



# **SAFETY GUIDELINES HANDBOOK - APPENDICES**

**Second Edition**

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# APPENDIX A

## WORKING AT HEIGHTS GUIDELINES

### Steps in Reviewing the Hazards Associated with Working at Heights

#### Risk Assessment-

#### *Identify potential Fall Hazards using the Preplanning Checklist*

**Hazard Analysis** - Exposure avoidance and control techniques

**Fall Hazard Controls** - Employee awareness & communication (preplanning and coordination), Protection systems

**Fall Restraint** - Guard rails, travel restraint systems

**Fall Arrest** - Personal arrest systems, safety nets, lifeline systems- vertical and horizontal walk line requirements

**Anchor Requirements** - Restraint versus arrest, temporary versus permanent

**Procedure Development** - Safe Work Practice Guidelines

### Recognizing Hazards

#### **Consider Hazardous Falls**

- Falls at the same level
- Falls against an object
- Falls from vehicles/equipment
- Falls from stairs, ladders and ramps
- Falls from one work level to another
- Falls into/through openings

#### **Underlying Causes of Falls**

- Reaching beyond the work surface
- Poor housekeeping
- Walking off unguarded edge
- Carrying objects
- Slippery surfaces
- Climbing onto or from work surface
- Using machinery or equipment
- Weather conditions: heat, rain, ice, and/or winds



## Daily Preplanning

*Identify:*

Existing and potential height related hazards and exposures to falls

*Ask:*

- 1) Why is this a hazard?
- 2) How do we abate or minimize the hazard?

*Know:*

- 1) Risks you impose on others and risk others impose on you
- 2) Risks of your trade and the risks of the trades around you

*Remember:*

If you see a hazard, see it gets fixed. SILENCE IS CONSENT!

## Preplanning Checklist

Excavations	_____
	_____
Scaffolds/ladders	_____
	_____
Ramps, runways, and walkways	_____
	_____
Crane supported work platforms	_____
	_____
Aerial platforms	_____
	_____
Temporary work platforms	_____
	_____
Welding, decking, bolting	_____
	_____
Roofing and roof openings	_____
	_____
Siding/sheeting	_____
	_____
Wall openings	_____
	_____
Boom & scissor lifts	_____
	_____
Steel erection, welding, bolting	_____
	_____
Flooring	_____
	_____
Elevator openings	_____
	_____
Stairwells	_____
	_____
Forming, pouring, stripping concrete columns/walls	_____
	_____
Perimeter/leading edge activities	_____
	_____
Weather	_____



## Fall Protection Options for Hazardous Exposures

**Working Over Dangerous Equipment:** guard rail system—safety net system—personal fall arrest system

**Excavations:** guard rail system—fences—barricades

**Floor/Roof Openings:** hole covers—guard rail system— personal fall arrest system—all restraint system

**Formwork and Reinforcing Steel:** safety net system— personal fall arrest system—positioning system

**Hoist Areas:** guard rail system—safety net system— personal fall arrest system—fall restraint system

**Holes Covers:** guard rail system—safety net system— personal fall arrest system—fall restraint system

**Leading Edge:** guard rail system—safety net system— personal fall arrest system—fall restraint system—fall protection

**Over-head Work:** guard rail system—safety net system—personal fall arrest system—controlled access zone

**Precast Concrete Erection:** guard rail system—safety net system—personal fall arrest system—fall protection plan

**Roofing Work:** guard rail system—safety net system— personal fall arrest system—safety monitor system— warning line with guard rail or safety net OR personal fall protection or fall restraint system

**Unprotected Sides and Edges:** guard rail system— safety net system—personal fall arrest system—fall restraint system

**Ramps, Runways, Walkways:** guard rail system— personal fall arrest system—safety net system Wall

**Openings:** guard rail system—safety net system— personal fall arrest system—fall restraint system

## Safe Work Practice Guidelines

### Eliminate Structure Collapse

**Follow** erection sequence

**Install** all temporary and permanent bracing

**Remember** bracing provides no value until both ends are connected

**Leave** all bracing in place until it can be safely removed

**Keep** erection within limits of bolts, welding and other fasteners

**Do not** over-load

**On** multiple story structures, check the status of the floor you are loading to ensure it can easily accommodate the anticipated load

**Once** plumb and square, install and secure bridging before loading, to eliminate possibility of collapse

## Safe Work Practice Guidelines

### Eliminate Scaffold Collapse

#### **Inspect:**

All pieces before erecting

All components before getting on any scaffold

Over-head anchors before each shift

#### **Do:**

Build base on level, solid surface to withstand weight

Consider and construct for wind loads

Follow erection procedures and manufacturers specifications Install bracing and out riggers

Travel only on level surfaces

#### **Do Not:**

Over-load

Climb on bracing

Use damaged or faulty planks or other components



**Eliminate Scissor Lift & Boom Supported Work Platform Tip-Over or Collapse**

- Do not over-load
- Be aware of all sources of electrical power
- Be alert for surface penetration covers
- Stay clear of workers, ladders, and scaffolds
- Use caution when attaching anything that could get caught (Cords, hoses, etc.)

**Eliminate Derrick Collapse or Failure**

- Use qualified operators
- Use qualified signal persons
- Do not over-load
- Ensure derrick flooring is adequately fastened
- Inspect all parts daily
- Refuse to use damaged derrick

**Eliminate Crane Collapse, Failure or Tip-Over**

- Use qualified operators
- Use qualified signal persons
- Do not over-load
- Travel only within manufacture's limits
- Inspect parts daily
- Refuse to use damaged crane
- Place outriggers on solid support

**Eliminate Ladder Collapse or Failure**

- Inspect daily
- Do not over-load
- Keep feet of ladder at even levels
- Use the proper ladder for the job



### **Eliminate Slipping & Tripping Hazards**

- Maintain good housekeeping
- Look for and remove nuts, washers, cords, rope & tools
- Keep loose parts and pieces in secure containers or non hazardous area
- Clean up and properly dispose of left over materials
- Pay attention to work surfaces; for mud, sand, water or ice
- Clean up oil, grease, paint, fireproofing, & dust

### **Ladders**

- Keep angle of the ladder within prescribed limits
- Secure ladders to prevent slipping
- Where possible, secure top and or bottom of ladder
- Do not splice together short ladders to make a longer ladder
- Destroy and discard damaged ladders
- When in traffic areas barricade or tape off the area
- Do not use the top two steps on step ladders

### **Eliminate Falling Objects**

- Maintain good housekeeping
- Dispose of left over materials
- Secure materials, tools, parts on hoists
- Eliminate over-head work of welders and burners—when unavoidable every effort to catch the fire must be made
- Preplan for catching slag and fire



**Eliminate Falls Through Roofs or Floor Openings**

- Barricade holes before removing covers
- Use appropriate fall protection equipment
- Highlight all barricade hazards with signs
- Cover holes with clearly marked covers

**Eliminate Unguarded Edges Hazards**

- Preplan for leading edge work at unprotected edge, side, or openings in floors, roofs, ramps, or runways where there is no guard rail system in place
- Use appropriate fall protection equipment

**Eliminate Lighting Hazards**

- Preplan to limit exposures in non-daylight hours
- Use good lighting to illuminate work areas, pathways, corridors, hall ways, working platforms
- Have a supply of flashlights

**Eliminate Weather Related Hazards**

- Keep work areas cleared, dry, sanded, covered, barricaded, or protected
- Use temporary bracing
- Use personal protective equipment

**Eliminate Electrical Hazards**

- Instruct crew members on location of all sources of electrical power and proper work practices including that equipment must be grounded or double insulated
- Tag, barricade and post warning signs in hazardous areas
- Watch distances when transporting ladders, or scaffolds, or other materials
- Flag roof mounted weather heads to prevent tripping or falling over power lines



## **Preplanning for Safety**

### Minimum Safe Distance From High Voltage

Power line voltage Phase to phase (kV)	Minimum safe clearance (feet)
50 or below	10
Above 50 to 200	15
Above 200 to 350	20
Above 350 to 500	25
Above 500 to 750	35
Above 750 to 1,000	45



# APPENDIX B

## GENERAL FIRST AID FOR INHALATION

The following suggestions on first aid for inhalation or suspected inhalation of compressed gases are generally applicable for most incidents. Prior to implementing the measures suggested in this section, the Material Safety Data Sheet (MSDS) for the suspected gas or gases should be consulted for specific recommendations. The measures suggested by the MSDS may be altogether different than those recommended in this Section. In the event of such a difference, always follow the MSDS. It is usually a good idea to remove exposed individuals to an area that is not contaminated.

### Asphyxiants

Anyone who is overcome by an asphyxiant gas should be moved to an uncontaminated area. If the affected person is not breathing, artificial respiration or oxygen (by means of a resuscitator) should be administered. In those situations where the affected person is breathing; but, finds it difficult oxygen should be administered. The affected person should be kept warm and quiet. Either the local emergency medical service or a physician should be contacted. Warning: Oxygen should be administered only by persons who have been properly trained the use of medical oxygen systems and regulators. Breathing of oxygen in high concentrations or at high pressures for long periods of time may be harmful.

