mpa essential materials sustainable solutions

Cement Pre-Heater Tower GUIDELINES



CONTENTS

Compliance with any guidance set out in this document does not absolve the user from his legal duties under the Health and Safety at Work etc Act 1974 to form his own site specific assessment of his workplaces and operations and to provide accordingly for such matters.

1. BACKGROUND

A Workshop was held on the 26th October 2012 with the participation of designers, scaffolders, refractory specialists, plant engineers & managers and safety specialists. The aim of the workshop was to build on earlier guidance on "Planned and unplanned maintenance on kilns and pre-heaters" and to work together to identify good practice and improve safety for all.

This document concentrates on a relatively narrow set of health and safety priorities specific to the wrecking and subsequent installation of pre-heater tower refractory linings in the United Kingdom. Recommendations made in earlier guidance on kiln maintenance and PPE may also apply to the wrecking of linings, for example on co-ordination, communication, management, supervision, emergency procedures, housekeeping, CDM regulations, isolation and PPE selection.

2. PLANNING AND DESIGN

Plans should include measures to control the risks posed by falling refractory and other materials such as scaffolding poles and bricks; control the fumes and flash generated by welding activities; resolve potential safety conflicts between different groups of contractors working in the pre-heater tower (e.g. welders or those working overhead); ensure that safe working loads of platforms are observed; control the delivery and storage of contractor materials; facilitate materials handling and good house keeping; and to maintain good occupational health.

ADVANCE PLANNING

Certain engineering measures may need to be put in place prior to the shutdown. These relate to improved access, facilitation of safer working practices and the provision of access ports for the installation of the Pre-Heater Tower Safety Net.

It is recommended that increased research is carried out on the effects of alternative fuels on refractory and anchor performance. Additionally CARDOX use has increased with the use of alternative fuels and this has knock-on consequences for the liner.

RECOMMENDATIONS

- Above the Riser: Provide a lifting beam along with a 'coffin' door to facilitate 'working downwards'.
- Access Doors: Should be designed to facilitate the installation of platforms and allow the recovery of casualties by SKED/ Stretcher. Additionally the closer the door to the top of the cyclone, the lower the risk associated with falling refractory. Subject to structural constraints, increasing the number of doors reduces the loading on the working platform, as the distance between platforms can be reduced.
- Access Routes: Facilitate the flow of materials and equipment (including automated wrecking machinery) to and from the access doors by improving access routes.
- Reduce manual handling injuries and the risk posed by falling materials by designing routes and by providing hoists etc. to facilitate the movement of scaffolding poles and boards; and by designing wrecked material flow routes out of the pre-heater tower and then down to the ground level .
- Facilitate the inspection of refractory condition, for example, by considering the use of sub panels in steel work to allow the inspection of refractory and anchors.
- If possible determine the condition of the refractory in advance of the shutdown by the use of cameras or by developing predictive tools based on refractory sampling.
- Install access ports to allow installation of the Pre-Heater Tower Safety Net.
- Increase research on the effects of alternative fuels.

Scaffold beam doors

Extra large access doors

Calciner cleaning hatches

PLANNING & DESIGN

The recommendations contained within 'Kiln Workshop Guide 1: Maintenance' need to be considered alongside the following guidance. In particular, participants on the 26th October 2012 re-emphasised the importance of the early Involvement of all parties (including designers, scaffolders, refractory wreckers and installers) at the planning stage; the importance of 'one man in charge'; good communications including effective feedback; visible management and supervision; good standards of housekeeping, identification of confined spaces (along with suitable permits and controls); and isolation procedures.

Design: Every year requirements change and the change in design needs to be budgeted for. Improvements in computer software mean that plans can be tested before they are put into effect. Where required, there should be third party confirmation of the scaffold design and erection.

Emergency Plans: There need to be effective emergency plans that include the recovery of casualties. Equipment and individuals need to be prepared, for example, to retrieve casualties at height from the scaffolding. Dialling 999 does not constitute an effective plan.

