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Record of amendments

Version	Amendment	Date
7	Section 2: Clarification of when a risk assessment is to be carried out inserted on page 6.	February 04
7	Section 4.1; page 13, reference to HSGN 017 platform inspection added.	February 04
7	Section 4.1; page 14, Space/ size requirements for platforms size reduced to 1.0m to line up with EA guidance.	February 04
7	Section 4.1: box text on page 15 modified to included new STA guidance document HSGN0017	February 04
7	Section 4.2; page 17, Falling objects during lifting/ lowering guidance note number changed	February 04
7	Section 4.3; page 19, text box updated and addition of STA guidance note HSGN015.	February 04
7	Section 4.7; page 23, Control Measures STA guidance note updated	February 04
7	Section 4.8; page 24, New section added on noise	February 04
7	Section 7.4; page 37, Wind chill factor updated to include positive temperatures and limited to 30 MPH	February 04
7	Section 7; page 39, text box updated to include STA guidance note HSGN018	February 04
7	Appendix – All drawings updated to take into account recommendations for platform size, monorail attachments and sample ports.	February 04
8	Book revised to take into account Work at Heights Regulations	April 2005
9	Various minor adjustments to take into account revised STA guidance.	October 2006
10	Chapter 3. Page 9 and 10. Remove confined space as a site hazard and replace in Chapter 5 on Chemical Hazards at the Stack	March 2008
10	All Chapters. Update and amend Further Information sections	March 2008
10	Chapter 4 Section 4.1 Page 11. Update statistics on fatalities	March 2008
10	Chapter 4 Section 4.8 Page 27 Update Noise Exposure Limits	March 2008
10	Chapter 5 Section 5.1 Page 29 Change references to occupational exposure limits to Workplace Exposure Limits	March 2008
10	Chapter 5 Insert text on confined space	March 2008
10	Chapter 7 Section 7.7 Page 41 Amend working day recommended maxima to 12 hours and include reference to Working Time Regulations, specifying a recommended maximum 48 hour week.	March 2008

1. INTRODUCTION

There are many hazards associated with carrying out a stack-emissions test in process industry. The basic principles of good health and safety practice must be applied. In particular, a risk assessment *must* be carried out before starting work. Keep the risk assessment in your job file – in the unfortunate event of an accident it will be needed.

This guidance booklet describes each of the most prominent hazards in turn. The factors that affect the risk of an accident from each hazard are listed and control measures are suggested which may be used to reduce the risk to an acceptable level. The STA recommends that, as a minimum, the routine hazards described in this booklet should be included in your risk assessment. But remember: this is not an all-encompassing list and there may be other hazards. Every site is different.

2. THE BASICS OF THE WORK RISK ASSESSMENT

The Risk Assessment Process

The fundamental stages can be summarised as:

The work risk assessment is the basic foundation of safe working on stacks. It's very important to understand what we mean by hazard and risk:

Hazard	The substance's or physical situation's inherent **potential** to cause harm.
Risk	An estimation of the **likelihood** of that potential being realised, within a specified period or in specified circumstances, and the consequence.

Using a very simple example to illustrate this, sunshine poses a health hazard (sunburn). But the corresponding risk of harm would be very low if the work was carried out in winter!

So, the work risk assessment must start out by identifying the hazards you will face, and then make a judgement on what the risk will be (i.e. the *likelihood* of an accident) in light of all the relevant factors. If the risk is not acceptable, then **control measures** must be put in place to reduce the risk. Only then should you start work.

Control measures can be:

- Collective - such as engineering measures (e.g. a self closing gate to reduce the risk of falls from the platform) and procedural measures (e.g. permit-to-work systems; safety induction training provided by the operator); or

- Personal – using personal protective equipment (PPE) (e.g. safety goggles to reduce the risk of eye injury when opening access ports).

For many hazards there will be a choice of control measures that could be put in place. Personal measures should be used to reduce the risk further *only* when Collective control measures fail to reduce the risk as low as reasonably practicable. PPE shall not be the control measure of first choice.

The Form of the Risk Assessment

Generic-type risk assessments are not generally suitable for stack monitoring organisations as the hazards will vary from site to site and between visits. A separate risk assessment must be carried out at each site. However, a structured approach can be useful to help cover the wide variety of hazards and so pro forma risk assessment sheets do have their place. The STA example of a work risk assessment summary form is available on the Source Testing Association website at www.S-T-A.org. It should be emphasised that this is an example only, and will not cover all hazards at all sites and will not be appropriate in every

case. Organisations should use a risk assessment format that is suitable for their specific needs.

In general, a qualitative risk assessment approach is used*, whereby the severity of the hazard is considered together with the likelihood of occurrence to obtain an estimate of the risk of injury. The risk can be described in several ways: some assessors classify the risks as "high", "medium" or "low". However the STA prefers the classification of risks as either "negligible", "as low as reasonably practicable" (ALARP), or "unacceptably high". The logic here is that if it is reasonably practicable to reduce the risk further, it should be done! Not to reduce the risk further when it is practicable to do so, is unacceptable.

It is important to remember that the assessment should be of the risk as it stands now. Not as you think it will be when any necessary control measures are in place. The work risk assessment should be repeated or revised once the control measures have been implemented.

Who Does What?

The Management of Health and Safety at Work Regulations 1999 place a duty on employers to have a safety policy and to carry out risk assessments. So both the consultancy *and* the client (usually the operator) have a responsibility to carry out a work risk assessment. Where work is being carried out directly for a regulator, it gets even more complicated, with the consultant, the operator *and* the regulator all having responsibilities* in this regard.

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* The quantitative risk assessment (QRA) approach - where the risk is assigned a probability, such as 1 in 10,000 risk of death - is not the usual approach for stack monitoring health and safety risk assessments.

* The HSE has advised the STA that for the purposes of the Health & Safety at Work Act, the monitoring organisation has a direct duty of care towards its own staff conducting the monitoring, and the process operator has a duty of care towards all persons working on the site, including the monitoring organisation. For STA members carrying out monitoring directly for the Environment Agency, the latter has a general duty to ensure the organisation it employs is competent and has safe systems of work in place.

In practice, an MCERTS certified Level 2 person will be best placed to assess the risks to themselves and to others during the monitoring work. MCERTS Level 2 personnel will have completed a risk assessment course specific to stack emission monitoring, such as the STA's safety and risk assessment training course.

Don't confuse the work risk assessment with the platform inspection. The Working at Height (WAH) Regulations make it clear that the latter must be carried out by the employer (i.e. the operator) using a competent person. These platform inspections are **not** carried out by the monitoring team. However, it is necessary to see the Platform Inspection Report to be able to properly carry out the risk assessment. The risk assessment will **not** be acceptable until the employer's Platform Inspection Report has been checked by the stack emissions monitoring team leader.

…and When?

For a new client a site visit may be necessary to assess the risks. This gives the site operator time to implement any control measures you find are necessary. For sites you are familiar with, a separate site visit may not be necessary but you must *still* carry out a work risk assessment before you start work. It is important that this risk assessment is carried out at the start of *every* monitoring campaign at the site, even if you have visited the site before. This is a good discipline because it focuses the team's attention on safety as the first issue to address on site, and it reduces the possibility of the staff becoming complacent after several visits because they feel they know all the issues.

The work risk assessment must be carried out at the start of each campaign and should be reviewed at least daily before starting work. However, it is important to note that there are some hazards, wind, lightning, etc, where conditions can

change rapidly and the risk may need to be re-assessed at more frequent intervals.

Monitoring work shall only commence when the risk assessment has been completed and the control measures have been implemented to the satisfaction of the competent person carrying out the risk assessment (i.e. the MCERTS Level 2 Team Leader). The risk assessment shall be communicated by the Team Leader to other members of the monitoring team before work commences.

Getting the operator Involved

On arrival at the site, the Team Leader should ask the operator to show them the WAH Regulations Platform Inspection Report for the stack(s) they will be working on. The Team Leader must check that the Report has been carried out within the time period specified in the WAH Regs and check that the Report states that the platform is safe to work on. The Platform Inspection Report shall be taken into account when carrying out the risk assessment. If no Platform Inspection Report is available for work at height, **do not proceed with the work.**

Once the risk assessment has been completed the Team Leader should brief the operator's representative on the findings. This will give the operator the opportunity to raise any additional issues of concern, and to comment on the findings of the assessment and the control measures required. If the operator has any comments, these should be assessed to see if they require inclusion in the risk assessment. Please note comments may reduce the risk further (which is fine), or hinder the reduction of risk (which is not).

