M505
Control of Hazardous Substances

Day 1

Site Emergency Procedures

(insert relevant information)

Lecturer(s) Background

(insert relevant information)

Ice Breaker Session

Insert suitable picture here to portray communication between students

Course Aim

To provide an introduction to the methodologies & technology available to control workplace exposures & reduce risk to health from exposure to hazardous substances

Course Learning Outcomes

- **Participants will be able to:**
  - **Describe the means by which contaminants are generated by typical processes**
  - **Recognise the range of approaches to workplace control & understand the importance of the hierarchy of control**
  - **Discuss the importance of design considerations as a means of reducing occupational exposures**

Course Learning Outcomes (cont)

- **Participants will be able to:**
  - **Describe the principle elements of ventilation systems**
  - **Perform the necessary measurements to ensure ventilation systems are operating effectively**
  - **Describe the principles of personal protective equipment including limitations and the elements of an effective programme**

What is Required to Complete this Course

- **Ask questions as we go through the notes**
- **Participate in the case study discussions**
- **Participate in the practical exercises**
- **Attempt the questions each night**

What is Required to Complete this Course (cont)

- **There are evening revision questions each day. These will be discussed at the start of the following morning**
- **Mock examination (evening of day 4)**
- **Practical assessment (day 5)**

Today’s Topics

- **Workplace control principles**
- **Designing control strategies**
- **Understanding sources of contaminants**
- **Process design & principles**

Workplace Control Principles

Key Elements of Occupational Hygiene

- Anticipation
- Recognition
- Evaluation
- Control

What is Control?

- **Control is a process of conception, education, design and implementation of beneficial interventions and changes carried out that eliminate, decrease or downgrade hazardous conditions**

What Does Control Involve?

- **Control involves changes to an operation or process to reduce exposure to a hazardous substance**

- **The changes may involve substitution, technological changes, process modification, ventilation, the use of personal protective equipment and procedural or administrative changes**

Reasons for Control

The primary reasons and objectives for control of hazardous substances include

- **Protect the workers health from exposure to substances**
- **Protect the workers comfort**
- **Comply with exposure standards**

Is the Worker Protected?

Source: R Alesbury – Reproduced with permission

Decisions about Control Options

- **Need to fully understand all the risks & how workers may be exposed before attempting control options**
- **Need to find out exactly what is causing the exposure**
- **How is the substance coming into contact with workers - consider all routes**

Decisions about Control Options (cont)

Example:

Emptying a bag of powder into a hopper

- **Tempting to just control airborne exposure from bag emptying**
- **Is this all that should be considered?**

What are The Risks of Exposure?

Source: BP International Ltd

What Else Needs to be Considered?

- **Other sources**
  - **Handling of empty bags to reduce bulk can generate significant clouds of dust**
- **Other issues**
  - **Is skin contact an issue?**
  - **Is RPE in use & is it appropriate for contaminant?**
  - **Is the thermal environment an issue?**
  - **Are there any ergonomic issues?**

When Evaluating a Situation (cont)

It is only after you have a full understanding of the issues will you have a chance of implementing a successful control strategy

Remember: your most important tools in developing a successful control strategy are your eyes & ears

When Evaluating a Situation

- **Look at what is happening**
  - **How does the process operate?**
  - **What do the workers actually do?**

- **Look for unexpected or other tasks**
  - **Periodic cleaning or maintenance**
  - **Opening containment vessels for inspections**

When Evaluating a Situation (cont)

- Look at the way the contaminants are generated
  - Leakage, handling of empty containers
  - Machinery movement causing dust or vapour clouds
  - Cross drafts
- Don’t forget the potential impact of skin contact
  - Direct handling or indirectly (contaminated clothing)

When Evaluating a Situation (cont)

- Can contaminated clothing be taken home?
  - Families of workers developing mesothelioma
- Personal hygiene habits
  - Wash hands before eating & drinking
  - Lead contamination of smoking materials
- Cleanliness of area
  - Are solvents used for cleaning?
  - Dry brushing in dusty industries

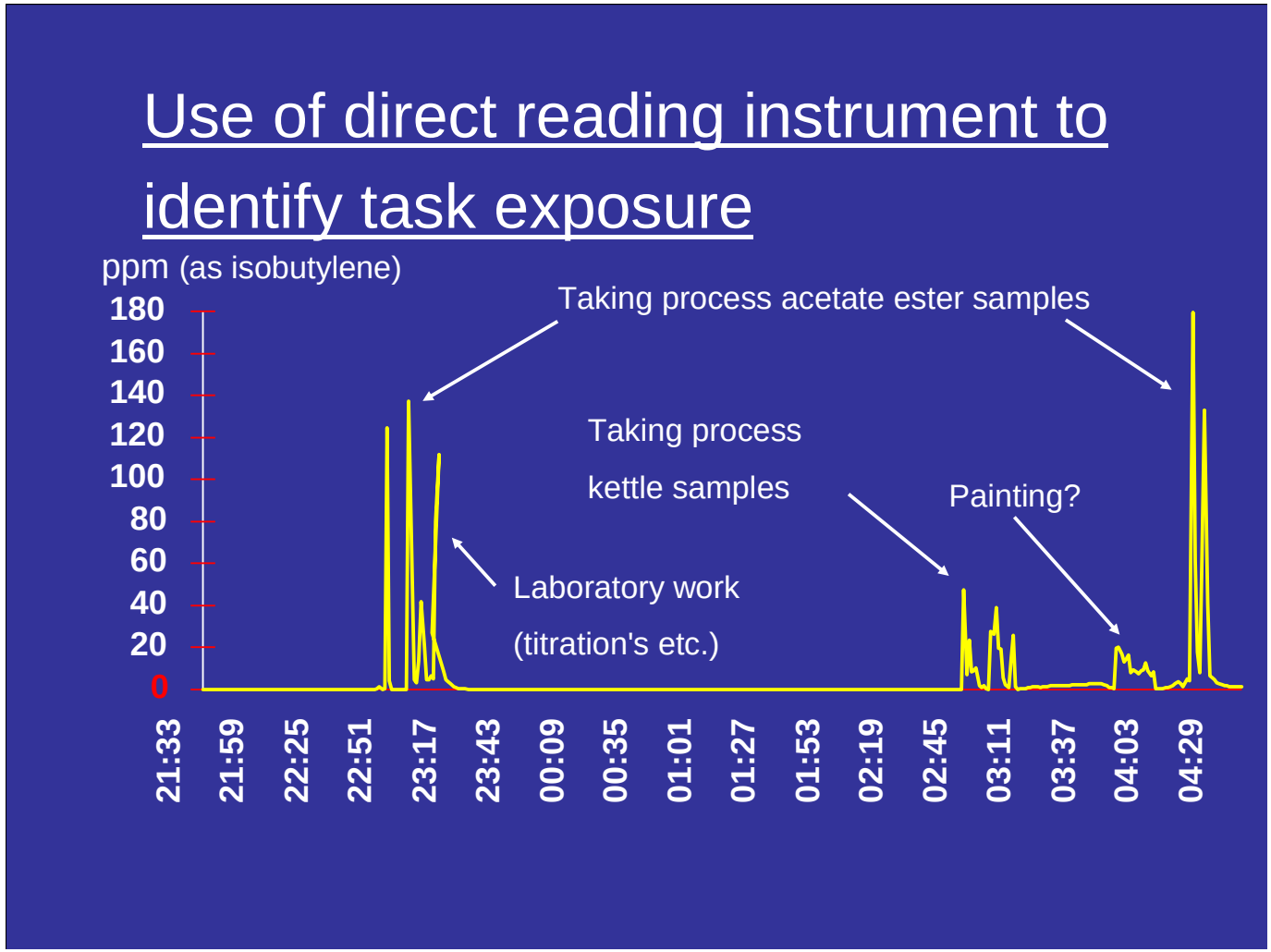
When Evaluating a Situation (cont)

- **Listen to what the workers involved in the process are saying**
- **Not all comments are necessarily valid but can help identify issues**
- **As many control measures require use by workers so it is vital they are involved in discussing control options**
- **Be objective - check facts via observation & measurement**

When Evaluating a Situation (cont)

- **Use survey equipment & monitoring to help characterise the problem**
- **Use dust lamps or direct reading instruments to help identify sources of emissions**
- **Personal monitors with data logging can be used alongside an activities log to identify causes of peak exposures**

Direct Reading Monitor Readout



Source: G Wilcox, BP Chemicals Ltd.

When Developing a Control Strategy

- **Don’t be afraid to try out ideas with pilot schemes before committing to a strategy**

- **If enclosure is a possible strategy consider making a mock up out of cardboard etc. to see if it will work and it does not interfere with operations**

When Developing a Control Strategy (cont)

Don’t consider the job finished until satisfactory control has been demonstrated and a strategy is in place for the regular testing, maintenance & review of the control measure in line with any good management system (e.g. OHSAS 18001)

Steps to Control

- **Review the risk assessment**
- **Review control strategies from similar operations**
- **Stop, look & listen**
- **Look at options for control**
- **Effectiveness of chosen option**

Step 1: Review the Risk Assessment

- Should be based on a RA of the work & process
- Have a full understanding of the nature of the hazards posed by work
- Establish the range of substances used, generated or by-products
- Look for routes of entry
- Look for other hazards that may complicate the control approach

Step 2: Review Control Strategies from Similar Operations

- Is this a typical process for this industry?
- Is information available for control options?
- Do other sites within the organisation have similar issues?
- Can suppliers help?
- Important to ensure that the control measures are appropriate to the situation under review

Step 3: Stop, Look & Listen

- Spend time getting to know the workers & supervisors
- Understand the process
- Try to characterise particular tasks against exposure profiles
- Establish what is practical & will be used by the workers

Step 4: Look at Options for Control

- What are all the hazards & what may ensure their control
- Use the hierarchy of control to select options
- Consider that for effective control it may be necessary to use more than one option. For particular environments it may be necessary to build in redundant layers of protection

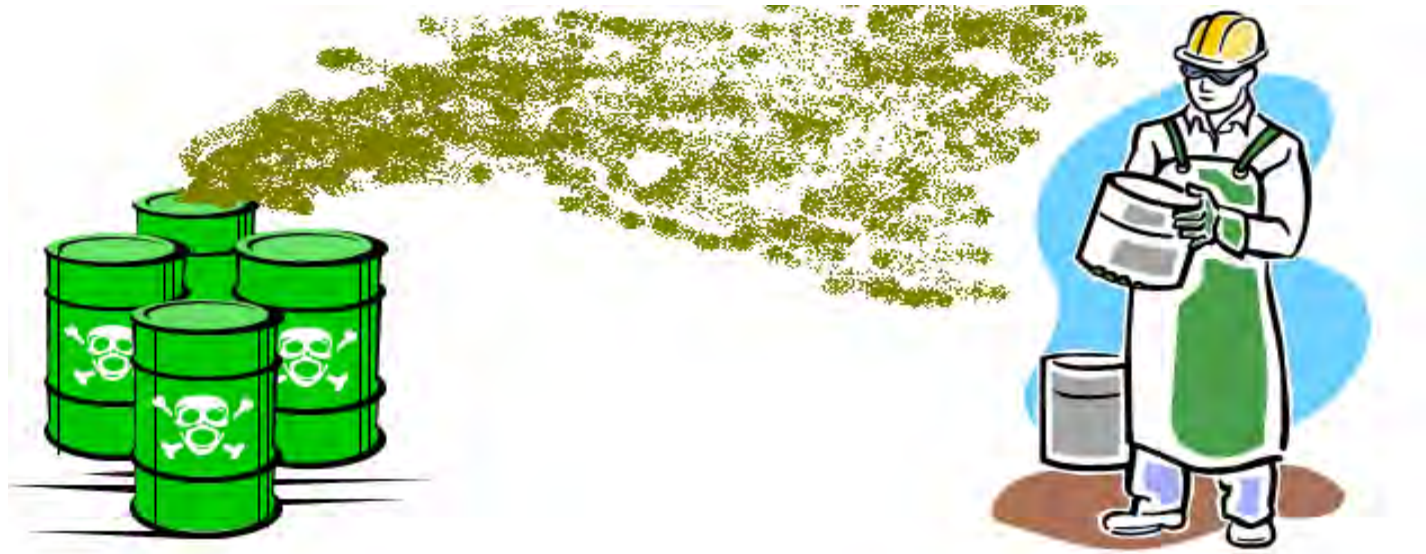
Step 5: Effectiveness of Chosen Option

- **Periodic reassessment**
- **Exposure monitoring (if appropriate)**

Control Challenges

- Most common challenge is cost constraints
- In many cases good control can bring direct financial benefits
  - Keeping a valuable product within the process so it is marketable is a better cost option than having it wasted as a fugitive emission
- Need to take a holistic view approach when considering the most cost effective control option

THE HIERARCHY OF CONTROL



Source Path Worker

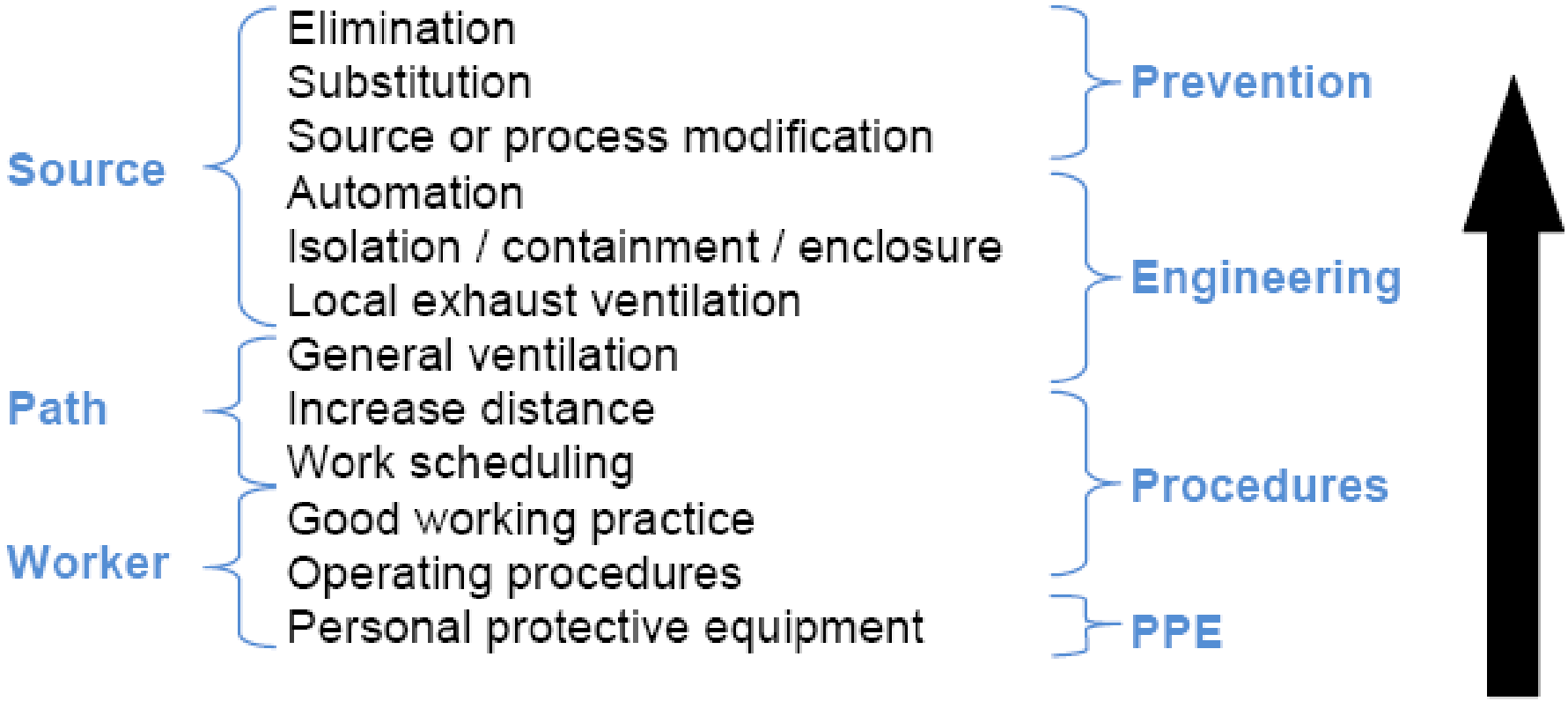
Source: Diamond Environmental Ltd-reproduced with permission

