BRE

Pollution control guide

Controlling particles, vapour and noise pollution from construction sites

Part 1
Pre-project planning and effective management

Vina Kukadia, Stuart Upton, Colin Grimwood and Chuck Yu

BRE Environment

Construction sites can be a major source of pollution if not managed and controlled properly, and can have an adverse impact on health and the local environment. Enforcement is disruptive and expensive. It is therefore important that construction personnel follow good environmental practice to control these emissions, comply with environmental legislation and prevent problems.

This Guide is the first in a series intended to assist with the control of air pollution and noise emissions from construction sites. It sets out guidance on controlling pollution emissions through effective pre-project planning and management issues that are an essential part of any construction project. Other Guides in the series give methods for controlling air and noise pollution from various construction and demolition activities.

Titles in this series on controlling particles, vapour and noise pollution from construction sites

1 **Pre-project planning and effective management**
2 Site preparation, demolition, earthworks and landscaping
3 Haulage routes, vehicles and plant
4 Materials handling, storage, stockpiles, spillage and disposal
5 Fabrication processes and internal and external finishes

Box 1 Definitions

Pollution from construction
Particles, noise, vibration and vaporous discharges.

Particles
All airborne particles and deposited dust.

Fine particles
Less than 10 µm in diameter, known as PM_{10}.

Noise
Excessive levels of sound and vibration.

Vapours
Volatile organic compounds (VOCs), such as formaldehyde and benzene, being released, for example from fuels, petroleum solvents and bituminous tar oils.

Air Quality Management Area (AQMA)
An area defined by a Local Authority when local action is needed to reduce pollution concentrations to meet government health-based targets.

Health effects of pollution emissions

Pollution emissions from construction sites can have a detrimental effect on health and the local environment. Particles and vaporous discharges can have an adverse impact on the health of site operators and local residents by affecting particularly the eyes, nose, mouth, lungs and skin. Fine particles can penetrate deep into the lungs, contributing to respiratory and cardiovascular problems. Large particles can cause nuisance through soiling of surfaces such as cars, property and washing. Excessive noise levels can be a hazard to site workers and can annoy neighbours and disturb local wildlife. Following good environmental practice to control these emissions,

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complying with environmental legislation and preventing problems are of great importance.

Target audience

Environmental issues need to be understood and considered by all those involved in the design and construction process, from the initial feasibility studies through to design, planning and actual construction on sites. As an example, Box 2 outlines the various specialised areas within the construction industry and the target audiences likely to benefit from the advice contained within these *Guides*.

Box 2 Target audience

Design and pre-construction
- Clients and developers
- Project managers and directors
- Construction planners
- Building designers and architects
- Consultants

Regulatory
- Local Authorities
- Government Departments and Agencies

On site
- Project managers and engineers
- Foremen and supervisors
- Contractors and operators
- Safety advisors
- Environmental officers

Suppliers
- Plant and equipment manufacturers and hirers
- Construction materials producers, suppliers and hirers

Others
- Fleet operators
- Education and training establishments
- Workers and the representative unions
- Trade associations and member institutions
- Community interest groups and local representatives

Benefits of working to good environmental practice

Benefits will be felt at both corporate and project levels with the potential for increased business and improved profit margins through:
- better local air quality and fewer complaints;
- reduced costs of mitigation, eg cleaning soiled property and repairing environmental damage;
- avoiding costly delays and interruptions in dealing with enforcement notices and defending prosecutions;
- meeting government and commercial sustainability targets by protecting health and the environment without imposing excessive economic costs;
- demonstrating corporate environmental responsibility;
- better workforce relations.

Vehicles and construction plant and other equipment should operate as quietly as possible and run on fuel that produces low emissions of fine particles and vapours

Pre-project planning

Identifying activities that generate pollution

Before the start of a project, an action plan should be drawn up to identify the construction activities likely to cause pollution problems along with methods to minimise them. Suitable control procedures and personnel responsible for implementation and follow-up should also be identified at this initial stage of the project. A checklist to help with this process is given on pages 6 and 7.

Environmental risk assessments

Environmental risk assessments will form a part of any Environmental Impact Assessment (EIA) required by the regulatory authorities. These may need to be prepared for all activities identified as potentially generating pollution discharges.

Under the Construction Design and Management Regulations 1994 (CDM), the designer has a duty to ensure that, so far as is reasonably practicable, any project design will conform with the hierarchy of risk control given in Box 3.

Box 3 CDM regulations: hierarchy of risk control
- To avoid altogether, if possible, risks to the health and safety of any person at work on building, maintaining, repairing or carrying out cleaning work on a structure.
- To combat risks to such persons at source.
- To give priority to measures that protect the whole workforce over those which protect only the individual.

In assessing the risks associated with pollution emissions, the following issues should be considered:
- the nature of the activities to be carried out;
- any dangerous or toxic materials (eg asbestos or contamination of the land) likely to be encountered during the works;

- the weather conditions that are likely to prevail during operations that generate pollution;
- the proximity of pollution-sensitive sites, such as nearby dwellings, schools and hospitals, as well as commercial and industrial areas;
- the effects on the general public and road users; and
- any restrictions placed on the site by the client, facilities manager or Local Authority.

Pollution emissions from construction sites will often result from the sum of a large number of small activities. Therefore, attention to detail is a critical feature of effective management of the overall site.

Specifying and selecting low emission materials

Selection of low emission materials during the design and contracting stage is recommended. Several product-labelling schemes exist in the European Union. Building designers should specify materials that meet the EN Standard for that product (eg BS EN 13986: 2002 for wood-based products) and are marked with the CE label. Information on European labelling schemes for products and emission guideline values can be found in BRE *Digest 464*.

Method statements

Comprehensive method statements to minimise pollution emissions from specific operations should be prepared and agreed at the outset of the project. They may also form a part of any subsequent Environmental Impact Assessment (EIA). Items that should be covered by the method statements are listed in Box 4.

Box 4 Preparing method statements

Method statements should refer to the use of:

- methods that minimise pollution emissions;
- particle control equipment that does not itself cause noise problems;
- prefabricated components and constructions wherever possible;
- building materials and furnishings with low pollution emissions;
- vehicles and construction plant operating on fuel that causes low emissions of fine particles and vapours;
- vehicles, construction plant and other equipment that operate as quietly as possible;
- an optimum site layout to ensure that:
  - ❏ pollution-generating activities are located away from sensitive receptors or housed in closed environments where possible;
  - ❏ barriers and screens are used effectively to screen noise sources such as engines, compressors, etc.;
  - ❏ there is an adequate supply of water for damping down particles with sufficient hoses to reach all parts of the site;
  - ❏ water supply is conveniently located near particle-generating activities and site exits;
  - ❏ proper control and disposal of 'run-off' water from damping down is carried out;
- good site housekeeping and management;
- controlled hours of operation of activities to minimise local impact (eg minimising noise early in the morning and pollutant emissions at weekends in residential areas);
- training and management procedures to ensure that appropriate method statements are applied.

Sheeting provides some screening for nearby building occupants; site hoardings display warning signs and contact details for enquiries and complaints

Pollution control equipment should be readily available to the site from the commencement of works. The choice of plant and equipment and the method of work should reflect the need to employ best practicable means. Generally, where alternative methods exist, intrinsically dusty operations, such as dry sweeping or dry sandblasting, and noisy practices, such as the use of unsilenced compressors, should be avoided.

Action and reporting: allocating responsibilities

All personnel on any construction or demolition site should understand their legal responsibilities and ensure that the generation of pollution is minimised. All appropriate site workers should be trained so that they know when to employ these methods and can use them effectively.

Training

Before the start of any project, appropriate training on how to control pollution emissions should be given to all personnel expected to be present on site. This should occur within the established site induction procedure and include:

- the benefits of reducing pollution to health and the environment;
- the benefits of minimising disruption from complaints and enforcement actions;
- methods to minimise the generation of pollution;
- action plans on what should be done if emissions breach any limits that have been set for the particular site;
- individual responsibilities and management procedures;
- the importance of effective communication between relevant personnel at all levels.

Satisfying planning requirements

Effective dialogue should occur between the Local Authority (both Planning and Environmental Health Departments), the main site contractor and other relevant parties at the earliest possible stage in any project to determine which planning requirements need to be satisfied. Pollution control measures should be considered during the initial stages of a project and included in planning applications and at the Environmental Impact Assessment stage.

The Town and Country Planning Act enables Local Authorities to attach planning conditions to planning permissions. By raising the issue of particle, vapour and noise control either at the pre-planning or planning stage, the use and cost of any control equipment can then be incorporated into the relevant tender documents and method statements.

The Local Authority may impose a planning condition requiring a method statement which includes monitoring and control of pollution emissions based on current best practice. It is therefore advised that discussions with the Local Authority Environmental Health Department are carried out at an early stage during pre-project planning to agree any requirements.

During the consideration of planning applications, it is expected that the following will be considered:

- the nature of the works that are being undertaken;
- the duration of work;
- the size of the site; and
- the locality.

A higher degree of control is generally needed from longer-term sites, sites handling contaminated soils and sites in sensitive locations, such as near to residential or business areas.

Selection of contractors/sub-contractors

Factors that should be considered when selecting contractors and sub-contractors for a project should include:

- company environmental statements and policies;
- a proven environmental track-record;
- the provision of environmentally sound method statements.

Implementation and on-site management

Handling public relations

Notice boards on site hoardings should display the following information:

- site programme;
- telephone contacts for enquiries and receipt of complaints;
- the name of the site representative who should be contacted.

The specified telephone must be attended during all operational hours by persons with the appropriate authority to act to resolve any problems that may occur. On some sites, there may be a need to display additional contact details for any out-of-hours pollution incidents.

Specific activities with the potential to cause pollution emissions should be notified within reasonable time to the Environmental Health Officer (EHO) and residents likely to be affected.

Setting working hours and days

Appropriate working hours and days should be set for the site, having regard to the nature of the locality and the types of any sensitive nearby sites. Once working hours and days have been agreed with the Local Authority, they should be adhered to. If there is an urgent need to work early or late, then the reasons and duration should be explained beforehand to any affected parties. On large, complex sites it may be necessary to enter into detailed agreements with the Local Authority and/or local residents over proposed working hours and any variation in procedures.

