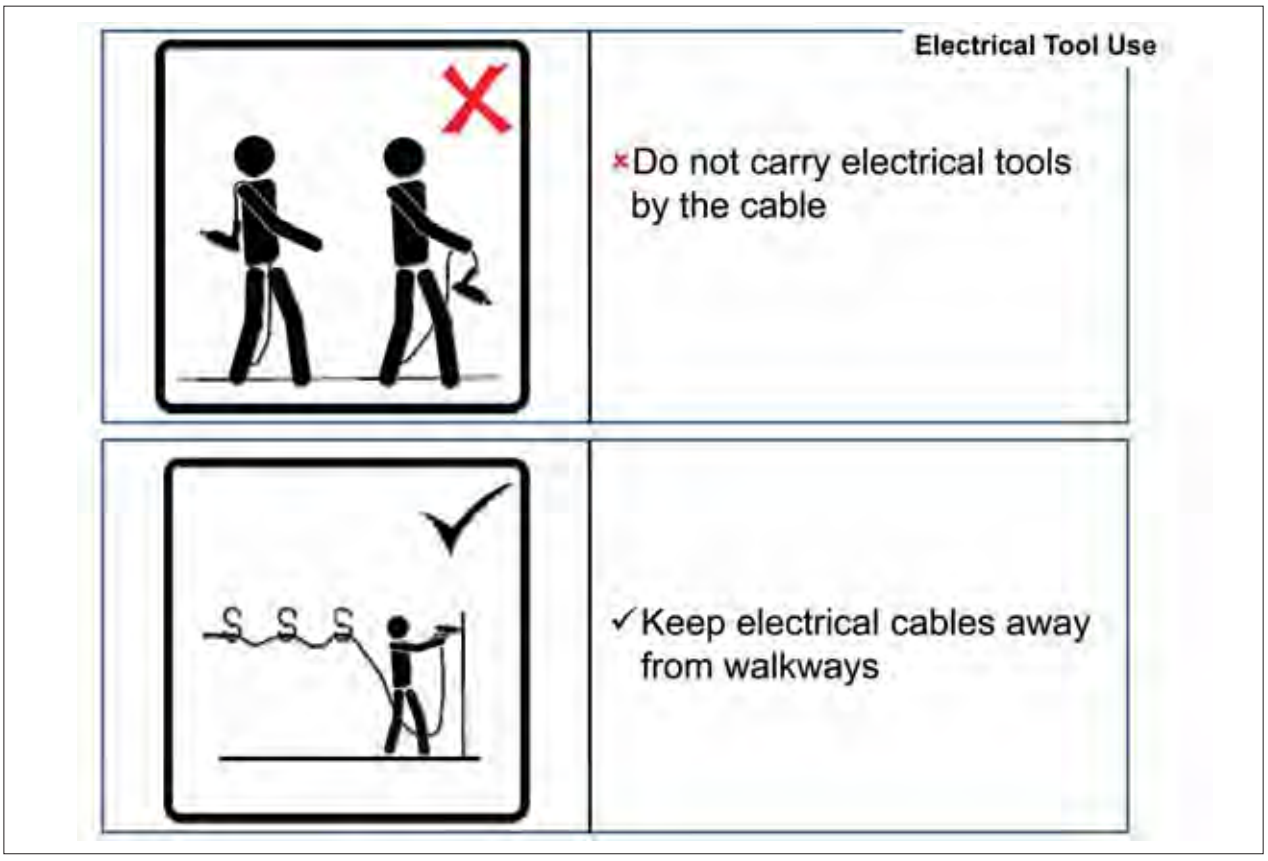

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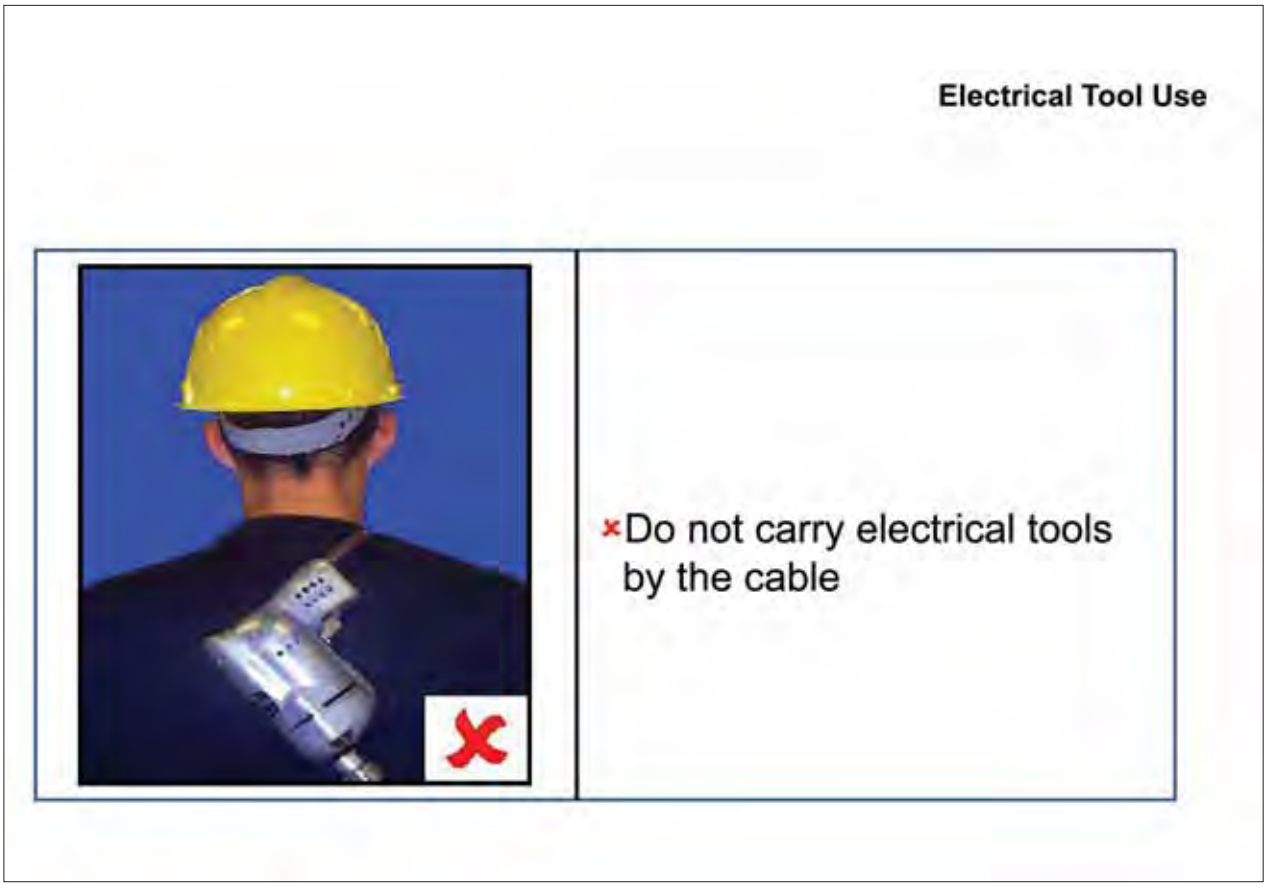