Group Exercise

List the controls that can be applied:

- **At source**
- **Along the pathway**
- **At the worker**

Hierarchy of Control



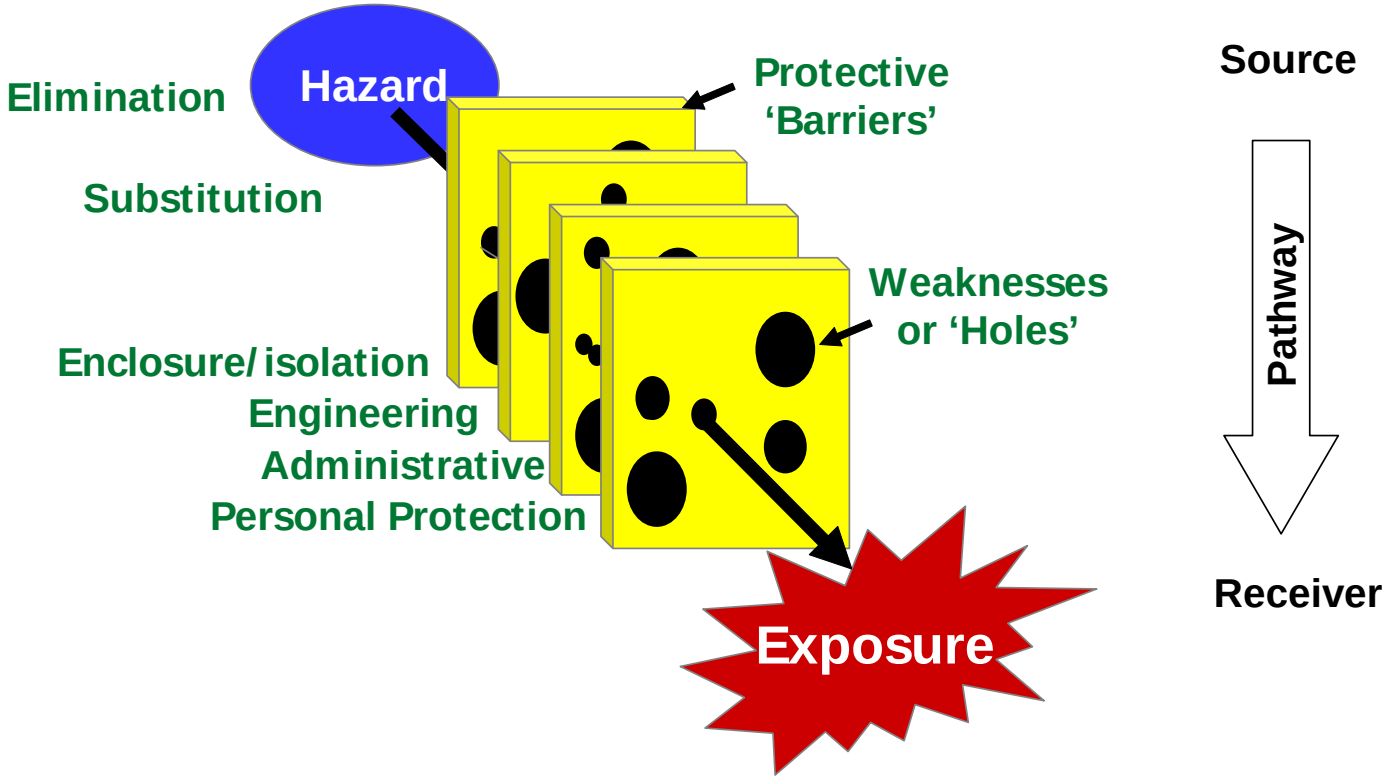
Key Elements of the Hierarchy of Control

- **Elimination**
- **Substitution**
- **Modification**
- **Containment**
- **Automation**

Key Elements of the Hierarchy of Control (cont)

- Isolation
- Ventilation
- Procedural controls (Administration)
- Personal protective Equipment

Using a Combination of Controls or The "Swiss Cheese" Model



Source: BP International Ltd

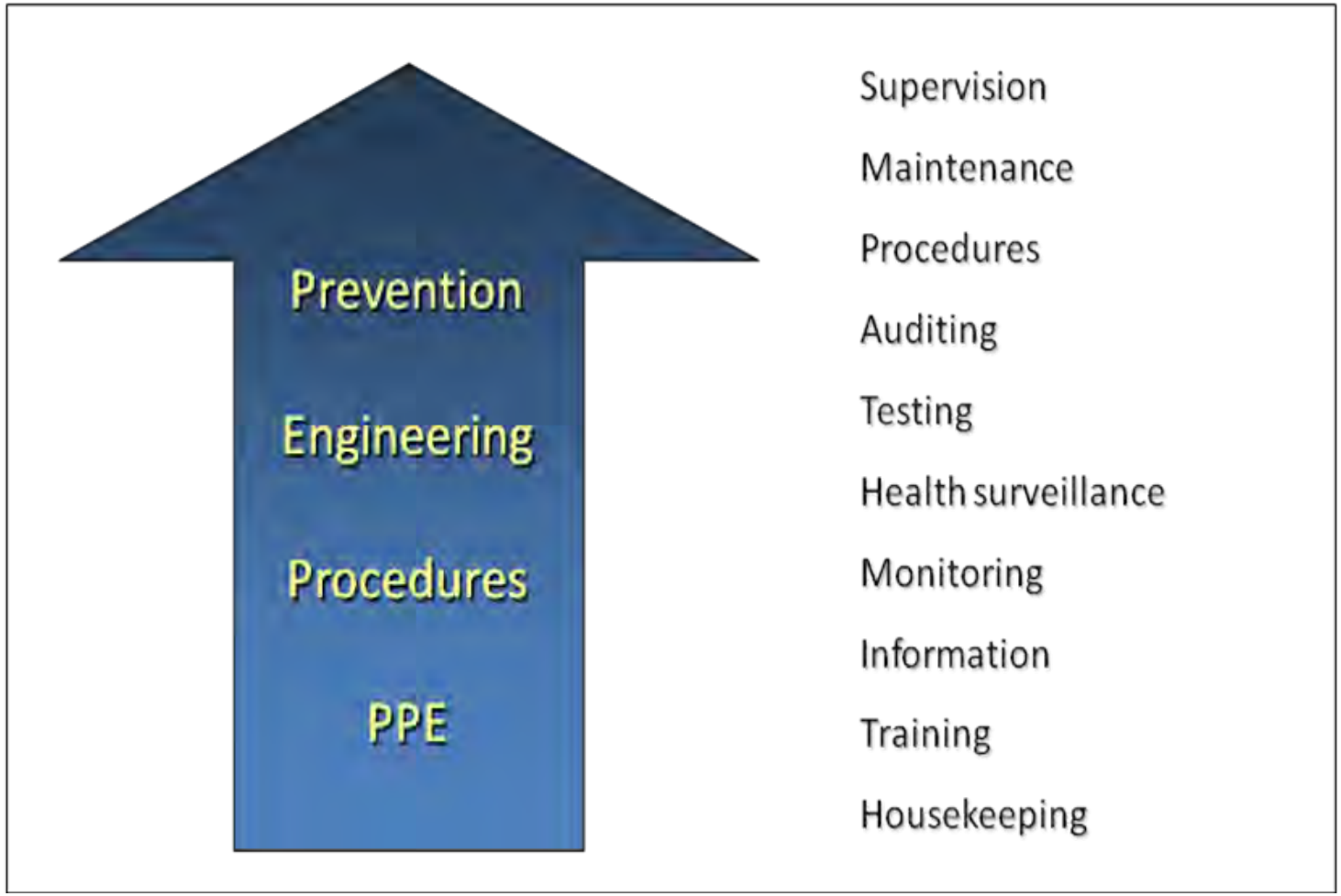
Example - Sand Blasting

Source: University of Wollongong

Sandblasting

- **Substitution**
- **Isolation / Enclosure**
- **Local exhaust ventilation**
- **PPE**

Managing Controls



Source: Diamond Environmental Ltd - *reproduced with permission*

Be Aware of the Unexpected

Source: BP International Ltd

Make Sure Controls Are Used As Intended

Source: Roger Alesbury – Reproduced with permission

The Health & Safety Management Cycle

Source: BP International Ltd

Close the Loop

- **Ensure training in all control measures is carried out**
- **Ensure controls are maintained & examined regularly**
- **Check effectiveness by periodic reassessment**

Designing Control Strategies

Class Exercise

What information would you need in order to decide on an appropriate control strategy ?

Factors to Consider When Designing Control Strategies

The hazard and the extent of the risk it poses

The practicality of various controls

The efficiency of different controls

Factors to Consider When Designing Control Strategies (cont)

- The consequences of failure of controls
- The relative costs of providing, operating and maintaining controls
- The acceptability by the workforce

Significant or Not Significant?

Not significant – unlikely to result in adverse affects to health of workers

Significant risk – likely adverse health effects. This is usually due to:

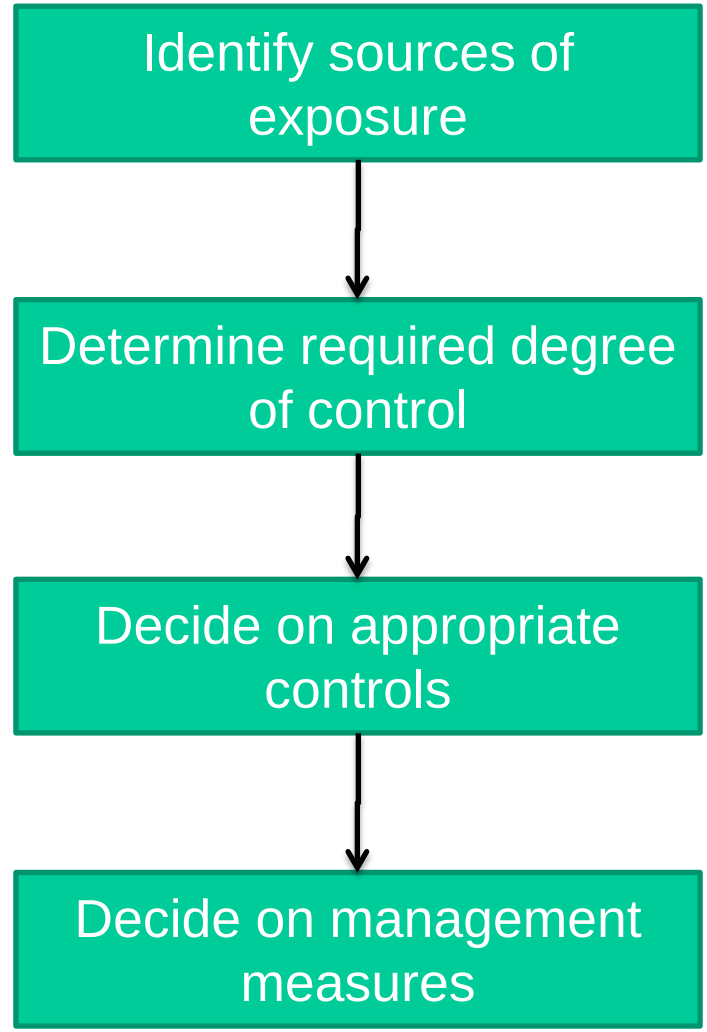
- **High exposure**
- **Substance is highly toxic**
- **Dangerous reactions with other substances can occur**
- **Leaks and spills are possible**

Significant Risks – What next?

Take actions to control risk:

- **Identify potential controls**
- **Evaluate the options**
- **Develop the control technology**
- **Implement the control**
- **Maintain the control**
- **Further actions (health surveillance)**

A Structured Approach



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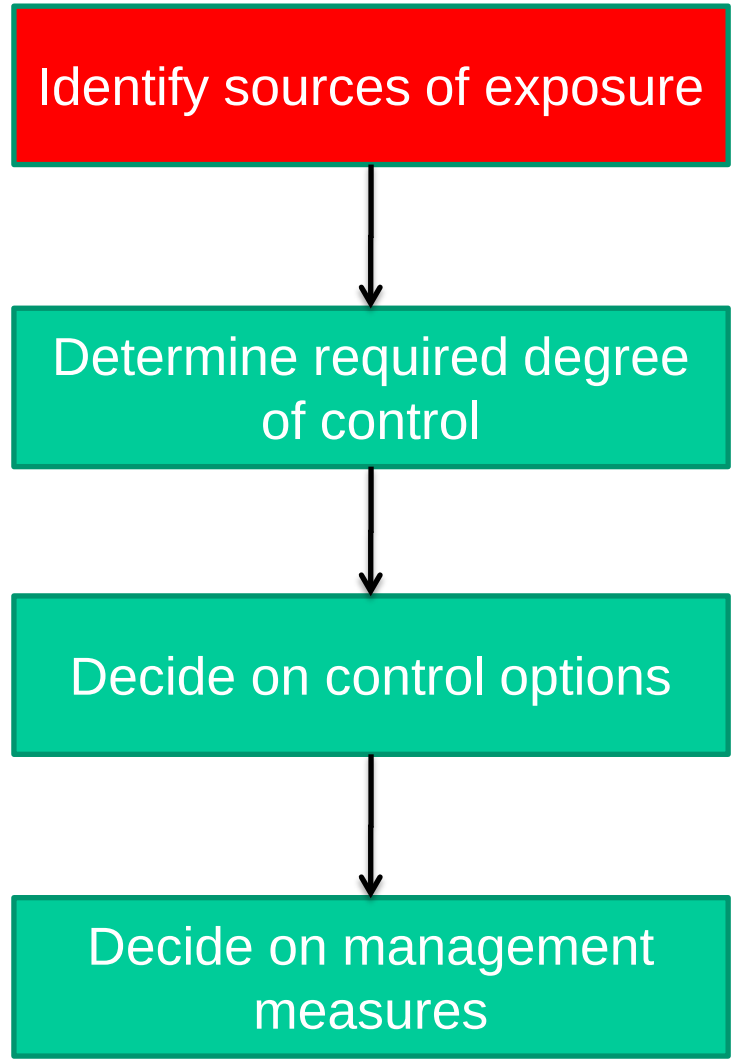
A Structured Approach (cont)



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Primary and Secondary Sources