Scaffolding: Scaffolders need to be involved at an early stage as sites need to know what scaffolders require. Fittings etc. should not be stored outdoors due to the issue of corrosion.

Storage of Materials: A suitable safe area, with due regard for vehicle and pedestrian segregation, should be provided for the storage of contractor tools, equipment and materials. The location of fire points and hydrants etc. should be considered when choosing this area.

Safe Working Loads of Platforms; are a key issue and should be taken into account at the design stage, along with the potential for impact damage from wrecked materials.

Reduction of material build up: Prior to the plant stop, as much build up should be removed as practical, e.g. by manipulating process conditions.

Safety standards should be maintained whether the work is planned or unplanned and as a general principle the order of work should be as follows:

Work from Top Down,

Initial External Clean

Install Safety Net

Full Clean Down

Re-Inspection

COMMUNICATION

Contractors highlighted good practice at EDF where each day/task started with a pre-job brief where the contractors were involved in the plans and the method statements were gone through. This also happened for the 12 hour pm shift.

Meetings work best when all parties are involved (including company internal departments e.g. electrical and engineering - don't under estimate the potential problems caused by lack of communication). The recommendations on co-ordination and communication contained within the 'Kiln Workshop Guide 1: Maintenance' should be considered.

SCAFFOLDING

General access scaffolds are covered under 'General access scaffolds and ladders' HSE Construction Information Sheet No. 49.

Scaffold design and checking is covered under BS5975: 2008 Code of practice for temporary works procedures and the permissible stress design of falsework. This gives recommendations and guidance on the procedural controls to be applied to all aspects of temporary works, including scaffolding. The items to be considered in the design brief are covered in Section 8.

Table 1 gives the following guidance on the checking of designs and possible examples have been provided by the scaffolding industry:

Category 0 scaffold

Scope - restricted to standard solutions only

Check - site design team

Context - basic as defined in TG20:08

Possible examples:

0.1 Access towers – multi lift with proper tie patterns – External scaffolds to all floors e.g. access to doors

0.2 Independents – multi lift with proper tie patterns – as above but longer scaffolds e.g. for ducting.

0.3 Birdcages light duty – multi lift with proper tie patterns – e.g. access for inspection to beam.

Category 1 scaffold

Scope - simple designs with simple analysis methods only needed.

Check - site design team

Context - simple bridges with beams, simple loading bays founded on the ground, edge protection made from scaffold components.

Possible examples:

1.1 Bridge sections with beams not exceeding 6m span – e.g. to span over push floor cooler plates

1.2 Loading bays based out at ground level – External scaffolds outside doors to load small items of equipment / plant onto or small amounts of refractory bricks onto.

1.3 Edge protection – around holes, voids, doors, roof-lights – to restrict access to certain areas

1.4 Scaffolds built on top of roofs - should ensure sign off before work erected to confirm roof can take the load to be imposed on it

1.5 Scaffolds that are sheeted – for dust containment, weather protection

1.6 Hanging scaffolds (small)- simple 1 lift inspection hangar scaffold e.g. in Riser

Category 2 scaffold

Scope - more complex or individual designs with a considerable degree of interpretation of loads/performance.

Check - by an individual not involved in the design and not consulted by the designer. Can be from the same or different organisation.

Context - public protection, complicated bridging arrangements, heavily loaded birdcages, scaffolds for vehicular access. Network Rail, London Underground and Highways Agency scaffolds will usually be either Cat 2 or 3 due to the increased risk of interaction with the public, even if simple scaffolds.

Possible examples:

2.1 Temporary roofs

2.2 Cantilever scaffolds – e.g. to extend existing scaffold over a void or a vessel

2.3 Large beam section over 6m span – Most major internals e.g. in Calciner and Cyclones

2.4 Heavy duty loading bays – for loading motors or gear boxes onto – the weight of the load must be pre-specified so the loading bay can be built accordingly

2.5 Scaffold where tie patterns cannot be met (buttress-kentledge) – e.g. free standing scaffold for roof access

2.6 Truss out – e.g. out of window in pre-heater building for concrete repairs

2.7 Hanging scaffolds (Large) – Most major internals throughout the system

2.8 Protective fan – e.g. over door entrances, pedestrian walkways.

2.9 Network rail scaffolds

Category 3 scaffold

Scope - complex or innovative designs, complex sequences of moving/construction, considerable exercise of engineering judgement.