Some of the control measures required may need to be put in place by the operator. The operator should confirm these have been completed, before work commences.

When the site work has been completed, it may be necessary to amend the risk assessment based on "lessons learnt" during the work. This will be useful for the next visit.

The Layout of this Booklet

The following sections describe each of the most prominent hazards in turn, grouped together in five main categories:

- general site hazards;
- physical hazards at the stack;
- chemical hazards at the stack;
- chemical hazards in the laboratory; and
- weather, environment and welfare.

Important factors affecting the risk are highlighted, together with some control measures that may be used to reduce the risk to an acceptable level.

It is recommended that this guidance, together with other relevant guidance, is consulted as part of the risk assessment process. However, safety management is a fast-evolving subject: new/revised guidance and legislation appears frequently. All parties involved in stack monitoring should ensure they take account of the most recent developments.

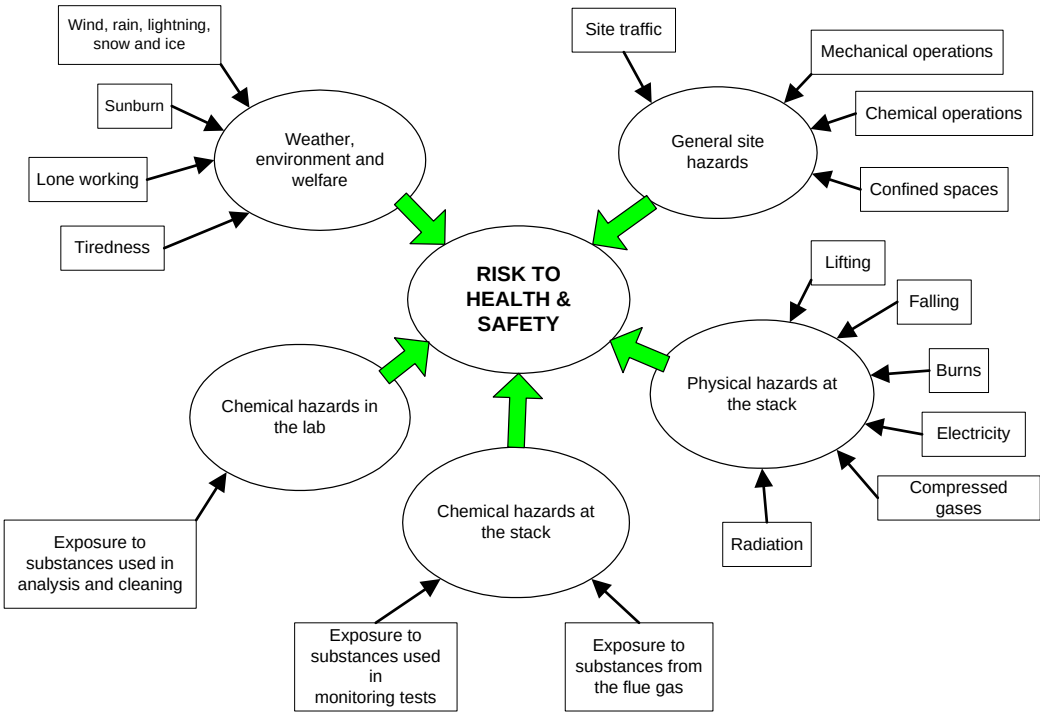


Figure 1 Some prominent hazards associated with stack monitoring

3. GENERAL SITE HAZARDS

Each site has its own specific set of hazards. These include:

- Site traffic hazards

  The movement of vehicles around site is a hazard. The sampling team may be in unfamiliar surroundings and they may be working on a temporary access platform, the existence of which is not known to the site drivers.

- Mechanical operations hazards

  The mechanical aspects of the process can be hazardous. The sampling workplace or access route may be in or near large, moving machinery.

- Chemical operations hazards

  Chemical processes are often hazardous. This includes the product stream and waste streams (e.g. stack gas releases, fugitive emissions, liquid discharges).

- Fire and explosion hazards

  At many sites, particularly in the organics and petrochemicals industry sectors, there are fire and explosion hazards.

- Climatic conditions

  The climatic conditions on site can be hazards in themselves (e.g. high or low temperatures) and can also increase the risk from other hazards (e.g. high wind increases the risk of a fall). Weather and the environment are covered in more detail in Section 7.

Control Measures

The importance of induction training and permit-to-work systems cannot be over-emphasised. Procedures for first aid on site and emergency evacuation procedures are required. These will vary greatly between sites. It is essential that the permit-to-work system, procedures for first aid and emergency evacuation

procedures for the site in question ***are fully understood***. All of these site specific details must be clarified before starting work.

All personnel must comply with any control measures that the site operator puts in place, e.g. site speed limits, use of intrinsically-safe equipment, use of PAT-tested equipment.

Work must only start work at the monitoring position if weather and environmental conditions are safe and stable.

STA guidance

STA HSGN 011 Safety Passports

STA HS 1057-00 Example Risk Assessment

Further information

Management of Health and Safety at Work Regulations 1999.

Workplace (Health, Safety and Welfare) Regulations 1992 and accompanying Code of Practice.

4. PHYSICAL HAZARDS AT THE STACK

4.1 Hazard: falls from heights

This is a very real hazard in stack testing. Twenty percent of fatal injuries to workers are by falls from heights, and there have been several fatalities from falls during stack monitoring. The risks of injury from falling from heights (or falling into dangerous substances) are so serious that a high standard of protection is required to reduce the risk as low as reasonably practicable.

The employer must ensure that the workplace and access meet all current legislative requirements, are maintained to a safe standard and have been inspected by a competent person. Under the Workplace Regulations, a safe place of work must be provided by the process operator, but under the Work at Height (WAH) Regulations there are some specific duties that fall on an employer when he engages people in work at heights, such as on a permanent platform, a properly secured temporary (e.g. scaffold) platform, or a rooftop.

Sampling from any elevated workplace, whether platforms, roofs or the tops of arrestment equipment, vessels and other ducts is unacceptable unless they have been inspected and assessed as being suitable by meeting the requirements for platforms in the WAH Regulations, EA Technical Guidance Note M1, and STA H&S Guidance Notes on: *Inspection of Permanent Elevated Work Platforms WAH 001.*

Mobile access platforms and “cherry-pickers” **must not be used**. Sampling from ladders is also unacceptable.

Factors affecting the risk

- To some extent, the height at which the stack monitoring is to be carried out is a risk factor. The Work at Height Regulations apply to work in *any* place, including a place above or below ground level, where, if measures required by those regulations were not taken, a person could fall a distance liable to cause personal injury. Special provisions apply to workplaces higher than 2 metres.

- The type of surface, objects or substances onto or into which a person could fall.
- The structural stability, strength, integrity and condition of the sampling platform.
- The size of the sampling platform.
- Provision of suitable safeguards to prevent falls, e.g. railings, self-closing gates.
- Environmental conditions (e.g. wind, rain, ice) at the work location.
- The adequacy and suitability of the means of access to the sampling position.
- The means by which equipment will be lifted to the platform.

Unless correct control measures are taken the risk of injury or death will be ***HIGH***. The risks must be reduced to as low as is reasonably practicable by appropriate control measures.

Control Measures – Hierarchy of Measures

The WAH Regulations require the employer to avoid carrying out work at height where reasonable practicable. However, if it **has to** be carried out, then he must take appropriate measures to prevent falls by:

i. firstly, taking the appropriate measures to prevent falls, preferably by working from an "existing place of work" (best thought of as anywhere where you do not need to use any extra work equipment to prevent a fall, i.e. a safe and fully protected place); or if this is not possible

ii. using work systems comprising the most suitable work equipment, instructions and training.

"Work equipment" includes relevant machinery, tools, appliances, apparatus, installations, guard rails, barriers, working platforms, collective fall arrestment devices (e.g. net or airbag), and personal fall protection systems (e.g. ropes,

harnesses, lanyards, fall arrestors). Collective measures must be given priority over personal protection measures.