Working hours and days should be agreed with the Local Authority and adhered to, to minimise disturbance to local residents

Controlling site traffic and setting up access routes

At the project planning stage, the positioning of any site entrances, exits and haul roads in relation to the surrounding area should be considered. If possible, these should be positioned to route vehicles, whether on or off the site, away from sensitive locations, such as residential areas, schools and hospitals. The positioning of exits should also consider the need and practicability of installing low noise vehicle washing facilities where it is appropriate to do so.

The imposition and enforcement of site speed limits should also be considered at an early stage to minimise noise and particle emissions from roadways. If vehicles are to use unsurfaced temporary haul roads, a limit of about 5 mph is recommended. On properly surfaced and maintained roads, a limit of no more than about 10 mph is recommended.

Monitoring of particles and vaporous discharges

There should be discussions with the relevant Local Authority at an early stage of the project to determine what, if any, monitoring is required to meet national and local aims. Specialist advice on monitoring of particle and vaporous discharges may also be required for complex sites. Off-site monitoring stations may require pre-agreement with other nearby land owners.

Sites that are likely to require monitoring include:

- sites in proximity to sensitive locations;
- longer-term sites in proximity to sensitive locations;
- sites containing any contamination;
- projects involving large-scale demolition and/or earthworks;
- sites situated within sensitive areas, ie within an existing or proposed Local Authority Air Quality Management Area (AQMA), in which air pollution levels are already high.

If implemented, ambient pollution monitoring can serve a number of purposes, such as:

- providing an objective measure of air pollution concentrations at the construction site;
- providing information on the success of abatement strategies;
- allowing attribution of particle concentrations to individual sources, processes or events (this may be required in the case of disputes, as in some cases the source of local pollution may be external to the construction site itself).

Noise monitoring

Noise monitoring may be required on site to ensure compliance with occupational health and safety legislation. Environmental noise monitoring at or outside the site boundary may also be required. Off-site monitoring stations may require pre-agreement with other nearby land owners.

In particular, noise monitoring may be required in the following special circumstances:

- where there are, or are likely to be, noise complaints from occupants of adjacent land.
- where formal noise control procedures under the Control of Pollution Act 1974 have been invoked by the developer or the Local Authority;
- where statutory action for noise nuisance under the Environmental Protection Act 1990 is being considered by local residents or the Local Authority;
- where maximum noise limits (or other noise controls) have been applied to the site through informal agreements, planning conditions, or other environmental legislation (eg Control of Pollution Act 1974, Environmental Protection Act 1990).

Housekeeping management

Good housekeeping is essential to running a safe site. A high standard of site supervision and a supportive attitude towards health, safety and the environment is very important. Site management staff are responsible for ensuring that equipment is used properly, and maintained effectively. Poorly maintained plant will usually be noisier and less efficient. Plant or equipment that is used inappropriately is unlikely to be effective. Examples of good housekeeping are given in Box 5.

Preventive measures should be taken to minimise the formation and spread of dust and vaporous discharges. This includes specifying and using plant and fuel with low pollution emissions. Site managers need to ensure that dust suppression measures are applied promptly and effectively as required. They should ensure that the questions listed in Box 6 can be answered affirmatively.

Care must be taken to ensure that any dust suppression technique used does not generate avoidable noise.

Damping down demolition activities with water sprays minimises dust emission and spread

Box 5 Examples of good housekeeping

- Servicing engines on construction plant and vehicles.
- Maintaining pumps and fans.
- Unblocking water sprays or water bowser jets.
- Water spraying of haul road surfaces.
- Enforcing site management practices such as speed restrictions, use of wheel washers and sheeting of loads carried by road-licensed vehicles.
- Implementing frost protection during winter months for water-based dust suppression systems.
- Routine checking for:
  - ❏ missing or corroded wind boards on conveyors;
  - ❏ missing or corroded sheeting enclosing crushing plant;
  - ❏ torn or missing fabric bag filters in dust control/filtration units;
  - ❏ missing silencers on noisy plant;
  - ❏ missing excavator bucket pins;
  - ❏ missing or damaged noise screens and barriers.

Box 6 Examples of checks to ensure dust suppression measures can be implemented

- Is an adequate supply of water available and are there sufficient hoses to reach all parts of the site?
- Is there sheeting to cover the skips?
- Are service and repair contracts in place to deal with the maintenance and breakdown of pollution control equipment?
- Has provision been made for the disposal of wastewater?
- Has a site log book been provided as part of the pollution management regime?

Checklist

A checklist is included on pages 6 and 7 to help with ensuring that all aspects relating to the control of pollution emissions have been considered. Depending on circumstances (eg additional planning requirements), further actions may need to be added to this checklist. It can be used to:

- carry out pre-project planning by designers and project managers;
- carry out audits by project environmental managers;
- check that all environmental aspects associated with dust, noise and vapours have been considered by Local Authority Environmental Health Officers.

Checklist

Action	*Yes/No*	*Responsible personnel*	*Observed close out*
Have the Local Authority Environmental Health and Planning Departments been contacted and involved?			
Have other regulators such as the Environment Agency, Health and Safety Executive, etc. been contacted and involved (eg for water run-off)?			
Have environmental risk assessments been completed?			
Have method statements been completed, agreed and put in place?			
Have appropriate working hours been agreed?			
Is the site in a Local Authority Air Quality Management Area (AQMA)?			
Has any statutory noise control action been taken under COPA1974 or EPA1990?			
Are there any specific requirements identified by the Local Authority or other regulator?			
Is monitoring required for dust, noise and vapour levels?			
Are methodologies for monitoring in place?			
Have particles, vapour or noise emission limits been agreed or imposed?			
Will breaches of emission limits shut down activities on the site?			
Are the costs and consequences of shutdown known by everyone?			
Have positions of site entrances and haul roads, and speed limits been considered?			
Have low pollution-emitting materials and techniques been specified?			

Cont'd.....

Checklist

Action	*Yes/No*	*Responsible personnel*	*Observed close out*
Does construction plant fitted with dust control measures also have appropriate silencers?			
Have costs of pollution control equipment and operation been incorporated into project specification and tenders?			
Is the specified pollution control equipment available for immediate use when needed?			
Are particle, noise and vapour control 'champions' to be appointed?			
Have the 'champions' been given sufficient time and resources for the task and level of responsibility?			
Are procedures for site logging of pollution-generating activities and control measures in place?			
Are public relations and information systems in place?			
Have the site management team and contractors been trained and informed?			
Are incentives or penalties in place for staff/contractors?			

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References

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Digest 464 VOC emissions from building products (2 Parts)

British Standards Institution

BS 5228: Noise and vibration control on construction and open sites

Part 1: 1997 Code of practice for basic information and procedures for noise and vibration control

Part 2: 1997 Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance

Part 3: 1997 Code of practice applicable to surface coal extraction by opencast methods

Part 4: 1992 Code of practice for noise and vibration control applicable to piling operations

BS EN 13986: 2002 Wood-based panels for use in construction — characteristics, evaluation of conformity and marking

HMSO

Construction (Design and Management) Regulations 1994

Control of Pollution Act 1974

Environmental Protection Act 1990

Town and Country Planning Act 1990

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Part 2
Site preparation, demolition, earthworks and landscaping

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BRE Environment

Figure 1 Sheeting of building before demolition

Construction sites can be a major source of pollution if not managed and controlled properly, and can have an adverse impact on health and the local environment. Enforcement is disruptive and expensive. It is therefore important that construction personnel follow good environmental practice to control these emissions, comply with environmental legislation and prevent problems.

This Guide is the second in a series intended to assist with the control of air pollution and noise emissions from construction sites. It sets out guidance on controlling pollution emissions associated with site preparation, demolition, earthworks and landscaping. Although techniques have not been validated under controlled conditions and therefore must be used with care, recommendations are drawn from cases where they have been found to be effective.

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Vapours
Volatile organic compounds (VOCs), such as formaldehyde and benzene, being released, for example from fuels, petroleum solvents and bituminous tar oils.

Air Quality Management Area (AQMA)
An area defined by a Local Authority when local action is needed to reduce pollution concentrations to meet government health-based targets.

Site preparation and restoration after completion

Preparation of the site before construction, and site restoration after completion, have the potential for emitting air pollution. In particular, if the land under development is contaminated, special measures may be required in the context of a remediation scheme agreed with the Local Authority to minimise the emissions, either in the form of particles and vapours to the air, or liquids to the ground.

Site preparation activities that may generate pollution include the following.

- Installation and dismantling of boundary fencing, barriers, scaffolding and screens around the site (see next section, page 2).

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- Earthworks for temporary drainage and surfaces (see section on page 5).
- Processing aggregates, especially crushing and screening (see section on page 7).
- Compacting soil aggregate and laying temporary roads and surfaces for car parking, temporary accommodation and drainage (see *Part 3*).
- Materials handling, such as loading and unloading lorries around the site (see *Parts 3 and 4*).
- Re-suspension of dust from stockpiles and surfaces in strong winds (see *Part 4*).
- Disposal and burning of waste materials (see *Part 4*).
- Vehicle and plant movement (see *Part 3*).
- Vehicles and static plant exhaust emissions (see *Part 3*).

Boundary fencing, barriers, scaffolding and screens

Boundary fencing or hoarding is usually required on construction sites for security purposes. Fencing has the added advantage of providing shelter from the wind, which reduces the likelihood of dust re-suspension from the ground and provides a degree of noise screening.

In general, the erection of boundary fencing, barriers, scaffolding and screens causes little generation of dust, particles and vapours. Any particles that may be generated can be damped down using water-suppression techniques. However, both fencing and scaffolding provide a suitable framework for the erection of lightweight sheeting, either at the site perimeter or around potentially dust-producing activities on the site, thereby minimising the spread of dust (Figure 1). Fencing and screening can also provide a shield against noise, although they will have little benefit unless they are constructed of solid material, without gaps or holes and are of sufficient height to screen noise-generating activities.

Boards used for scaffolding and other walkways often become coated with materials such as cement and plaster. When dry, particle re-suspension occurs from mechanical disturbance and wind erosion. Boarding at greater heights is exposed to higher wind speeds which increases the risk of particle suspension. Therefore, regular wet cleaning and maintenance are important.

The erection of scaffolding can lead to specific noise problems associated with its handling. The most significant noise sources are the arrival of the delivery lorry, handling and assembly of poles and fittings. In general, scaffolding often arrives early for assembly and is typically dismantled late in the day; therefore careful timing of activities is required to mitigate the nuisance. Lorries and storage bins should be lined with sound-attenuating material. Poles should be carried and placed, not thrown or dropped.