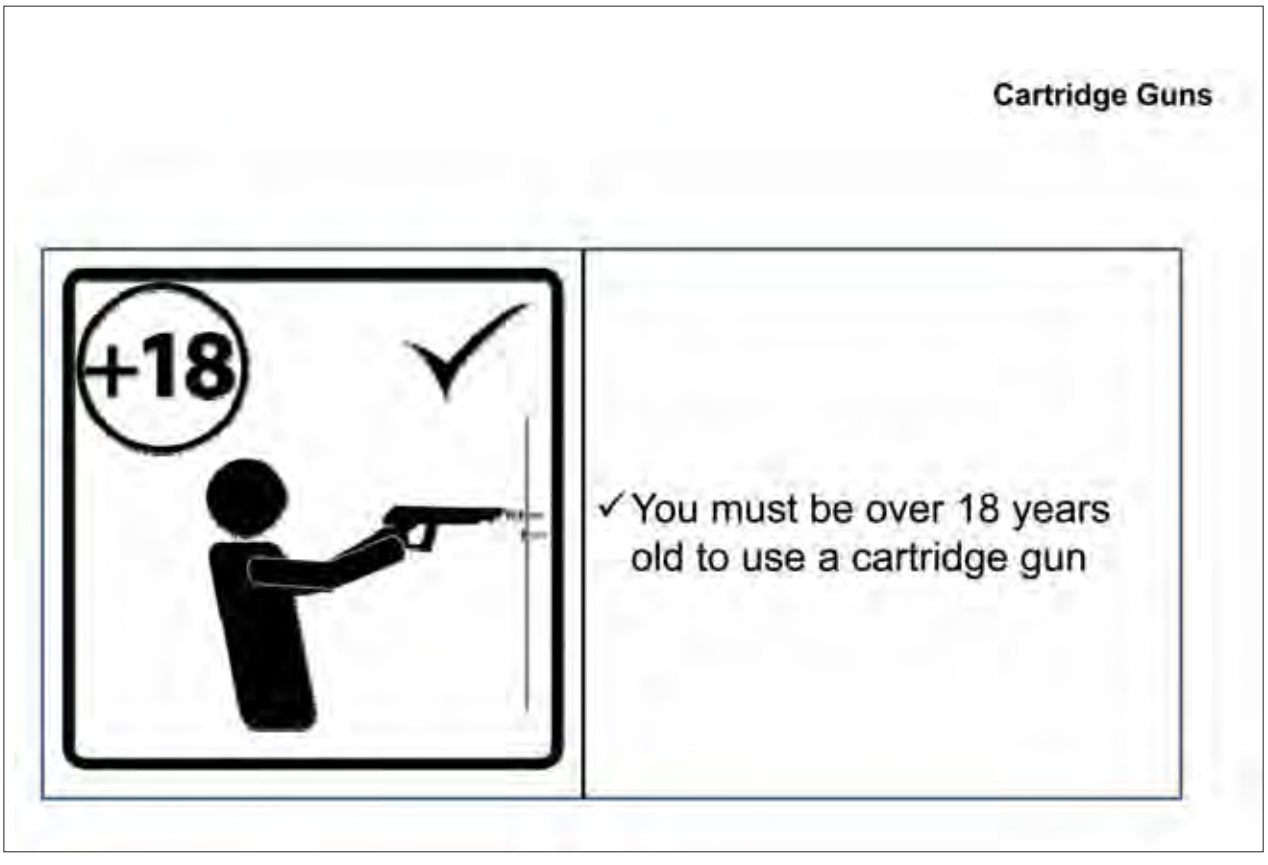

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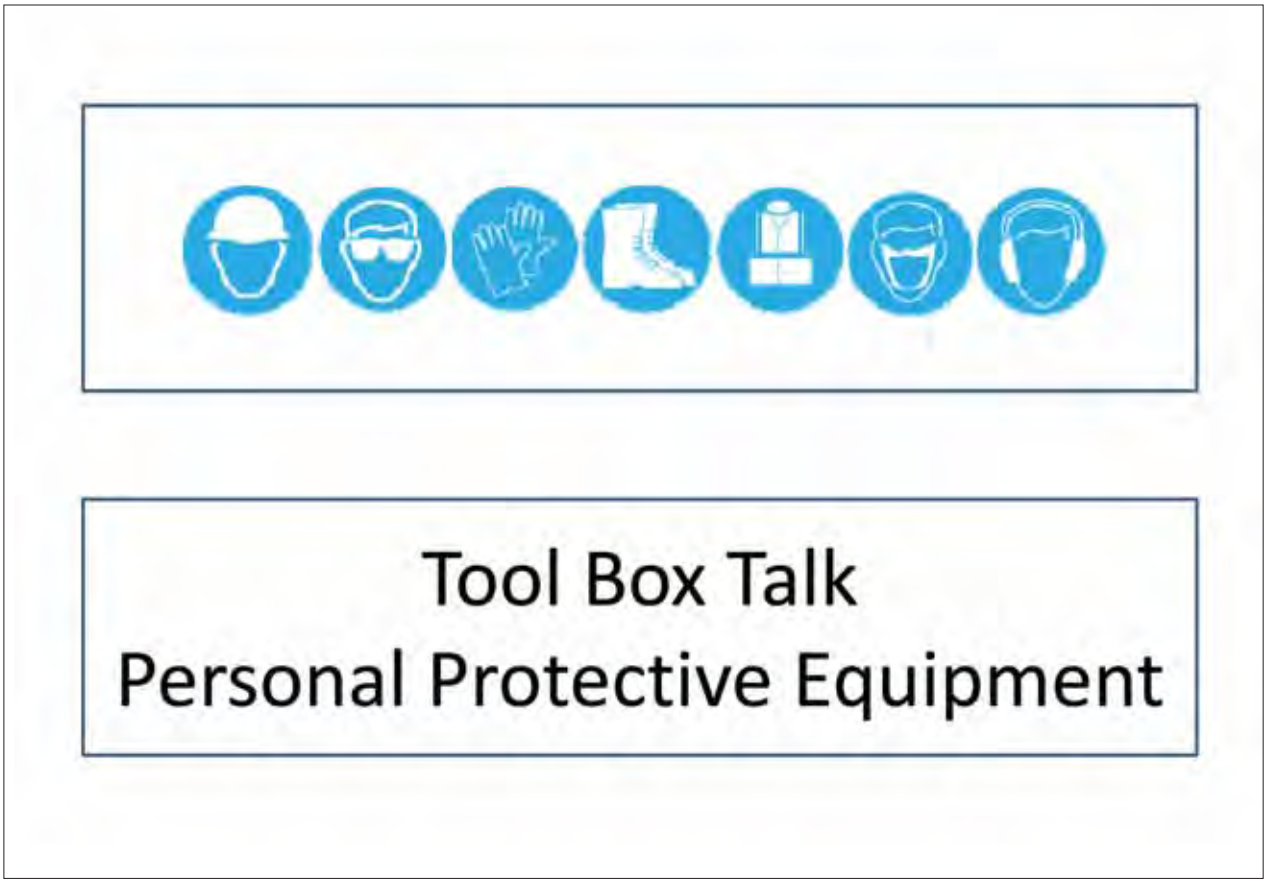
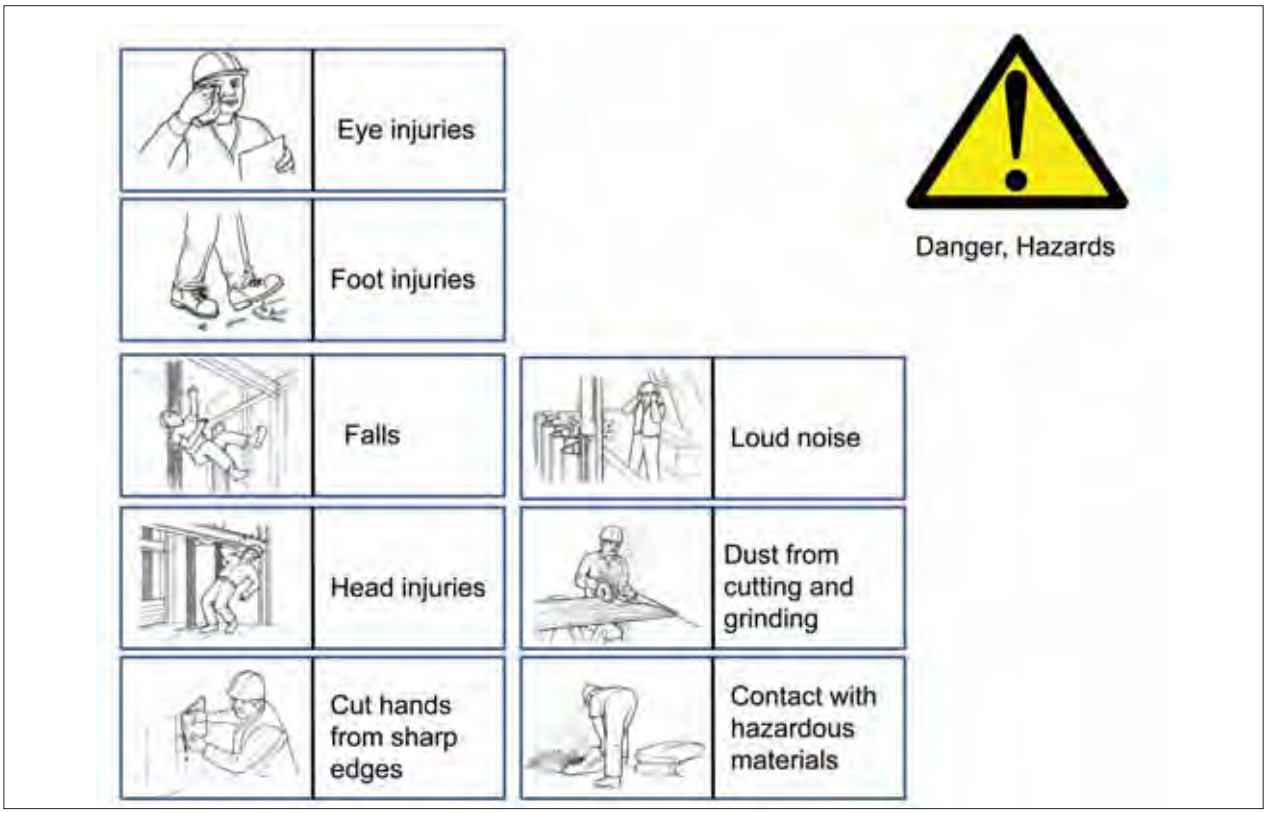
Use Portable Tools Safely





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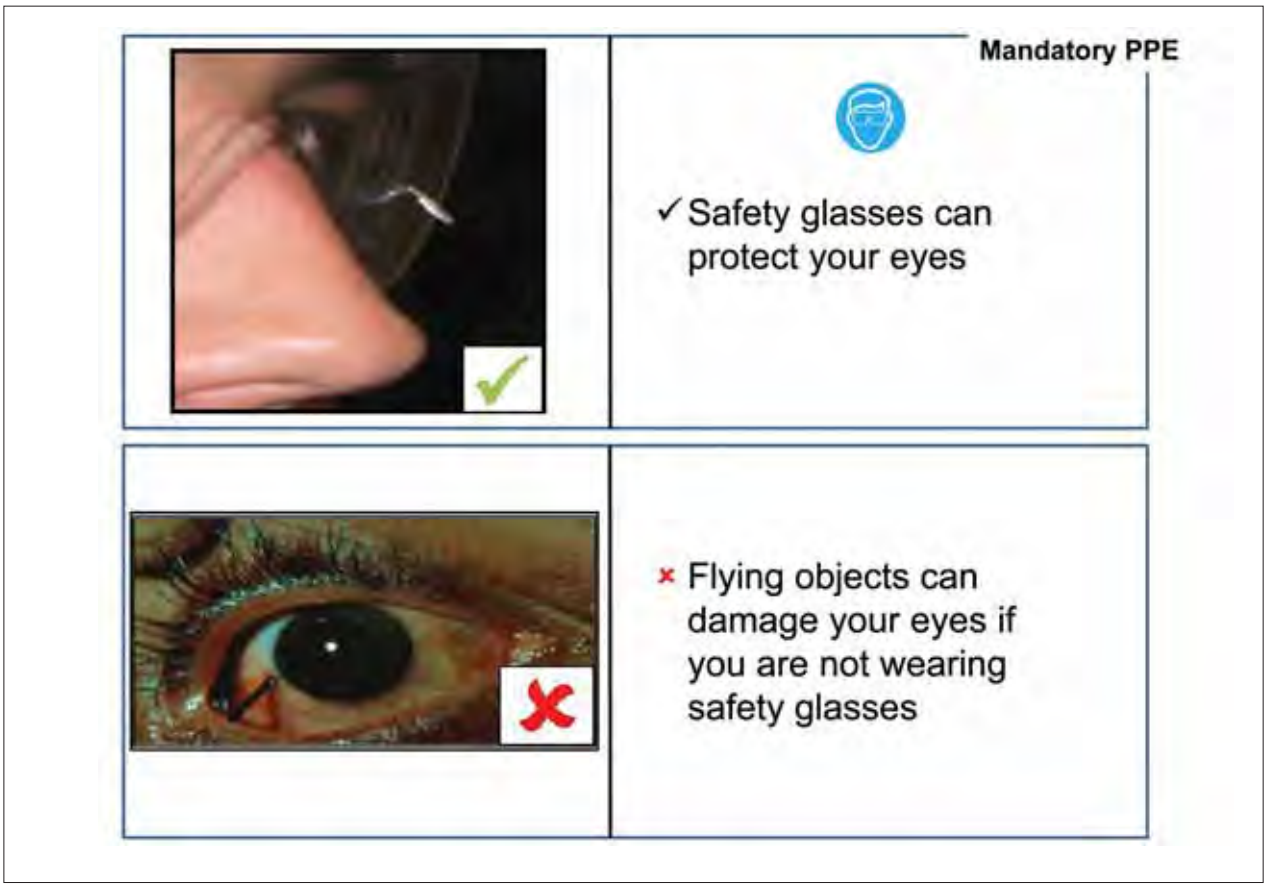