- **Primary Source**

  Main source of exposure and originates at the process

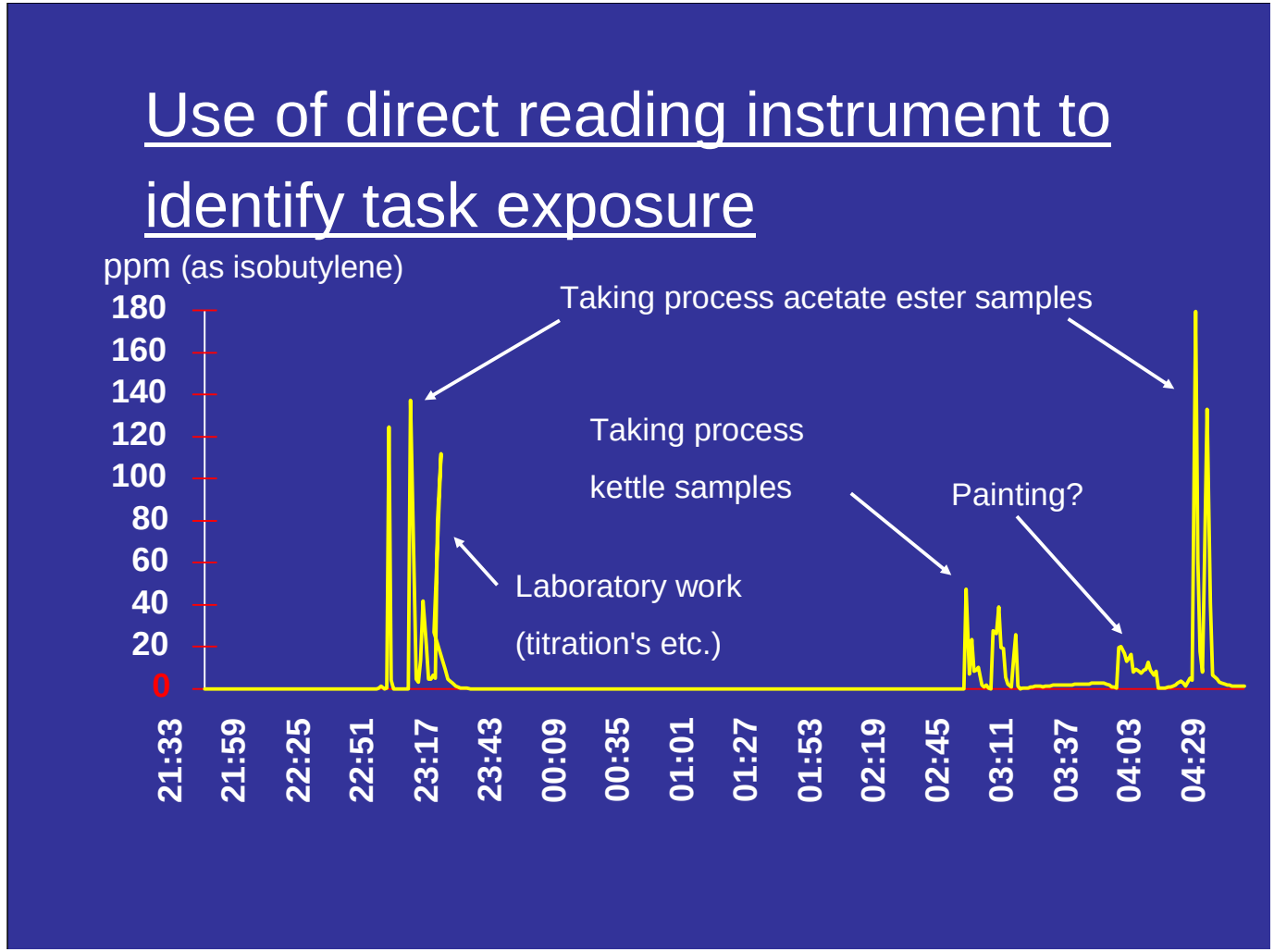
- **Secondary Source**

  Originates from contamination by the primary source

Primary & Secondary Sources

Source: BP International Ltd

Direct Reading Monitor Readout



Source: G Wilcox, BP Chemicals Ltd.

Uncontrolled Sources

- **Contribute a significant amount of exposure**
- **Can be additive**
- **Exposure by inhalation, skin absorption, ingestion**

Example- Uncontrolled Sources in Paint Factory

- Open drums of paint or solvent
- Open containers of cleaning solvents
- Discarded ‘empty’ containers
- Residual solvents on rags for cleaning

Identifying Sources

- Observations
- Discussions with workers / supervisors
- Visualisation techniques
- Direct reading instruments

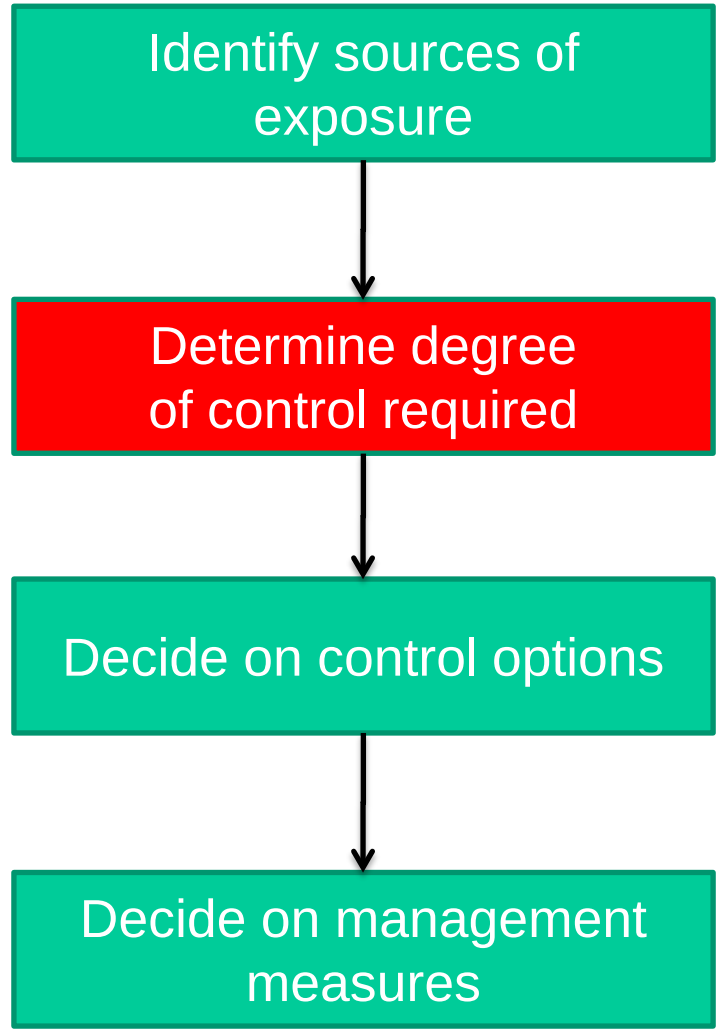
Don’t Jump To Quick Decisions

What you think may be present

What’s actually there

Source: HSE- reproduced with permission

A Structured Approach (cont)



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Adequate Control

Achieved when exposure is kept below an appropriate exposure level

Occupational Exposure Limits

- **Limitations to complying with OELs**
- **Inhalation is not the only route of exposure although most OELs only apply to airborne contaminants**
- **All routes of exposure must be controlled**

Occupational Exposure Limits (cont)

- **OEL’s not available for all chemicals**
- **OEL’s are for limited time only – ie 8 hour day per 40 hour week, and apply to nearly all workers**
- **Not absolute standards but regularly used this way**

Process Evaluation

A complete understanding of the contaminant and its health effects is necessary

- **Are short term exposures of concern?**
- **Does the substance have a STEL?**

Process Evaluation (cont)

Crystalline silica - no short term health effects but severe long term effects

Toluene – have STEL's and short high exposure can cause CNS damage

Applying OEL's - Belt Splicing

Process	Exposure (ppm)	Duration (mins)
Background/General	20	3 2 5
Gluing	80	7 x 10 minutes
Cleanup	160	15
TWA_{8hr} exposure of operator	30	

Toluene: ES 50ppm, STEL 150ppm

TWA_{8hr} is 30ppm, under ES of 50ppm,

Cleanup process 15 min, 160ppm – over the STEL, therefore control required

Applying OEL's - Coatings & Inks

Process	Exposure (mg/m^3)	Duration (mins)
General duties/background	5	420
Loading n-Butyl acrylate into system	40	5
Cleanup	60	10

n-Butyl Acrylate – TWA 5mg/m^3 & STEL 26 mg/m^3

Applying OEL's - Coatings & Inks

TWA = 6 mg/m3

If the exposure from the cleanup is reduced from 60 to 15mg/m^3 TWA is 5.1mg/m^3

If the general duties exposure is reduced from 5 to 3mg/m^3 then TWA is 4.3 mg/m^3

However the STEL during cleanup 41.7mg/m^3 so controls are still required

In-house Standards

- **Some larger/multinational companies have their own in-house standards of what they are willing to accept as adequate**
- **This allows one standard across many countries**
- **Often involves the use of statistics to determine if a measured exposure is acceptable or not**

Biological Exposure Standards

- **Biological monitoring determines exposure from all routes of entry**
- **Employee resistance**
- **Not a straightforward process**
- **BEI’s (ACGIH) correlate to inhalation exposure (ie TLV) only and if other exposure routes results will be higher**

Action if No Limits Set

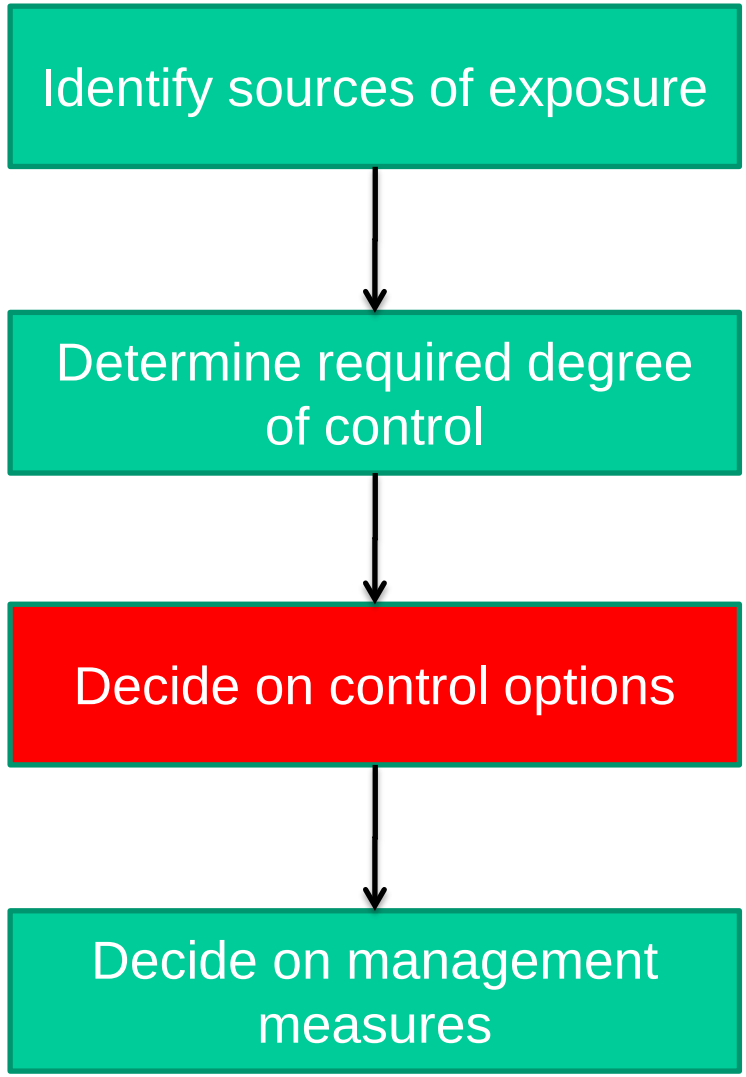
- Supplier's advice
- In-house limit
- Control banding
- Professional judgement

Professional Judgement - High Risk

Source: University of Wollongong

Professional Judgement – Negligible Risk

A Structured Approach (cont)



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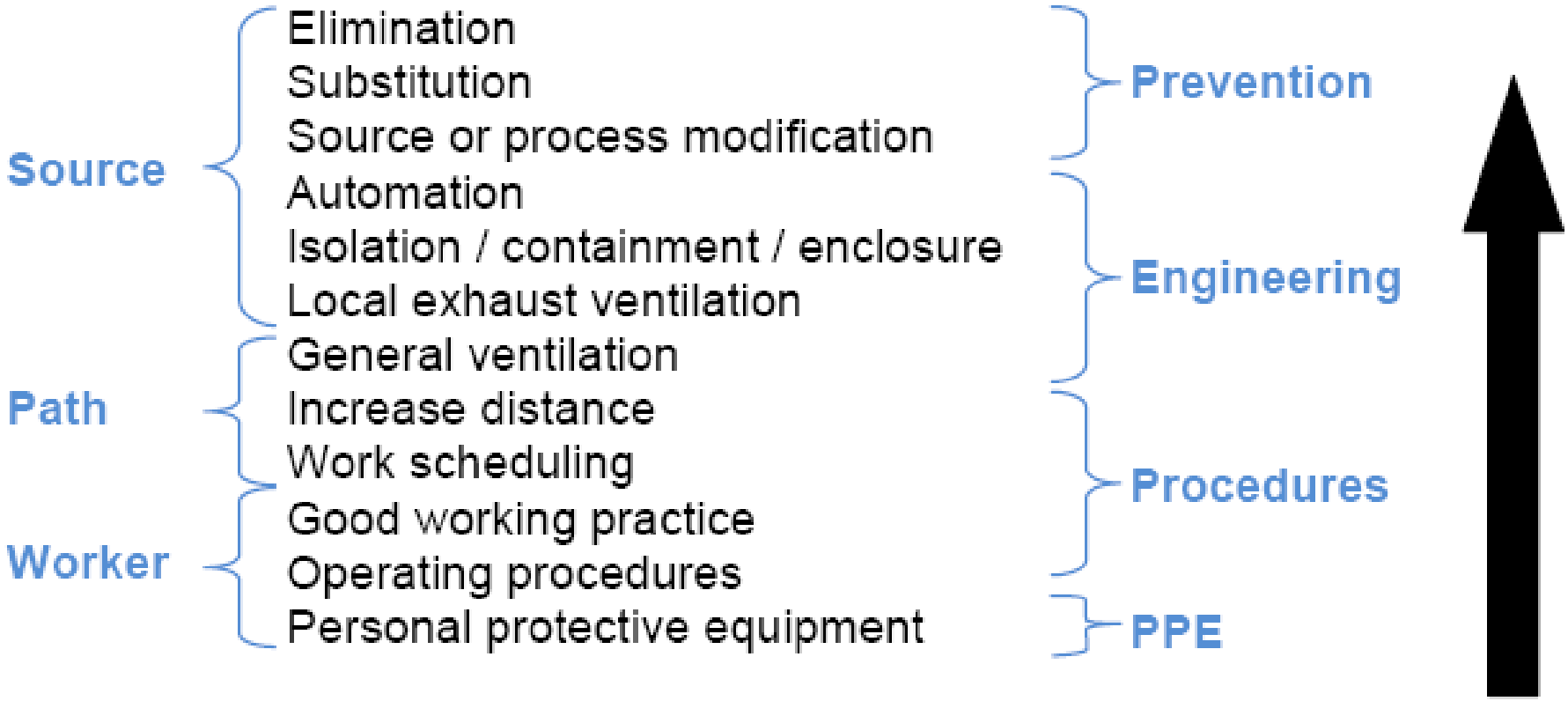
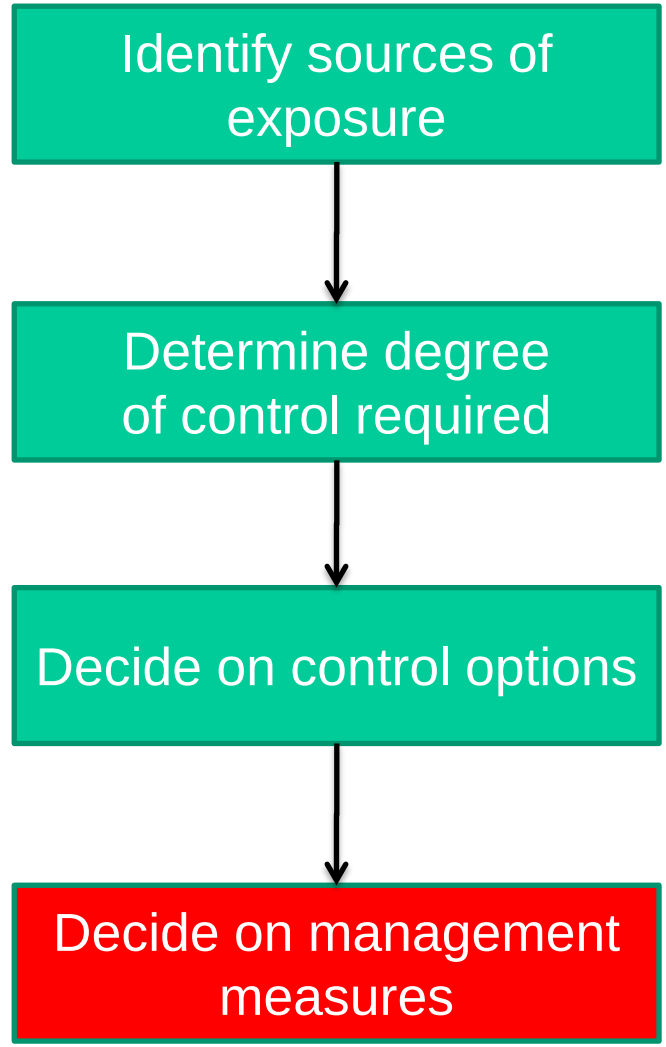
Hierarchy of Control