Barriers may be formed from existing buildings, such as site offices and even buildings waiting to be demolished. They may be located close to pollution-producing processes or may simply form part of the site boundary fencing (Figure 2). If site offices are used as barriers, then this must be done with due regard to the health and safety and efficiency of office users.

Figure 2 Old buildings around the site perimeter waiting to be demolished can provide effective screening against pollution crossing the site boundary

If barriers are treated with wood-preservatives or painted, vapour is likely to be discharged. Low pollution emission finishes should be used.

Guidance on controlling pollution associated with installation of boundary fencing is given in Boxes 2 and 3.

Box 2 General guidance on minimising emissions of particles, vapour and noise from site preparation, demolition, earthworks and landscaping

- Operate plant and equipment away from residential areas or other sensitive receptors near to the site.

Particles

- Spray demolition and earthworking activities regularly with water to damp down.
- Use vehicles and plant with low exhaust emissions (eg with particle traps[a]) and emission controls such as catalysts or diesel particulate filters (DPFs).

Vapours

- Use low emission fuels[b].

Noise

- Follow guidelines in BS 5228.
- Plant and vehicles should comply with EU noise emission limits.
- Select quiet plant whenever possible.
- Control the hours of operation of all plant and vehicles, and avoid their unnecessary use.
- Use acoustic screening where possible.

[a] Some plant, for example compressors and electricity generators, are available that run on LPG or other alternative fuels, reducing noise and exhaust emissions. Many diesel engine exhausts can be fitted with particle traps. Requirements can be specified in contracts.

[b] Many petroleum companies may supply ULS tax exempt diesel, if specified in the relevant contract(s), at no extra cost.

Box 3 Guidance on installing and dismantling fencing, barriers, scaffolding, screens and plastic sheeting

Particles

- Keep fencing, barriers, scaffolding and screening clean.

Vapours

- Use low pollution emission finishes on timber fencing.

Noise

- Follow guidelines for fences and enclosures given in BS 5228.
- Line flat bed lorries and storage bins with noise-attenuating materials.
- Handle materials carefully, eg scaffolding poles and fittings should be carried and placed, not thrown or dropped.
- Ensure that materials are delivered and installed during normal working hours.
- Ensure close site supervision during installation.

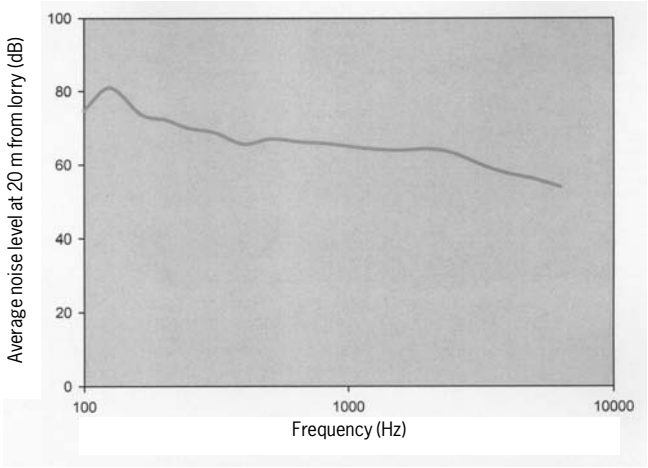

Figure 3 Typical noise levels resulting from the use of an excavator to load a lorry

Demolition

The specific demolition activities that have the potential for generating pollution include the following.

- Internal stripping of buildings prior to demolition (see Box 4).
- Demolition by using explosives, forced collapse or mechanical methods using, eg a demolition ball (see Box 4).
- Partial demolition using shoring, propping and underpinning (see section on *Demolition of buildings* on this page).
- Removal of fuel oil storage tanks.
- Mechanical cutting, crushing, hammering, sawing and drilling (see *Part 5*).
- Discharge of material via chutes to open ground or skips (see Box 4).
- Crushing of material for re-use or disposal (see Box 4).
- Materials handling such as gathering, loading and removal of demolition material from site (see Box 4 and *Part 4*).
- Waste burning (see Box 4 and *Part 4*).
- Suspension of settled dust and dust from piles of rubble in strong winds (see *Part 4*).
- Vehicle and plant movement (see *Part 3*).
- Vehicle and static plant exhaust emissions (see *Part 3*).

Stripping out of buildings before demolition

Internal stripping out of buildings before demolition should have reduced pollution impact on the local environment owing to the screening effect of the walls of the existing buildings themselves. If the buildings are structurally attached to occupied premises then specialist advice may be required on the likely transmission of sound and vibration. Specialist contractors must remove any asbestos present in the building (eg pipe lagging, roofing, etc.) in accordance with HSE regulations. Bagging of biological debris, such as birds' nests and droppings, before disposal is recommended to prevent them from becoming airborne. Some biological material can be highly hazardous, either to the population in general (eg some fungal toxins) or to sensitised people. Contaminated material needs to be treated with care and, if there is uncertainty as to the nature of the material, it should be tested.

Loading stripped out material into skips (see *Part 4*) and clearance from the site using loaders and lorries may create more noise and have a greater impact on dust and vapour generation than the stripping itself. Vapours can be emitted from loose paintwork and internal furnishings, but are more likely to arise from chemicals used in the stripping process or chemicals stored on the premises. They can also be emitted from combustion sources used on the site.

Typical noise sources include vehicle engines, rubble on chutes and loading into skips and lorries, water-pumping equipment and hard stripping of windows, roof tiles, etc. The typical noise emission resulting from the use of an excavator loading a lorry on site is shown in Figure 3.

Pollution control guidance is given in Boxes 2 and 4.

Demolition of buildings

During demolition, high concentrations of particles can be generated from all types of material. In addition to the materials used in the construction of a building, dust may have accumulated on the surfaces of the building and there may be biological debris (eg fungal spores, moulds and bird droppings). Care should be taken to prevent dust and spores from becoming airborne by removing biological debris before demolition or damping down using water sprays.

Pollution is emitted during all demolition activities whether it is carried out using explosives (Figure 4) or by using a demolition ball (Figure 5), sledge and jack hammers or other demolition plant and equipment. Demolition using explosives can result in large dust clouds and flying debris, usually lasting for a short period, while mechanical methods such as a demolition ball, hydraulic breaker or a crusher attached to an excavator (Figure 6) result in more localised dust clouds which often last for much longer, but are easier to control. Partial demolition using shoring, propping and underpinning can generate large quantities of fine particles from cutting, drilling and excavation.

All these demolition methods have the potential to cause significant noise emissions, from both the demolition process and, for example, from plant engines. Blasting can provide an

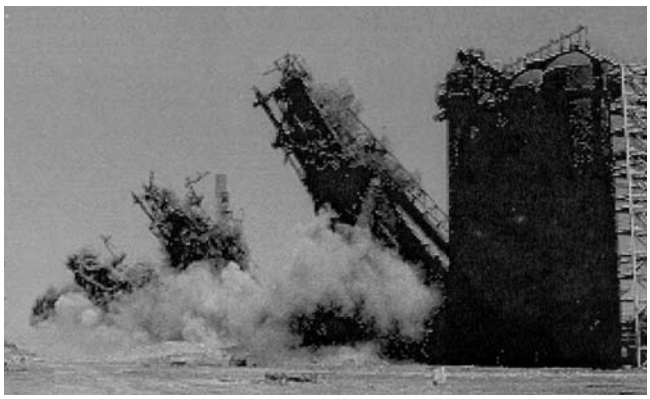

Figure 4 Large dust clouds from using explosives for demolition

Figure 5 A demolition ball in action

acceptable method of demolition because it balances the annoyance from short-term exposure to high levels of noise with longer-term disruption from alternative techniques. Mechanical methods, such as a demolition ball, are major sources of impact noise and ground-borne vibration. Crushing plant used to break down larger masonry or concrete pieces also produces impact noise and vibration. Specific guidance on how to control noise emission from demolition may be found in BS 6187 and BS 5228.

Various types of plant are used during demolition activities, for example, excavators, pneumatic crushers and cutting equipment, along with chutes and skips used for the collection of debris. Materials dropped via chutes into ground-level skips can be noisy and release particles from impaction on the skip and its contents. The use of closed chutes and covered skips, lined with sound-attenuating material is recommended.

If dust is likely to spread into areas beyond the site, as it may do in windy conditions, the risk should be assessed and appropriate measures put in place. For example, hand or mechanical, rather than explosive, methods will reduce the exposure to members of the public, but may increase the exposure to operatives, and in some cases overall dust exposure may be less with explosive methods. The choice of method will therefore depend on a variety of factors. Suitable personal protective equipment (PPE) may need to be provided for operatives. However, PPE is considered as a method of last resort under the COSHH regulations.

Figure 6 Grab attachment fitted to an excavator

To prevent pollution crossing the site boundary in the early stages, demolition should be carried out from the centre of the site outwards so that the buildings on the boundary of the site can act as a barrier. In addition, water-suppression techniques should be used to minimise the amount of dust and vapour that becomes or remains airborne (see Figure 2). Figure 7 shows that peak levels of fine particles can be reduced considerably when using water sprays.

Boxes 2 and 4 give guidance on controlling pollution from demolition.

Box 4 Guidance on soft stripping of buildings, demolition and handling demolition materials

General

- Minimise drop heights.
- Locate plant, eg crushers, as far away as possible from sensitive locations.
- See *Part 3* for consideration of all transport-related issues of removing demolition materials from site.
- Avoid burning waste if possible, otherwise use incinerators rather than bonfires (see *Part 4*).

Particles

- Arrange for a registered specialist contractor to remove asbestos.
- Screen buildings with suitable debris screens and sheets.
- Remove and bag bird droppings and other biological materials before loading into lorries.
- Keep external walls and windows intact.
- Enclose chutes and skips to drop material from a height.
- Cover loaded lorries and skips with plastic sheeting.
- Avoid prolonged storage of debris on site and its exposure to wind.
- Use composting facilities for vegetation if available through the Local Authority.

Vapours

- Put materials in suitable containers before appropriate disposal.
- Minimise the use of stripping chemicals.

Noise

- Line chutes, skips and flat bed lorries with noise-attenuating material.
- Handle materials carefully when loading into lorries and skips.
- See also BS 6187 and BS 5228.