Where work equipment is to be used as the safety measure(s), the hierarchy is:

a) use work equipment to prevent a fall (e.g. guard rails, or work restraint); then

b) use work equipment to minimise the height of the fall and its consequences (e.g. erection of nets, fall-arrest PPE); then

c) use work equipment to minimise the consequences of a fall (e.g. an airbag, or wear a lifejacket if working at height over water – it is not just the fall impact that needs to be considered); then

d) use work equipment that does none of the above (e.g. ladders, hop-ups, etc.) but minimise the risk of any fall occurring through appropriate measures (e.g. supervision and training, etc.)

Further Guidance on Collective "Work Equipment"

- ***Platform stability, strength, integrity, condition and inspection***

  - ***Platform design and construction*** – All platforms, whether temporary or permanent must be fit for purpose* and in particular must be of suitable dimensions and capable of supporting the required load.

  - ***Temporary platforms*** – the WAH Regulations (Schedule 3) places specific requirements on strength and stability calculations for scaffold, assembly, use, dismantling and marking/labelling. Compliance with these requirements is mandatory.

    Temporary platforms must be tied or supported to a permanent structure to prevent collapse or overturning. They

* A number of CEN standards have been drafted covering access and platforms and a British Standard exists covering permanent access.

must also be rated to a minimum “Scafftag” category of heavy duty or must meet the requirements stated in the monitoring standard that will be utilised, whichever is the greater.

Temporary platforms must be stable, and usually this will mean they must be secured to a suitable permanent structure, e.g. the stack.

Temporary platforms must be inspected and assessed by a competent person as required by the Working at Height Regulations. Monitoring teams should ask to see evidence of the inspection and assessment. A completed and dated “Scafftag” is one means of demonstrating and recording this inspection. Double-check that the inspection tag is for the load category suitable for stack emission work.

- ***Permanent platforms*** - must be capable of bearing at least 400 kg point load.

  The structural integrity and condition of permanently installed platforms (and any supports and attachments) must also be inspected and assessed by a competent person as required by the Working at Height Regulations.

  For post-1995 permanent platforms, an initial design assessment may have been carried out under the Construction (Design and Management) Regulations 1994, which should address whether the platform is fit for purpose. If not, the operator should arrange for a survey to be carried out by a competent person to establish its current integrity and condition. This baseline survey will then recommend the extent and frequency of subsequent periodic, routine inspections that will also include the effects of weathering, corrosion and damage. The frequency of inspection and the comprehensiveness of the inspection shall be commensurate with the risk of failure and the risk of serious injury. For example, a steel platform at great height and in a corrosive atmosphere of SO_2 may require a more frequent and thorough inspection than a low platform in a normal atmosphere.

Monitoring teams must ask to see evidence of the inspection and assessment before they ascend to the work area.

- ***Required features for all platforms***

  - ***Platform safety features*** - schematics of platform requirements are given in Environment Agency Technical Guidance Note M1 *Sampling and Safety Requirements for Monitoring Stack Releases to Atmosphere.* These diagrams should be referred to in conjunction with the following requirements.

    The platform shall be provided with guard-rails and toe-boards meeting the requirements of Schedule 2 of the WAH Regulations. The top guard rail shall be at least 950 mm* above the edge and an intermediate guard rail shall be positioned so that the gap does not exceed 470 mm. STA guidance is that toe-boards (also called kickboards) should be approximately 0.25 m high.

    Where the selected sample plane is located in a horizontal section of a large size rectangular duct, and where some of the sample points are positioned above a convenient and safe working height (nominally 1.75 m maximum for sample probe handling), it will be necessary to provide a dual level sampling platform of adequate design so that sampling staff can carry out the full range of sampling requirements in a safe and satisfactory manner. Removable chains or self-closing gates shall be used at the platform to prevent workers falling through access hatches or ladder wells.

    The platform may have weather protection for personnel and equipment. The platform shall not accumulate free-standing water: if necessary, drainage is to be provided.

* For existing guard-rails, the requirement is at least 910 mm. Previous STA guidance required for a top railing height of 1000 mm and so should meet this requirement.

- ***Space/size requirements for platforms*** - these are shown in Environment Agency Technical Guidance Note M1 *Sampling and Safety Requirements for Monitoring Stack Releases to Atmosphere.* These diagrams should be referred to in conjunction with the following requirements. The platform surface area should not be less than 5 m^2. It is advisable that the minimum width at any point is not less than 2 m. The minimum length in front of the access port shall be 2 m or the length of the probe (including nozzles, suction/support tubes, filter holders) plus 1.0 m (whichever the greater). Where the details of sampling equipment are not known, or may change, the rules given in M1 should be adhered to.

Further Guidance on Personal "Work Equipment"

The WAH Regulations (Schedule 5) place strict limitations on when personal fall protection systems can be used, and by whom. Specific requirements are given for fall arrest systems, work restraint systems, work positioning systems and rope access and positioning techniques.

Personal fall protection systems should only be used when a risk assessment has demonstrated that work can be carried out safely and that the risk of falling cannot be reduced to as low as reasonably practicable by collective work equipment. A personal fall protection system must be suitable and sufficient (and regularly inspected to show this), and the user must have received adequate training.

There are two types of harness: an arrestment harness designed to catch you, and a restraint harness designed to stop you falling in the first place. The HSE advise that the type suitable for use when lifting-up of equipment is a restraint harness. The STA's view is that if the sampling location is so risky that a harness needs to be worn **during actual sampling**, or that an arrestment harness needs to be worn, then the risk of injury outweighs the potential environmental benefits of the monitoring data, which therefore means the work should not

proceed. STA Guidance Note HSGN004 gives some further information on PPE.

Other Issues Concerning Work Platforms

- ***Planning, supervision and competence***

  The WAH Regulations require the employer to ensure that work performed at height is properly planned, appropriately supervised, and carried out in a way that is, as far as is reasonably practicable, safe. This includes selection of equipment, procedures for emergencies and rescues, and adverse weather conditions. The WAH Regulations also require the employer to ensure that competent persons carry out all activities (including organisation, planning, supervision and inspection).

- ***Essential services and facilities at the workplace***

  - The sampling position shall have artificial lighting and shall be well ventilated. Single phase 110 V electrical power of a suitable current shall be provided by means of a suitable number of outdoor waterproof sockets at the platform. Water, drainage and compressed air should be supplied if requested by the sampling team.

  - Lifting equipment is required for the raising and lowering of apparatus, where access to the sampling platform is by vertical or steeply inclined ladders or stairs. In all such cases, the lifting equipment (e.g. hoists) and attachments must be installed, inspected and maintained by the site operator (see Appendix, Figure 4). Inspections of lifting equipment should be undertaken at least once every twelve months and records should be kept for two years.

  - If an US EPA Method 5 type sampling train is to be used, the platform may need to be fitted with suspension points to enable the use of a sampling monorail (see Appendix, Figure 1 & 2).

  - The platform or workplace shall be, as far as possible, free from obstructions that would hamper the sampling effort.

- Protection from the elements will usually be required for an outdoor sampling position.
- An additional hole to vent sample air back into the duct may be necessary if the flue gas presents an exposure hazard.

➢ ***Emergency access route***

- The means of access and the access route must be safe at all times. Arrangements must be made for emergency evacuation.

STA guidance

STA HSGN 017 Platform Inspection

STA HSGN 019 Why MWEP are unsuitable for emission monitoring

STA HSGN 020 Platform Inspection Questionnaire

STA HSGN 021 Temporary platforms

Further information

Environment Agency Technical Guidance Note M1 *Sampling requirements for stack- emissions monitoring (2006)*

Work at Height Regulations 2005

4.2 Hazard: Falling Objects and Danger Areas

This hazard occurs because of objects potentially falling from the platform itself and also during lifting and lowering equipment. The risks of injury from falling objects can be serious.

Factors affecting the risk

- *Falling objects from platforms* – the risk of falling objects is increased when working on grid floors.
- *Falling objects from platforms* - temporary working platforms can have gaps between scaffold planks.
- *Falling objects from platforms* – the risk is increased if the platform does not conform to the requirements for kickboards/ toeboards specified in Environment Agency Technical Guidance Note M1
- *Falling objects during lifting/lowering* - there can be a large amount of unwieldy equipment to lift into awkward positions. The weight of the equipment and the height it needs to be lifted affect the risk of injury.
- *Falling objects during lifting/lowering* - the effects of cold and rain increase the risk.
- *Falling objects during lifting/lowering* - the risk of falling objects is increased if there is lack of adequate provision for lifting equipment.