### Irritants and Corrosives

Anyone who inhales an irritant or corrosive gas should be moved to an uncontaminated area. If the affected person is not breathing, artificial respiration or oxygen (by means of a resuscitator) should be administered. In those situations where the affected person is breathing; but, finds it difficult oxygen should be administered. Either the local emergency medical service or a physician should be contacted. Warning: Oxygen should be administered only by persons who have been properly trained the use of medical oxygen systems and regulators. Breathing of oxygen in high concentrations or at high pressures for long periods of time may be harmful.

If the eyes have come into contact with an irritating or corrosive gas, then the eyes should be liberally flushed with large quantities of water for at least 15 minutes. The lids should be gently separated in order to ensure that the eyes are thoroughly irrigated. Either the local emergency medical service or a physician should be contacted.

If the skin comes into contact with an irritating or corrosive gas, the affected area(s) should be flushed with large quantities of water for a period of at least 15 minutes while removing contaminated clothing and shoes. Either the local emergency medical service or a physician should be contacted. Creams, ointments, or other medication should not be applied to the affected area unless prescribed by a physician.



## **Toxics**

Anyone who inhales a toxic gas should be moved to an uncontaminated area. If the affected person is not breathing, artificial respiration or oxygen (by means of a resuscitator) should be administered. In those situations where the affected person is breathing; but, finds it difficult oxygen should be administered. Either the local emergency medical service or a physician should be contacted. The exposed individual should be kept warm and quiet. Warning: Oxygen should be administered only by persons who have been properly trained the use of medical oxygen systems and regulators. Breathing of oxygen in high concentrations or at high pressures for long periods of time may be harmful.

If the eyes or skin have come into contact with the toxic gas then the first aid procedures described for eye or skin exposure to irritant or corrosive gas should be followed. Either the local emergency medical service or a physician should be contacted.

It is extremely important that anyone who has been exposed or potentially exposed avoid exertion and contact a physician because medical observation may be required since effects of some toxic compounds occur on a delayed basis.

## **Cryogenic Materials**

Although those performing emission tests do not normally handle liquefied gases, they do sometimes handle dry ice (solidified carbon dioxide) and perform testing at facilities where liquefied gases are stored in cylinders or billets. Therefore, situations may be encountered where the applicable first aid measures may prove beneficial. Some compressed gases are liquid in the cylinder or billet. Cryogenic liquids or solids can vaporize rapidly and absorb large quantities of heat from the surroundings. If a liquefied gas comes into contact with the skin, it will absorb the heat from the tissue producing damage similar to thermal burns and severe frostbite accompanied by extensive destruction of tissue. In the case of a cold injury, the affected area should be gently flushed with large quantities of tepid water (102°F – 105°F). Frozen tissues are extremely vulnerable to additional injury and must be handled very carefully both before and after thawing. The affected tissues (whether frozen or thawed) should be covered with a loose covering while the injured person is being transported. Burns from contact with cryogenic require medical attention; therefore, either the local emergency medical services or a physician should be contacted.



# APPENDIX C

## EXTINGUISHING FIRES

This section briefly discusses the personal protective equipment and emergency procedures that are to be used in the event of small quickly extinguished fires and to reduce the injury/damage potential of a larger fire situation until the professionals arrive. This section is most applicable to facilities where a substantial number of cylinders are stored on a continuous basis or where other industrial operations are routinely conducted. This section is by no means a comprehensive treatment of the topic. Fire fighting is an activity that is best left to professionals.

Fire prevention and control, like so many other really important activities, is a process that begins with planning and education. In every case, the process should begin with a thorough review of appropriate Materials Safety Data Sheets (MSDS), manufacturer–provided safety information, Compressed Gas Association data, National Fire Protection Association (NFPA) guidelines, OSHA requirements, etc. The information obtained from the literature should be used to develop a fire prevention and control plan, and to purchase the required safety equipment.

Appropriate personal protective equipment including self–contained, positive–pressure breathing apparatuses (SCBA) must be available to any personnel who are expected to work with toxic or corrosive compounds in a fire or materials that are expected to form such compounds when exposed to fire. These individuals should be equipped with equipment that will protect both the eyes and skin from contact with corrosive or toxic gases and products of combustion that meet the requirements of 29 CFR 1910. Anyone who would be expected to wear respiratory protection equipment must be trained and skilled in the use of such equipment pursuant to the requirements of 29 CFR 1910 Subpart I.

The handling of a fire involving a flammable or oxidizing gas requires the calm application of “common sense.” If the flow of gas can be shut off without risk, it is advisable to do so — especially in those situations where the gas is feeding a fire that is out of control or there is a risk that the fire will spread. In the event that there is a controlled fire coming from a single cylinder and little risk of the fire spreading, it may be desirable to simply let the fire continue burning until the cylinder is empty. In those cases where the fire must be extinguished before the flow of gas can be turned off, make sure there is adequate ventilation to dissipate the gas. Also cool the cylinder(s) and the surrounding area. Avoid areas where flammable mixtures may have accumulated.



# APPENDIX D

## HAZARDOUS CHEMICALS

**Table 1. Hazardous Chemicals - Compressed Gases**

**Table 2. Hazardous Chemicals - Reagents**



## Table 1. Hazardous Chemicals - Compressed Gases

Simple Asphyxiants, Chemical Asphyxiants, Flammable Gases, Other Hazards)

All compressed gases require special cylinder handling.

**Simple Asphyxiants:** The only effect they may have is to dilute oxygen supply.

Chemical Name(s)	Health or Physical Effects	Job Precautions	First Aid and emergency
<b>Helium 100%</b>  <b>Methane in N<sub>2</sub></b>  <b>N<sub>2</sub></b>  All are colorless & odorless	<p><b>Health Hazard:</b> Simple Asphyxiant In large concentrations they may dilute oxygen supply to levels that no longer support life. Oxygen level below 19.5% must be avoided.</p> <p><b>Symptoms:</b> at <u>low conc.</u> euphoria and increase in respiratory rate; <u>mod. conc.</u> fatigue, headache, nausea, and vomiting; <u>high conc.</u> collapse, serious damage can occur after 5-8 minutes without air supply.</p> <p><b>Limits:</b> No PEL or TLV is established. However, they completely replace oxygen at very high concentrations only.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks.</p> <p>Ventilate work areas</p> <p>If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	Remove person to uncontaminated area Begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.
<b>CO<sub>2</sub> in N<sub>2</sub></b>  colorless & odorless	<p><b>Health Hazard:</b> Simple Asphyxiant--<u>But is slightly more hazardous because it can stimulate deeper, more rapid breathing.</u></p> <p><b>Limits:</b> No PEL or TLV is established.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks.</p> <p>Ventilate work areas</p> <p>If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	Remove person to uncontaminated area; begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.
<b>O<sub>2</sub> in N<sub>2</sub></b>  colorless & odorless	<p><b>Health Hazard:</b> Simple Asphyxiant</p> <p><b>Limits:</b> No PEL or TLV is established.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks.</p> <p>Ventilate work areas</p> <p>If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p>	Remove person to uncontaminated area; begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.

All compressed gases require special cylinder handling.



Table 1. (Cont'd)

**Chemical Asphyxiants** (They can have chemical and dilution effects)

All compressed gases require special cylinder handling.