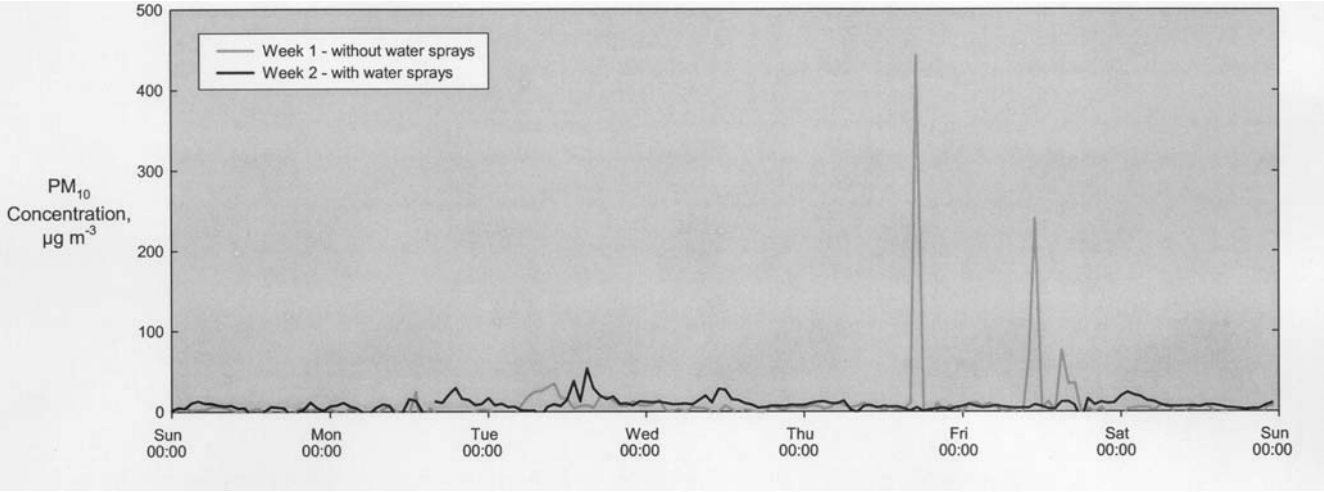

Figure 7 Using water sprays during demolition can reduce peak particle emissions by up to 10 times

Earthworking and landscaping

Range of activities

Earthworks, including excavation, trench digging, soil stripping, earthmoving, piling and landscaping can be significant sources of pollution generation.

Pollution-generating activities associated with earthworks and landscaping include the following.

- Tree and shrub felling and burning (see *Part 4*).
- Stripping and re-laying top soil (see next section, below).
- Excavation and digging foundations (see next section, below).
- Piling (see section on page 6).
- Crushing and screening aggregates (see section on page 7).
- Materials handling, especially loading and unloading of vehicles (see *Part 4*).
- Stockpiling materials (see *Part 4*).
- Disposal and burning waste materials (see *Part 4*).
- Vehicle and plant movements (see *Part 3*).
- Vehicle and static plant exhaust emissions (see *Part 3*).

Earthworks and landscaping

Earthworks involve separately lifting covering layers of topsoil and sub-soils and then removing them from the area. The ground may then be levelled or reshaped with the soil being either removed from the site or used in ongoing restoration or landscaping. These are intensive activities and, although they take place over relatively brief periods of time, they have the potential for generating significant amounts of pollution.

During excavation activities, previously stable surfaces are disrupted, exposing them to the wind. These can readily emit dust until the exposed surfaces stabilise, and either become crusted or covered by vegetation.

Both greenfield and brownfield sites have potential dust problems arising from wind-blown soil, due either to mechanical handling or wind-raised dust during and after clearance. Brownfield sites may have other potential complications, for example, the dust generated may contain toxic or carcinogenic contaminants.

Problems are most likely when materials have to be handled in a relatively dry state and the structure of the soils is to be retained. These dry, disturbed materials can easily become suspended by the wind or mechanical disturbance, and readily become airborne in significant quantities. Surfaces should always be disturbed as little as possible, and stabilised as soon as possible afterwards. Where large-scale earthworks have occurred (Figure 8a), the ground will need to be compacted and possibly stabilised before construction begins (Figure 8b).

Figure 8 (a) Earthworking activities at a typical construction site, **(b)** same site after levelling and stabilising, and before foundation and service laying

Compacting the soil involves large earthworking plant and/or rollers with possible particle, vapour and noise emissions from the engines. Stabilisation can be achieved by introducing cement into the top layer of the soil. This requires specialised plant and again may lead to pollution emissions. A thin bitumen layer can also be sprayed over the stabilised surface as a finish, leading to reduced particle generation but elevated vapour emissions.

Deep excavations may become flooded until water barriers are erected. This may require the use of pumps to remove the water. Emissions from such pumps (exhaust from diesel power pumps) and noise may need to be controlled, especially if they are required to be run overnight.

Landscaping involves the movement and shaping of soil and infill around a site to form its final profile. The work is usually carried out by construction plant. Topsoil and other materials are often delivered by truck to augment the material at the site.

There are two other potential sources of pollution associated with earthworking and landscaping that are covered in *Parts 3* and *4* and that may need to be addressed:

- emissions of noise, particles and vapours from the movement and operation of vehicles and plant (see *Part 3*); and
- particle emissions from materials handling and construction of stockpiles (see *Part 4*).

Guidance on controlling pollution from earthworking and landscaping activities is given in Boxes 2 and 5.

Box 5 Guidance on earthworks and landscaping

Particles

- Remove vegetation and cover in discrete sections and not all at once.
- Avoid activities during dry weather periods, if possible, otherwise keep damping down with water sprays.
- Stabilise surfaces of completed earthworks (including landscaped areas) and/or re-vegetate them as soon as possible.
- Seal surfaces of storage mounds by seeding or surfacing with vegetation or turf that has been removed previously from the site, or alternatively cover with correctly secured tarpaulins.
- Treat transitory soil mounds with surface-binding agents to reduce wind erosion. *Note:* Before using any binding agent consult with the Environment Agency.
- Consider temporary landscaping for secondary functions, eg visual screening and noise barriers.

Piling

Piling activity (Figure 9) can take many forms and use a variety of types of rig. The type of rig used will depend on the size and section of pile required and the constitution of the substrate through which the pile is to be driven. The driving of sheet, sectional or tubular piles to stabilise retaining structures or provide foundations for subsequent building are potentially noisy processes. Drop-hammer piling using a large mass to impact the top of the piles is particularly noisy.

In general, dust and vapour emissions are minimal during piling, although large emissions can be caused by associated activities, such as trenching for pile insertion, the movement of excavators and cranes and vehicle and plant exhaust emissions.

Figure 9 Crane lifting pile into position for driving (piling can cause high levels of noise and vibration to be generated)

The potential for noise disturbance from piling activity is high, and is reflected in the fact that some specialist documents (BS 5228 and British Steel, 1998) are dedicated solely to noise control from piling operations.

Percussive piling

Percussive piling generates high levels of noise from the striking action of the driving head on the dolly protecting the pile. This characteristic resonant 'ringing' of the exposed pile body is influenced by the height of the driving head above the ground. In addition, high levels of ground-borne vibration can occur. Noise emission can also be caused by associated power packs, generators and compressors.

Alternative piling techniques, such as hydraulic piling or auger piling can reduce peak noise emissions.

Hydraulic piling

Hydraulic piling rigs operate on a jacking-type system with the pile unit using a hydraulic pressure system to 'push' piles into the substrate. The rig then anchors itself on adjacent previously installed piles (Figure 10). The major noise and particle sources associated with the process come from the power pack supplying the hydraulic pressure and generators

Figure 10 Hydraulic piling is a relatively quiet piling method

for welding units. If there are noise-sensitive premises nearby, the power pack should be sited away from the rig.

Auger piling

Auger piling (Figure 11) is a quieter method than percussive piling as no impact is required; it is normally used for round or tubular section piles. The operation includes the use of a drilling rig on a crane gantry that is used to bore the required depth and diameter of hole for successful placement of the pile. The pile is then cemented into position. In some cases concrete piles are formed where steel reinforcement is placed within the bore section and concrete is pumped around it to form a cast-in-situ pile.

Often, high levels of noise are produced when spoil is removed from the auger itself by banging or shaking.

Figure 11 Auger piling for building foundations

Pollution control methods for piling are given in Boxes 2 and 6.

Box 6 Guidance on piling

Noise

- Use quieter piling systems where possible, eg hydraulic piling.
- Use silenced kit and keep access doors, etc. closed.
- Locate stationary plant away from noise-sensitive areas.
- See also BS 6187 and BS 5228.

Processing aggregates

Crushing and screening of aggregates is a common activity on construction sites with the potential for particle emissions and noise problems. Boxes 2 and 4 give general guidance on controlling these emissions. Specific guidance has been produced by the Department of Environment [now the Department for Environment, Food and Rural Affairs (Defra), the Scottish Office and the Welsh Office], for the control of air pollution related to mobile crushing processes and aggregates:

- *Mobile crushing and screening processes* PG 3/16(96),
- *Aggregates* PG 3/8(96).

Note: Mobile plant on site for crushing, screening and grading of materials may require authorisation (under Part 1a of the Environmental Protection Act 1990) by the appropriate Local Authority in whose area the operating company's registered office is situated.

Figure 12 Crushing and grading concrete components into recycled aggregates

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British Standards Institution

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BS 5228: Noise and vibration control on construction and open sites

Part 1: 1997 Code of practice for basic information and procedures for noise and vibration control

Part 2: 1997 Guide to noise and vibration control legislation for construction and demolition including road construction and maintenance

Part 3: 1997 Code of practice applicable to surface coal extraction by opencast methods

Part 4: 1992 Code of practice for noise and vibration control applicable to piling operations

Part 5: 1997 Code of practice applicable to surface mineral extraction (except coal) sites

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Pollution control guide

Controlling particles, vapour and noise pollution from construction sites

Part 3
Haulage routes, vehicles and plant

Vina Kukadia, Stuart Upton, Colin Grimwood, Chuck Yu and Robert Evans*

BRE Environment

*Johnson Matthey

Construction sites can be a major source of pollution if not managed and controlled properly, and can have an adverse impact on health and the local environment. Enforcement is disruptive and expensive. It is therefore important that construction personnel follow good environmental practice to control these emissions, comply with environmental legislation and prevent problems.

This Guide is the third in a series intended to assist with the control of air pollution and noise emissions from construction sites. It sets out guidance on controlling pollution emissions associated with haulage routes, vehicles and construction plant. Although techniques have not been validated under controlled conditions and therefore must be used with care, recommendations are drawn from cases where they have been found to be effective.