Unless suitable control measures are put in place, the risk of injury may be ***HIGH***. The risks must be reduced to as low as is reasonably practicable by appropriate control measures. Examples are listed below.

Control Measures

The WAH Regulations contain specific provisions relating to falling objects and the resulting danger areas. Amongst these are requirements for the employer, as far as is reasonably practicable, to:

i. firstly, prevent the fall of objects; then

ii. prevent a person being struck by a falling object.

Danger areas must be clearly indicated and, where reasonably practicable, equipped with devices preventing unauthorised entry.

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) apply. These cover, amongst other things, periodic checking of equipment, record keeping and visual checks before use. You should consult STA Health Safety Guidance Note HSGN008 for further guidance.

Some recommended control measures are:

- *Falling objects from platforms* – elevated platforms must have toe boards complying with EA TGN M1.
- *Falling objects from platforms* – Any gaps in the floor should be filled in (e.g. with mesh) where equipment or tools could fall and endanger people below.
- *Falling objects from platforms* – The area below the access and working platform should be designated a hazardous area. Restrict access to appropriate personnel. Use *Danger Working Overhead* signs and a physical barrier if possible.
- *Falling objects during lifting/lowering* - all elevated working platforms must have a secure lifting point (see Appendix, Figure 4). Ensure any temporary platform cannot topple over when equipment is hoisted up.
- *Falling objects during lifting/lowering* - use a safe lifting system of work. Two people should be used in all lifts. Ensure no one is directly underneath the lifting point during a lift.
- *Falling objects during lifting/lowering* - ensure that the loads do not exceed the safe working load (SWL) of the hoist or support. Ensure the lifting equipment is in serviceable condition. STA guidance HSGN009 gives an example of an inspection report record.

- *Falling objects during lifting/lowering* - PPE: hard hats, gloves and protective footwear should be used. STA Guidance Note HSGN004 gives some further information on PPE.

STA guidance

STA guidance HSGN008, *LOLER Regulations*

STA guidance HSGN009, *LOLER Inspection Reports*

Further information

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

4.3 Hazard: injuries during manual handling

The preparations and demobilisation for stack emissions testing usually require a considerable degree of manual handling of sometimes heavy equipment, gas cylinders, probes, etc. Such activities are subject to the Manual Handling Regulations 1992. An outline of the requirements is given in STA *Health & Safety Bulletin*, No.3, July 2001. It should be noted that there is a specific legal requirement to carry out a manual-handling risk assessment for tasks that cannot be eliminated or avoided and could result in injury.

Factors affecting the risk

Guidance to the Regulations issued in 1998, includes comprehensive advice on the assessment of manual-handling risks. Reference should be made to that document. However, major factors affecting the risk of injury are

- The weight of the object
- The shape and size of the object
- The distance to be moved through
- The physical capability of the employee to handle the load

- The extent of manual-handling training the employee has received

Control Measures

Examples of control measures that may be employed for stack monitoring are:

- ***Engineering controls*** – consider if it is possible to mechanise the task, e.g. using hoists for lifting.
- ***Procedural controls*** – ergonomic design is important, e.g. storage of equipment at a height that eliminates it being lifted from, or to, floor height. Training in safe lifting procedures, e.g. kinetic lifting technique, is essential. Management should ensure that staff employed to carry out such work are physically capable of carrying it out without injury.
- ***Personal Protective Equipment (PPE)*** – safety shoes/ boots should always be worn. Protective gloves may be needed for sharp or rough objects. Back supports are sometimes used as PPE for lifting: however, these are not a substitute for controlling the risk at source and they may encourage lifting beyond a person's normal safe limits.
- Guideline limits for lifting of 25kg for a man and 16kg for a woman.

STA guidance

STA Guidance HSGN015, *Manual handling*

Further information

HSE INDG143 Rev 2 Getting to grips with Manual Handling

HSE INDG383 Manual Handling assessment charts

Manual Handling Operations Regulations 1992

4.4 Hazard: electricity

A considerable amount of electrical equipment is used during stack testing – sometimes in quite adverse environments, e.g. rain, surrounded by lots of bare metal. The risks of injury from personnel receiving an electric shock, especially on a high platform, can be serious.

Factors affecting the risk

- Portable electrical equipment may be used in cramped spaces with a lot of bare metal.
- The design of probe-heating elements can increase the risk.
- Rain can increase the risk.
- The site power supplies can be unpredictable in terms of both stability of supply and type and suitability of socket.
- Some site plant may itself pose an electric-shock hazard, e.g. electrostatic precipitators.

Unless correct control measures are taken the risk of injury can be ***HIGH***. The risks must be reduced to as low as reasonably practicable, using appropriate control measures.

Control measures

The Electricity at Work Regulations 1989 apply to electrical equipment and instruments used for stack monitoring. The Regulations cover, amongst other things, portable appliance testing (PAT testing) and visual checks before use. You should consult STA Health Safety Guidance Note HSGN007 for further guidance on electrical supplies. Some other control measures are:

- The site operator must ensure the power supply and sockets are stable and safe. Environment Agency Technical Guidance Note M1 requires that the operator provides a suitable number of outdoor, waterproof sockets at the sampling location (platform or other workplace).

- The voltage on the equipment should be 110V, via an isolating centre earth transformer. Do not use 240V equipment on sampling platforms.
- Has the electrical equipment been regularly inspected and PAT-tested by a competent person?
- Regularly check electrical equipment yourself between PAT-tests. For example, visually check leads and cables.
- Protection devices such as RCDs should be used at the point of power.
- Trailing leads should be highly visible and should be protected from process operations.
- Don't wave probes, Pitots, etc. in the vicinity of live power lines.
- Don't sample too close to electrostatic precipitators (ESP). Hot gases conduct electricity quite well and can lead to shocks downstream if sampling too close. When sampling after ESP ensure that the equipment is suitably earthed using earthing straps.

STA guidance

STA Guidance HSGN006, *Understanding Electrical Supplies*

Further information

HSG107, *Maintaining portable and transportable electrical equipment* (2004)

HSE INDG231 Electrical Safety and you 2005

4.5 Hazard: burns

Hot flue gases and hot duct work and equipment can cause serious burns.

Factors affecting the risk

- The temperature of the flue gas
- Flue gas under high positive pressure
- Whether the hot surfaces are lagged or guarded
- Manipulating unwieldy equipment
- The amount of space available on the working platform

Control measures

- Find out the temperature and pressure of the flue gas before the visit
- Use PPE appropriate for the risk, e.g. protective gloves. Eye protection should **always** be worn
- Loosen ports slowly
- Sufficient staff should be available to safely handle the equipment
- The platform should be large enough to safely accommodate the equipment

4.6 Hazard: ionising radiation

There is potential for exposure to ionising radiation whilst working on stacks at some specific types of site. The Environment Agency advises that this applies only to a small number of specialised plant. These are specifically authorised to emit radioactive substances to air and generally have their own radiological protection advisers. In the event that an STA member organisation is invited to carry out stack testing from these plant, it is recommended that the risks from radiation and necessary control measures are assessed in close co-operation

with the site operator and under the guidance of the radiological protection advisers.

4.7 Hazard: compressed gases

It is very common to use compressed gases in stack testing. The hazards can be explosion, fire and toxicity. Here we deal only with explosion and fire. The toxicity is a chemical hazard and will be dealt with in the next section.

Factors affecting the risk

- How the gas cylinders are transported
- How the gas cylinders are secured
- Staff training

Control measures

STA Health Safety Guidance Note HSGN001 describes regulations applying to transport of chemicals. Some of the control measures used when transporting gas cylinders are:

- Stow cylinders securely, normally in the vertical position, to prevent them moving or falling.
- Disconnect regulators and hoses from cylinders whenever reasonably practicable.
- If necessary, fit suitable protective valve caps and covers to cylinders before transporting.
- Ensure the cylinders are clearly marked to show their contents and hazards.

Some of the control measures used in manual handling of gas cylinders are:

- Wear suitable safety shoes.
- Do not drop cylinders.
- Do not use valves and caps for lifting cylinders unless they have been designed and manufactured for this purpose.