Check - by another organisation.

Context - close proximity to working rail lines, scaffolding for structural support/shoring, access for the public.

Possible examples:

3.1 False work scaffold

3.2 Multi beamed areas

3.3 Complex or innovative designs

3.4 Considerable exercise of engineering judgement

A design check certificate should be produced for all categories, confirming that the design complies with all aspects of the design brief, the standards used and the loading conditions. HSE's understanding and interpretation of temporary works management can be found in the inspectors guidance note: SIM 02/2010/04 http://www.hse.gov.uk/foi/internalops/sims/constrct/2_10_04.htm

HSE have also prepared a checklist to clarify when scaffold design is required and what level of training and competence those erecting, dismantling, altering, inspecting and supervising scaffolding operations are expected to have obtained.

DESIGN AND INSPECTION ISSUES (HSE CHECKLIST)

- Unless a scaffold is a basic configuration described in recognised guidance e.g. NASC Technical Guidance TG20 for tube and fitting scaffolds or manufacturers' guidance for system scaffolds, the scaffold should be designed by calculation, by a competent person, to ensure it will have adequate strength and stability.
- All scaffolding should be erected, dismantled and altered in accordance with either NASC guidance document SG4 for tube and fitting scaffolds or the manufacturers' erection guide for system scaffolds.
- For scaffolds that fall outside the scope of 'Basic Scaffolds' as described in bullet point 1 (above), the design information should describe the sequence and methods to be adopted when erecting, dismantling and altering the scaffold, if this is not covered by published guidance as detailed in bullet point 2 (above).
- Any proposed modifications or alterations outside a generally recognised standard configuration should be designed by a competent person.
- Handover certificates should refer to relevant drawings, permitted working platform loadings and any specific restrictions on use.
- All scaffolding inspection should be carried out by a competent person whose combination of knowledge, training and experience is appropriate for the type and complexity of the scaffold he is inspecting. Competence may have been assessed under The Construction Industry Scaffolders Registration Scheme (CISRS) or an individual may be suitably experienced in scaffolding work and have received additional training under a recognised manufacturer/supplier scheme for the specific configuration he is inspecting.
- A non-scaffolder who has attended a suitable scaffold inspection course and has the necessary background experience would be considered competent to inspect a basic scaffold (ie a Site Manager).
- The scaffold inspection report should note any defects and corrective actions taken, even when those actions are taken promptly as this assists with the identification of any recurring problems.
- To prevent use by unauthorised persons of incomplete scaffolds, relevant warning signs identifying the areas where

access is not permitted should be displayed at the access points to these areas. In addition, access to the incomplete areas should be prevented by suitable physical means.

COMPETENCE AND SUPERVISION ISSUES (HSE CHECKLIST)

- All employees should be competent (or in the case of trainees, supervised by a competent person) for the type of scaffolding work they are undertaking and should have received appropriate training relevant to the type and form of scaffolding they are working on.
- Employers must provide appropriate levels of supervision taking into account the complexity of the work and the levels of training and competence of the scaffolders involved.
- As a minimum requirement, every scaffold gang should contain an appropriately qualified scaffolder for the type and complexity of the scaffold to be erected, altered or dismantled. This may be an individual who has received training under an industry recognised training scheme, e.g. CISRS, and has been awarded the scaffolder card or someone who has received training under a recognised manufacturer/supplier scheme, to the limit of the configuration(s) involved.
- Trainee scaffolders should always work under the direct supervision of a qualified scaffolder (i.e. a Working Foreman). Scaffolders are classed as 'trainees' until they have completed the approved training and assessment required to be deemed qualified.
- Erection, alteration and dismantling of complex designed scaffolding (e.g. suspended scaffolds, shoring, temporary roofs etc.) should be done under the direct supervision of a competent person. This may be a qualified Advanced Scaffolder, a Design Engineer providing they possess the necessary industry experience or alternatively an individual who has received training under a recognised manufacturer/supplier scheme to the limit of the configuration(s) involved.