Chemical Name(s)	Health or Physical Effects	Job Precautions	First Aid and emergency
<b>Carbon Monoxide (CO) in N<sub>2</sub></b>  Colorless  Odorless	<p><b>Health Hazard:</b> Reacts with blood hemoglobin preventing the hemoglobin from taking up oxygen. N<sub>2</sub> is simple asphyxiant. Combining the hazards of the two in extreme cases---high CO and low oxygen---death can occur in seconds without warning.</p> <p><b>Symptoms:</b> 400-1000 ppm continuously produces headache, confusion, and nausea in a few hours. 2000-3000 ppm continuously produces unconsciousness in 30 minutes. Higher concentrations can cause death. At the highest concentrations normally used in source testing, 5% concentration = 5000 ppm.</p> <p><b>Limits:</b> PEL=35 ppm; TLV=25 ppm.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks. If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p>Ventilate work areas</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	<p>Remove person to uncontaminated area; rescue workers may need SCBA.</p> <p>Begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p> <p>Get immediate medical attention for serious exposure.</p>
<b>Nitric Oxide (NO) in N<sub>2</sub></b>  Colorless  Pungent, sweet odor	<p><b>Health Hazard:</b> Mixture is simple asphyxiant. NO is toxic---it forms irritating Nitric and Nitrous acids in the respiratory tract.</p> <p><b>Symptoms:</b> <u>simple asphyxiant:</u> euphoria, increase in respiratory rate; fatigue, headache, nausea, vomiting; loss of consciousness.</p> <p><u>NO symptoms:</u> Chronic cough exposure of 25-60 ppm (chronic); Immediate irritation of nose and throat, cough, burning in chest and dizziness exposure of 60-150 ppm. Delayed pulmonary edema can occur 5-25 hours later. May cause death after very short exposure 200-700 ppm.</p> <p><b>Limits:</b> PEL=25 ppm; TLV=25 ppm.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks. If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p>Ventilate work areas</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	<p>Remove person to uncontaminated area; rescue workers may need SCBA.</p> <p>Begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p> <p>Get immediate medical attention for serious exposure.</p>
<b>Propane in N<sub>2</sub> or in Air</b>  Colorless  Odorless	<p><b>Health Hazards:</b></p> <p>I. As a simple asphyxiant may dilute oxygen supply to levels that no longer support life (large concentrations).</p> <p>II. Mild mucous membrane irritant, mild anesthetic action.</p> <p><b>Symptoms:</b> <u>simple asphyxiant:</u> euphoria, increase in respiratory rate; fatigue, headache, nausea, vomiting; loss of consciousness.</p> <p><u>Propane:</u> Brief exposures to 10,000 ppm cause no symptom. At 10% conc. causes dizziness in minutes.</p> <p><b>Limits:</b> PEL=1000 ppm; no TLV established.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks.</p> <p>Ventilate work areas</p> <p>If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	<p>Remove person to uncontaminated area; begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p> <p>Get immediate medical attention for serious exposure.</p>
<b>SO<sub>2</sub> in N<sub>2</sub></b>	<p><b>Health Hazard:</b> Mixture is simple asphyxiant. SO<sub>2</sub> is irritating to eyes, throat and respiratory tract.</p> <p><b>Symptoms:</b> <u>Asphyxiant symptoms:</u> euphoria, increase in respiratory rate; fatigue, headache, nausea, vomiting; loss of consciousness.</p> <p><u>SO<sub>2</sub> symptoms:</u> Irritation of nose and throat, cough, burning in eyes, constriction in chest exposure of 8-12 ppm. Acute irritation at minutes exposure to 150 ppm. A dangerous sense of suffocation at 30-60 minutes exposure to 500 ppm.</p> <p><b>Limits:</b> PEL=2 ppm; TLV=2 ppm.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks. If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p>Ventilate work areas</p> <p><b>Monitoring methods</b> Watch for symptoms</p>	<p>Remove person to uncontaminated area; rescue workers may need SCBA.</p> <p>Begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p> <p>Get immediate medical attention for serious exposure.</p>



Table 1. (Cont'd)

**Flammable** All compressed gases require special cylinder handling.

Chemical Name(s)	Health or Physical Effects	Job Precautions	First Aid and emergency
<p><b>H<sub>2</sub> in Helium</b></p> <p>Colorless gas at normal temperature and pressure</p> <p>Odorless</p>	<p><b>Physical Hazard:</b> Flammable; LEL=4%; UEL=75%. Flame is nearly invisible. Escaping gas may ignite "spontaneously". Hydrogen has low ignition energy. Fireball is formed if gas cloud is ignited immediately after release.</p> <p><b>I.Health Hazard: As a simple asphyxiant may dilute oxygen supply to levels that no longer support life (large concentrations).</b></p> <p><b>Health Symptoms:</b> at <u>low conc.</u> euphoria and increase in respiratory rate; <u>mod. conc.</u> fatigue, headache, nausea, and vomiting; <u>high conc.</u> collapse, serious damage can occur after 5-8 minutes without air supply.</p> <p><b>Limits:</b> No PEL or TLV is established.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks. Ventilate work areas. If cylinder leaks, ventilate area and move cylinder to hood or away from work area.</p> <p><b>Fire Extinguisher:</b> CO<sub>2</sub>, dry chemicals, water spray or fog.</p> <p><b>Special Fire Fighting Procedures:</b> Evacuate personnel; cool container with water spray, do not extinguish flames. Remove ignition source if possible. If flames are extinguished explosive re-ignition may occur. SCBA may be needed. Enter areas carefully.</p>	<p>Remove person to uncontaminated area; begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p>
<p><b>H<sub>2</sub>S</b></p> <p>Colorless gas with a strong odor of rotten eggs detectable at 0.13 to 100 ppm; paralyzes sense of smell &gt;100 ppm; liquid at high pressure, low temperature.</p>	<p>NFPA Rating: H=3, F=4, R=0</p> <p><b>Physical Hazard:</b> Very flammable; LEL=4%; UEL=44%.</p> <p><b>Health Hazard:</b> inhalation hazard to neurological functions. Eye irritant, skin irritant</p> <p><b>Symptoms:</b> Inhalation: irritation at .1 to 30 ppm; headache, nausea, vomiting, for higher concentrations; long term exposures can result in death.</p> <p><b>Limits:</b> OSHA PEL TWA=10 ppm; STEL=15 ppm.</p>	<p><b>Good Work Practices</b> Maintain gas cylinders properly to prevent leaks. Ventilate work areas. If cylinder leaks, ventilate area and move cylinder to hood or away from work area. Store cylinders in upright position.</p> <p><b>Handling:</b> II.Wear eye goggles, proper gloves (neoprene, nitrile), lab coat &amp; apron, proper respirator</p> <p><b>III.wash thoroughly after handling.</b></p> <p><b>Monitoring methods</b> Watch for symptoms</p>	<p>Remove person to uncontaminated area; begin first aid for asphyxiation: lay person on stomach with face to the side, chest lower than hips to drain lungs, or give oxygen, or start artificial respiration.</p>



**Table 2. Hazardous Chemicals - Reagents**

Name(s)	Health or Physical Effects	Handling, Spill & Disposal	First Aid and Emergency
<b>Acetone</b>  2-propanone  clear, colorless liquid, fragrant mint-like odor detectable at 33 to 700 ppm	<b>H=1, F=3, R=0</b> <b>Flammable liquid</b> LEL=2.6%; Flash point -20°C Vapor density=2 May cause: eye & skin irritation or damage; chronic exposure may cause dermatitis May cause central nervous system depression (headache nausea etc) if inhaled PEL: 750 ppm, STEL 1000 ppm TLV: 750 ppm	<b>Handling:</b> <ul style="list-style-type: none"> <li>Wear splash goggles, proper gloves (latex or nitrile), lab coat &amp; apron</li> <li>ventilation for vapor denser than air</li> <li>fire extinguisher: regular foam, CO<sub>2</sub>, or dry chemical. Use water spray to cool fire-exposed containers.</li> </ul> <b>Spill:</b> absorb spill with inert material <b>Disposal:</b> RCRA U002, banned from land disposal.	<b>First Aid</b>  <b>Eye contact:</b> Flush with water immediately. hold eyes open occasionally <b>Skin contact:</b> Flush with soap & water immediately <b>Inhalation:</b> Remove to fresh air
<b>DNPH Solution</b>  <b>(DINITRO-PHENYL-HYDRAZINE IN Hcl)</b>	<b>Shown mutagenic effects in lab experiments</b> <b>Hazards:</b> Health - severe ( <b>poison</b> ) Flammability - none Reactivity - moderate (strongly acidic) Contact - severe <b>CORROSIVE</b> Causes severe burns, fatal if swallowed.  Contains 6.5% Hcl –PEL and TLV=5 ppm	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear splash goggles, proper gloves, lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Store in acids area</li> </ul> <b>Spill:</b> Absorb spill with inert material. Neutralize with soda ash or lime <b>Disposal:</b>	<b>Eye contact:</b> Flush with water immediately, for 15 min. <b>Skin contact:</b> Flush with water immediately <b>Inhalation:</b> Remove to fresh air  Call Physician
<b>Hydrogen Peroxide- 30%</b> balance H <sub>2</sub> O  clear, colorless liquid, sharp odor	<b>HAZARDS:</b> Strong <b>OXIDIZER</b> Causes <b>BURNS</b> immediately <b>TOXIC</b> by ingestion <b>HARMFUL</b> if inhaled may cause severe eye damage, delayed effect irritant to nasal passages, bleach or blister skin possible cancer hazard Health:2, Flammable:0, Reactive:1, OXY TWA and TLV: 1 ppm	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear splash goggles, proper gloves (latex or nitrile), lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Store away from combustibles, organics, oxidizers, catalytic metals</li> </ul> <b>Spill: (Acid spill procedure)</b> Neutralize with SPILL-X or absorbent agents <b>Disposal:</b> EPA Waste Code D002	<b>Get medical attention for overexposure</b>  <b>Eye contact:</b> Flush with water immediately, for 15 min., hold eye(s) open <b>Skin contact:</b> Flush with large amount of water <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> do not induce vomiting, give water freely



Table 2. Hazardous Chemicals - Reagents (cont'd)