Influencing Factors

- **Practicability of installation of control**
- **Ergonomic issues**
- **Budget constraints**
- **Control of one issue doesn’t create another**

A Structured Approach (cont)



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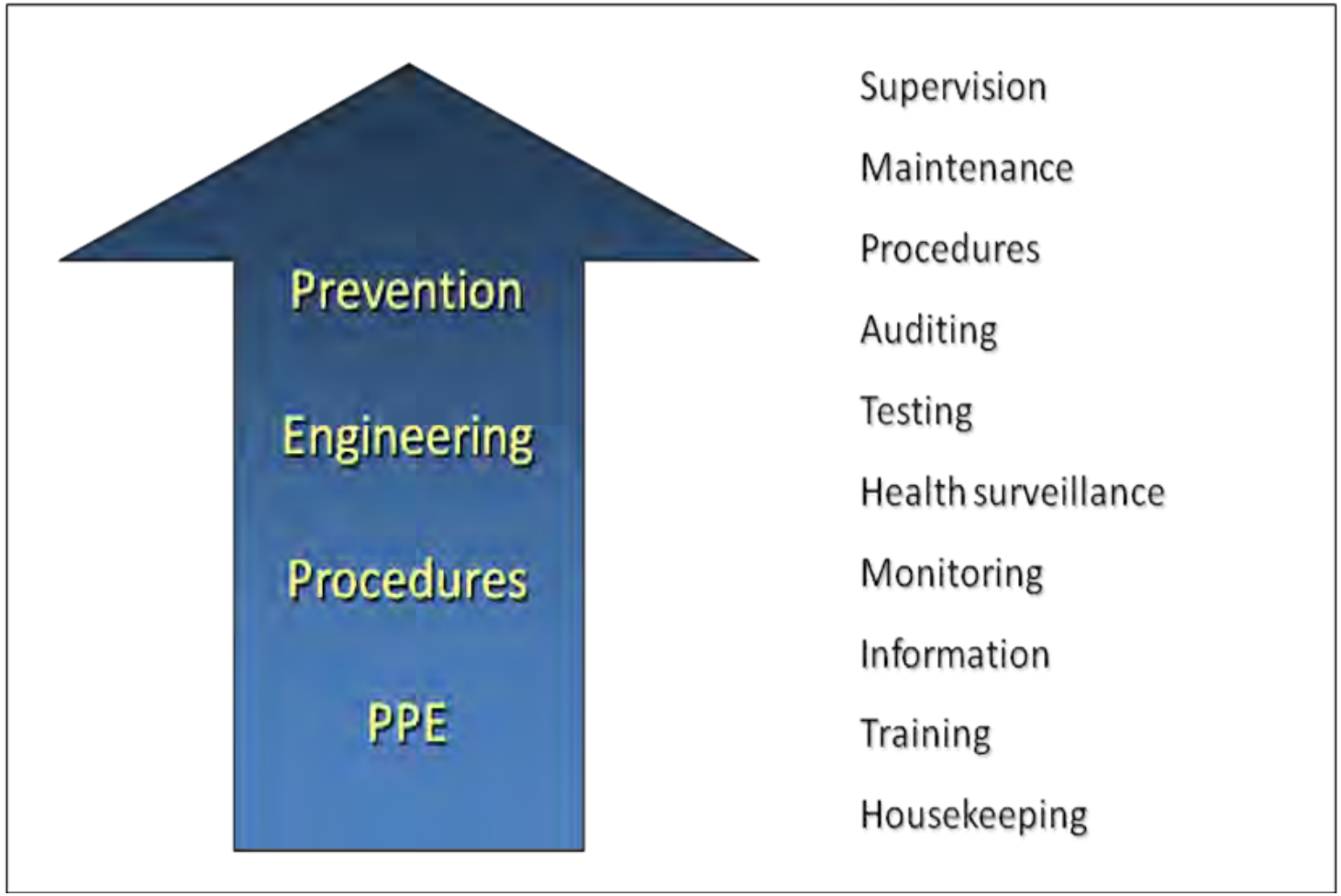
Managing Controls



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Control Banding

- **Simplified approach to selecting control measures**
- **Classifies controls into a few bands based on how far they reduce exposure**
- **Can be used when there are no OELs, called “Hazard Banding” – Pharmaceutical Industry**
- **Existing OEL – “Performance-Based OEL Banding”**

Hazard Banding (Pharmaceutical Industry)

- **Compounds assigned to Occupational Hazard Category (OHC) based on:**
  - **Potency**
  - **Pharmacological**
  - **Toxicological effects of active pharmaceutical ingredient**
- **Each category corresponds to a range of exposures likely to be ‘safe’**

Hazard Banding (cont)

- **Different schemes for different pharmaceutical companies**
- **Potential exposure assessed, including nature of process, volume of material handled, physical form and dustiness**
- **Define OHC and exposure assessment then determine the Exposure Control Approach (ECA)**

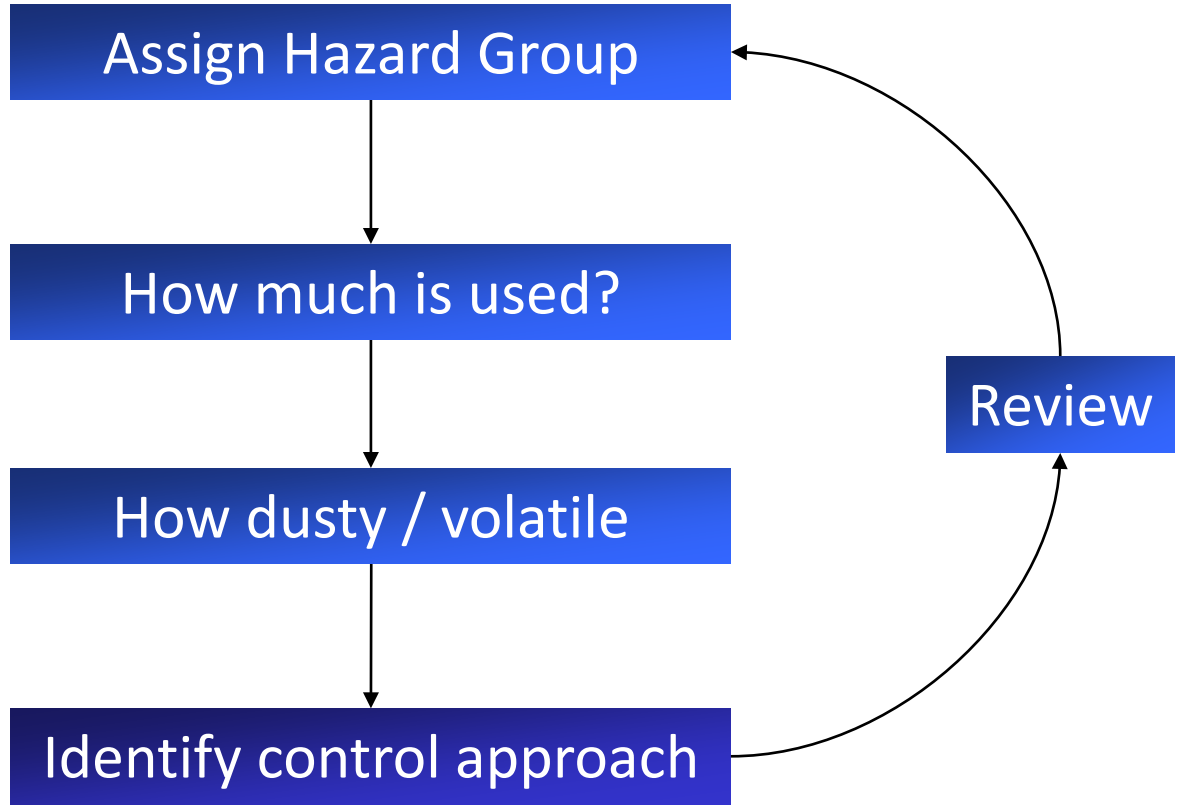
Hazard Banding Example

	Performance Band (µg/m³)
1	>1000 - ≤5000
2	>100 - ≤1000
3	>10 - ≤100
4	>1 - ≤10
5	≤1

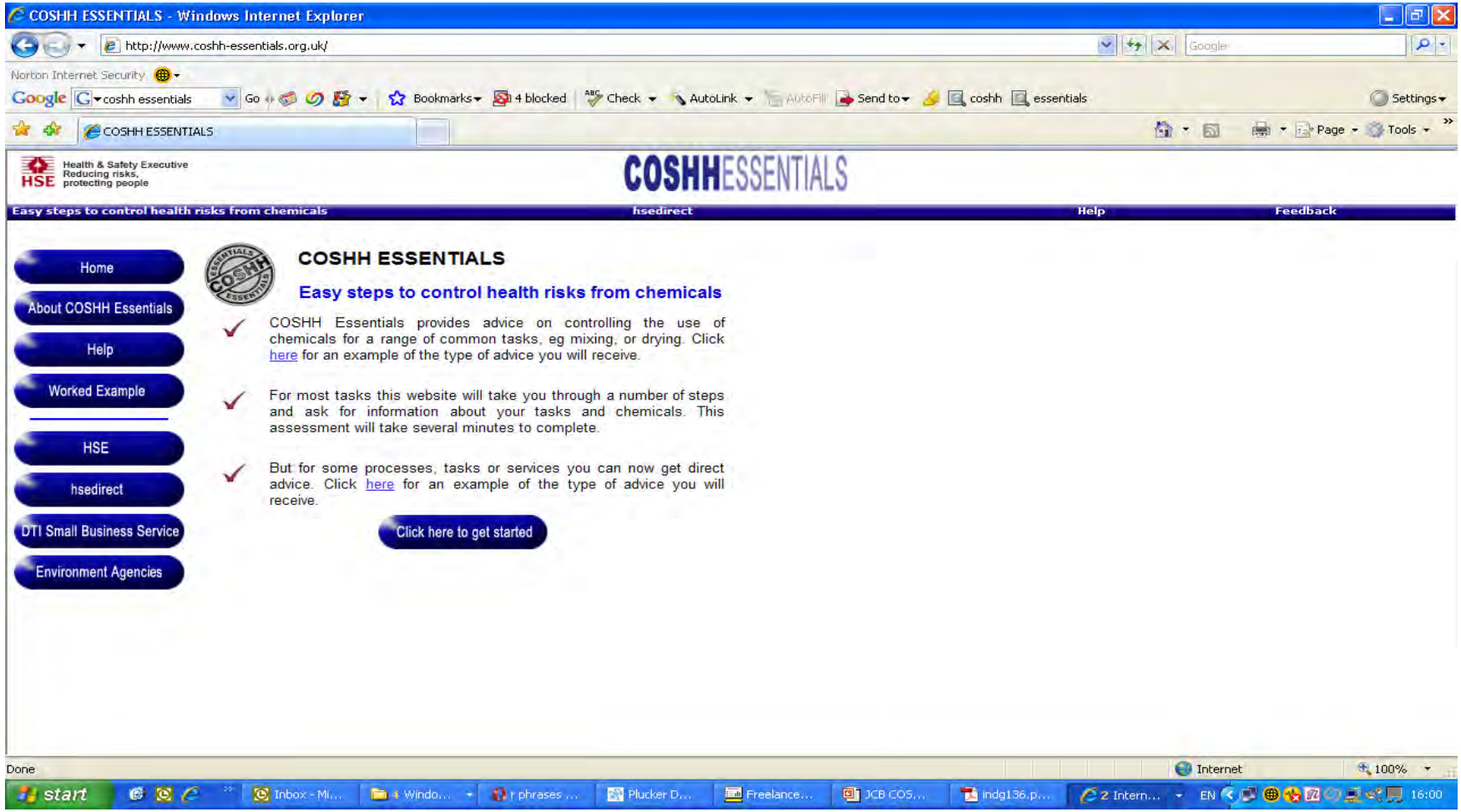
Exposure Assessment

ECA	Summary Description of Control Options
A	Room ventilation
B	Local extract ventilation
C	Partial enclosure
D	Enclosed processing and isolation
E	Enclosed processing plus additional containment

COSHH Essentials



http://www.coshh-essentials.org.uk/



Stages of the ILO Chemical Control Toolkit

Stage 1 Find the hazard classification and match it to a hazard group using the table supplied

Stage 2 Find out how much of the substance you are going to use

Stage 3 Find out how much of the substance is going to get into the air

Stage 4 Find the control approach

Stage 5 Find the task-specific control guidance sheet(s)

Example of Control Banding Approach

Source: Diamond Environmental Ltd - *reproduced with permission*

Glass Reinforced Plastic Fabrication Applying Resin

- **Boiling Point: 145°C**
- **R10 – Flammable**
- **R20 – Harmful by inhalation**
- **R36/38 – Irritating to eyes and skin**

Stage 1 – Hazard Classification

Hazard Group	EU R-Phrases	GHS hazard classification (class/level)
A	R36, R38, R65, R66 All dusts and vapours not allocated to another band	Acute toxicity (lethality), any route, class 5 Skin irritancy class 2 or 3 Eye irritancy class 2 All dusts and vapours not allocated to another band
B	R20/21/22, R40/20/21/22, R33, R67	Acute toxicity (lethality), any route, class 4 Acute toxicity (systemic), any route, class 2
C	R23/24/25, R34, R35, R37, R39/23/24/25, R41, R43, R48/20/21/22	Acute toxicity (lethality), any route, class 3 Acute toxicity (systemic), any route, class 1 Corrosivity, subclass 1A, 1B or 1C Eye irritancy class 1 Respiratory system irritancy (GHS criteria to be agreed) Skin sensitisation Repeated exposure toxicity, any route, class 2

Stage 1 – Hazard Classification (cont)

D	R48/23/24/25, R26/27/28, R39/26/27/28, R40 Carc. Cat. 3, R60, R61, R62, R63, R64	Acute toxicity (lethality), any route, class 1 or 2 Carcinogenicity class 2 Repeated exposure toxicity, any route, class 1 Reproductive toxicity class 1 or 2
E	R42, R45, R46, R49, R68	Mutagenicity class 1 or 2 Carcinogenicity class 1 Respiratory sensitisation
S **skin and eye contact**	R21, R24, R27, R34, R35, R36, R38, R39/24, R39/27, R40/21, R41, R43, R48/21, R48/24, R66	Acute toxicity (lethality), dermal only, class 1, 2, 3 or 4 Acute toxicity (systemic), dermal only, class 1 or 2 Corrosivity, subclass 1A, 1B or 1C Skin irritation class 2 Eye irritation class 1 or 2 Skin sensitisation Repeated exposure toxicity, dermal only, class 1 or 2