- Use suitable cradles, slings, clamps, etc. when lifting cylinders with a hoist or crane. Do not lift using the forks of a fork-lift truck unless adequate precautions are taken to prevent them from falling.

Some of the control measures for using gas cylinders at the monitoring position are:

- Use in vertical position unless specifically designed to be used otherwise.
- Securely restrain cylinders to prevent them falling.
- Close cylinder valve and replace dust cap (where provided) when not in use.
- Before connecting the cylinder to pipe work/equipment, make sure the regulator and pipe work are suitable for the type and pressure of gas being used and are in good condition.

STA guidance

STA HSGN001 The application of chemical transport regulations to stack testing operations

STA HSGN003 *Gas Cylinder Guidance*

STA HSGN014 Transportation of calibration gas cylinders and dangerous goods by road

STA HSGN 016 Hazards of filling gas cylinders

4.8 Hazard: Noise

Significant noise exposure can occur during stack emission monitoring. Impact noises such as rapping mechanisms on electrostatic precipitators and bag filtration plant are particular examples of noises that may significantly exceed the 87dB exposure limit level or the Peak Sound Pressure 140 dB. The lower action level of 80dB can be exceeded by continual

exposure to the equipment a stack test team may take to site. Equipment, such as US EPA Method 5 type pumps and heated head pumps are examples of noisy equipment that personnel are exposed to for long periods of time.

Control Measures

Identify the workers at risk from hearing damage (so you can prepare an action plan to control noise exposure).

Determine the daily noise exposure ($L_{ep,d}$) of workers.

Identify additional information to comply with legislation e.g. whether noise control measures or hearing protection are needed, and, if so, where and what type. Where employees are likely to be exposed to the second or peak action level or above, it is required that, as far as reasonably practicable, exposure must be reduced in ways other than by providing hearing protection.

STA guidance

STA guidance HSGN013, *Protection against noise*

Further Information

HSE INDG362 Guidance for employers on the control of noise at work Regulations 2005

HSE IND 363 Protect your hearing or lose it! (2007)

5. CHEMICAL HAZARDS AT THE STACK

5.1 Hazard: flue gases

This is a major hazard in stack testing. Unless the process operator has made you aware of the nature of the stack gas, the specific hazard will be unknown. There is no way to assess the risk of an unknown hazard: such stacks should be regarded as a high risk and the appropriate control measures taken to reduce the risk.

The hazards may be from the chemical nature of the flue gas or from the fact that it is depleted in oxygen. There may also be rapid changes in the nature of the flue gas which affect these factors and its toxicity. The temperature or pressure of the flue gas can also be a hazard, but this is dealt with in Section 4. Confined spaces have been dealt with in Section 3.

The consequences of personnel being overcome by fumes from flue gas, especially on a high platform, are very serious.

Factors affecting the risk

- There may be little or no information available on the nature of the flue gas.
- The concentrations of hazardous chemicals in the flue gas can be orders of magnitude higher than any workplace exposure limit (WEL).
- Flue gas may be under high positive pressure, which increases the risk of exposure.
- Sampling requires that the chimney stack or flue is opened up. This may be at two or three points around the stack.
- The sample ports may be a wide variety of shapes and sizes. Obtaining a good seal may be difficult.
- Extractive sampling equipment may exhaust toxic vapours into the workplace, increasing the risk of exposure.

- Ventilation efficiency at the workplace will have an important effect on exposure risk. On certain sites, the monitoring location may be in areas that can be classified as confined spaces, as defined by the Confined Space Regulations 1997. This may include mobile laboratories and vehicles in which the monitoring equipment may be placed when sampling.
- The sampling location may have a restricted escape route, which may prolong exposure in an emergency.

Unless correct control measures are taken, the risk of injury will be ***HIGH***. Treat all unknown flue gases as high risk. The risks must be reduced to as low as is reasonably practicable by appropriate control measures.

Control measures

There is a specific legal requirement under the COSHH Regulations for the "employer" to make an assessment of the risks to health from hazardous substances and implement measures to control exposure to them. You should consult STA Health Safety Guidance Note HSGN002 for further guidance on chemical exposure risks. Some other control measures are:

- Obtain information on the physical and chemical nature of the flue gas *before* sampling. The STA has a data-collection sheet *Exposure to Hazardous Stack Gases During Sampling* which can be sent to operators to complete. This sheet, which has also been endorsed and adopted by the Environment Agency, is available on the STA website. Once you have this information you should next assess the risk of exposure.
- Check whether there has been any process change (e.g. removal of dampers) from the last visit that could alter the expected stack gas concentrations.
- Ensure that the operator has provided adequate ventilation for the sampling location. This is a specific requirement of Environment Agency Technical Guidance Note M1. The STA generally recommends that no sampling is carried out in confined spaces. The HSE has produced guidance on work in

confined spaces. The relevance to stack monitoring has been discussed in STA *Health & Safety Bulletin,* Issue 2, February 2001. The STA recommends that, generally, members should not carry out work in confined spaces, unless they have been specifically trained in such work and have suitable control measures in place to reduce the risk to a low level.

- Sample ports should be closed firmly when not in use.
- The probe used should be a good fit with the dimensions and design of sample port.
- If the flue gas is hazardous, warning signs should be placed on or near the sample ports.
- Where the exhaust from the sampling equipment creates an unacceptable risk of exposure, vent it remotely or back into the stack via another port.
- If necessary, monitor the exposure of the sampling team and use alarm devices, e.g. personal SO_2 alarms and CO alarms
- There should be a good system of liaison between the sampling team and the process operator. If there are any variations expected in the flue gas due to process changes then the sampling team must be informed.
- There may need to be a system for emergency communication between the samplers and other personnel.
- Personal Protective Equipment (PPE) – the following hierarchy of exposure prevention should be applied: exposure prevention> engineering control measures> procedural control measures> PPE. If exposure can be prevented or minimised by moving the sampling position or installing ventilation, then this should be done in preference to using breathing apparatus (BA) or other respiratory protection equipment (RPE) even if it costs more. The STA does not endorse carrying out any stack monitoring work where it is necessary to use BA: in such situations the risk of personal injury outweighs the environmental benefit that may be gained from sampling. Breathing apparatus (BA) may be appropriate as an escape

precaution, but as with all PPE, personnel must be trained in its use. STA Guidance Note HSGN004 gives some further information on PPE.

- Health surveillance may be necessary for some monitoring organisations. For example, the monitoring organisation should assess whether it is appropriate to give blood tests if its staff could experience significant exposure on lead sites.

5.2 Hazard: Chemical substances used during stack monitoring

Whereas it is sometimes difficult to get information on the hazardous nature of the stack gas, all STA members should have a detailed knowledge of the hazards posed by any substances (e.g. chemical reagents and gases) used in the stack monitoring tests. The hazards are not just confined to substances that are toxic by inhalation; substances that are corrosive can be a hazard to the skin and eyes too.

Factors affecting the risk

- The toxicity/corrosive nature of the substances used.
- Whether the substance is contained or used in the open.
- The actual work activity you are performing, e.g. pouring an acid.
- Frequency and duration of the work.
- Ventilation efficiency.
- Personal protection used.

Control measures

The COSHH Regulations require the employer to make an assessment of the risks to health from hazardous substances and implement measures to control exposure to them. This assessment must be documented. An ideal place for this is in a safety section in the organisation's written technical procedure for the test. You should consult STA Health Safety Guidance

Note HSGN002 for further guidance on chemical exposure risks. Some control measures are:

- Substitute hazardous substances in the test for less-hazardous substances where this is practicable. For example, substitute hazardous blue silica gel for less-harmful orange indicating gel.
- Reduce the amount of contact with the substances so far as is practicable.
- Carry out the test according to your work procedure, using the control measures specified.
- Ensure adequate ventilation.
- PPE: if other control measures cannot reduce exposure to an acceptable level, PPE may be required, e.g. protective gloves, goggles, respiratory protective equipment (RPE). Personnel must be trained in the use of their PPE. STA Guidance Note HSGN004 gives some further information on PPE.

STA guidance

STA HSGN 002 *Chemical Exposure Risks During Stack Testing Operations*

STA HSGN 004 *Personal Protective Equipment*

STA HSGN 010 Confined spaces

STA HSGN 012 Stack-gas exposure information sheet

STA HS 1058-00 Example COSHH Assessment

Further information

Personal Protective Equipment at Work Regulations 1992.