Name(s)	Health or Physical Effects	Handling, Spill & Disposal	First Aid and Emergency
<b>Isopropyl Alcohol</b>  synonyms: 1-Propanol 2-Propanol IPA  Clear colorless liquid with an odor of rubbing alcohol.	<b>Physical Hazards:</b> <b>EXTREMELY FLAMMABLE</b> Flashpoint 12°C; vapor density 2.1 HYGROSCOPIC. May form explosive peroxides. <b>Health Hazards:</b> May cause: · Eye and skin irritation or damage. · Central nervous system depression if high concentration is inhaled. · Kidney damage if ingested. · Reproductive effects based upon animal studies. OSHA PEL=400 ppm TWA; STEL=500 ppm	<b>Handling:</b> · Use with adequate ventilation · Wear splash goggles, proper gloves (latex or nitrile), lab coat & apron, proper respirator · Wash thoroughly after handling. <b>Fire fighting:</b> For small fires, use dry chemical, CO <sub>2</sub> , water spray or alcohol-resistant foam. Use water spray to cool fire-exposed containers. Water may be ineffective. <b>Spill:</b> absorb spill with inert materials <b>Disposal:</b> not RCRA listed	<b>Get medical attention for overexposure</b>  <b>Eye contact:</b> Flush with water immediately, for 15 min., hold eye(s) open <b>Skin contact:</b> Flush with large amount of soap & water <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> induce vomiting, give milk & water freely
<b>Methyl Alcohol</b>  <b>Methanol</b>  Colorless liquid with a characteristic, pungent odor detectable at 4 to 6000 ppm	<b>Physical Hazards:</b> <b>FLAMMABLE LIQUID</b> <b>POISON</b> Flashpoint 12°C; vapor density 1.1 Incompatible with oxidants such as barium perchlorate or hydrogen peroxide. <b>Health Hazards</b> depression Eye & skin irritant Harmful to respiratory if inhaled, If ingested: harmful to central nervous system, digestive tract, kidney, liver; cause blindness. OSHA PEL=200 ppm TWA; STEL=250 ppm	<b>Handling:</b> · Use with adequate ventilation · Wear splash goggles, proper gloves (latex or nitrile), lab coat & apron, proper respirator · Wash thoroughly after handling. <b>Spill:</b> absorb spill with inert materials <b>Disposal:</b> RCRA U154, banned from land disposal.	<b>Get medical attention for overexposure</b> <b>Eye Contact:</b> Flush with water immediately 15 min. <b>Skin Contact:</b> Wash thoroughly with soap & water <b>Inhalation:</b> Remove to fresh air
<b>Methylene chloride</b> Dichloro-methane  Colorless liquid with a chloroform-like odor. Odor threshold 160 to 230 ppm. Solvent.	<b>Physical Hazards</b>  <b>Health Hazards</b> <b>Do not</b> swallow or inhale. Central nervous system depressant Skin, Eye, Respiratory Irritant <b>POSSIBLE CANCER HAZARD</b>  OSHA PEL 25 ppm TWA; 125 ppm STEL Monitor by OSHA method (charcoal tube, or detector tube), especially if using indoors.	<b>Handling:</b> · Use with adequate ventilation, and this vapor is heavier than air. · Wear splash goggles, proper gloves (latex or nitrile), lab coat & apron. · Wash thoroughly after handling. · Wear supplied-air respirator if workplace air >PEL. <b>Spill:</b> absorb spill with inert materials (dry sand or earth) <b>Disposal:</b> RCRA U080, banned from land disposal.	<b>Eye contact:</b> Flush with water immediately- 15 min. hold eyes open occasionally <b>Skin contact:</b> Flush with plenty of water, discard contaminated clothing <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> Call Physician <b>immediately.</b>



Table 2 Hazardous Chemicals - Reagents (cont'd)

Name(s)	Health or Physical Effects	Handling, Spill & Disposal	First Aid and Emergency
<b>Nitric Acid</b>  <b>0.1 NORMAL</b>  colorless, odorless solution  no published NFPA 704 rating	<b>Hazards:</b> Corrosive: eye, skin, inhalation, ingestion May cause severe irritation or burns to respiratory or digestive tracts May cause severe irritation or burns to eyes or skin  OSHA PEL: 2 ppm, ACGIH STEL: 4 ppm; NIOSH IDLH 25 ppm.  Note: for muriatic acid, all this information applies, but the hazard is more severe  Fuming Nitric Acid, 90%: the same except for spills neutralize with sodium bicarbonate, and use water spray to disperse gas and vapor.	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear splash goggles, proper gloves (latex or nitrile), lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Store in acids area</li> </ul> <b>Spill:</b> Neutralize with soda ash or lime (sodium bicarbonate)  <b>Disposal:</b> no RCRA listing, not banned from land disposal	<b>Get medical attention for overexposure</b>  <b>Eye contact:</b> Flush with water immediately, for 15 min., hold eye(s) open <b>Skin contact:</b> Flush with soap & water immediately <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> do not induce vomiting, give water or milk
<b>Potassium Permanganate</b>  purple or bronze crystals, odorless	<b>Physical Hazards:</b> Strong Oxidizer, contact with other material may cause a fire  <b>Health Hazards:</b> Vapor Irritating To Respiratory Passages, to skin, eyes, nose Harmful If Inhaled Or Swallowed  possible mutagen	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Do not breathe dust or vapor. Avoid splattering when making solution</li> <li>Do not get in eyes, on skin or clothing</li> <li>Wear splash goggles, proper gloves (latex or nitrile), lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Fire extinguisher: regular foam, CO<sub>2</sub>, or dry chemical. Use water spray to cool fire-exposed containers.</li> </ul> <b>Spill:</b> xxxxxxxx <b>Disposal:</b> EPA Waste Code D001xxx, no RCRA listing, not banned from land disposal.	<b>Get medical attention for overexposure</b> <b>Eye Contact:</b> Flush with water immediately, 15 min. Hold eyes open. <b>Skin Contact:</b> Wash thoroughly with soap & water <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> Do not induce vomiting; give water freely



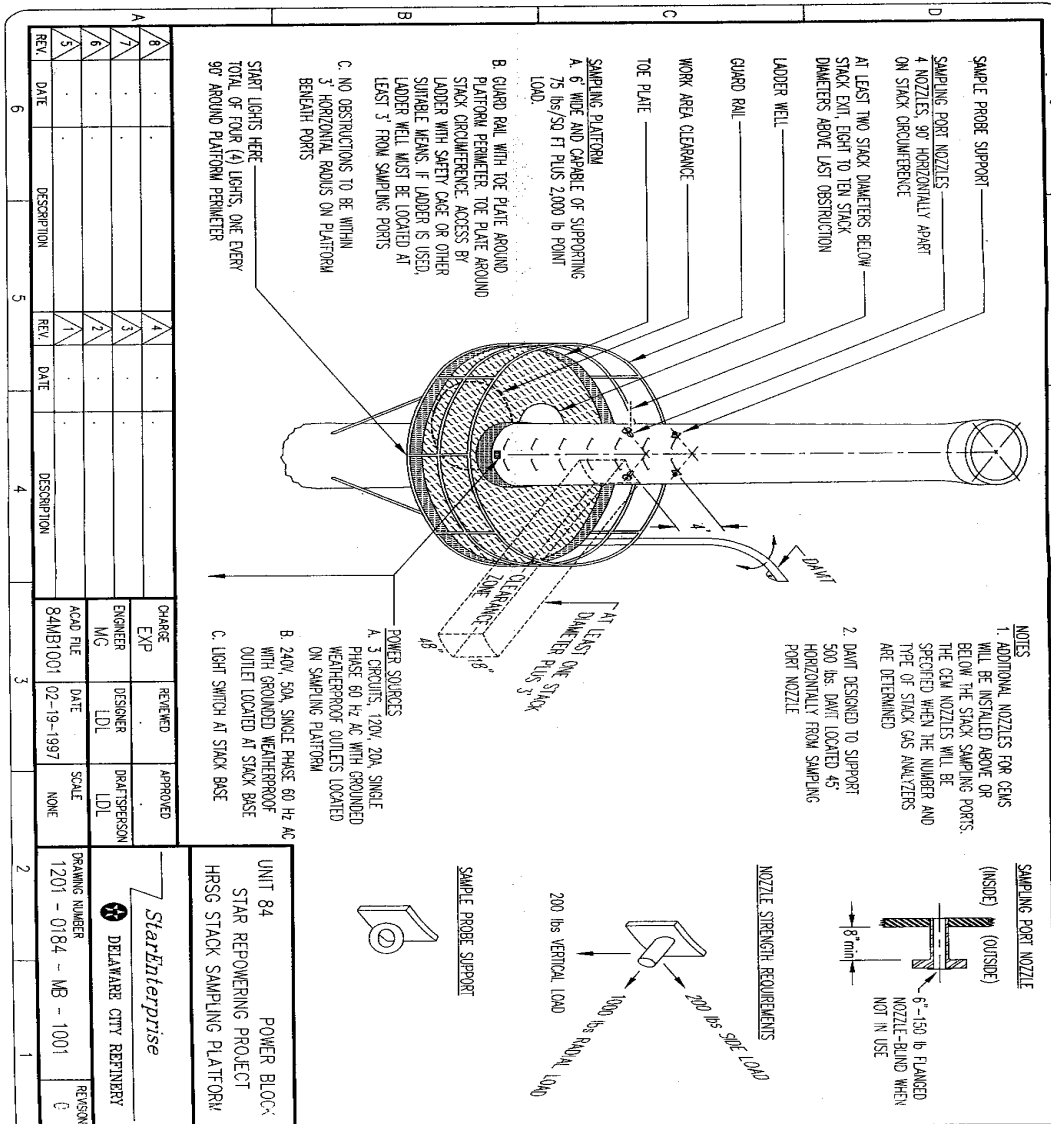
Table 2 Hazardous Chemicals - Reagents (cont'd)