Titles in this series on controlling particles, vapour and noise pollution from construction sites

1 Pre-project planning and effective management
2 Site preparation, demolition, earthworks and landscaping
3 Haulage routes, vehicles and plant
4 Materials handling, storage, stockpiles, spillage and disposal
5 Fabrication processes and internal and external finishes

Box 1 Definitions

Pollution from construction
Particles, noise, vibration and vaporous discharges.

Particles
All airborne particles and deposited dust.

Fine particles
Less than 10 µm in diameter, known as PM_{10}.

Noise
Excessive levels of sound and vibration.

Vapours
Volatile organic compounds (VOCs), such as formaldehyde and benzene, being released, for example from fuels, petroleum solvents and bituminous tar oils.

Air Quality Management Area (AQMA)
An area defined by a Local Authority when local action is needed to reduce pollution concentrations to meet government health-based targets.

Roads and haulage routes

Activities associated with laying temporary roads and haulage routes, and with vehicle and plant usage, often have the potential for emitting air and noise pollution. Effective control is virtually impossible once particles and vapours have become airborne. The most effective technique is to control them at source, so preventing them from becoming airborne and dispersing into the surrounding area. Guidance on control measures to minimise emissions of particles, vapours and associated noise is summarised in Boxes 2–11.

Some of the techniques rely on washing and damping down. It is important therefore that the run-off water does not itself become a source of

A BRE research project supported by
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water pollution. Guidance on disposal of run-off water may be obtained from the Environment Agency.

In preparation for construction-related activities, temporary roads may be laid to allow access to and from the site. Recycled aggregates, that have the potential to emit particles, are often used. During dry and windy weather conditions, particles from roads and haulage routes can become airborne as a result of wind and site activities such as movement of vehicles. Depending on the type of roads chosen, laying them may also result in the discharge of vapours, for example from bituminous materials, heavy organic solvents or chemical binders. Boxes 2–5 summarise guidance on control measures for reducing particles, vapour and noise pollution.

Box 2 General guidance on minimising emissions of particles, vapour and noise from site vehicles and plant

General

- Locate haul routes away from sensitive sites such as residential areas, schools and hospitals. If routes pass sensitive sites consider installing barriers to protect the sites from noise.
- Don't leave engines running unnecessarily.
- Operate plant and equipment away from residential areas or other sensitive receptors near to the site.
- Maintain engines and exhaust systems so that exhaust emissions do not breach statutory emission limits set for the vehicle/equipment type and method of operation.
- Schedule servicing of vehicles and plant routinely, rather than just following breakdowns.
- Position exhausts at a height to ensure adequate local dispersal of emissions.

Particles

- Check vehicles and equipment to ensure that they don't emit black smoke from exhaust systems except during ignition.
- Use vehicles and plant with low exhaust emissions (eg with particle traps[a]) and emission controls such as catalysts or diesel particulate filters (DPFs).
- Direct vehicle exhausts away from the ground and other surfaces, and preferably upwards to prevent road dust from being re-suspended to the air.

Vapours

- Use low emission fuels[b].

Noise

- Plant and vehicles should comply with EU noise emission limits.
- Maintain vehicles regularly to reduce engine, exhaust and body rattle noise.
- Control the hours of operation of all plant and vehicles, and avoid their unnecessary use.
- Use acoustic screening where possible.
- Explain the benefits of the proposed development to affected parties.
- Where high level exhausts are necessary, operate them away from sensitive areas and ensure that silencer systems are functioning.

[a] Some plant, for example compressors and electricity generators, are available that run on LPG or other alternative fuels, reducing noise and exhaust emissions. Many diesel engine exhausts can be fitted with particle traps. Requirements can be specified in contracts.

[b] Many petroleum companies may supply ULS tax exempt diesel, if specified in the relevant contract(s), at no extra cost.

Box 3 Guidance on construction and maintenance of haul roads and traffic routes, unsurfaced roads and verges

Particles

- Install haul roads as permanent hard surfaces, and inspect them regularly.
- Keep unsurfaced roads and verges in a compacted condition using static sprinklers, bowsers, commercially available additives and binders (subject to Environment Agency and Scottish Environment Protection Agency requirements).

Vapours

- Ensure additives and binders are low emission products.

Noise

- Ensure that hard road surfaces are well maintained to reduce rattling of vehicles.

Box 4 Guidance on cleaning roads

Particles

- Clean roads regularly using an approved mechanical road sweeper. Public roads will need to be cleaned subject to Local Authority or Highway Authority requirements. Site roads will need to be cleaned on a daily (working day) basis and maybe more frequently.

Noise

- Use mechanical sweepers with noise attenuators.

Box 5 Guidance on cleaning edges of roads and footpaths

Particles

- Clean by using a hand broom with controlled damping.

Vehicle and plant movements

Depending on the size of the construction site and the type of work being carried out, vehicle movement can be considerable owing to delivery and removal of materials to and from the site and the movement of plant and vehicles within the site boundary. This can lead to re-suspension of particles from haulage routes if road surfaces and vehicle speeds are not managed properly.

Damping down techniques are effective forms of control for preventing particles from becoming airborne. However, this can lead to mud and dirt being picked up by vehicle wheels as these travel around the site. In these cases, wheel washing is important to prevent vehicles transporting this mud off site onto public highways.

On relatively small sites, wheel washing can be carried out using a hose and brush which in itself will not cause a particular noise problem. However, on some sites, a purpose-built wheel-washing facility (Figure 1a) with its own power plant (Figure 1b) for the water sprays and wheel brushes may be used. Such facilities can be a source of unwanted noise, either from the power plant, the water sprays, brushing actions or the vehicle entering or exiting the plant.

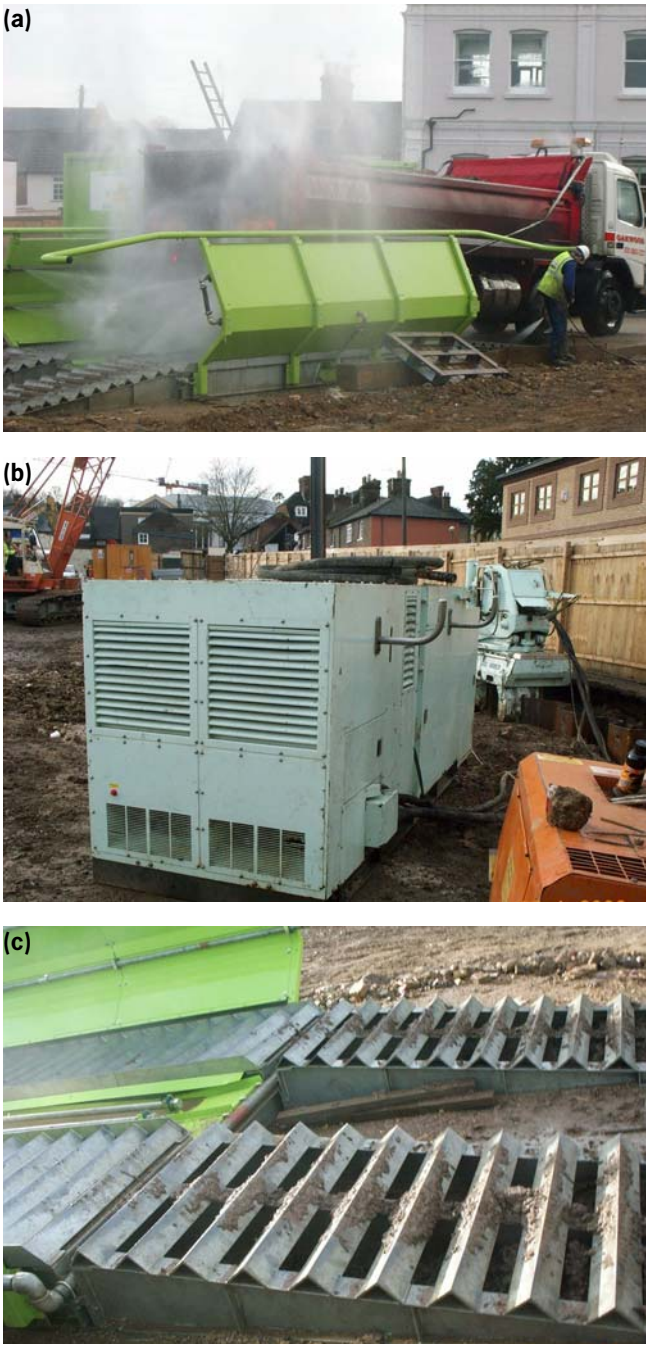

Figure 1 (a) Wheel-washing facility, **(b)** associated power plant and **(c)** rumble grids

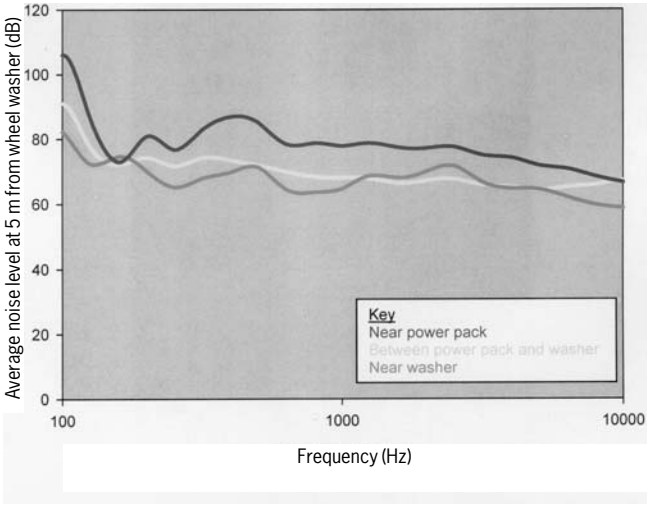

Figure 2 Typical noise levels measured 5 m from a wheel washer

Rumble grids (Figure 1c) are often a part of the wheel-washing facility. The grids are angled such that they remove the majority of the mud by scraping. Noise is caused by the wheels running over the grids, which may cause significant vehicle vibration and noise. Figure 2 shows noise emission measured on site during a wheel-washing cycle using the facility shown in Figure 1. Typical noise levels at 5 m from wheel-washing facilities are 79–92 dBA indicating the need for careful placement and possible screening in order to minimise disturbance.