COSHH Essentials Categorisation of Substances

A	B	C	D	E	S
R36 R36/38 R38 R65 R66 R67 All dusts and vapours not allocated to another band	R20 R20/21 R20/21/22 R21, R21/22 R22	R23 R23/24 R23/24/25 R23/25 R24 R24/25 R25 R34 R35 R36/37 R36/37/38 R37 R37/38 R41, R43, R48/20 R48/20/21 R48/20/21/22 R48/20/22 R48/21 R48/21/22 R48/22	R26 R26/27 R26/27/28 R26/28 R27 R27/28 R28 R40 Carc. Cat. 3, R48/23 R48/23/24 R48/23/24/25 R48/23/25 R48/24 R48/24/25 R48/25 R60, R61, R62, R63, R64	R40 Muta cat 3 R42 R42/43 R45 R46 R49	R21 R24 R27 R34 R35 R36 R36/37 R36/37/38 R36/38 R38 R41 R42 R42/43 R43 R48/21 R48/21/22 R48/22 R48/23 R48/24 R48/24/25 R48/25 R66

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Stage 2 – How Much is Used

Quantity	Solid		Liquid	
	Weight	Typically received in	Volume	Typically received in
Small	Grams	Packets or bottles	Millilitres	Bottles
Medium	Kilograms	Kegs or drums	Litres	Drums
Large	Tonnes	Bulk	Cubic metres	Bulk

Stage 2 – How Much is Used

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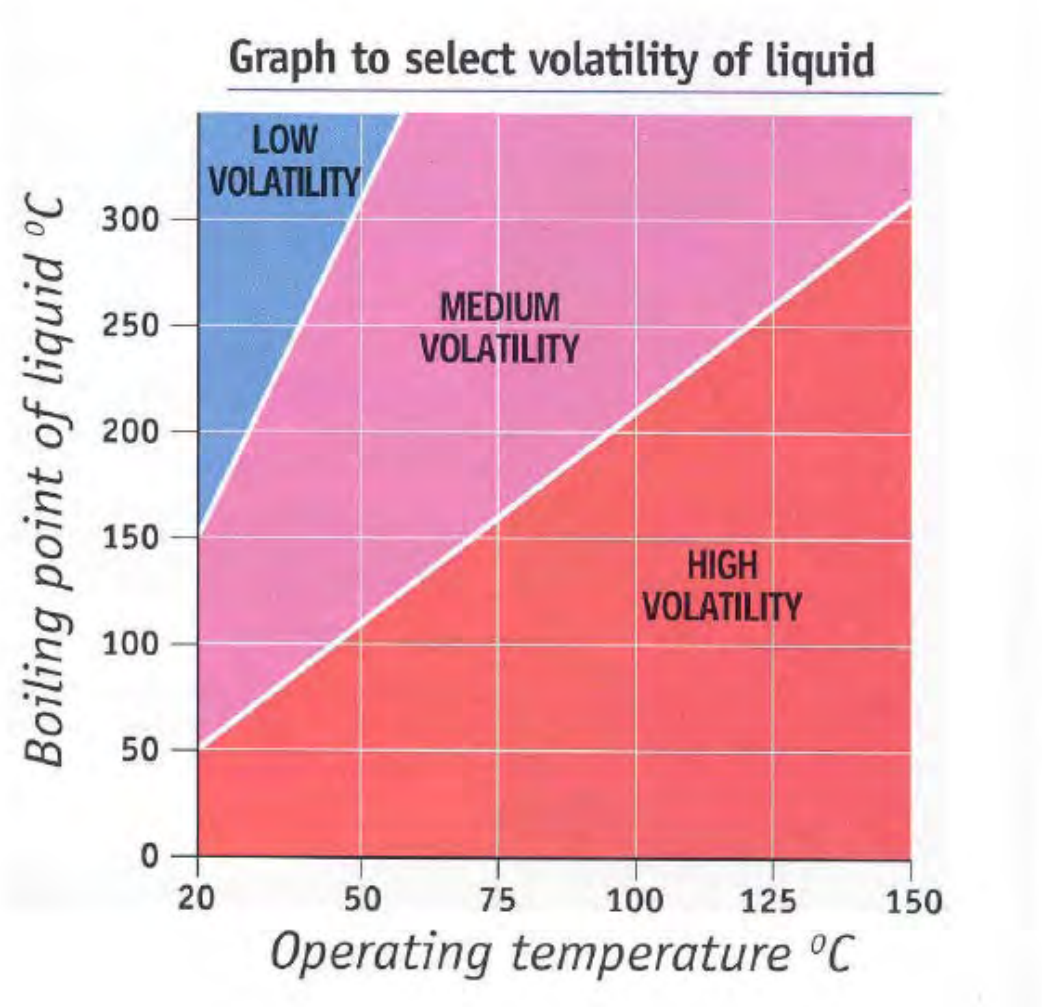
	Weight	Typically received in	Volume	Typically received in
Small	Grams	Packets or bottles	Millilitres	Bottles
Medium	Kilograms	Kegs or drums	Litres	Drums
Large	Tonnes	Bulk	Cubic metres	Bulk

Stage 3 - Dustiness

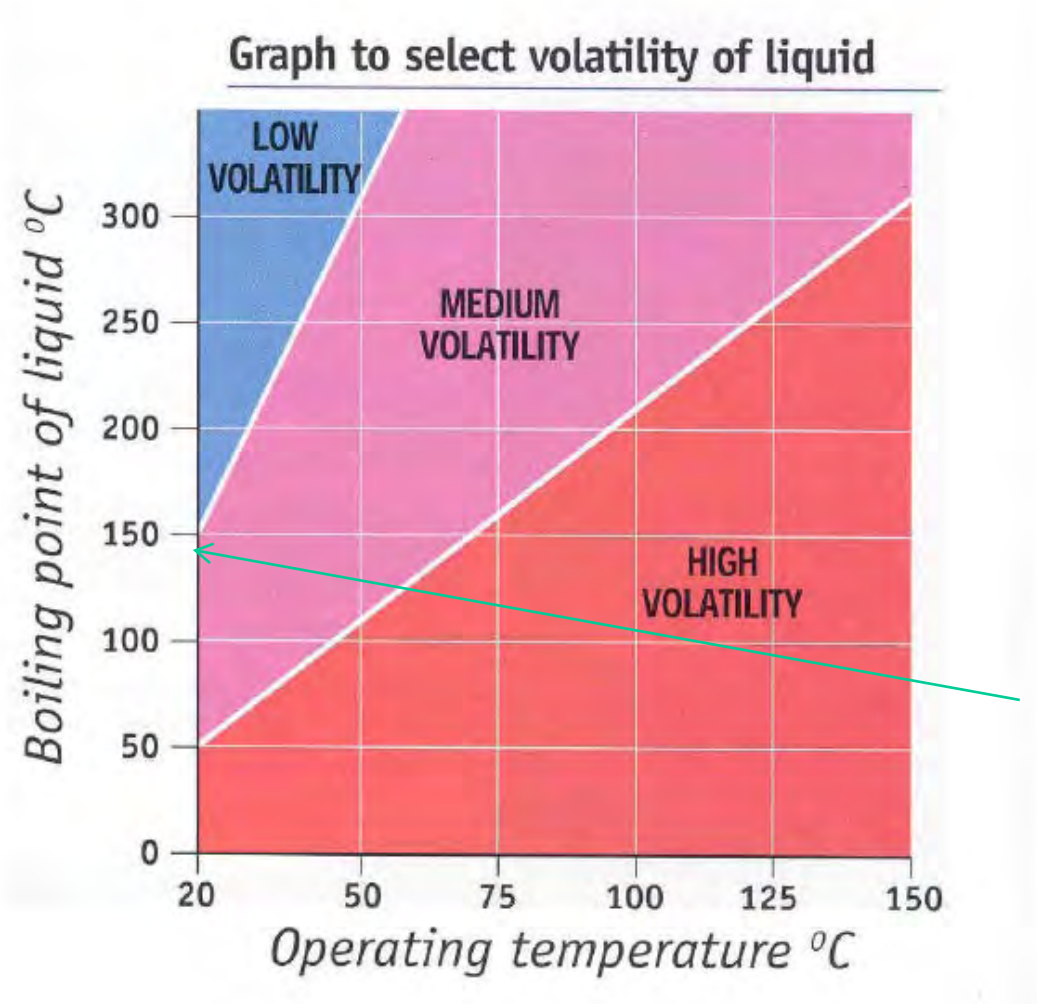
- Low: Pellet like solids that don't break up. Little dust is seen during use e.g. PVC pellets, waxed flakes
- Medium: crystalline, granular solids. When used, dust is seen, but settles out quickly. Dust is left on surfaces after use e.g. soap powder.
- High: fine, light powders. When used, dust clouds can be seen to form and remain in the air for several minutes e.g. cement, carbon black, chalk dust.

Stage 3 – Volatility



Source: ILO toolkit

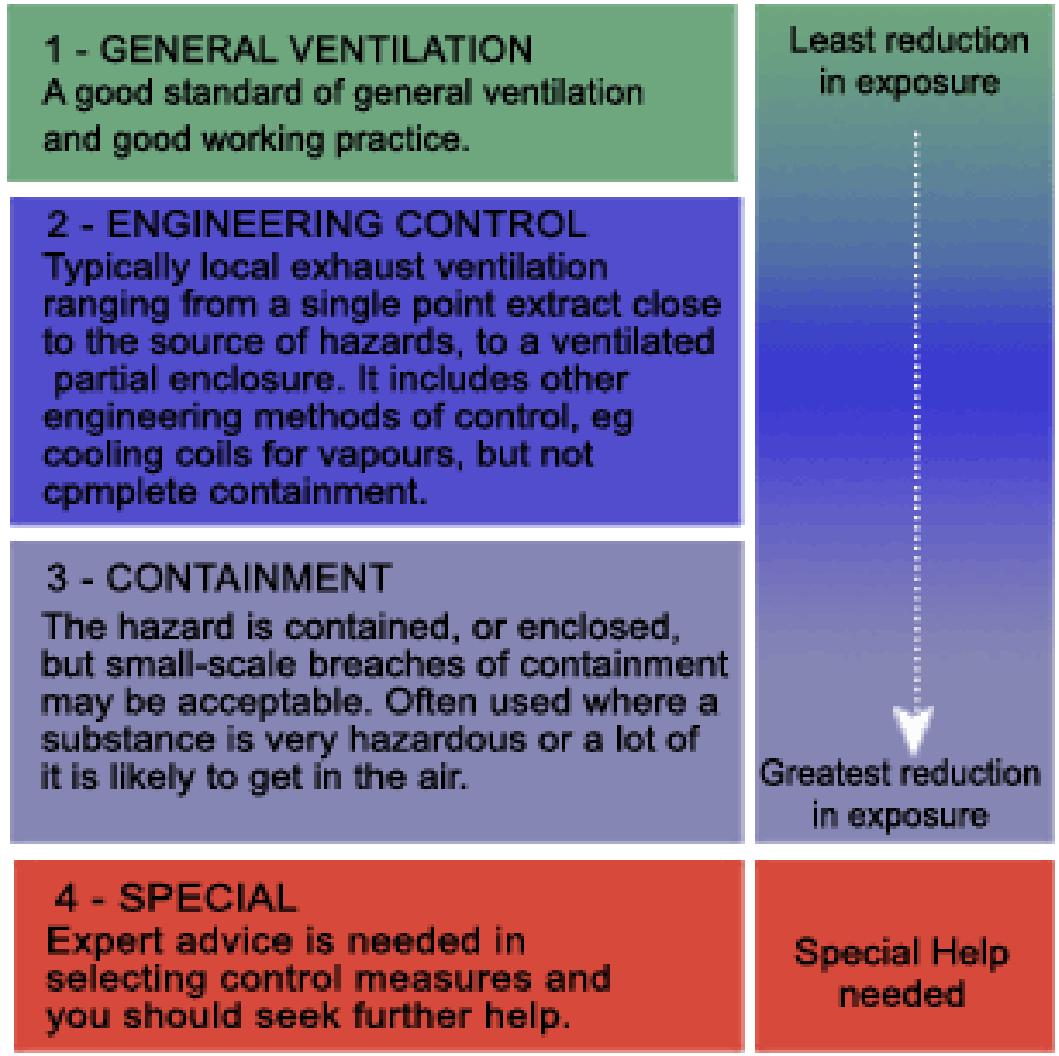
Stage 3 – Volatility



Boiling Point: 145°C

Source: ILO toolkit

Stage 4 – Control Approach



Source: HSE- reproduced with permission

Stage 4 – Control Approach

Amount used	Low dustiness or volatility	Medium volatility	Medium dustiness	High dustiness or volatility
Hazard group A				
Small	1	1	1	1
Medium	1	1	1	2
Large	1	1	2	2
Hazard group B				
Small	1	1	1	1
Medium	1	2	2	2
Large	1	2	3	3
Hazard group C				
Small	1	2	1	2
Medium	2	3	3	3
Large	2	4	4	4
Hazard group D				
Small	2	3	2	3
Medium	3	4	4	4
Large	3	4	4	4
Hazard group E				
For all hazard group E, substances, choose control approach 4				

Source: ILO toolkit

Stage 4 – Control Approach

Amount used	Low dustiness or volatility	Medium volatility	Medium dustiness	High dustiness or volatility
Hazard group A				
Small	1	1	1	1
Medium	1	1	1	2
Large	1	1	2	2
Hazard group B				
Small	1	1	1	1
Medium	1	2	2	2
Large	1	2	3	3
Hazard group C				
Small	1	2	1	2
Medium	2	3	3	3
Large	2	4	4	4
Hazard group D				
Small	2	3	2	3
Medium	3	4	4	4
Large	3	4	4	4
Hazard group E				
For all hazard group E, substances, choose control approach 4				