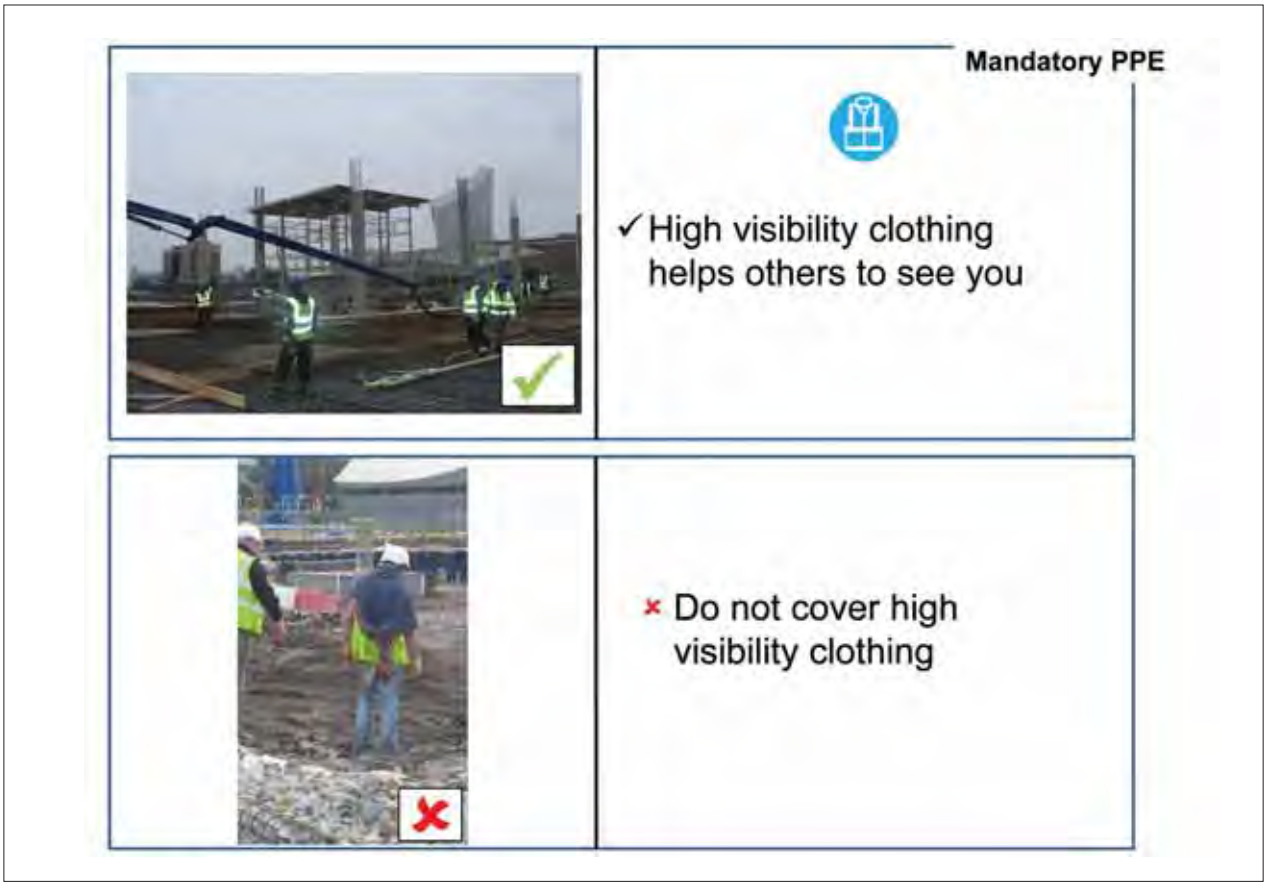
Mandatory PPE

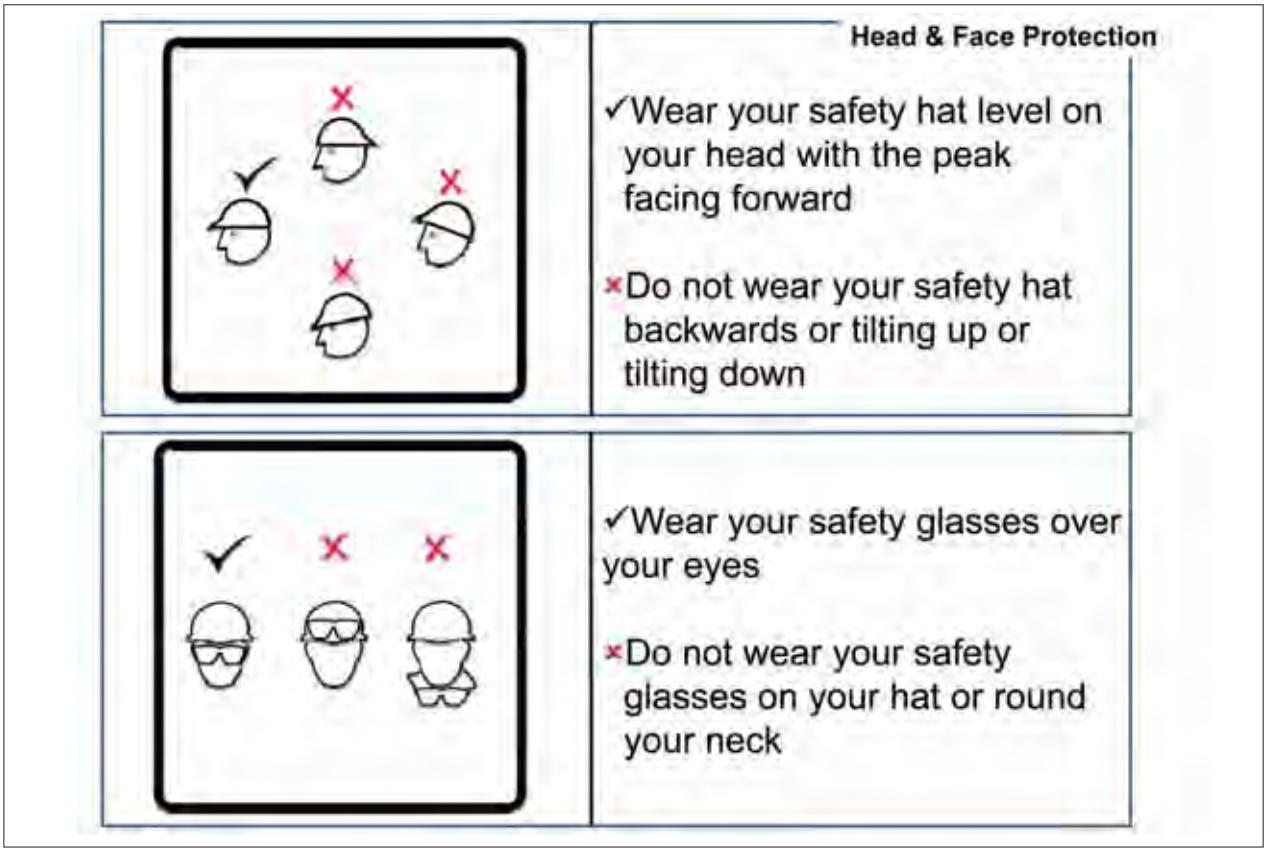
✓Wear gloves to prevent hand injuries.