3. INSPECTION AND CLEAN DOWN

As with all working, operations during inspections and cleaning should follow the hierarchy of control. The aim should be to eliminate risk by external working where possible and where entry to the pre-heater is necessary to introduce procedures to strictly control any residual risk.

3.1 PRE-INITIAL INSPECTION CLEAN DOWN

RECOMMENDATIONS

- A pre-inspection clean down of cyclones, riser ducts and bars should be undertaken externally using air lance/water blasters/CARDOX/gyro whips etc.

3.2 INITIAL INSPECTION

RECOMMENDATIONS

- The initial inspection of all areas should be carried out from an external safe point following the cooling down period of the system.
- Only competent and experienced personnel should carry out the inspection.

3.3 PRE-HEATER TOWER SAFETY NET

RECOMMENDATIONS

- The Pre-Heater Tower Safety Net should be installed before anyone enters the cyclone of the pre-heater tower.

HANSON SAFETY NET

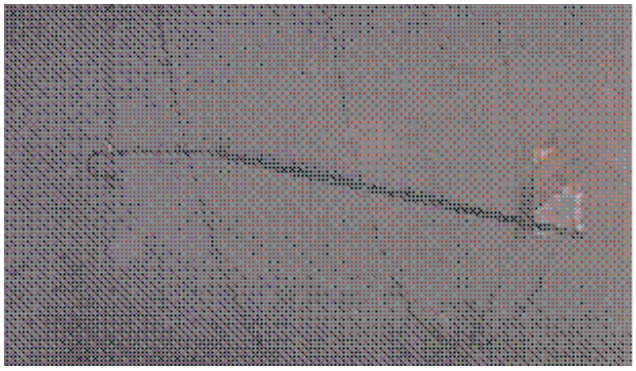
As part of Hanson Cement's 2012 Zero Harm objectives, the engineering department came up with a netting system, installed at the start of the shutdown, to retain the roof refractory. Working with a leading UK netting company Huck Tec Ltd (http://hucktek.co.uk/) the original ideas were turned into a working design which prevents any cyclone roof material falling onto people during maintenance.

Figure 1: Cyclone roof with partially wrecked refractory

HOW IT WORKS:

Ropes are dropped through access ports in the roof of the cyclone

The ropes are then hooked and dragged through access doors



The ropes are then connected to the net on the outside of the cyclone

The connected net is then fed back into the cyclone through the access door

The connected net is then pulled up to the underside of the roof

The ropes are pulled out through the cyclone roof, disconnected and the tensioning rods are fitted through the brackets and tensioned.

The nets are tensioned and pulled up tight to the underside of the roof and the refractory roof is restrained.

The net mesh size is 100mm and the gap between the net sections is 50mm. The net can restrain 5 tonnes and there is also an option to fit side netting if required. It is believed that the provision of port holes in brick lined cyclones should not be an insurmountable problem.

CEMEX DEVELOPMENT

During the annual maintenance project at CEMEX's Rugby works, the safety net was modified to suit their purposes; so that the individual net sections were stitched together and a fine mesh inner net was incorporated to catch smaller debris.

RECOMMENDATION

- Design changes should be put in place to accommodate the use of the net.

3.4 CLEAN DOWN

RECOMMENDATIONS

- Permit to Work must say its safe to enter.
- The clean down should be achieved by:
- Use of air lances/ bars/high pressure water through poke hole doors etc (i.e. remove as much build up as possible using an external method).
- Build scaffolding access to clean down areas and undertaking cleaning.

Or

- By provision of Bosun's chair access to clean down areas.