Source: ILO toolkit

Stage 5 – Task Specific Control Guidance Sheet

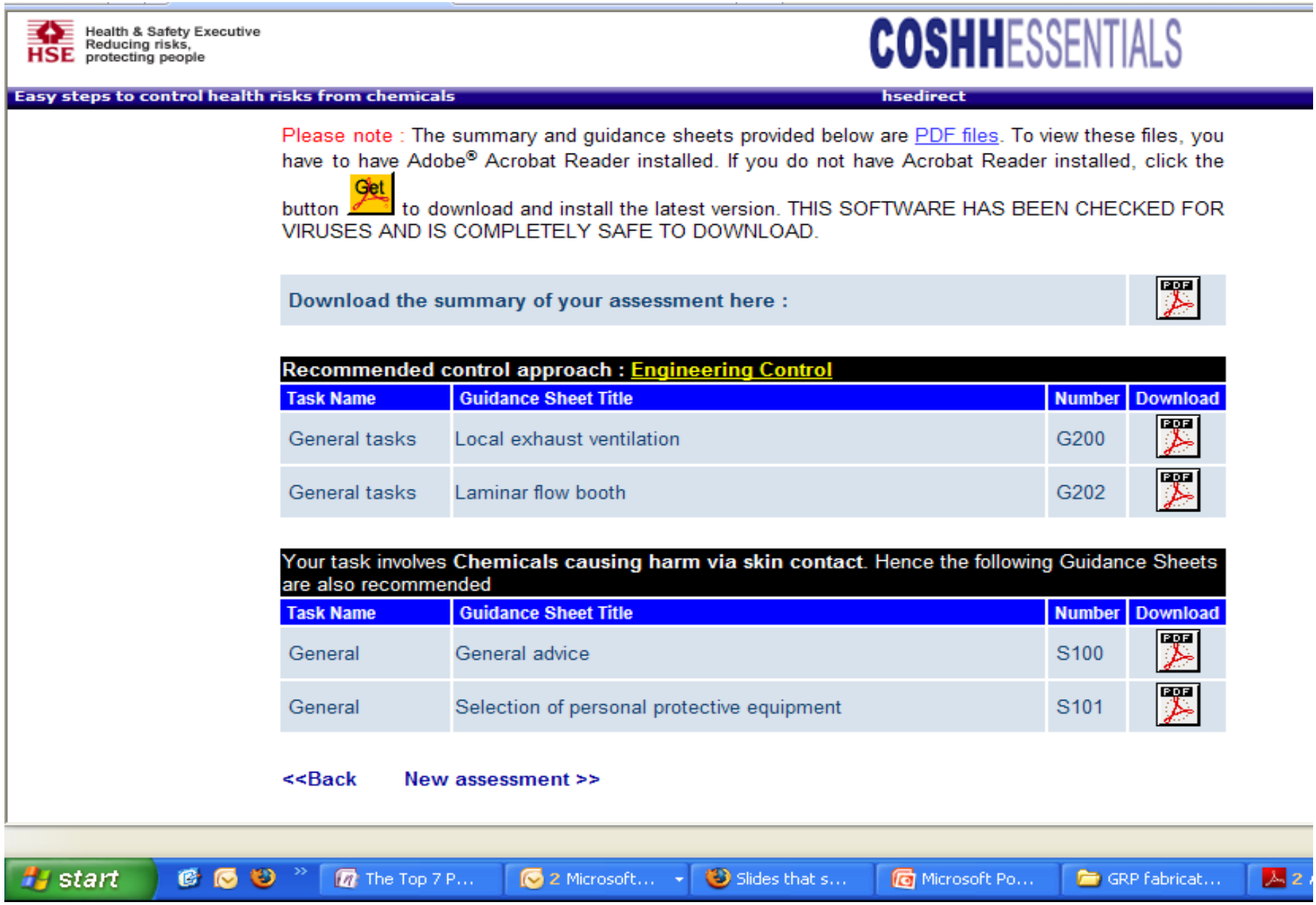
Task description	Task control sheet
Control Approach 1	
General principles	100
Sack, bottle and drum storage	101
Bulk storage	102
Removing waste from air cleaning unit	103
Control Approach 2	
General principles	200
Ventilated workbench or cupboard	201
Ventilated booth	202
Removing waste from air cleaning unit	203
Conveyor transfer	204
Sack filling	205
Sack emptying	206
Charging reactor or mixer from sack or keg	207

Source: ILO toolkit

Stage 5 – Task Specific Control Guidance Sheet

Control Approach 3	
General principles	300
Glove box	301
Removing waste from extraction unit	302
Transferring solids	303
High throughput sack emptying	304
Drum filling	305
Drum emptying	306
IBC filling and emptying (solids)	307
IBC filling and emptying (liquids)	308
Tanker filling and emptying (solids)	309
Tanker filling and emptying (liquids)	310
Keg filling	311
Transferring liquid by pump	312
Filling small containers (packets and bottles)	313
Weighing solids using a load cell	314
Weighing liquids using a load cell	315
Mixing solids	316
Mixing liquids with liquids or solids	317
Vapour degreasing bath	318

Source: ILO toolkit


Health & Safety Executive
Reducing risks, protecting people
COSHHESSENTIALS
Easy steps to control health risks from chemicals
hsedirect
Please note : The summary and guidance sheets provided below are PDF files. To view these files, you have to have Adobe® Acrobat Reader installed. If you do not have Acrobat Reader installed, click the button Get to download and install the latest version. THIS SOFTWARE HAS BEEN CHECKED FOR VIRUSES AND IS COMPLETELY SAFE TO DOWNLOAD.
Download the summary of your assessment here :
Recommended control approach : Engineering Control
Task Name | Guidance Sheet Title | Number | Download
General tasks | Local exhaust ventilation | G200
General tasks | Laminar flow booth | G202
Your task involves Chemicals causing harm via skin contact. Hence the following Guidance Sheets are also recommended
Task Name | Guidance Sheet Title | Number | Download
General | General advice | S100
General | Selection of personal protective equipment | S101
<<Back
New assessment >>
start
The Top 7 P...
2 Microsoft...
Slides that s...
Microsoft Po...
GRP fabricat...

Control guidance sheet 200

Local exhaust ventilation

Control approach 2

Engineering control 200

This guidance sheet is aimed at employers to help them comply with the requirements of the Control of Substances Hazardous to Health Regulations 2002 (COSHH) by controlling exposure to chemicals and protecting workers' health.

The sheet is part of the HSE guidance pack *COSHH essentials: easy steps to control chemicals*. It can be used where the guide recommends control approach 2 (engineering control) as the suitable approach for your chemical(s) and task(s).

This sheet provides good practice advice on using local exhaust ventilation which is the commonest form of engineering control. It can be applied to a range of tasks involving small, medium and large scale use of solids or liquids. It describes the key points you need to follow to help reduce exposure to an adequate level.

It is important that all the points are followed.

Some chemicals can also be flammable or corrosive. Where they are, your controls must be suitable for those hazards too. Look at the safety data sheet for more information.

Depending on the scale of work, releases into the atmosphere may be regulated within the pollution prevention and control (PPC) framework. You should consult your local authority or the Environment Agency. In Scotland, consult the Scottish Environment Protection Agency (SEPA). They will advise you if PPC legislation applies to your company, and about air cleaning and discharging emissions into the air. Otherwise, minimise emissions into the air.

Access

✓ Restrict access to the working area to authorised staff only.

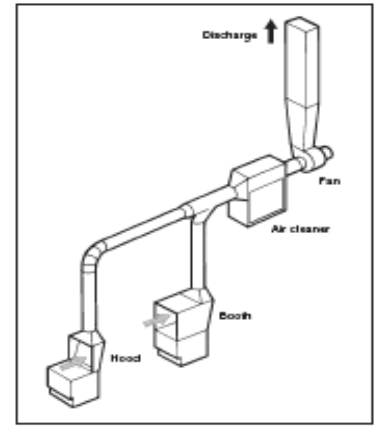
Design and equipment

✓ Apply local exhaust ventilation (LEV) at the source of exposure to capture the dust or vapour.

✓ Enclose the source of dust or vapour as much as possible to help stop it spreading.

✓ Don't allow the worker to get between the source of exposure and the LEV, otherwise they'll be directly in the path of the contaminated airflow.

✓ Where possible, site the work area away from doors, windows and walkways, to stop draughts interfering with the LEV and spreading the dust or vapour.



✓ Have an air supply coming into the workroom to replace extracted air.

✓ Keep ducts short and simple, and avoid long sections of flexible duct.

✓ Provide an easy way of checking the LEV is working, eg manometer, pressure gauge or tell-tale.

✓ Discharge extracted air to a safe place away from doors, windows and air inlets.

✓ With exposure to dusts, you can re-circulate clean, filtered air into the workroom.

✗ With exposure to vapours, re-circulation is not recommended.

Maintenance

✓ Maintain the LEV as advised by the supplier, in effective and efficient working order.

Source: HSE – Reproduced with permission

Current Control Banding Limitations

- **Doesn’t apply to process dusts/fumes**
- **Doesn’t consider individual process variations**
- **Doesn’t provide sufficient protection for susceptible groups (young or pregnant)**

Understanding Sources of Contaminants

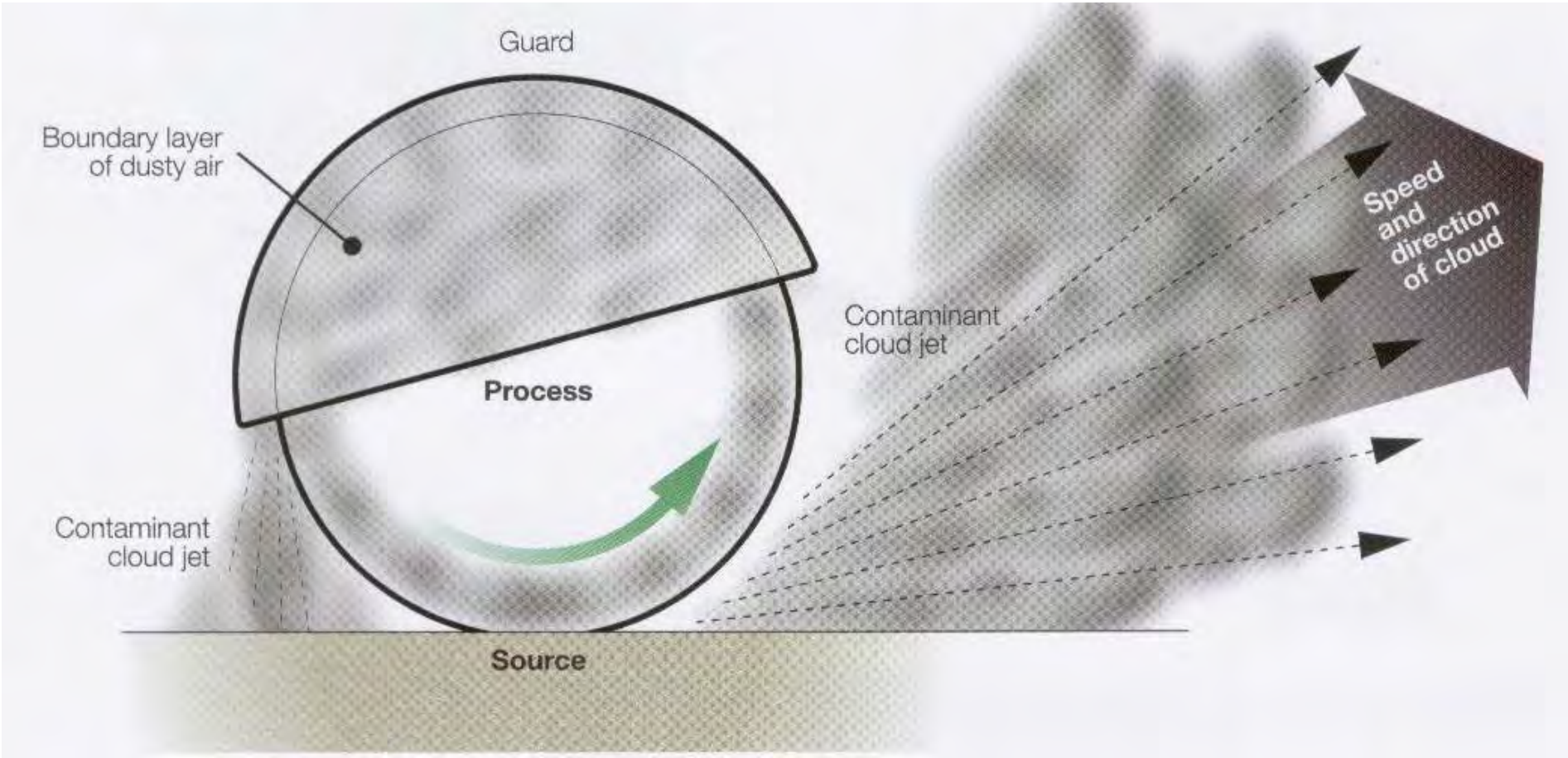
Introduction

Before considering specific measures to control hazardous substances it is important to have a good understanding of the sources of contaminants that require control

Processes & Sources

- **Process – The way airborne contaminants are generated. For example in woodworking the processes could be cutting, routing, planing or sanding**
- **Source – The point where the contaminant is generated by a process**

Processes & Sources (cont)



(Source: HSE – *reproduced with permission*)

Types of Sources

- **Buoyant**
  - **Hot fumes**
- **Injected into moving air**
  - **Spray painting**
- **Dispersed into workplace**
  - **Draughts**
- **Directional**
  - **Power tools**

Buoyant Sources

Source:HSE –Reproduced with permission

Source: University of Wollongong

Injected into Moving air

(Show HSE Video Clip 1)

Dispersed into Workplace

(Show HSE Video Clip 2)

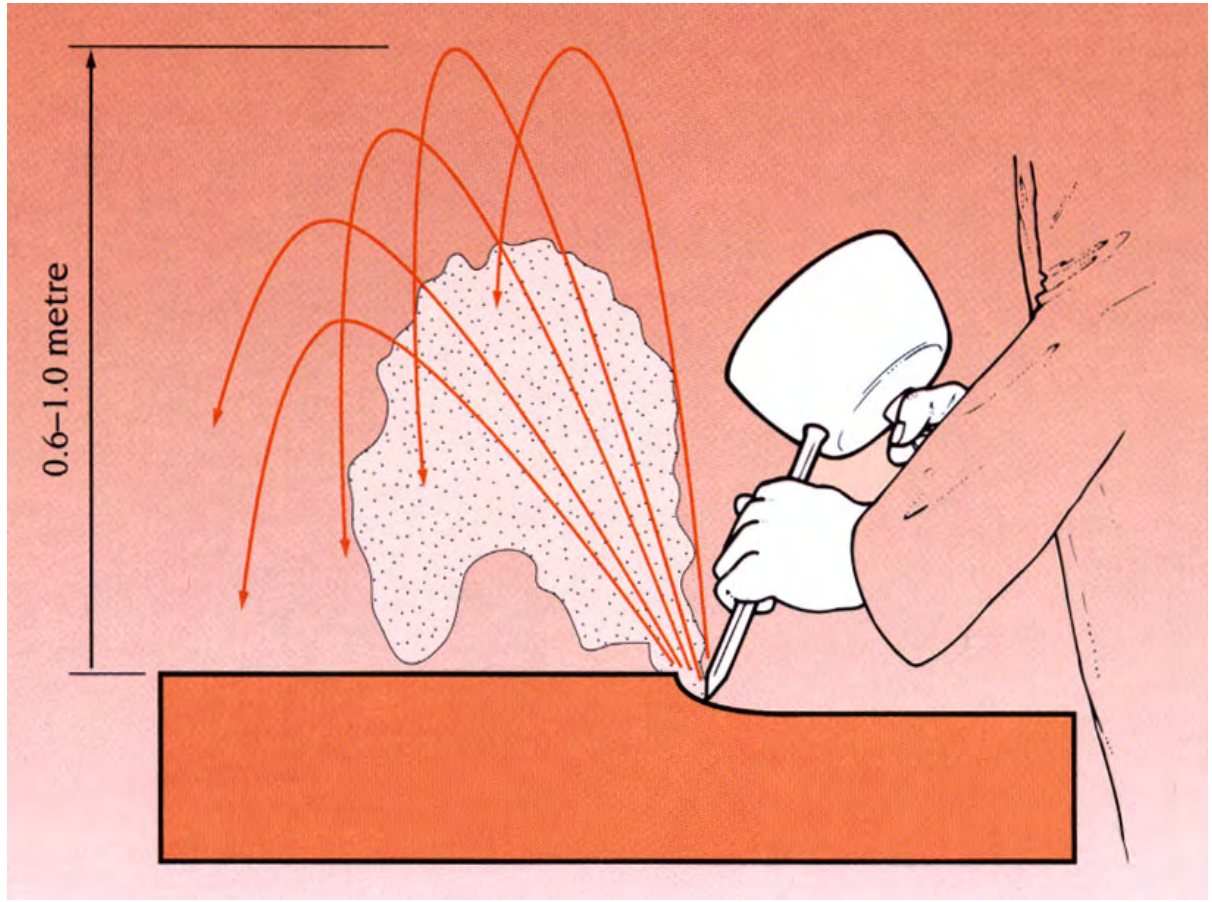
Directional

(Show HSE Receiving Hood video)

Sub Groups of Directional Sources

- **Explosive release**
- **Progressive release**
- **Doughnut-shaped release around a rotating disc**
- **Broad fan-shaped release from a rotating disc**
- **Narrow jet release from cutting trench**