Mandatory PPE

× Hazardous chemicals can damage your skin if you do not wear the correct gloves

× Sharp objects can cut your hands if you do not wear the correct gloves





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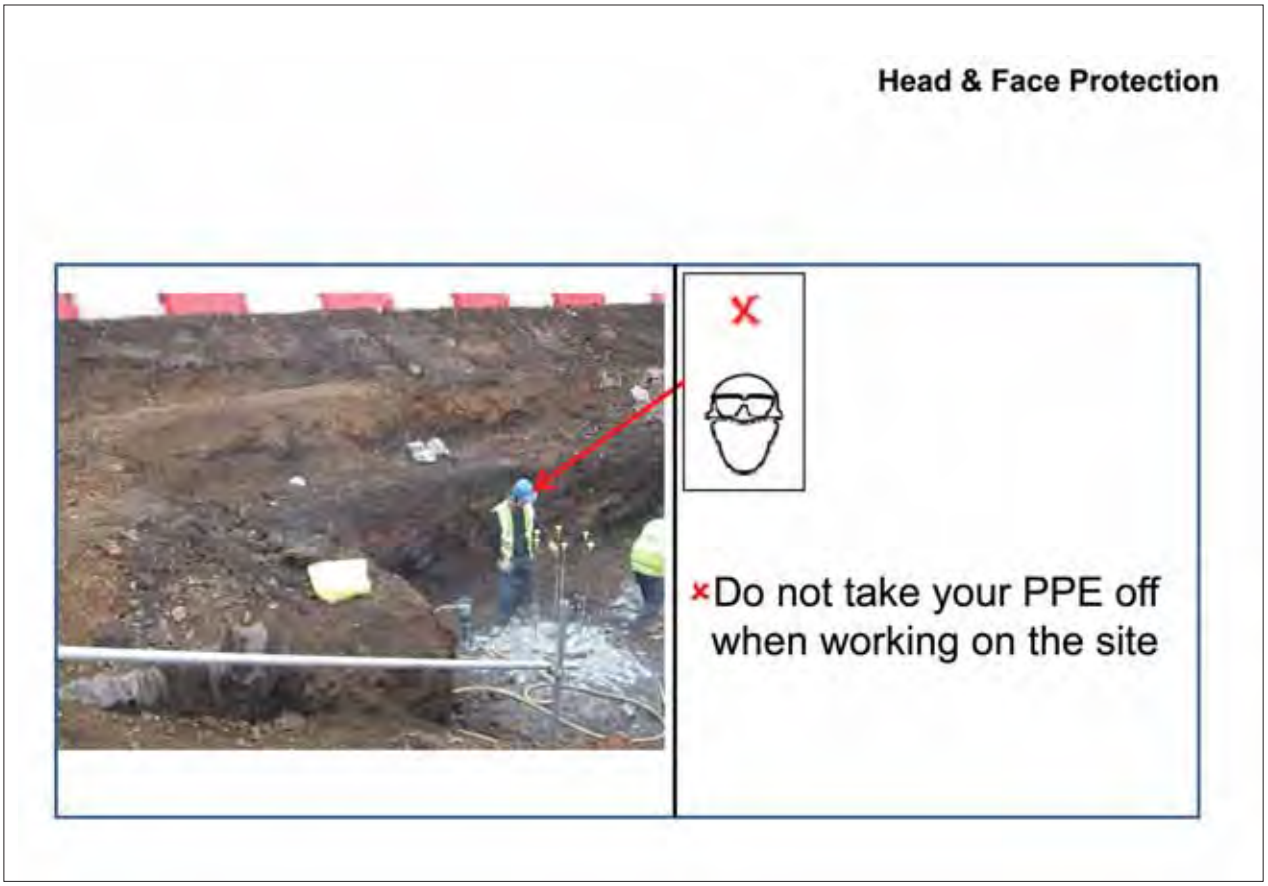

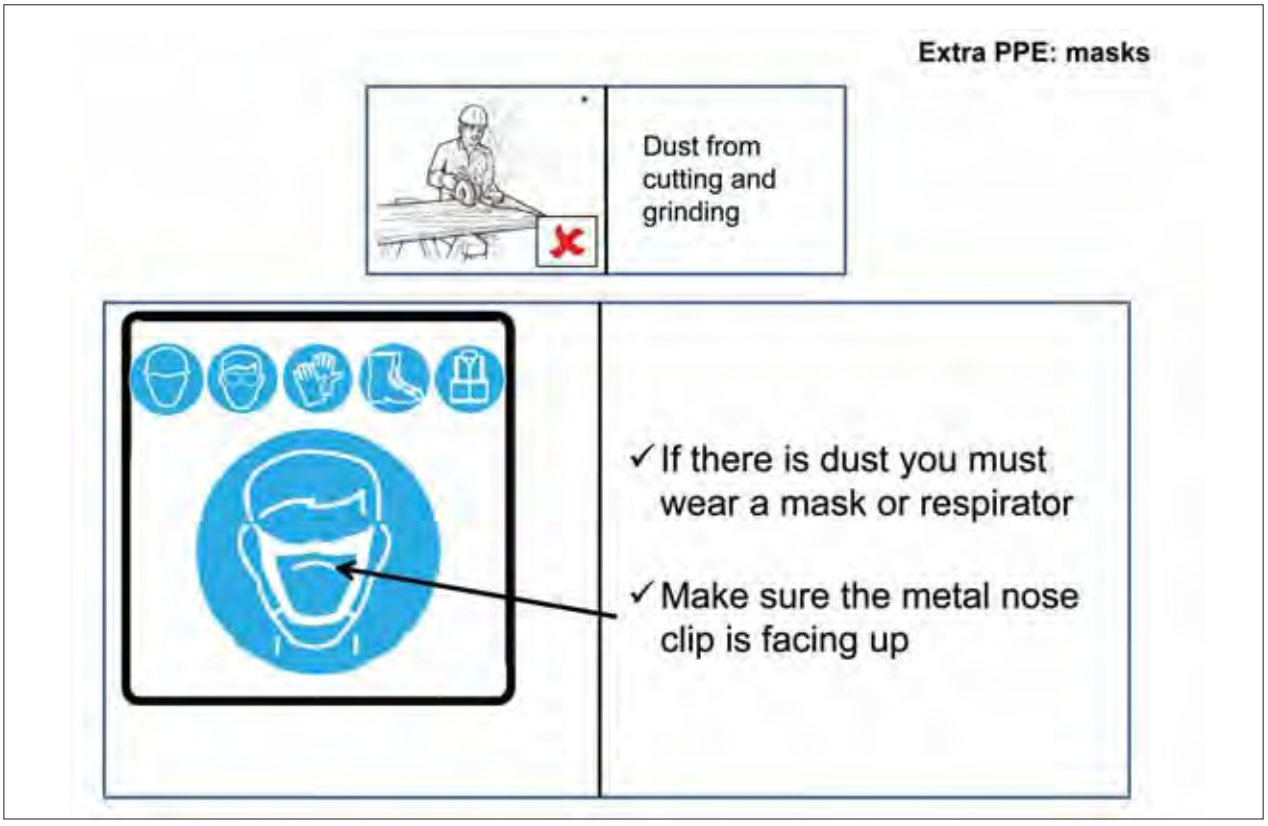

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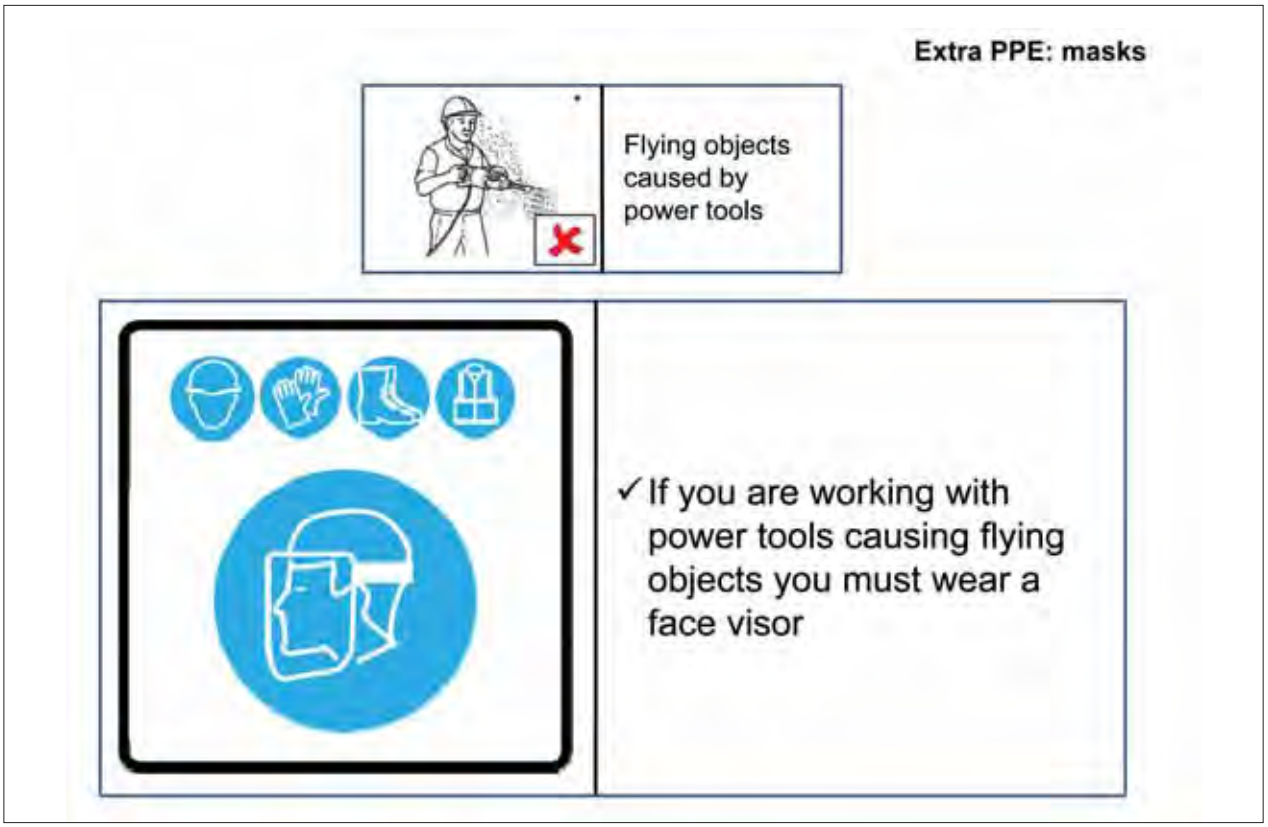