Name(s)	Health or Physical Effects	Handling, Spill & Disposal	First Aid and Emergency
<b>Silica Gel</b>	<b>Dust Irritating, Eye Irritating</b> <b>Prolonged Breathing May Cause Damage To Respiratory System</b> <b>Skin Irritating</b>	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear proper hand and respiratory protection</li> <li>Wash thoroughly after handling.</li> </ul>	<b>Eye Contact:</b> Flush with water <b>Skin Contact:</b> Wash thoroughly with soap & water <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> Get immediate medical attention
<b>Sodium hydroxide</b> NaOH 1N to 50%, solid  clear, colorless, odorless solution; or white pellets	NFPA Rating not published  <b>Health Hazards:</b> Corrosive: acute contact hazard for eyes, skin, nose, respiratory tract and stomach Pellets are hygroscopic  OSHA TWA PEL: 2 mg/m <sup>3</sup> ; NIOSH IDLH: 10 mg/m <sup>3</sup> NFPA 704 Rating:	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear splash goggles, proper gloves (latex rubber), alkali resistant lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Store in alkali area</li> </ul> <b>Spill:</b> Dike with soil or non-combustible absorbent. Neutralize with dilute acid In large spills CO <sub>2</sub> release--ventilate  <b>Disposal:</b> no RCRA listing, not banned from land disposal.	<b>Get medical attention for overexposure</b>  <b>Eye contact:</b> Flush with water immediately, for 15 min., hold eye(s) open <b>Skin contact:</b> Flush with soap & water immediately <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> do not induce vomiting, give water freely
<b>Sulphuric Acid 0.1 to 2.6 Normal</b>  Colorless (pure) to dark brown, oily, dense liquid with sharp, acrid odor.	NFPA Rating: not published  <b>Health Hazards:</b> Eye Corrosive (redness, pain, blurred vision) Skin Corrosive Inhalation - Damages Mucous Membranes & upper respiratory tract Ingestion Corrosive  Suspected human carcinogen  OSHA TWA PEL: 1 mg/m <sup>3</sup> ; NIOSH STEL: 3 mg/m <sup>3</sup> NIOSH IDLH: 15 mg/m <sup>3</sup>	<b>Handling:</b> <ul style="list-style-type: none"> <li>Use with adequate ventilation, keep container closed</li> <li>Wear splash goggles, proper gloves (latex, neoprene, or nitrile), acid resistant lab coat &amp; apron, proper respirator</li> <li>Wash thoroughly after handling.</li> <li>Reacts with metals to release H<sub>2</sub></li> <li>Add acid to water, not vice versa</li> <li>Store in acids area</li> </ul> <b>Spill:</b> Neutralize with soda ash or sodium bicarbonate; dike with inert absorbent such as dirt, vermiculite.  <b>Disposal:</b> no RCRA listing, not banned from land disposal.	<b>Get medical attention for overexposure</b>  <b>Eye contact:</b> Flush with water immediately, for 15 min., hold eye(s) open <b>Skin contact:</b> Flush with plenty of water <b>Inhalation:</b> Remove to fresh air <b>Ingestion:</b> do not induce vomiting, give water freely



# APPENDIX E

## SAMPLING PLATFORM DIMENSIONS





# APPENDIX F

## SAFETY CHECKLISTS

Source Testers may encounter a wide variety of hazards during test programs. To better prepare for these potential hazards, a safety plan and/or safety checklist should be completed. Many facilities require that all contractors, such as stack test firms, complete a safety checklist prior to the start of field work. This appendix provides examples of several safety checklists that may be useful to Source Testers to raise awareness of potential hazards and to better plan for a safe test program. Note that simply completing a Safety Checklist does not replace the need for general safety training that covers typical stack test safety topics nor does it replace the need for site specific safety training. Each member of the stack test crew should review the safety checklist and take note of the potential hazards. A daily review of the Safety Checklist is useful since the tasks to be performed each day may vary and the working environment and weather also may impact safety considerations.

### EXAMPLES OF SAFETY CHECKLISTS

There are numerous Safety Checklists in use by Source Testers and facilities. Safety Checklists can range from one page to several pages in length. One checklist alone will not meet the needs of every source test program. Seven examples are discussed below to illustrate the diversity of safety topics that a test crew may need to consider. Most checklists are intended to be reviewed and discussed and signed by each crew member at the start of each test program, if not the start of each test day, at a “tool box” meeting. These seven example checklists are provided **IN A SEPARATE FOLDER ON THIS CD**. They are in a format where you may either print out the form and use it, or save the file onto a computer and fill in the information online.

#### **Checklist Example 1.                      General Site Safety Gut Check**

This checklist is comprised of a series of questions that each crew member should answer prior to the start of work. It is designed to make each person think about how or what they would do in the event a safety issue arises. Safety is everyone’s responsibility and this checklist, which is formatted as a series of questions, is intended to make each person think how they would handle situations that might arise. By answering the questions, each person should be better prepared should they encounter a hazard or unsafe condition.



**Checklist Example 2.                      Tool Box Meeting / Daily Safety Checklist**

This topical list of issues to be considered each day is intended to make each crew member think about the hazards they may encounter and be better prepared.

**Checklist Example 3.                      Safe Plant of Action Checklist and Safe Plan of Action**

This example utilizes a checklist to identify the types of work permits required by the facility, types of Personal Protective Equipment (PPE) needed, and types of hazards associated with the day's activities. For each of the hazards identified, a "Safe Plan of Action" should be completed and reviewed by each test crew member.

**Checklist Example 4.                      Field Services Job Site Inspection Checklist**

This 4-page checklist is designed to identify key safety aspects of a project by posing a series of "yes or no" questions with space provided for comments regarding job specific measures or actions.

**Checklist Example 5.                      Sit Safety Program Audit Checklist**

This is an example of an Audit Checklist used by a facility safety inspector to evaluate whether the test crew is following the appropriate or required safety practices and working safely.

**Checklist Example 6.                      Site Safety Checklist (provided by LEHDER Environmental Services)**

**Checklist Example 7.                      Site Checklist (provided by LEHDER Environmental Services)**

**Checklist Example 8.                      Scaffolding Safety Checklist**

**Checklist Example 9.                      Platforms Safety Checklist**



## Safety Checklist - Areas of Concern

The Source Tester is subjected to many different environments in the conduct of a source emissions test. The environment can have a multitude of safety hazards which will affect the health and welfare of the tester. In order to ensure that the tester is aware of safety conditions of the site it is highly recommended that during the site survey and during the actual test program the following checklist be completed.

### 1. Platform

- a) ladders
- b) deck type
- c) guard rails
- d) toe guards
- e) sampling ports
- f) monorails , proper support, length
- g) electrical power outlets, grounded (GFI) outlets, power extension cords
- h) distance from stack/duct wall to guard rails
- i) protruding objects/ equipment from stack wall
- j) tripping objects on deck
- k) harnesses, lanyards
- l) hookup devices
- m) climbing devices
- n) davits, hoisting devices
- o) upper guard rails cut to allow movement of train, replacement rail, chains
- p) load bearing weight per square inch, total > 2000 pounds
- q) minimum width 3-4 feet

### 2. scaffolding

### 3. man lifts

- 4. respiratory protection, organic and inorganic vapors, acid gases, mists, particulates, concentrations, air purifying, air line , SCBA , half and full face masks
- 5. eye protection - safety glass, goggles, face shields
- 6. hearing protection
- 7. heat and cold protection
- 8. gloves, chemical - acid, base, organic i.e. MeCl<sub>2</sub>, toluene, etc.  
climbing, heat protection, cold protection
- 9. recovery area ventilation - solvent fumes



10. decontamination shower, etc.
11. flat roof work area, hook up devices, guard rails, pitch of work surface, hoisting devices
12. liquid puddles on floor, corrosive, organic
13. steam vents
14. electric power from facility mains
15. high temperature sources
16. positive pressure sampling locations
17. over head obstructions
18. body protection
19. radios- hazard due to activation of facility equipment
20. safety boots- steel toe, metatars
21. facility safety rules and emergency procedures
22. safety hats
23. facility first aid representative, location of first aid station(s), local hospital, local doctor, ambulance
24. written health and safety plan, site specific
25. toxic hazards, gaseous, liquid , solids - MSDS sheets , other
26. site specific safety training required - local geographic area training required
27. OSHA 40 hour/8 hr refresher hazwoper and stack safety training courses
28. temporary scaffolds - height, wire bracing, footings, cross bracing, diagonal bracing, guard rails, toe boards, safety screen around upper platform, load bearing planks, - wood, steel, plastic grid as per OSHA 1910.
29. sampling ports - proper height above platform etc, need for power wrenches to open work/safety permits/lockout tag out requirements
30. tool box and tools - tie off, not loose
31. confined space
32. intrinsically safe electric equipment
33. portable ladders
34. CEMS calibration and GC gases, storage on site.