Explosive Release



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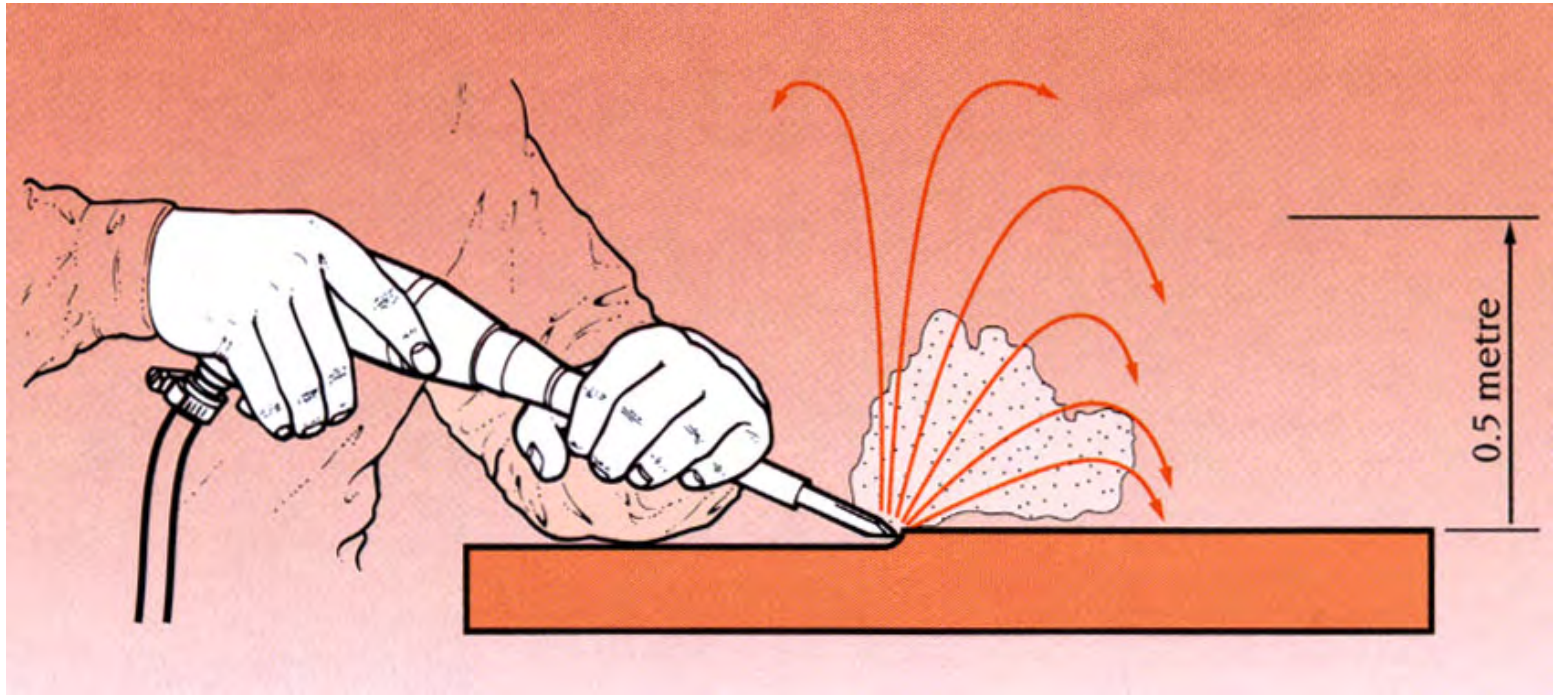
Progressive Release



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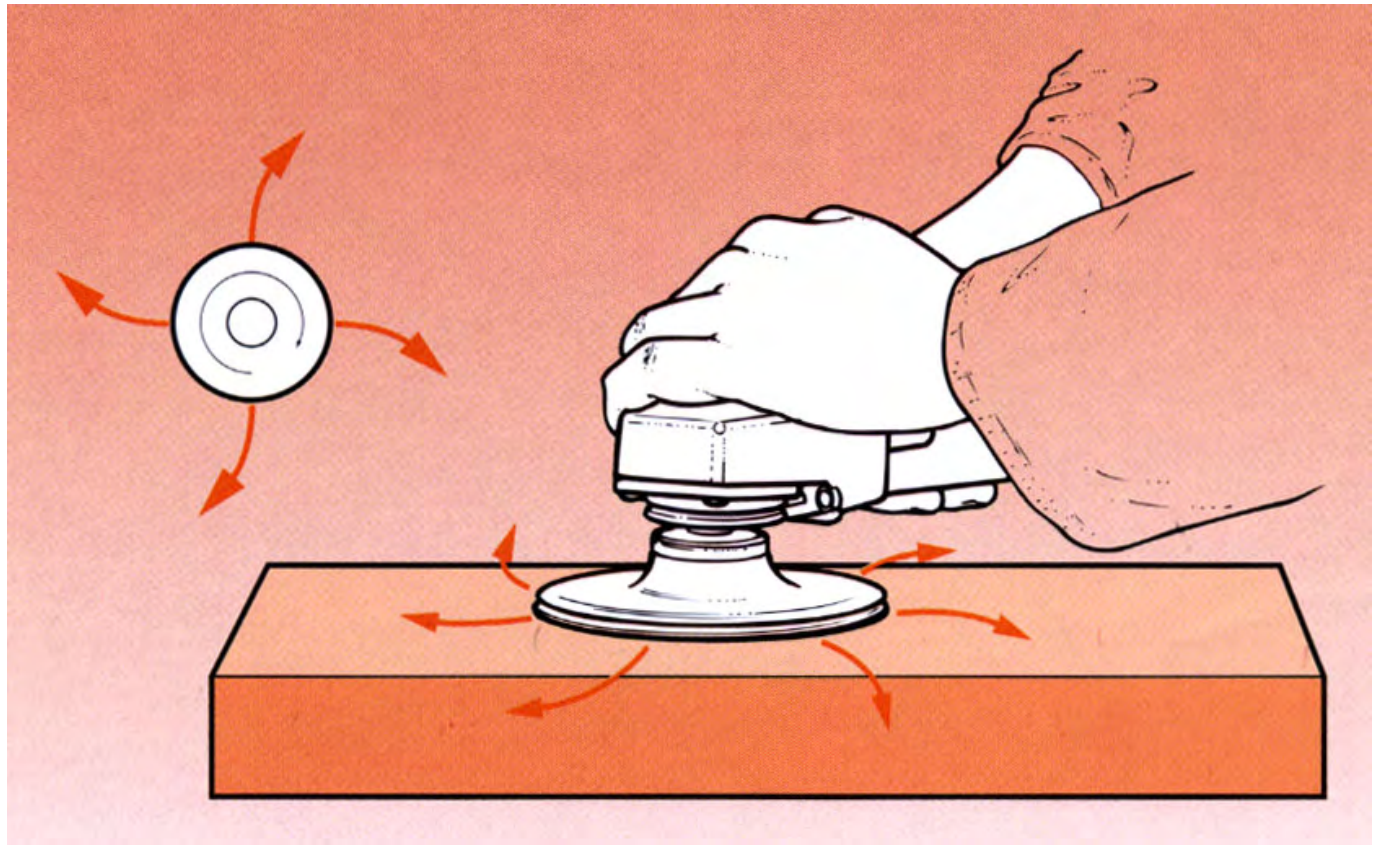
Doughnut-shaped Release Around a Rotating Disc



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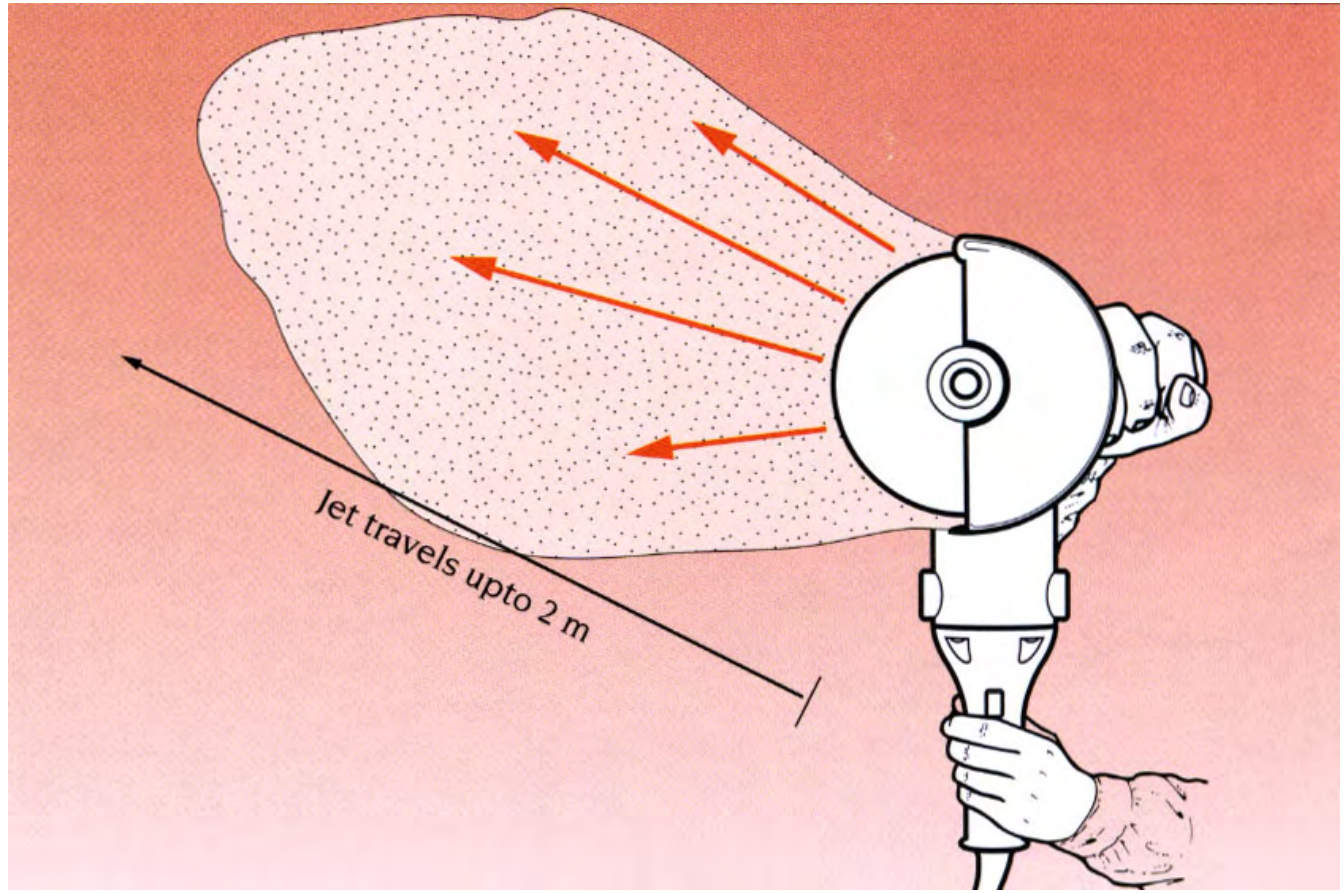
Broad Fan-shaped Release From a Rotating Disc



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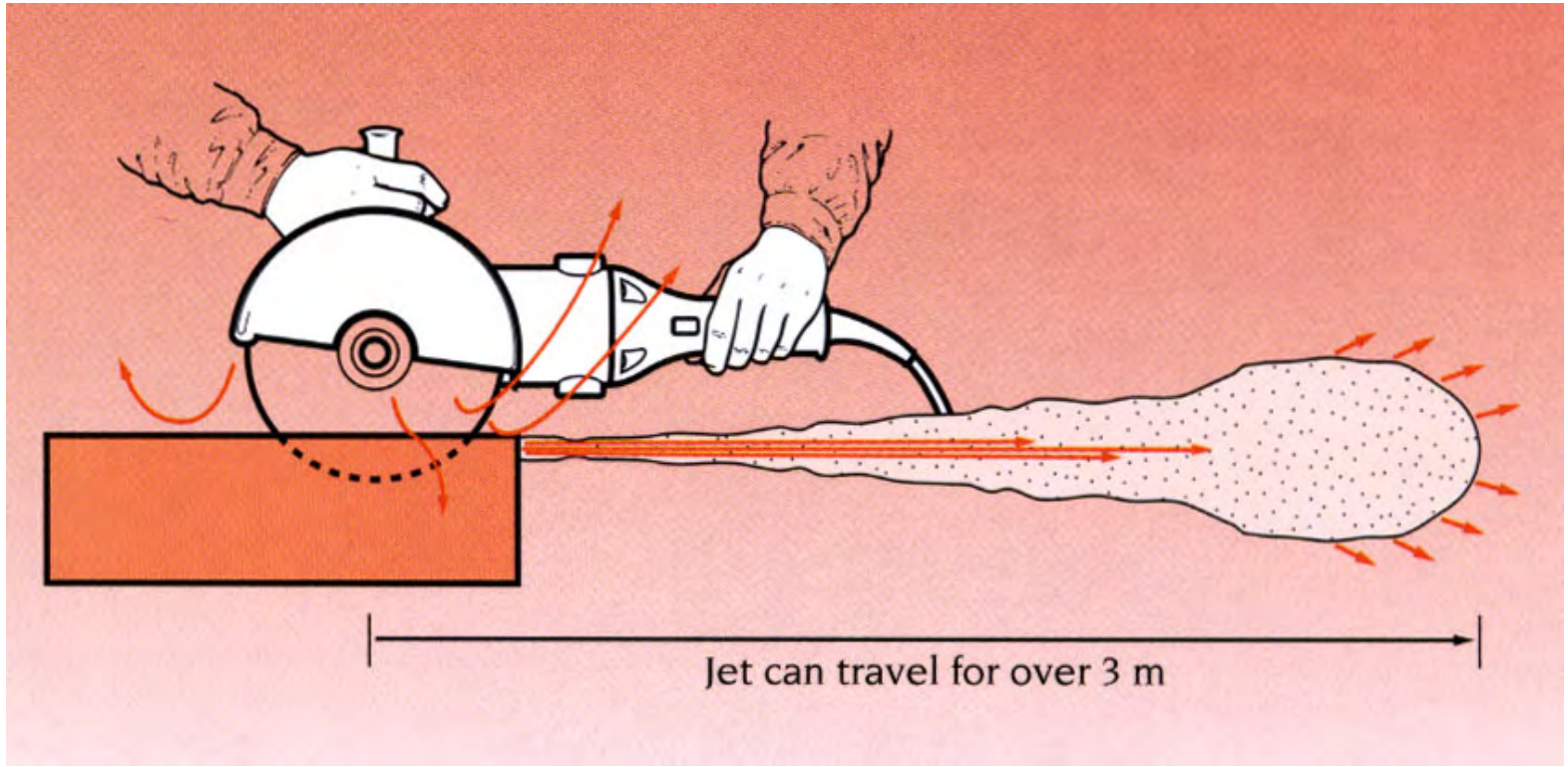
Narrow Jet Release From Cutting Trench



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Strength of Sources

When considering the strength of a source it can be defined in terms of the area from which the contaminant originates, the flow of the contaminant away from the source and the atmospheric concentration of the contaminant

Contaminant Clouds

- **As the contaminant moves away from its source the more dispersed it becomes and thus much larger**

- **While dilution reduces the contaminant concentration within the atmosphere, it is always more effective to control the contaminant close to its source**

Reasons to Control Clouds at Source

- **The volume of contaminant in the atmosphere is smaller and thus easier to control**
- **Collection of the whole contaminant cloud is more likely**
- **Operators are less likely to be exposed**

Controlling Hazardous Substances

Consequently, the approach to controlling a particular hazardous substance is determined to a large degree by a combination of factors including:

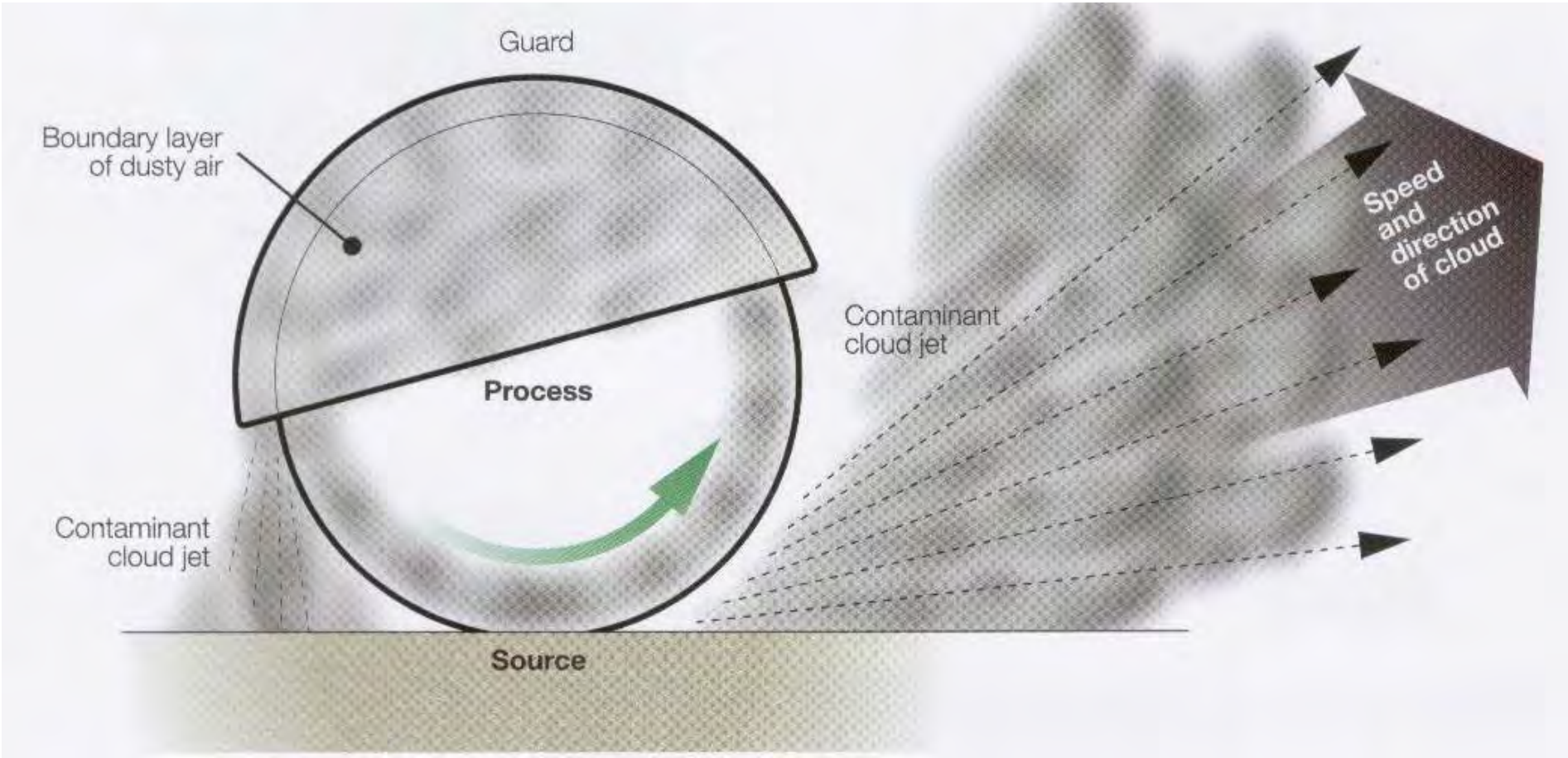
Factors which Determine Control Approach

- **Source strength**
- **Contaminant cloud volume, shape, speed and direction of movement**
- **Contaminant concentration**

Multiple Sources

Notwithstanding these factors, it is important to understand that a single process can create several sources of contaminants at different stages

Multiple Contaminant Clouds



(Source: HSE – *reproduced with permission*)

Don’t Jump To Quick Decisions

What you think may be present

What’s actually there

Common Processes & Sources

- **Rotating tools & parts**
  - **Orbital, belt & disc sanders**
  - **Disc cutters**
  - **Lathes**
  - **Drills**
  - **Abrasive wheels**
- **Hot & cold processes**
  - **Furnaces & casting**
  - **Soldering, brazing & welding**
  - **Using liquid nitrogen**

Common Processes & Sources (cont)

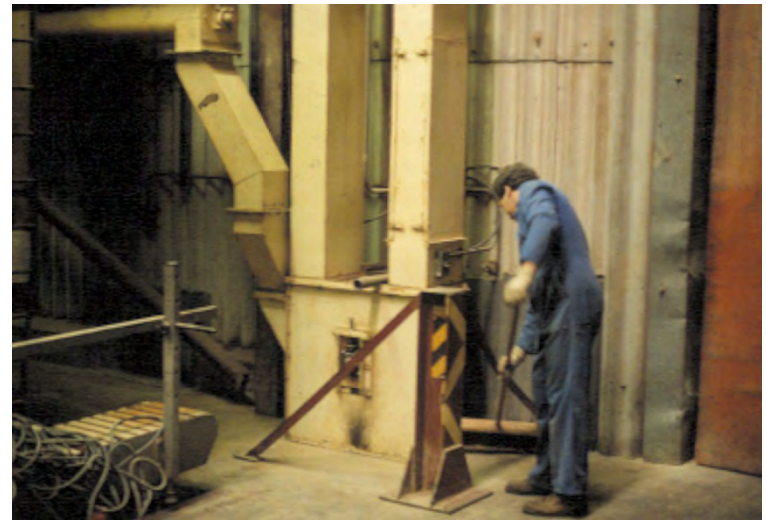
- **Free-falling solids, liquids & powders**
  - **Falling liquid, powder & solid material**
  - **Conveyor transfer of powders or solids**
- **Displacement**
  - **Liquid, powder and granular solid transfer into a container**
- **Spraying & blasting**
  - **Paint spraying & abrasive blasting**

Common Processes & Sources (cont)

- **Fracturing solids**
  - **Rock crushing**
- **Impact & vibration**
  - **Dumping dusty bags on a hard surface**
  - **Machinery vibration re-suspending dust**
- **Compaction**
  - **Waste crushing**

Common Processes & Sources (cont)

- **Handling**
  - **Sorting waste**
- **Machining**
  - **Milling, turning**
- **Abrasion**
  - **Sanding, grinding, polishing**
- **Sweeping**
  - **Dust & particulate matter**



Source: BP International Ltd

OTHER ROUTES OF EXPOSURE

Skin, ingestion & sometimes injection

Skin Contact

- **Immersion**

Source; HSE – Reproduced with permission

Skin Contact

Immersion

Direct contact

Source: Diamond Environmental Ltd - *reproduced with permission*

Skin Contact

Immersion

Direct contact

Splashes

Source; HSE – Reproduced with permission

Skin Contact

Immersion

Direct contact

Splashes

Deposition

Skin Contact

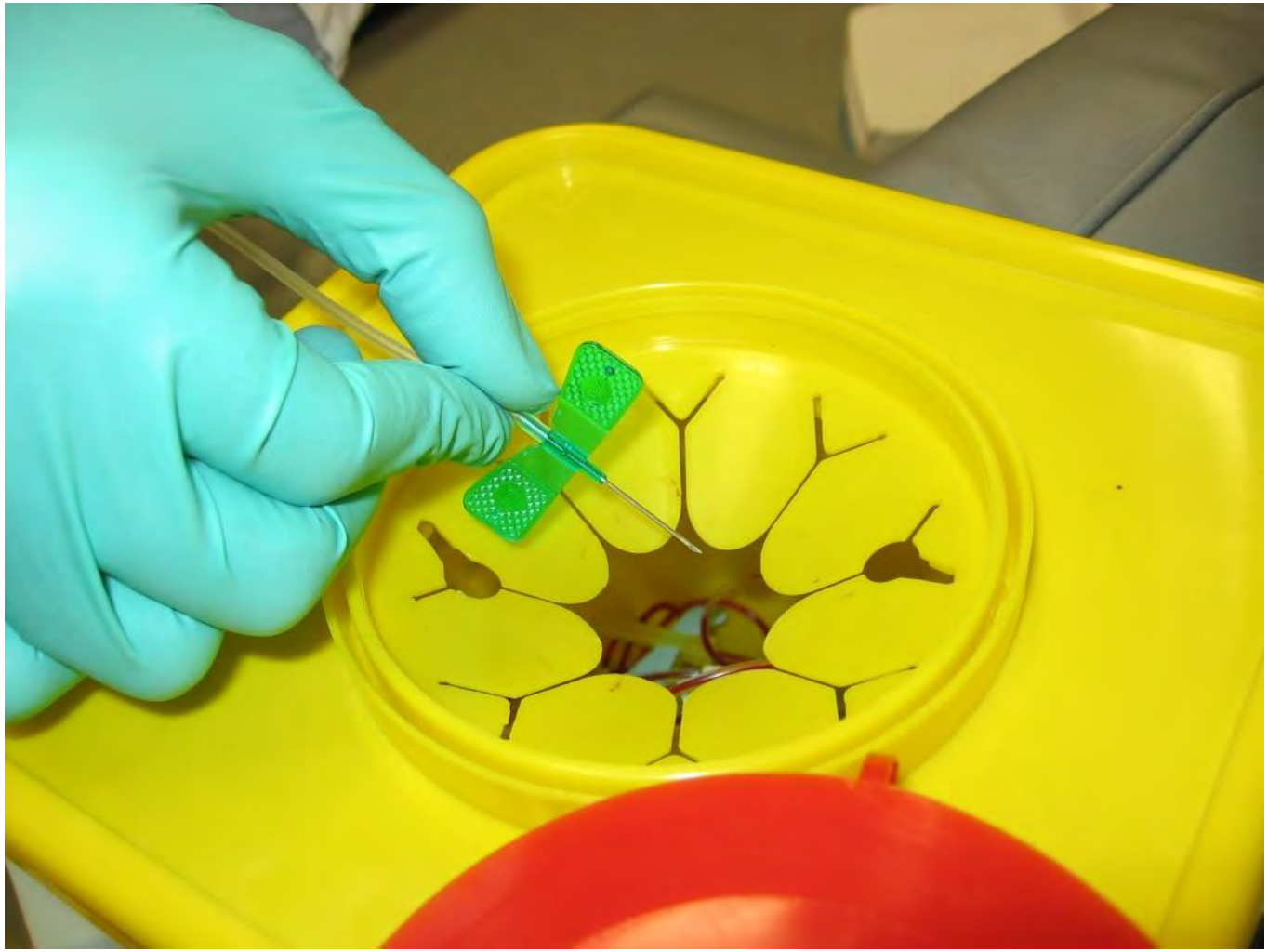
- Immersion
- Direct contact
- Splashes
- **Deposition**

Source; HSE – Reproduced with permission

Ingestion

Source: University of Wollongong

Injection



Source: University of Wollongong

Key Point To Remember

For every process there is a need to investigate & evaluate the significance of every contaminant source before considering which control strategies are appropriate

Process Design & Principles

General Design of Equipment & Workplace Layout

Source: NOHS

General Design of Equipment & Workplace Layout

Source: Diamond Environmental Ltd - *reproduced with permission*

Workplace Design

- **Doors & windows**
- **Ventilation outlets**

Automation

Example – welding

- Less experience required, good results
- Saving in consumables, QC, time
- Higher current – better fusion
- Continuous weld – no weakness in seam
- Reduced health effects of respiratory system, cancer and urinary tract

Automation

Prevention by Substitution

- **Substitution at the source is the best control**
- **Substitute either the process or substance**

Examples:

- **Lead free paints**
- **Asbestos has been substituted with SMF in some cases**
- **Substitute pellets instead of powder**

Chemical Substitution

- **Be aware of the volatility of chemicals**
- **Volatile and non-volatile chemicals can have a similar toxicity**
- **However, the vapour pressure of volatile chemicals is sufficient for them to become a hazard when passive**
- **Glutaraldehyde replaced formaldehyde as a hospital disinfectant, still health issues. Ortho-phthaladehyde (OPA) is replacing glutaraldehyde. Similar toxicity but used more diluted with less chance to vapourise**

Process Substitution

- **Replacing dry sweeping with broom to vacuuming or wet method**
- **Electric motors instead of diesel**
- **Use airless spray or brush application to paint rather than air spray painting**

Substitution – Points to Consider

- **Ensure one hazard is not being replaced with another**
- **Evaluate and compare the hazards**
- **Determine changes required to all aspects of process**
- **Costs are saved with reduced need of ventilation, engineering controls and PPE, although the substitute substance may cost more**

Volatile Materials

- **Evaporate quickly**
- **Include liquefied gases, liquids, solvents, molten metal and aqueous mixtures**
- **Irritation and sensitisation through skin absorption, but quick to evaporate off skin**
- **Quick to evaporate off surface (unless absorbent)**
- **Must understand the evaporation rate, vapour pressure and toxicity of a volatile substitute material**

Non-Volatile Material

- **Do not evaporate easily**
- **Include solid metals, powders, dusts, pastes and low volatility liquids**
- **Generally do not become airborne**
- **Greater risk of skin and ingestion exposure**
- **Remain settled on an area until removed**
- **If change from volatile to non-volatile chemical – need to understand the change in route of exposure**

Aqueous Solvents

- **Organic solvents replaced by aqueous solvents (water)**
- **Additives to the water must be considered**
- **Some plant may not tolerate water**

Semi-aqueous Solvents

- **Difference between aqueous and semi is surfactant type**
- **Surfactants allow the water to penetrate smaller areas by reducing tension**
- **Not all surfactants will mix with water**
- **Cheaper than aqueous solutions**

Organic Solvents

- **Liquid hydrocarbon (MEK, toluene)**
- **Dissolves paints, grease, varnish**
- **Volatile**
- **May replace own kind but not usually aqueous or semi-aqueous solutions**

Group Exercise

- **Find a substitute for trichloroethylene for degreasing using information provided**

- **What other factors would you need to consider when deciding on an alternative?**

Solvent	Limit	CHIP	LD50	Vapour pressure	Flammable?
1-bromopropane	None	Toxic Rep 2	2530 to 2950 (ipr)	111 mm Hg @ 20 C	No
Bromochloromethane	None	N/C	4300 to 5000 (oral)	143 mm Hg @ 25 C	No
Isopropanol	400 ppm	Irritant	3600 to 6410 (oral)	45.5 mm Hg @ 25 C	Yes
Solvent 702	None	N/C	No data available	0.01 mm Hg @ 25 C	No
Trichloroethylene	400 ppm Carc	Toxic Carc 2	2402 to 4920 (oral)	69 mm Hg @ 25 C	No

N/C = not classified. Note-This does not mean that it is not toxic

Legislation as a Means of Achieving Control

- National
- Regional
- International
- Industry specific – coal mining industry

Legislation – REACH

- European Community Regulation on chemicals and safe use
- Registration, Evaluation, Authorisation of Chemical Substances
- Industry has a responsibility to provide health and safety information on substances
- Substances will be phased out if risks are unacceptable
- Substitute chemicals will be recommended

Group Exercise-Control Banding

- Use the information provided to develop a control strategy using the control banding approach
- Is the control strategy appropriate

Review of Today's Topics

- **Workplace control principles**
- **Designing control strategies**
- **Understanding sources of contaminants**
- **Process design & principles**