Vehicle and plant movement and operation can also lead to excessive noise levels from engines and mechanical noise from their operation and movement. As an example, Figure 3 shows the results of a study on the number of trucks that accessed a construction site during the demolition and earth-working activities, in preparation for a housing development. The site covered an area of approximately 6500 m^2. During this period, up to 70 trucks per day, each carrying 20 tonnes of material accessed the site, leading to an average of one truck passing through the wheel washer every 8 minutes on such days. This amount of vehicle activity can cause a considerable level of noise disturbance.

Road sweepers are often used to clear material that may have been taken by trucks onto the public highway at the site exit. Engine noise, as well as the noise from the brush and water action, can be a problem. However, the degree of nuisance or disturbance from such an activity may be offset by a public perception that something is being done to improve the environment.

Boxes 6–8 summarise pollution control measures for vehicle and plant movement and operation.

Box 6 Guidance on movement of vehicles within the site

Particles

- Avoid unnecessary vehicle movements and manoeuvring, and limit speeds to 5 mph on unsurfaced roads and 10 mph on properly surfaced and maintained roads.
- Use water bowsers or hand hoses as appropriate on roads.
- Locate water suppression techniques (eg wheel-washing facility) away from sensitive local sites.

Noise

- Locate routes away from sensitive sites and ensure road surfaces are well maintained to reduce rattling of vehicles.

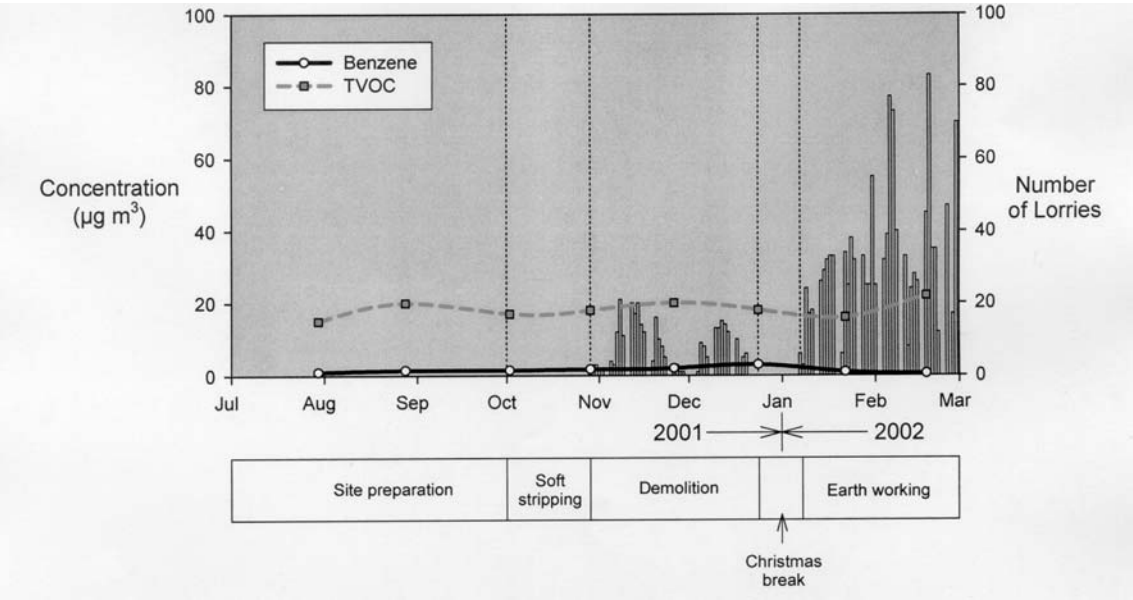

Figure 3 Variation in the number of trucks accessing a typical site during the early phases of development

Box 7 Guidance on movement of vehicles from the site

General

- Locate exit and wheel-washing facilities away from sensitive local sites.

Particles

- Use wheel-washing facilities with rumble grids to remove excess mud from wheels.

Noise

- See Box 2.

Box 8 Guidance on loading vehicles

Particles

- Avoid over-filling vehicles.
- Use sheeting to cover loads to prevent wind-raised particles.

Noise

- See Box 2.

Figure 4 Exhaust fumes from diesel plant

Static and mobile combustion plant and vehicle exhaust emissions

Emissions of fine particles and vapours from vehicle and plant exhausts (Figure 4) should be properly controlled. Engine exhaust emissions, especially from those operating on diesel fuel, can be a significant source of fine particles and vapours on construction sites. As the particles emitted are small, they can easily be transported beyond the site boundary and affect the local air quality and potentially the health of the local people as well as the workers at the site.

Of the sources of fine particle emissions measured during monitoring of a construction site, diesel engine exhaust emissions were identified as being a significant contributor to the overall pollution burden from the site. These fine particle emissions originated from two main sources:

- diesel engines operating, for example excavators, cranes and generator sets on the site for construction-specific tasks; and
- diesel-powered trucks transporting materials and equipment to and from the site.

Ways of reducing fine particle emissions from these sources are detailed in Box 2.

Exhaust emissions from new diesel engines used in road-going vehicles are subject to limits imposed by European Union legislation. These emission limits represent the minimum acceptable standard of environmental performance for engines to be sold. For both on- and off-road vehicles it is possible to reduce fine particle emissions significantly below legislated levels by fitting an exhaust after-treatment, notably diesel particulate filters (DPFs) which cut fine particle mass by more than 90%. The use of DPFs (Figure 5) is considered

Figure 5 Diesel particulate filter (DPF) fitted to plant exhaust. Courtesy of Johnson Matthey

best practice in construction regulations applied in the United States and is mandatory on larger sites in Switzerland.

During the winter months, if the weather is wet, it is unlikely that any damping of construction-generated dust will be required. However, there will be generation of diesel particles from plant and vehicles. These need to be controlled at source using, for example, DPFs as mentioned above. The use of electrically powered handling plant, or plant that uses low emission fuels (eg ultra-low sulphur diesel or LPG) and technologies should also be considered.

Organic vapours that can be dangerous, such as benzene, are discharged from diesel exhausts. Figure 3 shows the results of monitoring carried out on a construction site. At this site, good practice, such as switching off engines when not in use, was already being observed. The concentrations of benzene measured here were relatively low, even though the number of lorry movements was large during the earthworking phase.

Box 9 Guidance on combustion plant and vehicle exhaust emissions

Particles and vapours

- Compile an inventory at pre-planning stage of all equipment likely to cause pollution emission to give an indication of the scale of the problem so that measures can be put in place before work begins.
- See Box 2.

Tarmac laying, bitumen surfacing and coating

Tarmac laying, bitumen surfacing and coating can produce high levels of black smoke particles and unpleasant organic vapours. In particular, the direct application of flames to bitumen-based materials generates large quantities of black smoke which often contain products that are carcinogenic. The use of melted bitumen often results in spillages. Allied to the common use of open-flame burners and open pots, the burning of molten bitumen spillages in the flame and accidental fires are common, exacerbating the production of black smoke.

Road coatings using bitumen or related materials as binders, are often delivered hot ready for laying. In this state they are under better control than processes carried out directly on site and are likely to cause fewer problems.

To avoid overheating bitumen, the optimum temperature for producing the required bitumen mix for laying road surfaces should be determined. Spraying water mist into the air over the surface can help to minimise fume generation by reducing the temperature of the hot bitumen. Rubbing sand over such surfaces can reduce excess tar oil on surfaces, reduce evaporation of bitumen vapours and improve the surfacing of the road. The freshly laid bituminous surface is likely to have sufficient tack to reduce possible dust generation when sand is applied to the surface, and spraying water mist into the air will further minimise dust generation. Another possibility is to cover the surface with damp hessian while the bituminous material is being cured as this will also reduce the discharges of vapours and dusts during the operation.

Pollution control guidance is given in Box 10.

Box 10 Guidance for laying tarmac, bitumen surfacing and coating

Particles and vapours

- Transport hot bituminous material in closed containers.
- Cover pots or tanks containing hot bitumen using a well-fitting lid.
- Don't overheat bitumen; use the minimum acceptable temperature.
- Measure the temperature directly, especially on large heating plant.
- Avoid heating with open flame burners if possible.
- Extinguish small accidental fires immediately.
- Minimise spillages, especially any likely to contact open flames.
- Use great care when applying open flames direct to the surface ('torching') and avoid overheating.*
- Use of water sprays, sand or hessian can reduce vapour emissions.

*Torching is rarely used for road work, but is often applied on roofing.

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Part 4
Materials handling, storage, stockpiles, spillage and disposal

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Figure 1 Dust raised as a result of dropping material into a skip from height

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4 Materials handling, storage, stockpiles, spillage and disposal
5 Fabrication processes and internal and external finishes

Box 1 Definitions

Pollution from construction
Particles, noise, vibration and vaporous discharges.

Particles
All airborne particles and deposited dust.

Fine particles
Less than 10 µm in diameter, known as PM_{10}.

Noise
Excessive levels of sound and vibration.

Vapours
Volatile organic compounds (VOCs), such as formaldehyde and benzene, being released, for example from fuels, petroleum solvents and bituminous tar oils.

Air Quality Management Area (AQMA)
An area defined by a Local Authority when local action is needed to reduce pollution concentrations to meet government health-based targets.

Handling of materials

A wide range of materials is regularly handled on construction sites, including demolition products such as wood, metal and rubble, soil from earthworking, bricks, blocks and tiles, and mortar and cement. Figures 1 and 2 show materials being loaded into a skip and the resulting clouds of dust.

Where practicable, the use of dry and powdery material on site should be minimised. As a general rule, material-handling operations should be kept to a minimum, as this reduces the amount of air and noise pollution that will be emitted from the material and the handling plant. The use of electrically powered handling plant, or plant that uses low emission fuels and technologies, should be considered.

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Figure 2 Dust being raised during loading of a skip

Drop heights of materials should always be kept to a minimum to reduce potential air pollution and noise problems (Figure 1).

Damping down can be used in a number of cases to reduce emissions of particles into the air, for example in the handling of demolition materials, dry soils, etc. Figure 2 shows materials from demolition being loaded into a skip before disposal; damping down before handling (Figure 3) could have reduced particle emissions.

Dusty material damped down using water may require advice and approval from the Environment Agency on how to control any run-off water or slurry. Wet material is likely to dry out during periods of hot weather and it is likely that more frequent damping will be required.

Many materials may be supplied palletised and plastic wrapped. These should be left intact until they are delivered to their point of use within the site (Figure 4).

The principal noise impacts from materials handling are attributable to the drop heights of materials, storage locations, engine noise from handling or water spray plant, and associated vehicle movements. The guidance on particle emission control recommends reduction in drop heights that will also reduce impact noise from loading materials. Control of noise from vehicle movements is covered in *Part 3*.