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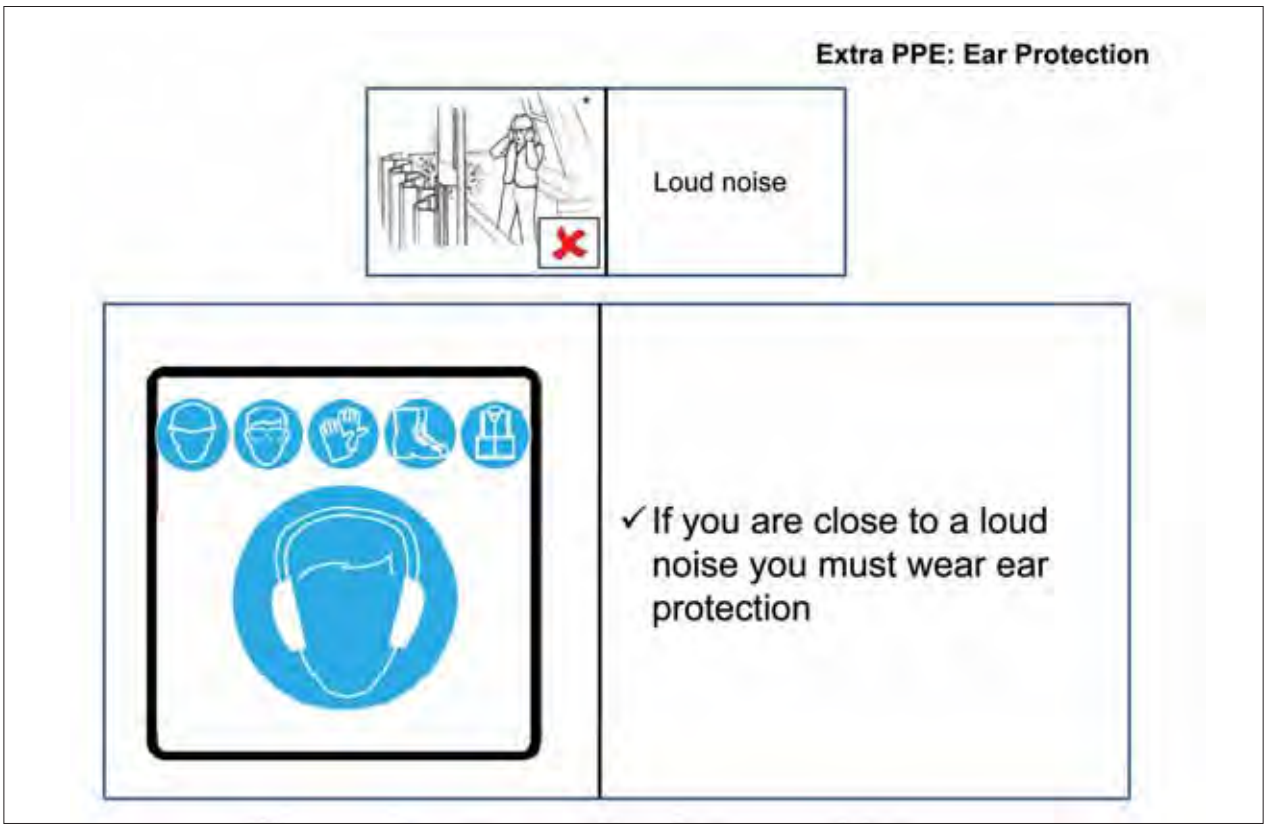
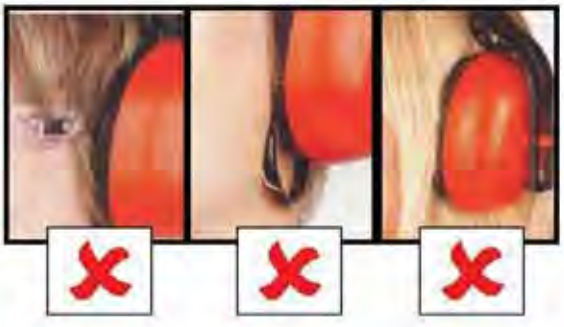


Source: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London

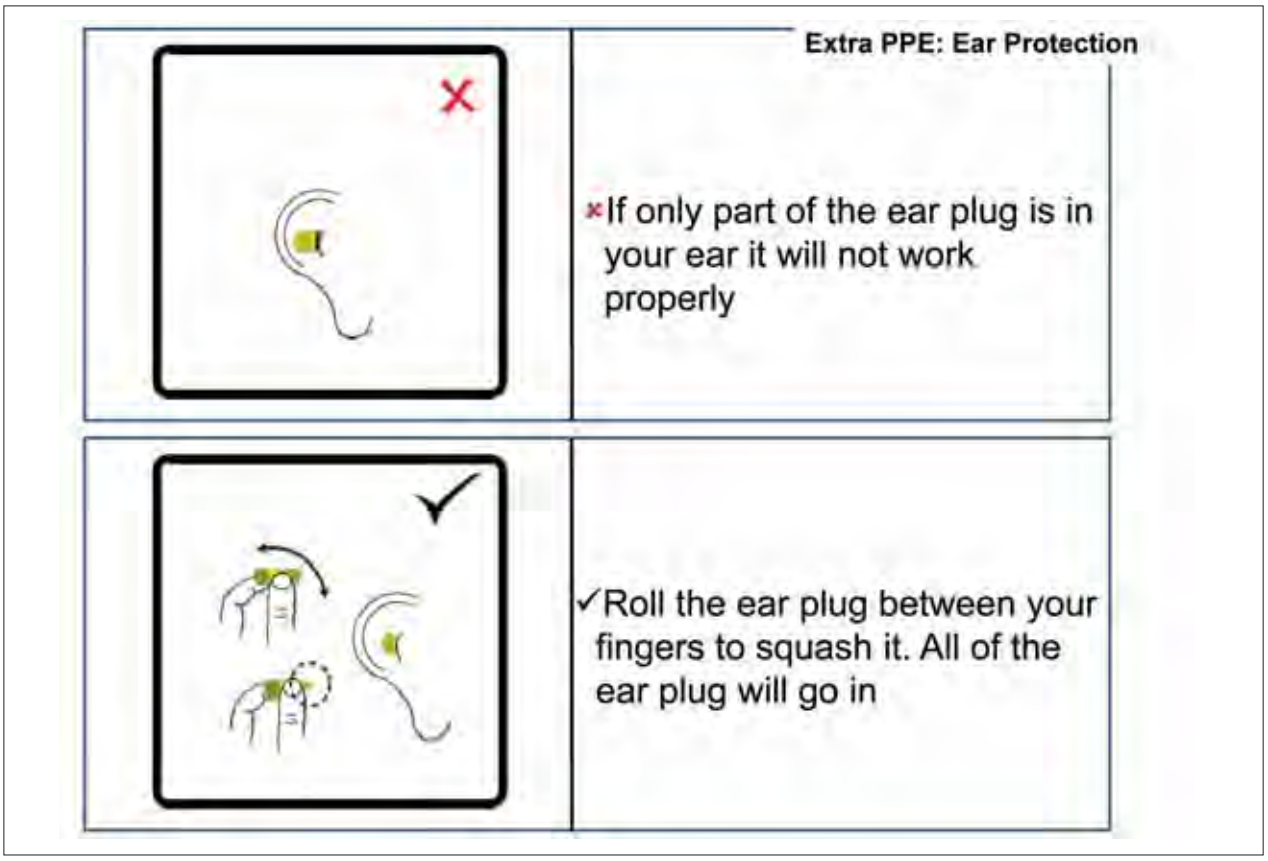
Extra PPE: Ear Protection

✓ If you are in a 'noise zone' you must wear ear protection

Extra PPE: Ear Protection



✗ Do not wear objects between your ears and the mufflers for example glasses, earrings or long hair