# APPENDIX G

## STA SAFETY BOOKLET

Written permission was obtained from the STA Administrator, Dave Curtis, for SES to append this booklet to our Safety Manual. Reproduction by others of the booklet (including SES members) must be obtained from STA. Dave Curtis/STA may be contacted at [Health.Safety@S-T-A.org](mailto:Health.Safety@S-T-A.org).

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**Version 9 - October 2006**

## 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

# 1. INTRODUCTION

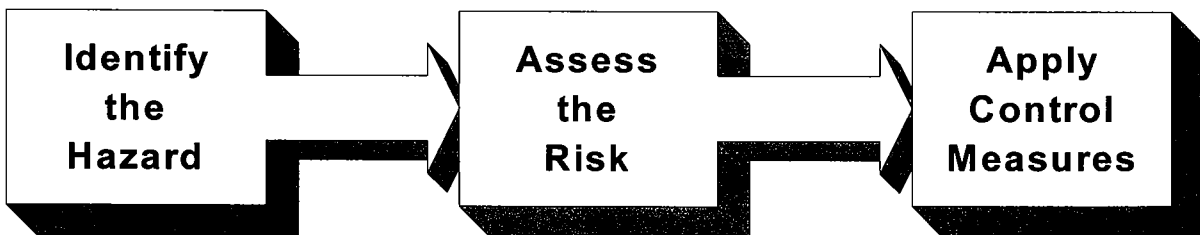
There are many hazards associated with carrying out a stack-emissions test in process industry. The basic principles of good health and safety practice must be applied. In particular, a risk assessment *must* be carried out before starting work. Keep the risk assessment in your job file – in the unfortunate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

<i>Hazard</i>	The substance's or physical situation's inherent <b>potential</b> to cause harm.
<i>Risk</i>	An estimation of the <b>likelihood</b> 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](http://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. In practice, you – as an MCERTS qualified stack technician - will be best placed to assess the risks to you and others during the monitoring work you do on site – don’t be tempted to leave the workplace risk assessment

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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.

to someone else. You must be competent to carry out the work risk assessment: for example, you have successfully completed 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 make the work risk assessment. Your work risk assessment will **not** be suitable and sufficient if you have not seen the employer's Platform Inspection Report.

### **...and When?**

For a new client a reconnaissance visit to the site 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 reconnaissance 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 work risk assessment has been completed and the control measures have been implemented to the satisfaction of the competent person carrying out the risk assessment (normally the monitoring Team Leader). The work 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, you should ask the Employer to show you the WAH Regulations Platform Inspection Report for the stack you will be working on. 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. Take the Platform Inspection Report into account when making your work risk assessment or your insurance cover could be invalidated. If no Platform Inspection Report is available for work at height, **do not proceed with the work.**

The STA recommends that when you have made your work risk assessment you 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 you have decided will be necessary. If the operator has any comments, you will wish to consider these and assess whether they can be incorporated into the assessment and its findings: they may reduce the risk further (which is fine), or hinder the reduction of risk (which is not).

Some of the control measures you require may need to be put in place by the operator. Get the operator's confirmation that these have been completed, before you start work.

When you have finished the site work, make any relevant comments on the work risk assessment based on any lessons learned. This will be useful for the next visit.

## **The Layout of this Booklet**

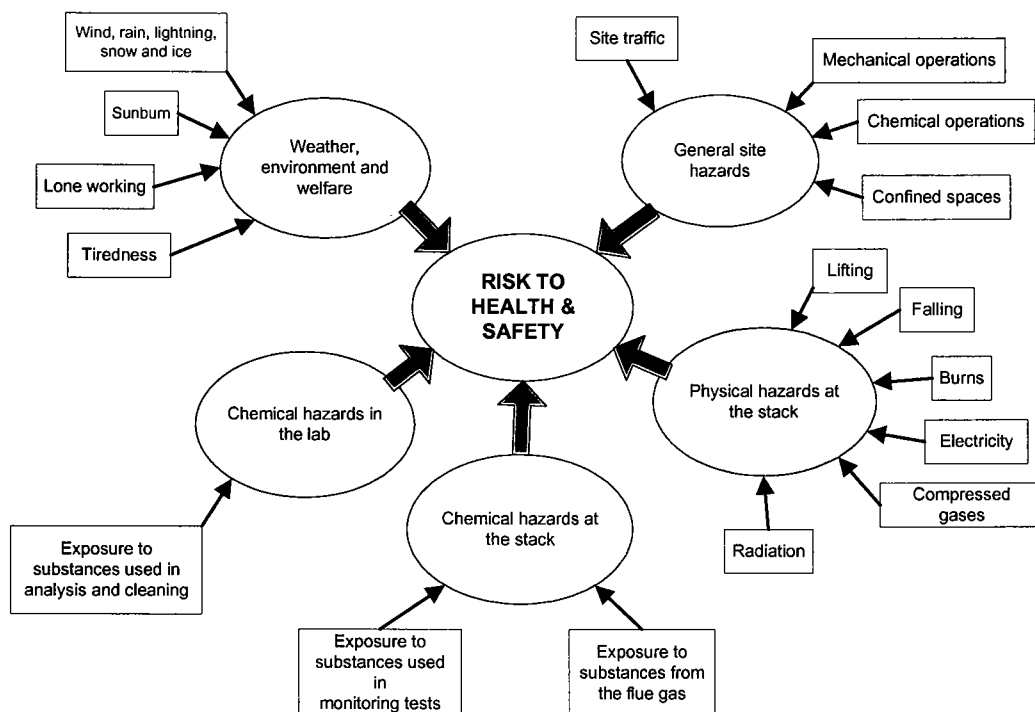
The following sections describe each of the most prominent hazards in turn, grouped together in five main categories:

- 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.

- Confined spaces

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.

- 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 must be generated. These will vary greatly between sites. It is essential that you fully understand the permit-to-work system, procedures for first aid, and emergency evacuation procedures for the ***site in question***. If you are unsure of any of these aspects, they must be clarified before starting work.

You 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.

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 working and have suitable control measures in place to reduce the risk to a low level.

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

### Further information

Management of Health and Safety at Work Regulations 1999.

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

Confined Space Regulations 1997

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

## 4. PHYSICAL HAZARDS AT THE STACK

### 4.1 Hazard: falls from heights

This is a very real hazard in stack testing. Fifty percent of accidental deaths in the construction industry are by falls from heights, and there have been several recent 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: *Platform Inspection*; *Working from Permanent and Temporary Elevated Work Platforms*; and *Working on Stacks Penetrating Roof Structures*.

Mobile access platforms and “cherry-pickers” are **not acceptable**. 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<sup>\*</sup> 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.

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<sup>\*</sup> A number of CEN standards have been drafted covering access and platforms and a British Standard exists covering permanent access.

Temporary platforms must be tied or supported to a permanent structure to prevent collapse or overturning. They 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 properly completed and dated “Scafftag” is one means of demonstrating and recording this inspection. Double-check yourself that the inspection tag is for the load category suitable for your 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<sub>2</sub> may require a more frequent and

thorough inspection than a low platform in a normal atmosphere.

Monitoring teams should 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<sup>\*</sup> 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.

There is also a practical requirement for the tops of handrails should be far enough below the centre line of the access holes / ports so that they do not interfere with the insertion and removal of the sampling apparatus. Though the 125 mm minimum quoted in standards is adequate for Pitots and simple sample probes, a clearance of 500 mm is required to allow access with more complex sampling trains having back-end sample collection.

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

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\* 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.

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

- ***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<sup>2</sup>. The minimum width at any point shall be 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, impingers, cold box) plus 1.0 m (whichever the greater). Where the details of sampling equipment are not known, or may change, the general 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 has advised us that the type suitable for use when carrying out lifting-up of equipment, etc. is a restraint harness. The STA is of the view 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 to our members outweighs the potential environmental benefits of the monitoring data and therefore 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 shall 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 will 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 may need to be made for emergency evacuation.