Figure 3 Damping down of demolition materials before handling

Boxes 2 and 3 summarise guidance on control measures for reducing particles, vapour and noise pollution during material-handling operations.

Box 2 General guidance on minimising emissions of particles, vapour and noise from handling materials, storage, spillage and disposal

General

- Service and maintain vehicles and plant regularly.
- Locate storage and stockpiles away from sensitive sites (eg residential, commercial and educational buildings, places of public access or other features such as watercourses).

Particles

- Use vehicles and plant with low exhaust emissions (eg with particle traps[a]) and emission controls such as catalysts or diesel particulate filters (DPFs).

Vapours

- Use low emission fuels[b].

Noise

- Plant and vehicles should comply with EU noise emission limits.
- Avoid noise-sensitive areas.
- Plan effectively to ensure timely deliveries of materials.
- Observe a no-waiting policy.

[a] Some plant, for example compressors and electricity generators, are available that run on LPG or other alternative fuels, reducing noise and exhaust emissions. Many diesel engine exhausts can be fitted with particle traps. Requirements can be specified in contracts.

[b] Many petroleum companies may supply ULS tax exempt diesel, if specified in the relevant contract(s), at no extra cost.

Box 3 Guidance on handling materials

General

- Keep the number of handling operations to a minimum.
- Keep drop heights to a minimum, and enclose skips wherever possible.

Particles

- Use handling methods that minimise the generation of airborne dust.
- Keep handling areas clean and free from dust.
- Use closed tankers for transporting fine powdery materials.
- Use enclosed or sheeted vehicles for transporting dusty materials and aggregates.
- Damp down using water when loading materials onto or into vehicles, onto conveyors and into chutes and skips.

Vapours

- Keep volatile materials in sealed containers for as long as possible and keep them as cool as possible.

Noise

- Install noise barriers around material-handling equipment.

Storage of materials

Method statements and procedures for the storage and handling of fine, powdery and dry materials should be established and agreed at the planning stage of the project (see *Part 1*).

Dry, powdery materials, such as bulk cement and bentonite, should ideally be delivered by tanker and stored in silos (see Figure 4). The silos should be fitted with particle filters. All such materials should be stored, wherever possible, in bunded areas within the site, away from the site boundary and any sensitive areas.

'Just in time' deliveries of materials may reduce the amount required to be stored on site at any given time. However, this will need to be considered against the extra traffic movements and emissions generated, and additional delivery costs.

Boxes 2 and 4 summarise pollution control measures for storage of materials.

Figure 4 View of a construction site showing plastic-wrapped palletised materials in the foreground and a cement silo towards the rear of the site

Box 4 Guidance on storing materials

Particles

Bulk cement, bentonite and similar materials

- Deliver by tanker and store in silos.
- Fit silos with particle control technology.

Fine dry materials

- Store in buildings or enclosures, or give adequate protection from the wind, eg by using sheeting.

Dry materials

- Store in bunded areas.

Vapours

- Keep volatile materials in sealed containers for as long as possible and keep them as cool as possible.

Stockpiles of materials

Stockpiled materials and previously settled dust have the potential to become airborne during windy conditions. Solid fencing or hoarding can provide shelter from the wind and reduce the possibility of dust suspension from the ground. However, any improvement will occur only in the region of the fence.

Fences around particle-generating activities need to be of the same order of size as the activity being protected if they are to be effective. Areas of the site that are expected to be strong local sources of dust generation can be fenced in this way. Stockpiles can also be treated with water containing additives, such as bonding agents. However, water sprays and bonding agents may not be suitable for all types of material, and may need Environment Agency approval. Sheeting to cover the stockpile can be used instead to reduce wind erosion. Grassing over or capping longer-term stockpiles may also be considered.

In some circumstances, stockpiled materials and any protective fences can form a useful noise barrier, particularly if located close to any noise sources.

Guidance on controlling pollution from stockpiles is given in Boxes 2 and 5.

Figure 5 Working a stockpile. Courtesy of Johnson Matthey

Box 5 Guidance for material stockpiles

General

- When building stockpiles:
  - ensure the slopes, tips and mounds are at an angle not greater than the natural angle of repose of the material,
  - avoid sharp changes of shape in the final stockpile,
  - consider the use of size and shape to form effective noise barriers.

Particles

- Protect stockpiles from wind erosion by:
  - keeping small or short-term stockpiles enclosed or under sheeting,
  - shrouding larger and long-term stockpiles or capping or grassing over.
  - damping down dusty materials using suitable and sufficient water sprays.
  - controlled spraying of the surface of long-term stockpiles with chemical bonding agents (subject to the necessary approval from the Environment Agency).
  - using wind barriers (protective fences) of similar height and size to the stockpile.

Materials spillages

Spillages are frequent on construction sites, in particular dry powders (such as cement), and also molten bitumen (see *Part 3*).

Procedures should be in place to ensure that the site is regularly inspected for spillages of potentially dusty materials. Method statements should be prepared in advance (see *Part 1*) and cleaning equipment should be available to deal with such problems immediately.

Guidance on controlling pollution from spillages and cleaning-up procedures is summarised in Boxes 2 and 6.

Box 6 Guidance for materials spillages

Particles

- Ensure methods and equipment are in place for immediate clean-up of accidental spillages of dusty or potentially dusty materials (eg when filling and operating silos).
- Regularly inspect the site for spillages.
- Install audible and visual alarm systems in silos.
- Use wet handling methods for cleaning up spillages of cement powder and similar.

Noise

- Service and maintain cleaning equipment (eg vacuum cleaners).
- Don't leave equipment running unnecessarily.
- Implement a maintenance schedule for regular testing of audible alarm systems on silos to minimise the incidence of false alarms.

Disposal and burning of waste materials

Disposal of waste materials

Waste is often collected in skips and then taken off site by lorries. During these activities, water suppression techniques should be used and all loads should be covered to prevent emissions of particles. Guidance on controlling pollution associated with haulage routes and vehicle wheel washing is given in *Part 3*.

Guidance on controlling pollution during disposal of waste is given in Box 7.

Burning of waste materials

Under the Clean Air Act 1993, open fires are generally not permitted on site. The only burning that may take place on site is of infected material; everything else should be removed by a licensed contractor. Where infected material is burned, the best practicable means must be used to minimise emissions. The use of small incinerators is regarded as being acceptable but the use of these would need to be approved by the Local Authority, under Section 21 of the Clean Air Act 1993.

Waste timbers from construction sites (especially roofing timbers) are often impregnated with treatments to prevent bacterial, fungal and insect attack or painted with lead-based paint. Toxic compounds can be released in the fire plume if they are subsequently burned so it is therefore advised that such timbers are not burned on site.

Another recommendation is to reclaim and reuse uncontaminated building materials wherever possible.

Pollution control guidance during burning of waste is given in Box 7.

Box 7 Guidance for disposal and burning of materials

General

- Dispose of timbers treated chemically as soon as is practicable.

Particles

- Employ alternative disposal methods to burning if possible.
- Use an incinerator (approved under the Clean Air Act 1993) rather than bonfires.
- Supervise fires and incineration at all times.
- Don't burn timbers treated chemically to resist rotting, insect infestation, etc.

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Pollution control guide

Controlling particles, vapour and noise pollution from construction sites

Part 5
Fabrication processes and internal and external finishes

Vina Kukadia, Stuart Upton, Colin Grimwood and Chuck Yu

BRE Environment

Figure 1 Dust raised during dry sand blasting. Courtesy of Hynburn Borough Council

Construction sites can be a major source of pollution if not managed and controlled properly, and can have an adverse impact on health and the local environment. Enforcement is disruptive and expensive. It is therefore important that construction personnel follow good environmental practice to control these emissions, comply with environmental legislation and prevent problems.

This Guide is the fifth in a series intended to assist with the control of air pollution and noise emissions from construction sites. It sets out guidance on controlling pollution emissions associated with construction fabrication processes and internal and external finishes. Although techniques have not been validated under controlled conditions and therefore must be used with care, recommendations are drawn from cases where they have been found to be effective.

Titles in this series on controlling particles, vapour and noise pollution from construction sites

1 Pre-project planning and effective management
2 Site preparation, demolition, earthworks and landscaping
3 Haulage routes, vehicles and plant
4 Materials handling, storage, stockpiles, spillage and disposal
5 Fabrication processes and internal and external finishes

Box 1 Definitions

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Volatile organic compounds (VOCs), such as formaldehyde and benzene, being released, for example from fuels, petroleum solvents and bituminous tar oils.

Air Quality Management Area (AQMA)
An area defined by a Local Authority when local action is needed to reduce pollution concentrations to meet government health-based targets.

Fabrication processes

Cutting, shaping and machining materials

Mechanical operations that generate large quantities of particles include planing, sanding, routing, cutting and drilling. Wood machining (sawing, planing, sanding, trimming and routing), in particular, produces large amounts of particles, in fact more than cutting with hand tools. Hardwoods, particle boards and medium density fibre board (MDF), generate more particles than softwoods.

The use of portable high-speed cutting tools, such as disc cutters (Figure 2) and angle grinders to cut, for example brick, block, stone and tiles also generates particles in large quantities. Measures to control the emission of particles at

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Figure 2 (a) A circular saw generating dust when cutting roof tiles, **(b)** the same circular saw using a water spray when cutting tiles. Courtesy of Marley Building Materials

source should always be used with these types of machinery, and operations on site should be kept to a minimum where possible. Pre-fabrication and off-site construction in pollution-controlled environments is recommended. Figure 3 shows a construction site where good practice, such as the use of prefabricated roof timber sections and window frames, was followed.

If cutting and grinding operations are carried out on site, equipment and techniques should be used that keep pollution emissions to a minimum, incorporating the best available suppression measures. This may include fixed benches or portable cutters with water sprays (Figures 2 and 3) or extract systems to control particle emissions. As improvements in pollution control methods continue, more effective equipment will become available on the market. Therefore, plant hire companies should be consulted for information on the best equipment currently available.

These activities also have the potential for generating high noise levels that can exceed occupational safety limits. Noise control is difficult, and when these processes are carried out outside, control is largely restricted to screening activities. Damping down of operations to reduce particle emissions may also reduce noise levels. When working indoors, ideally any cutting, grinding and sanding areas should be isolated from the outside. Any doors and windows should be closed to reduce the effect of noise on noise-sensitive neighbours.