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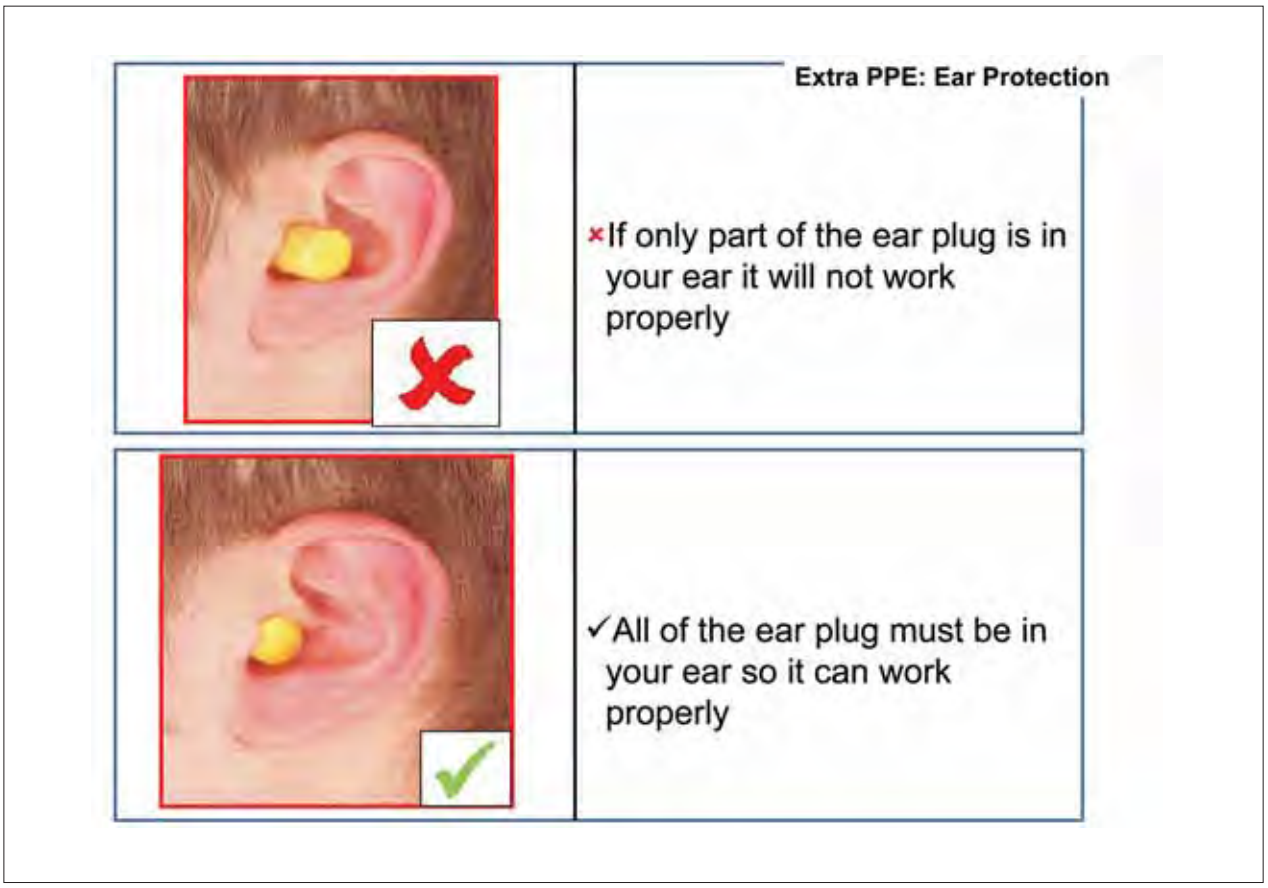
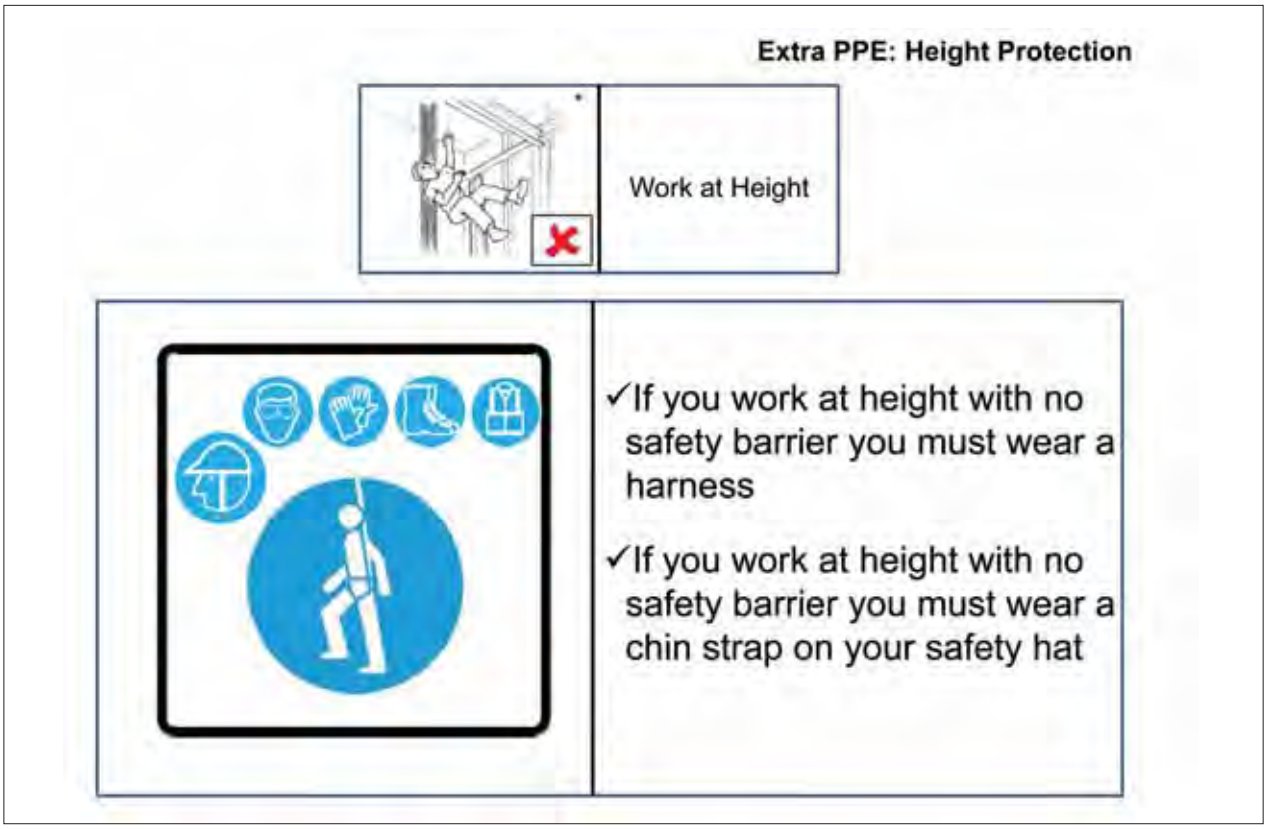
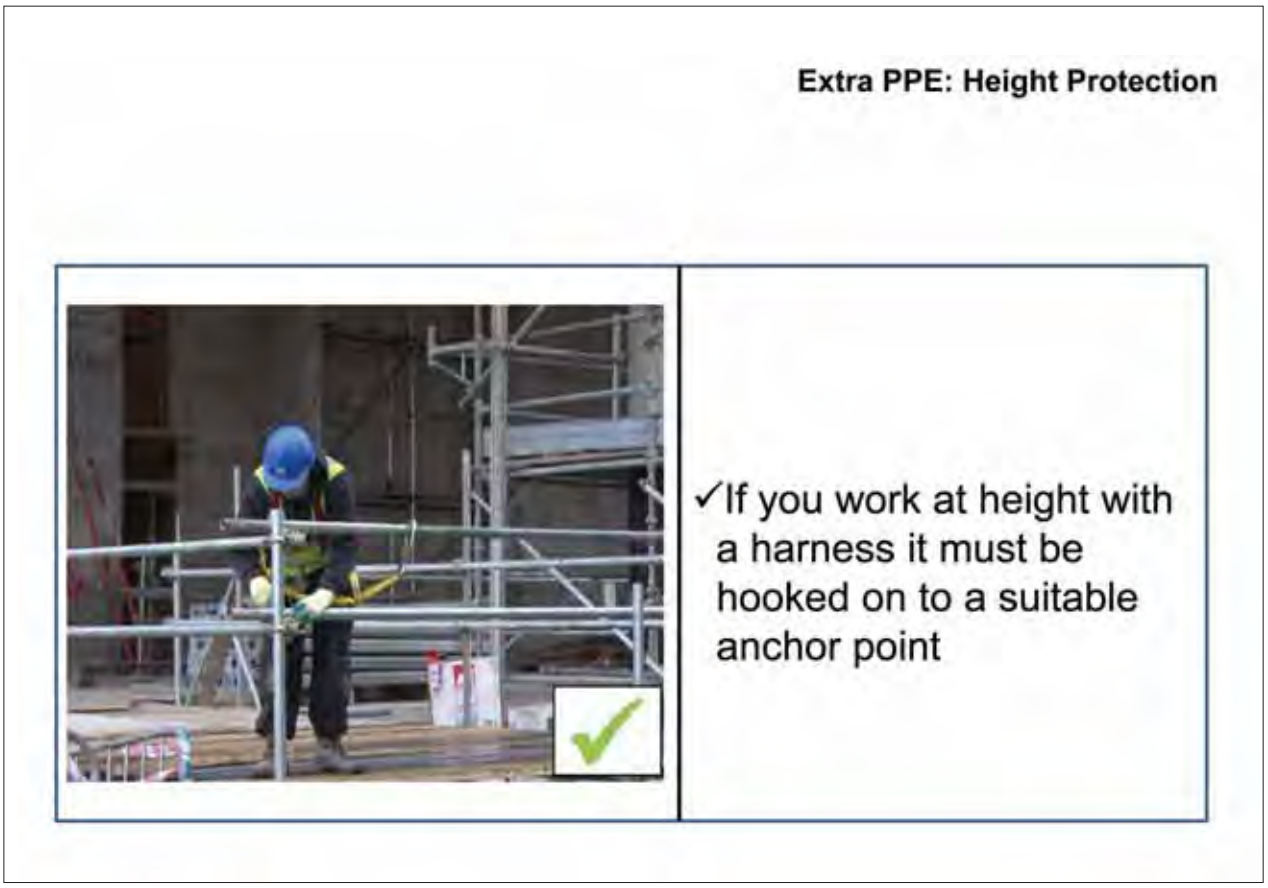
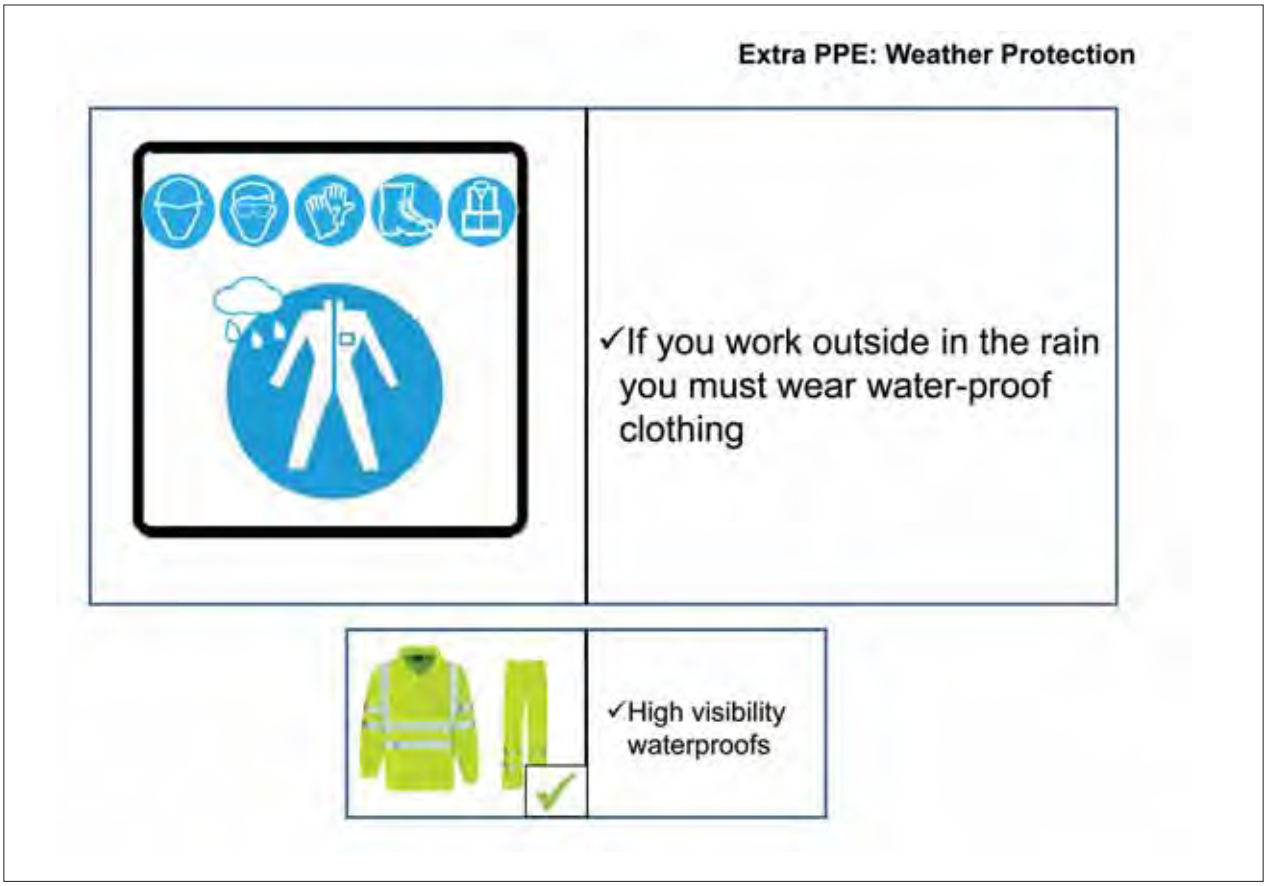
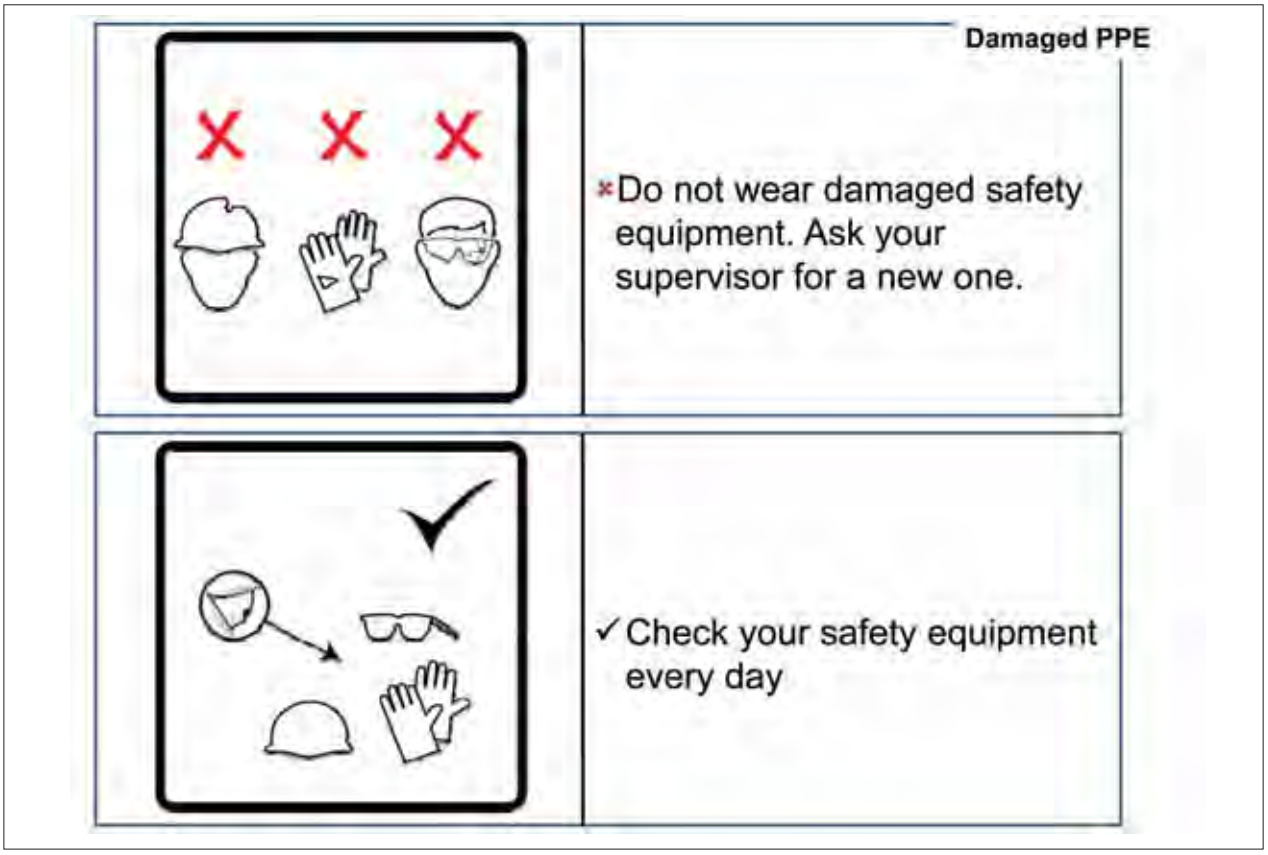