HSE INDG136 Rev 3 COSHH A brief guide to the regulations 2005

Confined Space Regulations 1997

HSE INDG258: *Safe Work in Confined Spaces* (1997)

6. CHEMICAL HAZARDS IN THE LABORATORY

6.1 Hazard: substances used during cleaning and analysis

The risks associated with cleaning and analysis carried out in the laboratory are beyond the scope of this booklet, which focuses on site activity. There is a wealth of existing guidance on applying COSHH and other aspects of health and safety to laboratory work, and this should be referred to. In practice, much of the guidance given in the preceding Section 5.2 will apply.

Further information

COSHH in Laboratories, Version 3. Royal Society of Chemistry, 2003.

7. WEATHER, ENVIRONMENT AND WELFARE

7.1 Hazard: temperature extremes

The Workplace (Health, Safety and Welfare) Regulations 1992 and accompanying Approved Code of Practice (ACOP), provide a general set of minimum standards for thermal comfort in the workplace. However, these are not designed to cover those working in extremes of temperatures outdoors or around processes. The risk assessment made under the Management of Health and Safety at Work Regulations 1999, should include the effects of heat, cold and humidity where appropriate. Note also that for elevated workplaces, the WAH Regulations specify that work should only be carried out where weather conditions do not jeopardise safety.

The hazards due to extreme cold include frostbite and hypothermia. Cold hands also make manual handing more hazardous.

The hazards associated with hot environments are dehydration, heat exhaustion and fainting. In addition, metal surfaces and tools can become very hot to touch leading to the risk of skin burns. If radiant heat is present, e.g. in furnaces, rolling mills and glass manufacture, the eyes and skin may be affected.

Factors affecting the risk

- Time of year
- The ambient temperature
- Duration of the work
- How exposed the working platform is, e.g. provision of shelter
- Wind chill factor (see Section 7.4)
- The height of the working platform
- Location: e.g. sampling positions are often located in the roof spaces above processes, where heat collects.

- Process: there are some processes, e.g. incineration, cremation and steel production, where the ambient temperature in the work space above the processes can reach as high as 40-50°C.
- Personal protection used

The risk assessment must consider both the environment and the individual when calculating the risks involved, e.g. pregnant women tolerate heat less well and may more readily faint and be more liable to heat stress. It maybe necessary to use medical screening to exclude high-risk individuals from working in very hot or very cold environments, for example employees who:

- Are over 50
- Are overweight
- Have chronic skin disease (in the case of radiant heat)
- Suffer from cardiovascular or renal disease
- Suffer from peripheral vascular disease (Raynaud`s disease or white finger)

Control measures

Ideally, thermal comfort should be through building design and the incorporation of thermal insulation. However, this is often an impracticable solution for stack monitoring. Additional workplace controls may include:

- Controlling the source of heat/cold, e.g. by insulation
- Separating the source from the person, e.g. by erecting barriers
- Controlling the task, e.g. limiting workloads
- Controlling ventilation in the workplace, e.g. air conditioning

If temperatures providing reasonable comfort in the working environment cannot be achieved, suitable protective clothing (e.g. warm clothing) and rest facilities should be provided. For extremes of cold, periods of exposure should be followed by adequate spells of rest in warm, well-ventilated rest areas.

When working in hot environments, frequent rest periods should be taken (particularly if strenuous work is involved) and drinks should be taken regularly.

If radiant heat is present, tinted protective glasses may be needed.

The risk assessment should take all these factors into account to decide on a safe maximum working time for exposure to heat or cold.

7.2 Hazard: snow and ice

Snow and ice greatly increase the hazards of falls from height, and make manual handling more risky.

Factors affecting the risk

- The ambient temperature
- The height of the working platform
- How exposed the working platform is
- Provision of shelter
- Duration of the work

Control measures

All the control measures applying to hazards that are worsened by cold, snow and ice (e.g. falls, manual handing) should be reassessed. More stringent control measures may be required than in the absence of cold, snow and ice. The most basic additional control measures are:

- Request shelter to be provided at the sampling location
- Do not work on platforms outside if there is snow or ice.
- Avoid starting work outside in conditions if snow and ice are likely, e.g. temperatures below 2°C.
- At temperatures above this where there is no snow or ice, use appropriate PPE, e.g. warm clothing and gloves.

7.3 Hazard: sunburn

When working outside, the uv radiation in strong sunlight can lead to sunburn and sunstroke. The most serious long-term effect is an increased chance of skin cancer later in life.

Workplace factors affecting the risk

- Time of year of the work
- Duration of the work
- Location of the work
- The risk of sunburn is increased when the working area is surrounded by reflective surfaces, e.g. metal roofs.

Personal factors affecting the risk

Some people are more liable to burns and/or skin cancer than others. The HSE recommends you take particular care if you have:

- White skin: fair or freckled skin that doesn’t tan easily is most at risk
- Red or fair hair and light-coloured eyes
- A large number of moles: over 100 in young people or over 50 in older people.

Control Measures

- Determine a safe maximum working time for exposure to heat or sunlight
- Work in the shade if possible
- During periods of sunny, very hot weather, consider avoiding outdoor site work in the 3 or 4 hours around mid-day, when the sunlight is most intense
- wear clothing covering exposed skin

- It is good practice to use sun block as this will give some protection – its recommended that an SPF rating of at least 15 is used
- Health surveillance: regularly check for skin abnormalities

7.4 Hazard: winds

The hazards due to wind include causing workers to lose their balance, causing objects to be blown from the work platform and causing ropes, cables and sheeting to whip about. Wind also makes verbal communication difficult even over short distances. Thus many of the hazards identified previously (e.g. falls from height, falling objects) are worsened by wind. Wind can therefore pose a serious risk of injury unless a high standard of protection is required to reduce the risk to as low as reasonably practicable.

Factors affecting the risk

- The strength of the wind
- The height of the working platform
- How exposed the working platform is
- Provision of shelter
- Personal protection used

Control measures

You must decide what a safe upper limit of wind speed is suitable for the sampling location, taking into account the height you are working and how exposed you are. The following are criteria that have been found suitable in some general situations:

- Do not go up the stack if the ground wind speed exceeds 30 mph
- If the wind speed up the stack exceeds 30 mph during sampling, stop work and come down if it is safe to do so.

- If it is not safe to come down, stay where you are and if available secure yourself with a safety harness.

  The wind speed can be measured using a hand-held anemometer or estimated from the Beaufort scale (e.g. trees bending). At 30 mph, light equipment will sway significantly when being hoisted.

  Wind chill factor, see table, must also be taken into account

		Temperature °C						
		10	4	-1	-7	-12	-18	-23
Wind Speed (MPH)	5	9	3	-3	-9	-14	-21	-26
	10	4	-2	-9	-16	-23	-31	-36
	15	2	-6	-13	-21	-28	-34	-43
	20	0	-8	-16	-23	-32	-39	-47
	25	-1	-9	-18	-26	-34	-42	-51
	30	-2	-11	-19	-28	-36	-44	-53

7.5 Hazard: rain

The hazard due to rain is that it increases the risk of many of the hazards identified previously (e.g. falls from height, electric shock).

Factors affecting the risk

- The strength of the rain
- The height of the working platform
- The presence of electrical equipment
- How exposed the working platform is
- Mud/dirt on the platform

- Provision of shelter

Control measures

All the control measures applying to the hazards worsened by the rain (e.g. falls, electric shock) should be reassessed if there is rain. More stringent control measures may be required than in the absence of rain. The most basic additional control measures are:

- Weather protection at the sampling location
- Do not work on platforms where dust can turn to mud. This is common at some minerals sites.

7.6 Hazard: lightning

The hazards associated with lightning are burns, possibly fatal, from lightning strikes.

Control measures

- All outside work should be **stopped** during lightning storms. The team must come down from the stack if it is safe to do so.

7.7 Hazard: tiredness

The hazard associated with tiredness is that it increases the risk from many of the previously described hazards. In addition, driving whilst tired poses a serious risk.