Oxy-acetylene cutting can sometimes be used in place of other cutting techniques and has the benefit of giving a cleaner finish, reducing the need for further finishing with, for example, noisy angle grinders.

Boxes 2 and 3 summarise guidance on control measures for reducing particles, vapour and noise pollution.

Box 2 General guidance on minimising emissions of particles, vapour and noise from fabrication processes and external and internal finishes

General

- Use off-site fabrication as much as possible to avoid cutting and machining activities on site (Figure 3).
- Turn off plant when not in use.

Particles

- Use vehicles and plant with low exhaust emissions (eg with particle traps[a]) and emission controls such as catalysts or diesel particulate filters (DPFs). *See Part 3.*
- Service and maintain fans and filters to ensure efficient operation.

Vapours

- Use electrically powered tools.
- Use low pollution emission materials (eg water-based paints) and additives.
- Use low emission fuels[b].

Noise

- Plant and vehicles should comply with EU noise emission limits.
- Locate activities and plant away from sensitive receptors.
- Install screens around activities.
- Use noise attenuators where needed.

[a] Some plant, for example compressors and electricity generators, are available that run on LPG or other alternative fuels, reducing noise and exhaust emissions. Many diesel engine exhausts can be fitted with particle traps. Requirements can be specified in contracts.

[b] Many petroleum companies may supply ULS tax exempt diesel, if specified in the relevant contract(s), at no extra cost.

Box 3 Guidance on cutting, shaping and machining operations

General

- Locate any cutting operations away from sensitive sites and in large enclosures or old buildings whenever possible.
- Avoid cutting out errors and re-bars; infill whenever possible.
- Use angle-grinders and disk cutters fitted with particle control equipment.

Particles

Cutting, grinding, drilling, sawing, trimming, planing, sanding, etc.

- Employ equipment and techniques that minimise particle emissions and use best available suppression measures, eg:
  - ❏ use fixed benches or portable cutters with dust control measures,
  - ❏ use water sprays to minimise particle emissions from cutting equipment,
  - ❏ use local exhaust ventilation where possible,
  - ❏ use particle extraction/minimisation systems where possible.

Design: filling joints, etc.

- Design to fill rather than cut back oversize work wherever feasible.

Figure 3 Examples of good practice: ① = prefabricated roof timber sections; ② = prefabricated window frames; ③ = bricks and blocks polyethylene-wrapped until required; ④ = bench-mounted cutter with water dust suppression; ⑤ = cement silo

Mixing

Mixing operations involving the handling of dry materials (see also *Part 4*) are likely to generate large quantities of particles, both from the materials and from the exhaust of the vehicles transporting the material to the site. The operation of plant using diesel generators, is also likely to generate fine particles and noise (see *Part 3*). Boxes 2 and 4 summarise pollution control measures for mixing processes.

Foundations and concreting

When laying foundations, fine particles and vapours may be discharged from materials used and from vehicles and plant involved in the process. Any damp proofing additives used should be low pollution emission products (see section below on *Internal and external finishes*).

The use of materials such as self-compacting concrete, where appropriate, can reduce the noise, particle and vapour emissions associated with vibrating equipment and its power plant.

Control measures for minimising pollution emissions from these activities are given in Boxes 2 and 4.

Box 4 Guidance for mixing, foundation laying, concreting and welding and soldering

General

- Mix concrete or bentonite slurries in enclosed or shielded areas.
- Use local exhaust ventilation where required.
- Use correctly sized sections to avoid the need for cutting and drilling on site.

Particles

- Use pre-mixed concrete, plasters and masonry compounds.
- Palletise and shrink-wrap fine dry materials.
- Keep foundations moist to prevent the generation of fine particles.
- Use larger pours of concrete rather than repeated small pours.

Noise

- Use self-compacting concrete (where appropriate) to reduce the need for vibrating equipment.

Welding and soldering

Welding and soldering operations, for example during steel erection, can emit particles and vapours that can be toxic and therefore a health risk. The use of correctly sized steel sections will reduce the noise and other emissions that would otherwise result from cutting and drilling them on site. Control measures for minimising pollution emissions from welding and soldering are given in Boxes 2 and 4.

Ductwork

Ductwork for use in ventilation or heating systems in buildings should be delivered to and stored on site with the ends sealed. This will prevent later contamination of these systems.

Internal and external finishes

Finishing processes, such as plastering, rendering, painting, decorating, fitting out, grouting and cleaning all have potential for generating pollution. A number of activities carried out during painting and decorating procedures have the potential for generating fine particles. These include for example, preparation of surfaces prior to the application of paint and wallpaper, sanding down plaster and the installation of, for example, plumbing, lighting and furnishings. Paints, pastes and wood that are treated with preservatives can all emit vapours. These emissions should be minimised by specifying low pollution emission materials, for example those that are water-based. Boxes 2 and 5 give a summary of pollution control measures during internal and external finishing activities.

Specifying low pollution emission materials

Health and safety issues relating to vapour discharges during construction, including air quality in the completed building, should be important considerations in building design.

Emissions of organic vapours can be minimised by the use of low pollution emission building materials and furnishings. These should be specified at the pre-project planning stage of the building design and construction process (see *Part 1*). This is being included in the EC Construction Products Directive 'Essential Requirements', which sets the framework for limiting the use of materials that could pose a health risk to building occupants.

Sources of organic vapours and for which low pollution emission materials should be selected and used include:

- fungicide wash and other biocidal materials;
- cleaning products;
- damp proofing emulsions and membranes;
- concrete and masonry surface treatments;
- timber preservatives and coatings;
- roofing compounds;
- adhesives;
- sealants;
- paints and architectural coatings;
- wall coverings;
- carpets and vinyl floorings.

Box 5 Guidance for internal and external finishes

Particles

- Fit cutting and sanding machinery with dust suppression or collection equipment (Figures 2 and 3).
- Vacuum clean whenever possible.
- Wash and damp down whenever necessary.
- Damp sweep using a fine mist.
- Avoid dry sweeping but if unavoidable, use vacuum extraction.

Installation of fire proofing and insulation

- Use dust suppressants when blowing fibres into voids and spaces.
- Use encapsulated materials.
- Use local exhaust ventilation when handling and cutting fibrous insulating materials.

Installation of fire proofing and insulation

Manmade mineral fibres (MMMF) are mainly used for fire-proofing and insulation and may be divided into the following categories:

- mineral wools;
- ceramic fibres;
- special purpose fibres;
- continuous filament fibres.

Mineral wools include substances such as glass, rock and slag wool. Typical applications are in the thermal and acoustic insulation of buildings and in structural fire protection. The wools are often supplied as mats or blankets.

Hand laying of mineral wool quilt, blowing mineral fibre into roof spaces and the cutting of mineral wools and ceramic products without particle suppressants all have the potential for emitting particles. Careful specification can mitigate many of these problems or avoid them occurring in the first place. Control measures for minimising pollution emissions from this activity are given in Boxes 2 and 5.

Scabbling

Scabbling is the mechanical chipping of a formed concrete surface by a machine tool to produce a clean and sound interface for further structural bonding with concrete or other materials. The need for scabbling often results from the deliberate or accidental over-sizing of components in order to achieve design tolerances. Dust nuisance from scabbling stems from the operation itself and from subsequent sweeping up.

If possible, avoid scabbling altogether. Alternative strategies include:

- designing tolerances for infilling rather than cutting back over-sized work,
- increasing the size of concrete pours to reduce the need for scabbling,
- using bonding agents,
- using wet grit blasting for outside work.

If scabbling cannot be avoided, control measures for minimising pollution emissions are given in Box 6.

Box 6 Guidance for scabbling

Particles

If scabbling cannot be avoided:

- assess the particle emission risk by considering the size of the area to be scabbled and the amount of particles likely to be emitted.

If necessary,

- fit tools with particle bags,
- pre-wash work surfaces,
- screen off areas to be scabbled to limit the spread of particles,
- vacuum up residual particles rather than sweeping them up.

Noise

- Use additional localised shielding/barriers around pumps and compressors, and at the work face.
- Control duration of activity and working hours.

Sand, grit or shot blasting and façade cleaning

Sand, grit or shot blasting may be carried out using either dry or wet processes. The former involves blowing abrasive grit under air pressure to scour away surfaces, causing particle generation (see Figure 1). Although wet blasting offers better control of particle generation, the fine spray of water droplets it produces also contains entrained particles. On evaporation of the water droplets, the particles remain suspended. Silica is often used for abrasive cleaning but should be avoided if possible. Pollution control guidance is given in Boxes 2 and 7.

Box 7 Guidance for sand, grit or shot blasting and façade cleaning

Particles

- Use silica-free material for abrasive cleaning as the inhalation of silica dust is more harmful.
- Use wet processes whenever possible since these introduce water into the air/grit stream, greatly reducing the dust hazard to both building occupants and the general public.
- Ensure that slurries don't dry out.

If dry grit blasting is unavoidable:

- assess the quantity of dust that will be generated (especially respirable dust),
- sheet all work areas before work begins,
- seal all windows and openings in the structure with polyethylene sheeting,
- use local exhaust extraction if possible.

Noise

- Use additional localised shielding/barriers around pumps and compressors, and at the work face.
- Control duration of activity and working hours.

Bitumen surfacing and coating

Bitumen surfacing and coating can produce high levels of black smoke particles and unpleasant organic vapours. In particular, the direct application of flames to bitumen-based materials generates large quantities of black smoke that can contain carcinogenic products. The use of melted bitumen often results in spillages. Allied to the common use of open-flame burners and open pots, the burning of molten bitumen spillages in the flame and accidental fires are common, exacerbating the production of black smoke. It is recommended that the optimum temperature for producing the required bitumen mix is always determined to avoid overheating. Pollution control guidance is given in Box 8.

Figure 4 Uncovered tar boiler emitting vapour. Courtesy of Envirobods Ltd

Box 8 Guidance for bitumen surfacing and coating

Particles and vapours

- Transport hot bituminous material in closed containers.
- Cover pots or tanks containing hot bitumen using a well-fitting lid.
- Don't overheat bitumen; use the minimum acceptable temperature.
- Measure the temperature directly, especially on large heating plant.
- Avoid heating with open flame burners if possible.
- Extinguish small accidental fires immediately.
- Minimise spillages, especially any likely to contact open flames.
- Use great care when applying open flames direct to the surface ('torching') and avoid overheating.*
- Use of water sprays, sand or hessian can reduce vapour emissions.

*Torching is rarely used for road work, but is often applied on roofing.

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