Source: *CDM 2007 Construction work sector guidance for designers* (third edition). Construction Industry Research and Information Association, Report C662, London







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Appendix 2: Follow-up interviews

Follow-up interviews were conducted with staff from Site 1 and Site 2 one month after the interventions. The line manager and subcontractor supervisor on each site were interviewed about the following:

- the managers' and supervisors' reaction to using of the toolbox talk materials
- the supervisors' perception of the workers' reaction to the toolbox talk materials
- potential reasons for higher initial test scores than previous pilots
- potential reasons why observation scores for Site 1 remained high while corresponding scores for Site 2 reduced one month later.

The following text summarises the interviews. The researcher's questions are prefixed R and any interpretations of the respondents' answers are given in square brackets.

Site 1

Location: London
Type: retail and office development
Cost: £200 million
Duration: 120 weeks; completion due late 2010

Site 1: Principal Contractor's line manager (LM1)

1.1.1 R	So can you tell me, in general, how well you think the toolbox talk materials were received?
1.1.2 LM1	Yeah, well, the guys didn't have any complaints. You know, at first there were a few funny faces [looks sceptical]. But they know we take safety seriously here so they bought into it [the importance of existing strong safety culture and trust] quite quickly.
1.1.3 R	What about your own thoughts? Did you have any reservations?
1.1.4 LM1	No, not at all. The pictures should be used for everyone, I think. They really help to get the message across. But lots of the guys on the project were asking if the background could be something other than plain white... as when they were placed on the white boards, they just blend into the background. [The images were used as posters without the researchers' knowledge.]
1.1.5 R	What do you mean exactly? Do you mean during the presentation of the toolbox talks?
1.1.6 LM1	No, on the white noticeboards around the site. They need a bit more colour to help them stand out. I think they would get ignored. All they need is a more eye-catching background.
1.1.7R	OK, I see. This was not the original intention of the images. They were purely for toolbox talks. But it is good to see the managers thought enough of the images to use them in this way.
1.1.8 LM1	Yeah, we printed off a fair number of them. The guys here even had a few ideas of their own. It's really got them thinking... It's just getting the time to work them up, but it's a good sign, I think, that there's some mileage in the idea [the long-term adoption of the method].
1.1.9 R	Can you let me see some of the images you have put on the noticeboards?
1.1.10 LM1	Sure, I'll take some photos and email them to you. [See Figure 35 for an image of A3 versions of the toolbox talks.]
1.1.11 R	This is interesting, because the observation results after one month remain quite high, whereas on the other site they take a dip. I was hoping to investigate any possible reasons for this. Do you think the posters have helped keep the safe images in the workers' minds?
1.1.12 LM1	It could be. Or they've just continued to work safe because they know we have high standards here. But the images have done no harm, if you know what I mean.
1.1.13 R	Did you put all the images up on the noticeboards?
1.1.14 LM1	No, just the ones that we liked, the ones most relevant to the work being done in that area. It would just get too much if we used all of them... The pictures showing how to stack materials safely were good [see Figure 35; images showing safe acts were preferred.]
1.1.15 R	Which did you find best – the photos, drawings or pictograms?
1.1.16 LM1	We used a combination of them all. Well, actually, not the drawings. But the photos and the cartoons [pictograms] stood out well, so we used them. [The drawings were

Figure 35
Example of toolbox talk images used as posters

possibly not bold enough to use as posters; they also showed only injuries and consequences but not safe acts and controls.]

1.1.17 R OK. That's all very interesting. Thanks for that. Can you tell me anything else? For example, anything you would change or recommendations to make the materials better?

1.1.18 LM1 Mmm [thinking]. I'd need to give that some thought... As I said, they could be more eye-catching [to use as posters], but they are generally quite good. You can see there's been a lot of work put into them. I think I would just like to see more of them [covering other topics].

1.1.19 R OK. I just have one more area. What did you think of the image-based test?

1.1.20 LM1 It was a bit cryptic. But I can see why you did it that way [with no words]. For me, the answers were obvious though. But then again, if I got any wrong I would be worried. Maybe the next ones could be a bit harder. But I suppose you are just wanting to check they know the basics.

1.1.21 R Well, I actually have a specific question about the test scores. They were a bit higher than I was expecting, based on previous pilots. Why do you think this was the case?

1.1.22 LM1 I don't know really... Maybe we have better workers here. We have high standards, you know. No one gets on our sites without a CSCS card, for a start.