And

- Access to the kiln should be prevented when the pre-heater is being cleaned down.
- The issue of alkali burns must be addressed through risk assessment, safe working procedures and inductions.

Best Practice: Access following external clean down

- A Senior Manager (Works Manager or Production Manager) should authorize the first entry into high risk areas e.g. kilns/ cyclones/riser area where there is a potential for a materials fall. This should be preferable done in writing.
- Consideration should be given to repeating the procedure when conditions change, for example temperature, material contraction or when unexpected conditions arise.

3.5 RE-INSPECTIONS

Knowledge, understanding and expertise are required, due to the dynamic situation created by the cooling process; and efforts need to be made to check the anchorage of the monolith. New shell designs and the use of brickwork at Hope works have facilitated the sampling and overview of anchor points.

RECOMMENDATIONS

- A re-inspection should be carried out after the clean down by a competent person.
- Further re-inspections should be carried out on a frequent basis (at least daily).
- Inspect linings and anchor integrity by:
- Inspection ports.
- Considering the use of Refractory "tell tale" devices.
- Visually following access scaffold erection.
- Isolate feed pipes to cyclones.
- Insert plate blades. Best practice is the use of pneumatic valves.
- Erection of scaffold access to be undertaken by competent persons.
- Re-inspect regularly and whenever conditions change (this includes the night shift).

4. WRECKING OF LINING

Subject to the constraints of plant layout and geometry; sites need to work closely with wrecking companies to facilitate the use of automatic wrecking techniques, where possible. Along with falling refractory, one of the most critical safety issues during pre-heater tower working is ensuring that working platforms do not become overloaded.

RECOMMENDATIONS

SCAFFOLD PLATFORM

- The scaffold platform should be suitable for wrecking operations i.e. fit for purpose regarding access to wrecking areas (i.e. no over-reaching) and with an appropriate load bearing specification.
- Normal scaffolding inspection regimes should be stepped up due to the increased potential for impact damage on scaffold boards.
- Protection scaffolds should be used as standard (segregation scaffold platforms with mattress and edges closed for example by use of profile boards, sandbags, expandable foam and sheeting). Double netting should be provided on hand rails from Bottom to Top.
- Wrecked material must be regularly cleared for safe access/ egress and to avoid overloading of scaffold structure. MAKE IT EASY TO REMOVE WASTE (e.g. by providing conveyors/tracked dumpers). Ideally the route for waste should be out of the pre-heater tower and then down.
- Loading of platforms needs to be constantly policed and awareness of the dangers posed by overloading should be raised through tool box talks, Safe Working Practices, Risk Assessments and Method Statements. Simple information on loading (e.g. what does a tonne look like) and the requirement to spread the load across platforms needs to be provided to wreckers. A regular inspection regime should be introduced and a new Inspection/assessment should be carried out after every incident (e.g. when the scaffold has been struck by falling material).

Make this a visible felt leadership focus

WRECKING OF AREAS

- Wrecking to be carried out by competent person(s).
- Provide separate access for services (hoses etc.) and people.
- Tools and equipment must be in serviceable condition. Hose and whip checks are mandatory.
- Utilise mechanical wrecking where reasonably practicable.
- Minimise hand wrecking/use of vibration equipment.
- Rotation of people wrecking – to minimise exposure.
- PPE should be appropriate to the task and its use should be enforced.
- Work top down on wrecking process.
- Wrecking team to include watcher observing any change in other areas "loose materials".
- Isolate wrecked areas from continuing work to allow different tasks to be carried out independently. There should be no overhead working without segregation/protection.
- Be aware of hazards created by the wrecking process – for example, the exposure of old anchors (protruding steel).
- Issues raised by jack hammering of monolithics e.g. noise, dust, hand arm vibration and PPE should be covered by the risk assessment and method statement.
- Refractory installers should be subject to regular safety audits/ inspections.

OTHER

- Provide protection against welding flash for others working in the vicinity of welding activities.
- Provide protection against welding fumes. (Forced air helmets are now seen as best practice for welders).
- Provide local exhaust for welding fumes (also a consideration for refractory product spraying activities).