**Further information**

Environment Agency Technical Guidance Note M1, *Sampling Requirements for Monitoring Stack Emissions to air from Industrial Installations (2002)*

Work at Height Regulations 2005

The Workplace Regulations 1992

Safety in Construction HSG150 :1996

BS4211:1994 Specification for ladders for access to chimneys, other high structures, silos and bins'

BS EN 360:2002 Personal protective equipment against falls from a height, retractable type fall arresters.

BS 8437:2005 Code of practice for selection, use and maintenance for personal fall protection svstems and equipment for use in the workplace.

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 and protective footwear should be used. STA Guidance Note HSGN004 gives some further information on PPE.

### **Further information**

The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)

STA guidance HSGN008, *LOLER Regulations*

STA guidance HSGN009, *LOLER Inspection Reports*

Workplace Regulations 1992.

Health and Safety in Construction HSG150 gives guidance on small lifting equipment.

Personal Protective Equipment at Work Regulations 1992.

### **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.

### Further information

HSE INDG143 Rev 2 Getting to grips with Manual Handling

HSE INDG383 Manual Handling assessment charts

STA Guidance HSGN015, *Manual handling*

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.
- Have your electrical equipment 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. 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.

#### **Further information**

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

HSG150, *Health and Safety in Construction*

STA Guidance HSGN006, *Understanding Electrical Supplies*

HSE INDG231 *Electrical Safety and you* 1996

## **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 pipework/equipment, make sure the regulator and pipework are suitable for the type and pressure of gas being used.

### **Further information**

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

STA guidance HSGN003, *Gas Cylinder Guidance*

## **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 90dB(A) second action level or the Peak Action Level of 200 Pa (140 dB). The first action level of 85dB(A) 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.

### **Further Information**

HSE INDG362 Noise at Work Advice for Employees HSE 2002

HSE Reducing noise at work. Guidance on the Noise at Work Regulations 1989

HSE IND 363 Pocket Cards. Protect your hearing or lose it!

STA guidance HSGN013, *Protection against noise*

HSE INDG136 Rev 2 COSHH A brief guide to the regulations 2003

## **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 maximum exposure limit (MEL) or occupational exposure standard (OES).
- 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. Good seals 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.

- The sampling location may have a very 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 (see Section 3).
- 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<sub>2</sub> 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. This must **not** be subject to the BATNEEC principle, i.e. 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. For work as complex and high-risk as stack monitoring, this assessment should 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.

#### **Further information**

Personal Protective Equipment at Work Regulations 1992.

The Workplace Regulations 1992.

STA guidance HSGN002, *Chemical Exposure Risks During Stack Testing Operations*

STA guidance HSGN004, *Personal Protective Equipment*

HSE INDG136 Rev 2 COSHH A brief guide to the regulations 2003

## **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**

HSE IND136 Rev 2 COSHH : A brief guide to the regulations 2003

COSHH in Laboratories, Royal Society of Chemistry, 1996.

## **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 handling 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 cool drinks and salt tablets (or food rich in salt) 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 handling) 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, say, 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 (whereas the HSE states that Black and Asian workers are at almost no risk of skin cancer from sunlight)
- 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
- Avoid working in the 3 or 4 hours around mid day in summer when the sunlight is most intense.
- wear clothing covering exposed skin
- Use sunblock: this will give some protection – use an SPF rating of at least 15
- 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 use 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:

- Request shelter to be provided at the sampling location
- Do not work on platforms where dust can turn to mud. This is common at 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 should 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 number of clients and consultants stipulate a normal maximum of 10 hours with occasional maxima of 14 hours.
- 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. Some employers have stipulated that rest breaks of at least one-quarter of an hour should be taken every 2 hours during a drive.
- Design and cost the job to allow for the above

## 7.8 Hazard: lone working

It is most 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 Part B processes where lone working is acceptable. The STA has issued separate guidance on the hazards, risks and safety control measures for lone working, HSGN005.

### Further information

The Workplace (Health, Safety and Welfare) Regulations 1992 and accompanying ACOP

Management of Health and Safety at Work Regulations 1999

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

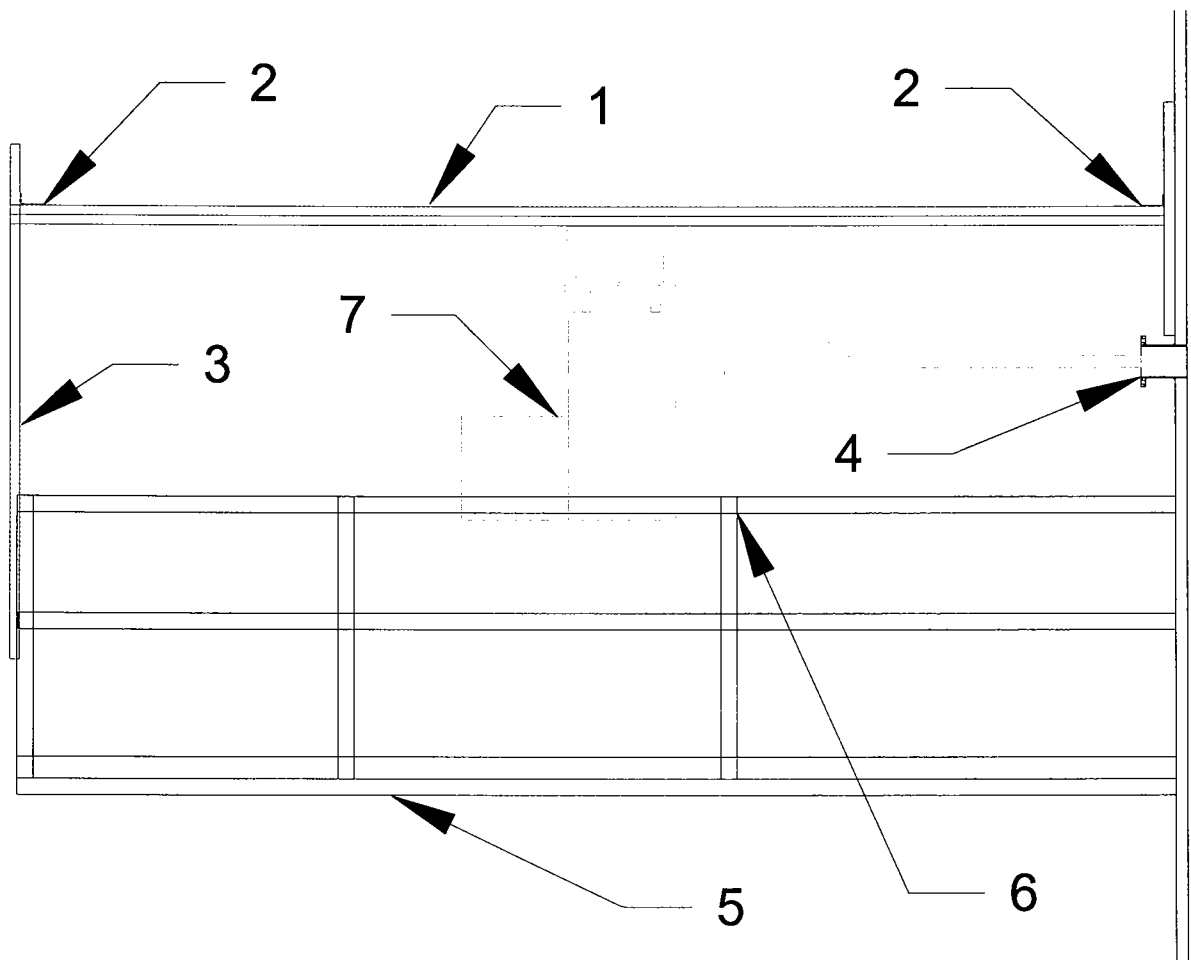
HSE INDG147Rev 1 *Keep Your Top On – Health Risks from Working in the Sun 1998*