1.1.23 R That's a good point. Do you really think that the CSCS card has made such a difference?

1.1.24 LM1 Well, it has its critics, doesn't it? But it's a start. As I said, we don't let guys on the site without one. They can even take the test in their own language... We have access to the CSCS system online, so we can check the dodgy ones [fake/counterfeit cards]. But we also check for CPCS cards and stuff like that... and we literally turn the guys away if they don't have the right ticket [certificate or proof of competence].

1.1.25 R OK. Well, thanks for that. You have been most helpful.

Site 1: Subcontractor supervisor (SS1)

1.2.1 R Can you start by telling me, generally, what you thought of the materials?

1.2.2 SS1 I like the flipchart. I like the way you can take it on site or anywhere without the need for PowerPoint or anything.

1.2.3 R What about the actual images?

1.2.4 SS1 Yes, it helps to bring the talk to life. Everybody understood the little red guy meant 'this is wrong' [used to show exclusion zones]. But there were a few of the pictures, of how to store materials, that didn't really relate to our work.

1.2.5 R Did this cause a problem?

1.2.6 SS1 Well they [the operatives] didn't complain or anything. But I know myself that we deal with mostly cladding panels and stuff like that. So if I was doing it myself [creating the materials] I would leave some of them out... Actually, the way the pages are laid out, I could take one or two out with no problem.

1.2.7 R So what did the guys think of the booklets? Did they appreciate them or find them condescending or anything?

1.2.8 SS1 Well, they get a lot of paperwork and booklets. You tend to find them in the skip sometimes. But they liked them, it got their attention and got them talking, so I suppose that's the idea, isn't it?

1.2.9 R Yes, I was hoping they would use them during the toolbox talk, and then keep them for reference later.

1.2.10 SS1 It's a good size for keeping them in their pocket, but they're not waterproof or anything, so I'm not sure how long they will last. [The booklets were prototypes and were not laminated.]
1.2.11 R Yes, I see your point. Maybe if we did this again they should be laminated... Let's discuss the test materials now. Were there any problems there?
1.2.12 SS1 Well, I needed the help of [a bilingual supervisor] to explain it, but apart from that it was straightforward enough.
1.2.13 R Was this a drawback then? What I mean is, did it become a hindrance?
1.2.14 SS1 No, I wouldn't say so, because the pictures were self-explanatory. It was just to explain that the images were part of a test.
1.2.15 R If I could just go back to the toolbox talk for a moment, then. Did you also need [the bilingual supervisor] to help deliver this?
1.2.16 SS1 Yes, I did. But the good thing about the images was they helped to explain the translation. We did a bit of a double act. It went well.
1.2.17 R Would he normally deliver toolbox talks in the workers' own language anyway?
1.2.18 SS1 Yes, you're right, but most of the guys speak some level of English. It's just convenience, to let him do it in their own language. But this way [with the images], I've had a chance to get involved.
1.2.19 R OK, well that makes sense. Now, returning to the tests: the guys scored quite high, higher than I expected. Can you think of any reasons for this?
1.2.20 SS1 If you have worked here [on UK construction sites] for a while, you get to know the safety rules. And they need a CSCS card to work on this site. So they have probably picked up what they need to know along the way.
1.2.21 R OK, that's some good points you made there. The guys have also scored high on the observation scores even after a month later. Can you think of any reasons for this?
1.2.22 SS1 Well they're good guys. They know if it's not right they can get kicked off the site. We don't say here 'just get it done'. We appreciate the guys and they give us respect as a result [this shows the importance of trust]. So, that's all I can say, I think.
1.2.23 R OK. Well that's fine then. Thanks for your time.

Site 2

Location: Manchester
Type: broadcasting and media development
Cost: £415 million
Duration: 3 years; completion due mid-2010

Site 2: Principal Contractor's line manager (LM2)

2.1.1 R The first thing I'd like to discuss is the toolbox talks. What did you think of them?
2.1.2 LM2 They looked familiar, as if I'd seen them before.
2.1.3 R You could be right there. They were based on existing images, and the photos came from your own safety manager.
2.1.4 LM2 That's a good idea, to use existing stuff like that. There's no point in re-inventing the wheel... I think this means there's a better chance of it being used as well.
2.1.5 R Was there anything specific about the images that you liked or disliked? Or the way they were presented?
2.1.6 LM2 Well, I'd say a key area that needs attention is slips and trips. I'd like to have seen something on this.
2.1.7 R That's a good point. But the themes were based on input from the safety team and data from audits and inspections. Although, if we do any more in the future, this would probably make a good topic. But would you say the images used were useful?
2.1.8 LM2 Well [the subcontractor's supervisor] would probably be better placed to give you feedback on that. But it made sense to me. But I wasn't sure why there were photos and the stick man pictures used to explain the same thing.
2.1.9 R This is because the stick man pictograms explain the concept and the photos help to put it in context. At least, that's the theory.
2.1.10 LM2 Well, when you put it like that, it sounds logical. You should speak to [our safety trainer] who delivers the site induction training. I think he would find this stuff quite useful.
2.1.11 R You're right. In actual fact, I've already done this on another project last year. It worked well, but we didn't go as far as assessing behaviour, like we have done here. Actually, the behaviour observation scores here dropped a little after a month. This was something I wanted to discuss with you. Why do you think this happened?
2.1.12 LM2 Well, if it was a major omission or unsafe act, I'd be very surprised as this doesn't

happen here. But, based on the information you showed me before [eg task-specific PPE, lanyards on hand tools at height], I believe these were corrected swiftly. The overall standard has been high.

2.1.13 R You are right, the standard is higher here than elsewhere. In fact the observation criteria were based on the site-specific requirements, which are higher than normal industry practice. So maintaining these must require constant effort.

2.1.14 LM2 Yes it does, especially on a site of this size. I'll give you an example. I was on the site and I saw a foreign worker without eye protection on. [This is mandatory PPE on the site, which is above normal industry requirements.] When I asked him where his safety glasses were, he just called out the name of his employer. He was telling me this because he thought that was what I was asking him... or pretending he didn't know what I was talking about. But if I had one of the little booklets you have, I could have used this to explain to him what I was looking for. So it has uses beyond just the toolbox talks and the testing.

2.1.15 R That's an interesting point. It is also not the first time I have heard a similar story. Now, one final area I want to discuss is the knowledge test using the images. Did you get a chance to look at that?

2.1.16 LM2 Yes, it looked fine.

2.1.17 R Did you think it looked too easy?

2.1.18 LM2 Well I have a NEBOSH certificate; a lot of the site managers here have been through similar training. So I understood what you were looking for. The workers may have found it a bit more difficult.

2.1.19 R The test scores were actually quite high.

2.1.20 LM2 Well I suppose that doesn't surprise me – we don't let just anybody on the site. They need a CSCS card as standard.

2.1.21 R I think maybe this has been a factor – thanks for that. But unless you have anything else you want to say, I think we are done for now, thanks.

Site 2: Subcontractor's supervisor (SS2)

2.2.1 R OK, well, can you tell me first of all what you thought of the toolbox talk materials?

2.2.2 SS2 Yeah, they're OK. I understand what you're trying to do and all. It's a good idea.

2.2.3 R Was there anything specific you liked or disliked?

2.2.4 SS2 Well, there was a bit of chat about the rope on the tools when working above head height. It's a bit of a debatable area, but I realise why it's there. Apart from that, the rest was fine [showing the importance of agreeing the site rules with the workforce].

2.2.5 R Did the booklets work well with the flipchart?

2.2.6 SS2 Yeah, the booklets went down quite well. There were a few laughs and stuff. But they [the workers] looked like they liked them. They were following each page of the book as we went through it.

2.2.7 R Did you need any help with translating or did the workers follow you in English?

2.2.8 SS2 No, we had [a bilingual supervisor] on hand to do some interpreting. He actually did quite a lot.

2.2.9 R Did this mean that the materials were not really needed?

2.2.10 SS2 I wouldn't say that. As the old saying goes, a picture tells a thousand words, so I could see the benefit in using them.

2.2.11 R But what if it was just you on your own? Do you think you could get the message across?

2.2.12 SS2 That scenario wouldn't be allowed to happen; we would struggle with getting the work done, let alone safety, in that situation. Anyway, a good number of the guys speak English as well. So I would never be in that position with a bunch of guys in front of me who didn't speak a word of English. But if that's what you're asking me, then I think yes, it would take a lot longer, and I'd feel a bit of an idiot, but it could be done.

2.2.13 R OK. Let's discuss the picture-based test. What did you think of that? Was it too easy?

2.2.14 SS2 Don't be too sure about that... I saw a few faces when they were doing the test and they looked a bit flustered... You know there were a few guys asking why some of the test questions didn't have pictures in the booklet.

2.2.15 R That's because half the questions related to the toolbox talks that came with pictures and half related to the ones that were merely text. This was so I could compare the impact of the images compared to text alone.

2.2.16 SS2 Ah, right, I see. Well it looked like without the images they were struggling. And, like I said, a lot of them didn't find the test as easy as you thought they might.

2.2.17 R That's quite interesting. So would I be right in saying the images helped, and in fact improved the workers' understanding?

2.2.18 SS2 Yes, well not on everything – for example the pictures on how to insert earplugs correctly. The guys already know this [points to a large tub of earplugs on his desk]. But some of the stuff on hand tools would have been new to them.

2.2.19 R Good. I am glad to see it has been useful... I just want to finish by talking about the observation scores. These dropped a bit after one month. Why do you think this happened?

2.2.20 SS2 I don't know, really. If they did, it couldn't have been by much. But there have been a few changes of shift, you know. There could have been other workers counted in the figures, who didn't get the training or the booklet. That's about all I can think of to be honest.

2.2.21 R OK. I understand. These things never go entirely to plan. But I think that is about all I need for now. Thanks for your time.

IOSH
The Grange
Highfield Drive
Wigston
Leicestershire
LE18 1NN
UK

t +44 (0)116 257 3100
f +44 (0)116 257 3101
www.iosh.co.uk

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