5. REFRACTORY INSTALLATION

Refractory installers/designers should be involved early in the in the planning stage and quality control procedures should be improved.

Alternative fuels will have an effect on the design and refractory products used. Refractory manufacturers are coming up with improved materials and clients will have to consider the various merits of increased use of pre-cast block, brick versus monolith; more Shotcrete applications: and work with them to develop robotic monolithic installation techniques.

RECOMMENDATIONS

- Clients to review quality control procedures to ensure that product quality and the quality of installation are adequately covered. This should include:
  - The competence of installers (including installers of anchors).
  - The specification for anchors (consider the use of 330 stainless anchors or ceramic anchors: and anchors with 'plate' attachments).
  - The quality of anchor installation.
  - Product quality (e.g. are materials left over from the previous year's work in date?).
- Consider issuing radios to refractory supervisors.
- Use a safe container such as a galvanized bucket for transporting anchors (they are supplied in Hessian sacks which often have holes in them as they have been dragged due to their weight. The anchors weigh 2 to 3 lb and poke through the sack, they can also fall out).
- Holding daily information meetings between client and installer would be advantageous to all.
- Promotion of a challenge culture by installers to prevent unsafe acts and conditions.
- Hold pre/post installation site inspections to maintain housekeeping.

6. NEAR MISS/HITS

REPORTING

The normal rules for successful near hit reporting need to be followed to encourage contractors to submit near hit reports, and sites need to lead by example, e.g. by maintaining high standards of housekeeping.

RECOMMENDATIONS

- Site Managers should welcome the reporting of near hits as a valuable tool in preventing injury.
- Contractors should be encouraged to report near hits and they should be treated in the same manner as employees. Where 'no discipline' guarantees are in operation for employees who report near misses, consider extending them to contractors.
- The normal rules of successful near hit reporting schemes should be followed: keep it simple, make it easy to report incidents, do not hold reports against contractor, ensure prompt action is taken, and provide feedback on the action that was taken. If necessary, open up confidential whistle blowing hotlines to contractors.

OCCUPATIONAL HEALTH

- Refractory installers should be introducing occupational health monitoring on a risk based approach. i.e. exposure to manual handling, noise, dust, hand arm vibration, fumes etc.
- Consider PPE such as metatarsal protection on boots.
- Participate in daily pre-work briefs on health effects.

7. LONGER TERM

In the longer term, the design of pre-heater tower vessels needs to change to facilitate safer ways of working. Managers need to start challenging why anyone needs to enter under refractory.

INNOVATION:

- Planning and execution. 3D modelling can be used to demonstrate that designs work.
- Consider redesign of vessels to facilitate new ways of working (examples exist in the gas and power industries where demountable roofs have been designed that allow for an access platform with a protective roof to be lowered in).
- Where economics are dictating "make it last", more effort needs to be made with respect to refractory sampling to determine condition and to build up a record of performance (e.g. so that the effects of alternative fuels can be predicted). Sampling existing refractory annually will give a history of condition and could be used as a predictive tool to decide on life of product and replacement. This could be seen as similar to condition monitoring.
- Other methods such as ultrasound and thermal imaging should be explored in determining refractory condition.
- Consider the use of remote cameras to identify problem areas to facilitate advance planning.
- Consider new methods of remote working, for example, emergency short term repairs are being carried out remotely on blast furnaces to get the plant through to the planned shutdown.

make the link to mineral products

MPA Cement is part of the Mineral Products Association, the trade association for the aggregates, asphalt, cement, concrete, dimension stone, lime, mortar and silica sand industries. MPA Cement members are CEMEX UK, Hanson Cement, Lafarge Cement UK and Tarmac Buxton Lime & Cement

MPA Cement

38-44 Gillingham Street, London SW1V 1HU

Tel 020 7963 8000
Fax 020 7963 8001
info@mineralproducts.org
www.mineralproducts.org

mpa essential materials sustainable solutions