STA guidance HSGN005, *Lone Working*

STA guidance HSGN018 *Lightning*

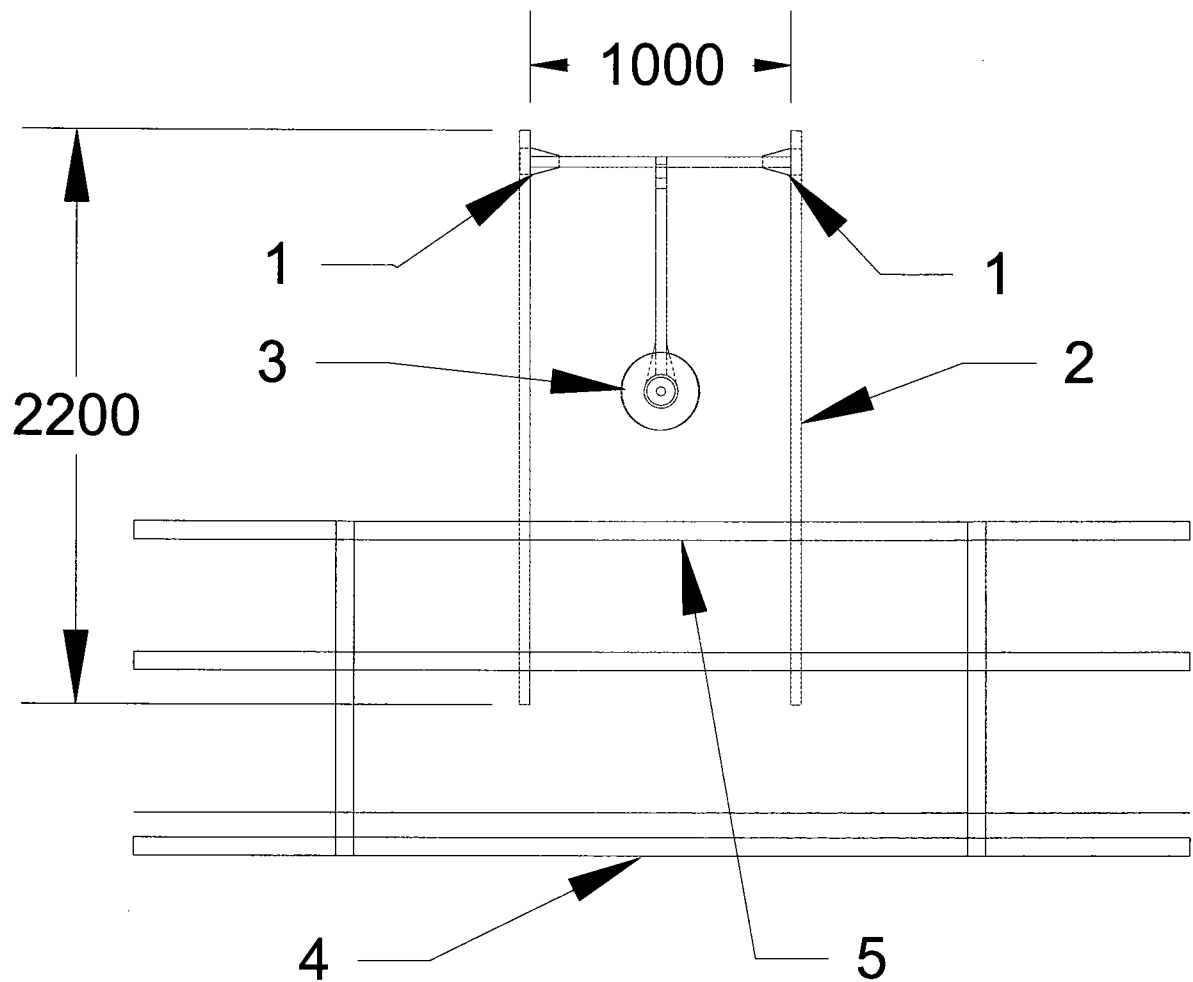
## APPENDIX

**Figure 1: Example of a monorail system**



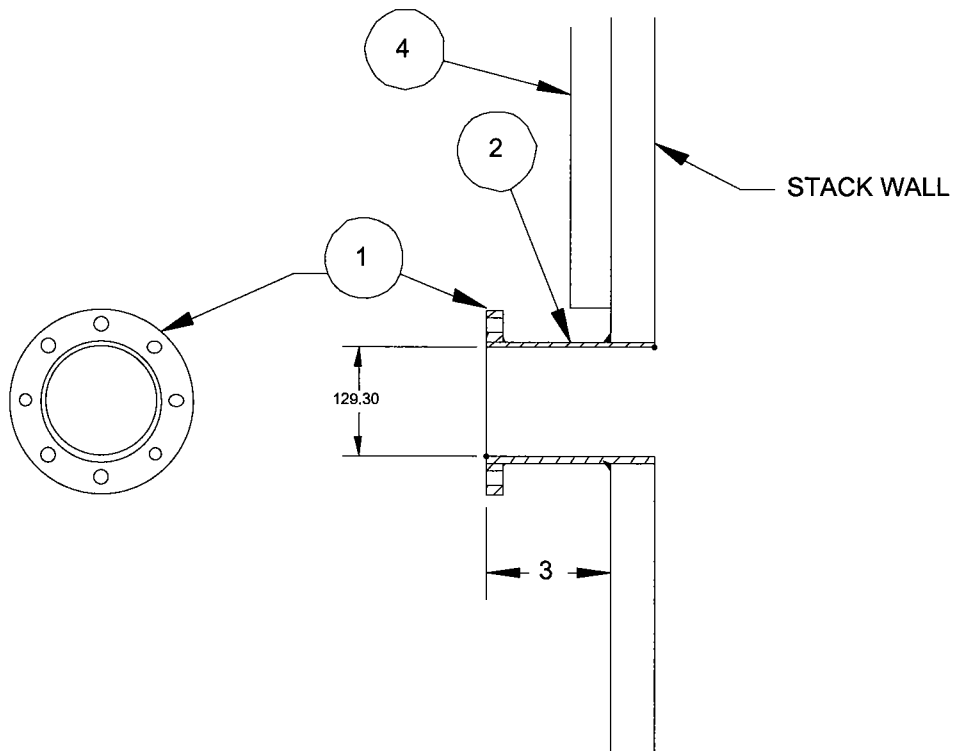
1. Monorail Unistrut P1001
2. L brackets Unistrut P2484
3. Unistrut H frame, refer figure 2
4. Standard 125 mm sample port, refer figure 3
5. Sampling platform, refer Environment Agency Guidance Note M1
6. Platform hand rail
7. Example of sample train

**Figure 2: Monorail end view**



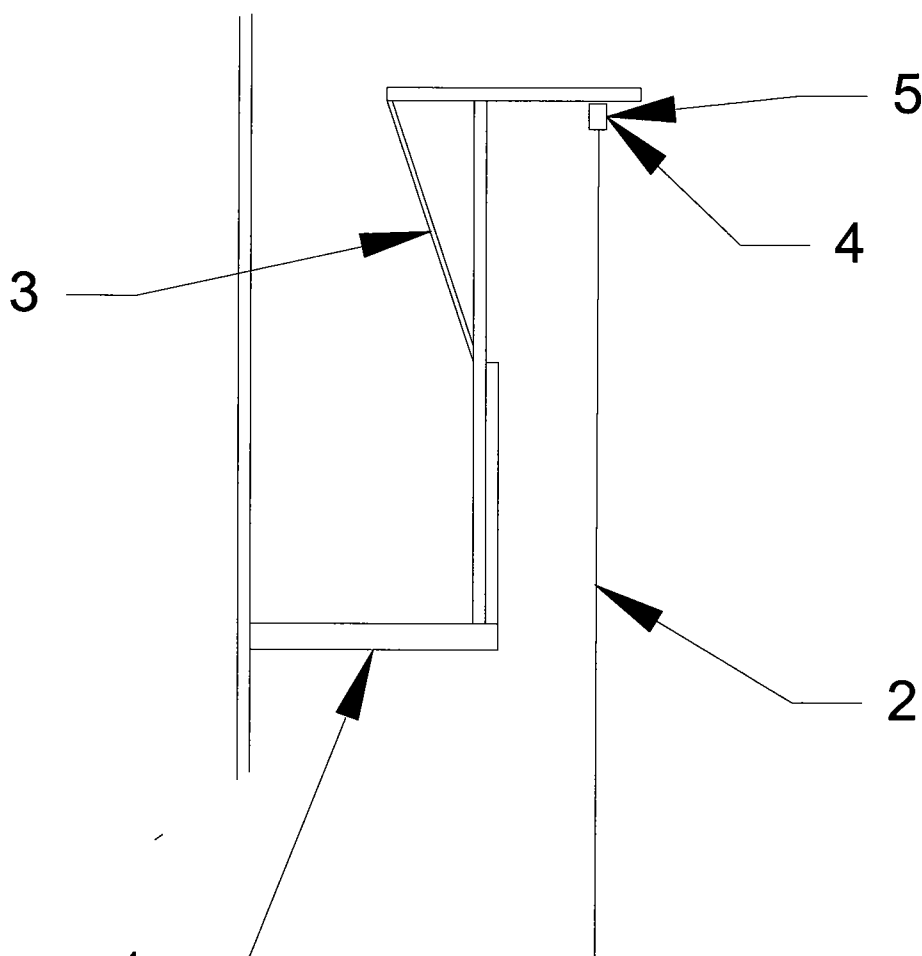
1. Bracket Unistrut P1358
2. Unistrut P1000
3. Standard sample port, refer figure 3
4. Sampling platform, refer Environment Agency Guidance Note M1
5. Platform hand rail

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.



# APPENDIX H

## NIOSH POCKET GUIDE TO CHEMICAL HAZARDS

This pocket guide will be found in a separate folder on the Safety Manual CD.