Factors affecting the risk

- Duration of the work on site
- Duration of the journey to/ from site
- Amount of physical exertion
- Other factors, e.g. heat exhaustion

Control Measures

- Determine a safe maximum daily working time, to include site work and travelling. A normal maximum of 10 hours per day with occasional maxima of 12 hours is advisable.

- Take rest breaks
- Do not drive if you are unfit to do so. Some employers stipulate a maximum distance that can be driven in a day if a full day's work is also to be carried out. It is recommended that rest breaks of at least one-quarter of an hour are taken for every 2 hours of driving.
- Design and cost the job to allow for the above
- The requirements of the Working Time Regulations provide more information on this subject. It is recommended that site teams should not carry out onsite monitoring work for more than 48 hours per week.

7.8 Hazard: lone working

It is unlikely that a workplace risk assessment of stack monitoring on complex Part A IPC/IPPC processes would conclude that lone working is safe. However, there may be occasions with less-complex, less-hazardous processes where lone working is acceptable. The STA has issued separate guidance on the hazards, risks and safety control measures for lone working, HSGN005.

STA guidance

STA HSGN005 *Lone Working*

STA HSGN 007 Limitations on working hours in stack sampling

STA guidance HSGN018 *Lightning*

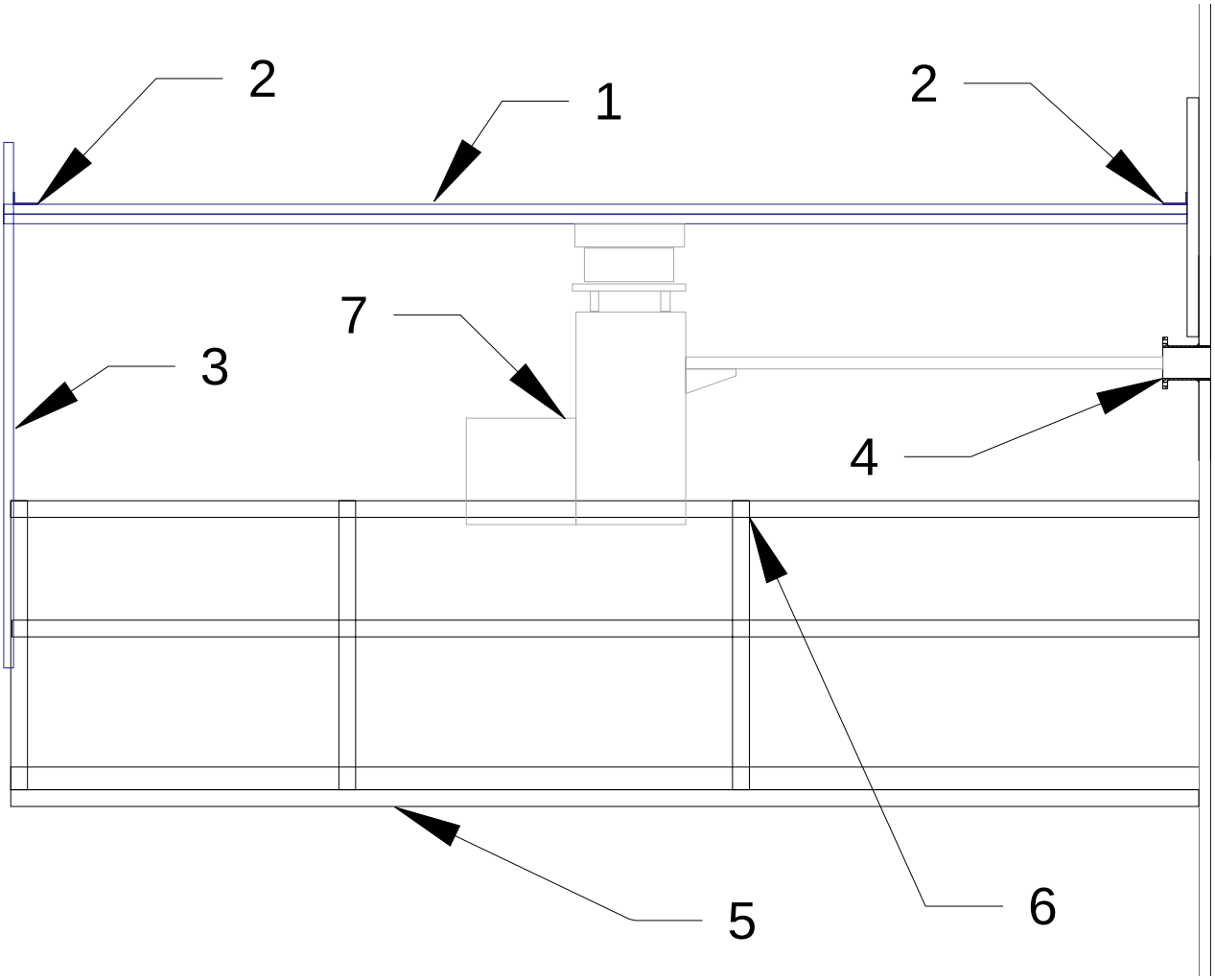
Further information

HSE INDG 337, *Sun Protection Advice for Employers of Outdoor Workers 2001*

HSE INDG147Rev 1 *Keep Your Top On – Health Risks from Working in the Sun* 1998

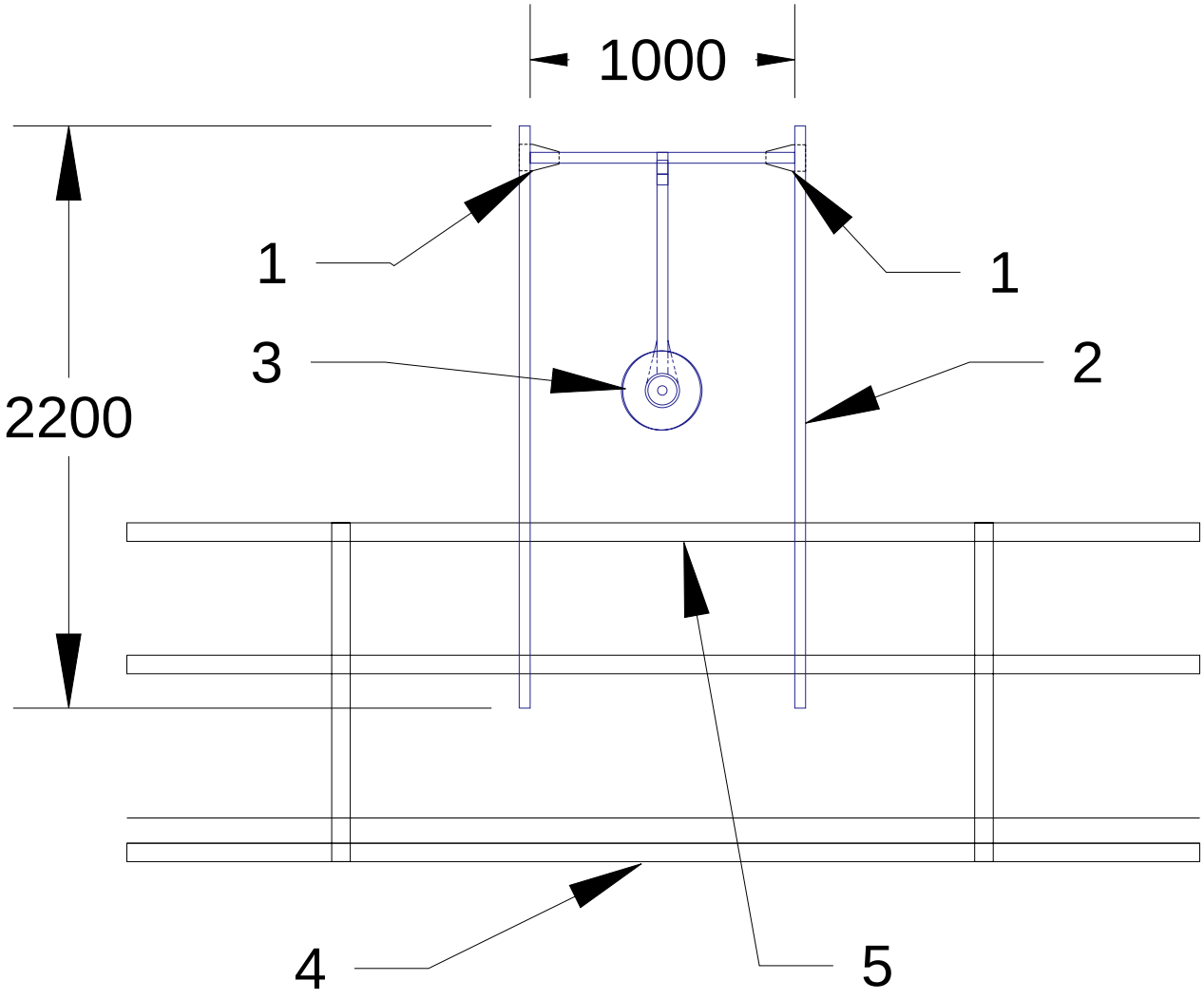
APPENDIX

Figure 1: Example of a monorail system



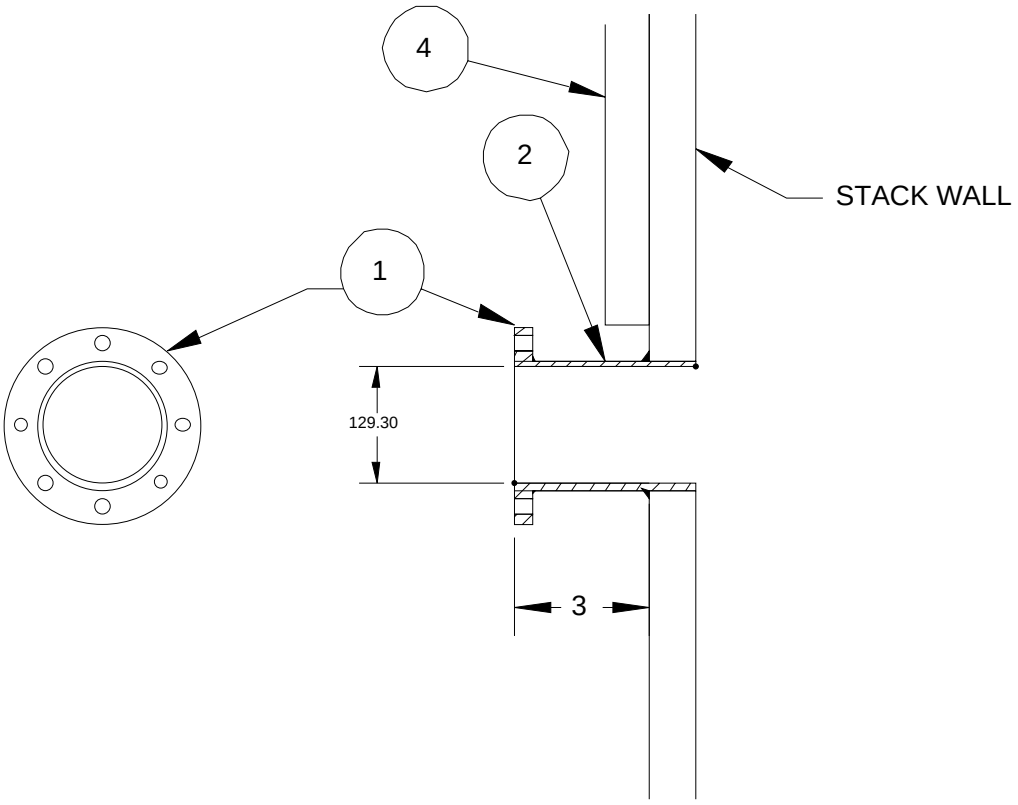
1. Monorail Unistrut P1001
2. L brackets Unistrut P2484
3. Unistrut H frame, refer figure 2
4. Standard 125 mm sample port, refer figure 3
5. Sampling platform, refer Environment Agency Guidance Note M1
6. Platform hand rail
7. Example of sample train

Figure 2: Monorail end view



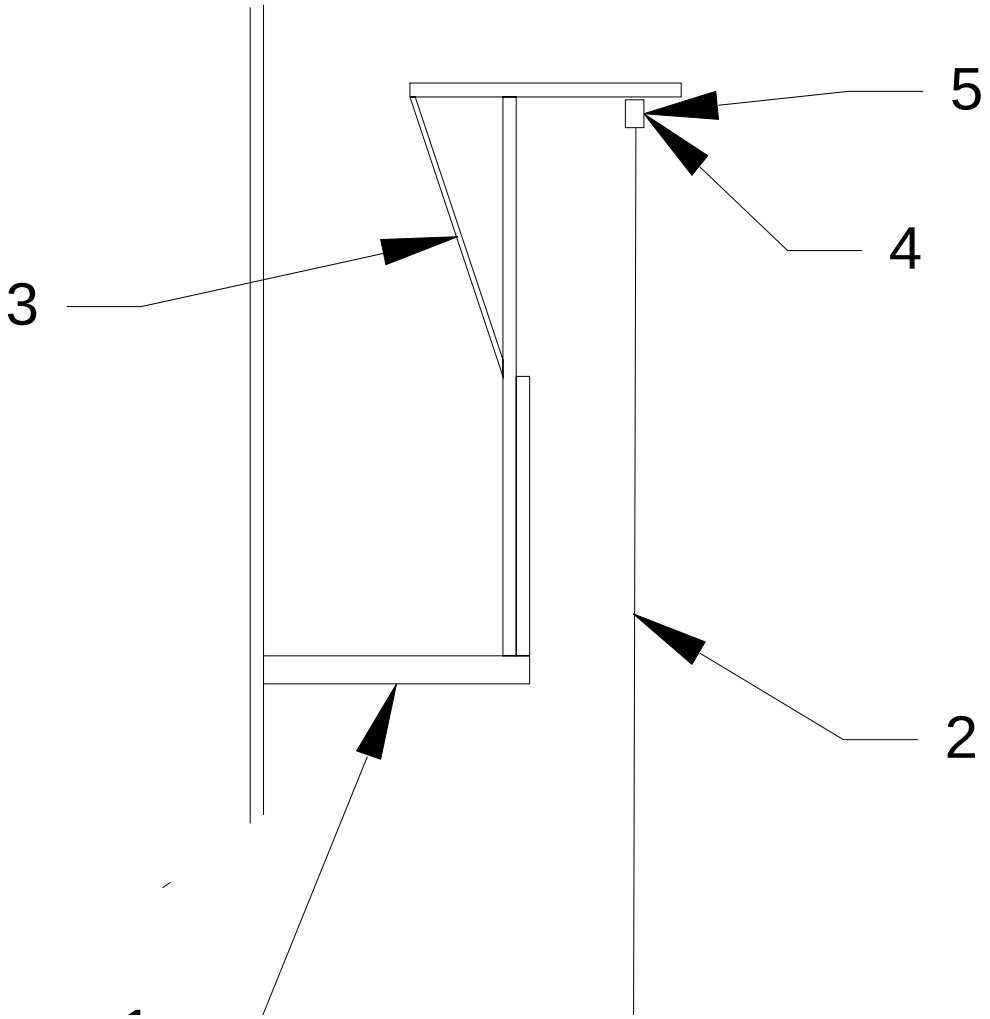
1. Bracket Unistrut P1358
2. Unistrut P1000
3. Standard sample port, refer figure 3
4. Sampling platform, refer Environment Agency Guidance Note M1
5. Platform hand rail

Figure 3: Standard 125mm Sample port



1. Flange BS10 –125mm (5”)
2. Pipe stub 125mm schedule 40
3. Pipe stub length should be a minimum of 75mm from the stack wall (recommended is 100mm)
4. Recommendation that 1000mm of Unistrut P1000 is fitted vertically on the centre line of the sample port for positioning of the monorail

Figure 4: Lifting point



1. Sampling platform, refer Environment Agency Guidance Note M1
2. The lifting point must be able to withstand a resultant force of at least 100kg.
3. The construction design of the lifting point is at the discretion of the engineer involved but should be able to conform to the specifications on this diagram.
4. Loop (minimum internal dimension - 20mm x 15mm) to which a karabiner with a rope and pulley system will be attached prior to sampling apparatus being hoisted and removed after sampling has taken place and all equipment has been lowered from the platform. It should therefore be easily accessible from the platform without having to reach over the edge of the handrail to such an extent that there is a risk of falling. The boom would ideally rotate.
5. Height of loop above the platform.

Notes

Notes