RSPH Level 3 Award in Asbestos Air Monitoring and Clearance Procedure

Pre-Read Qualification Information

Qualification Overview

To provide the knowledge and competency to analysts for carrying out air sampling, fibre counting and 4 stage clearance procedures on completion of asbestos removal and remedial works.
Instruction: 15 hours over 3 days
Prior learning/pre-reading: 3 hours
Assessment:

1. Written exam - short answer questions and calculations sheet
2. Practical assessment – witnessed exercises and counting of RICE slides

Day 1

1. **Unit 1** – Health, safety and legal aspects relating to asbestos
2. **Unit 2** – Theory of air sampling, fibre counting and clearance procedures

Day 2

1. **Unit 2** – continued
2. **Unit 3** – Practical air sampling, fibre counting and clearance procedures

Day 3

1. **Unit 3** – continued
2. **Unit 4** – Use of decontamination units and Type-H vacuums

Day 4

1. Written Exam
2. Practical assessments and RICE slides
3. Calculation Booklet
4. 4 stage clearance procedure

The RSPH Qualification

Royal Society for Public Health (RSPH) is the awarding body for the level 3 certificate for Asbestos Air Monitoring (Analysts).
The Level 3 qualification is equivalent standard to an A Level and covers sampling, analysis and clearance procedures outlined in The Analyst Guide (HSG 248).
The qualification depends on a candidate achieving 60% in a written exam for Units 1 and 2 and a satisfactory witnessed practical assessment in;

1. Microscope set up and rescue
2. Pump calibration
3. Enclosure fault finding
4. Use of DCU and Type-H vacuums
5. Selection of PPE

Contents

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UNIT 1

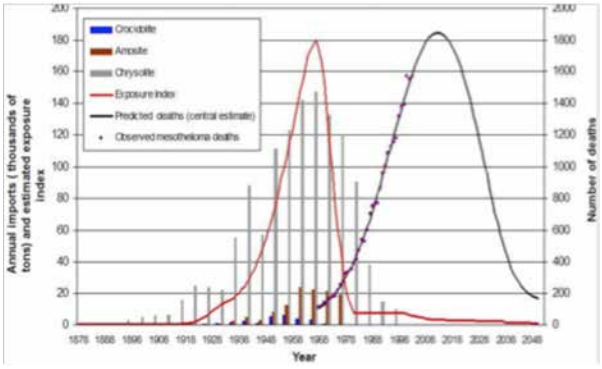
Health, safety and legal aspects relating to asbestos

Section 1:
Properties and usage of asbestos

HSE Statement

'Asbestos is the greatest single cause of work related deaths in the UK.'
Currently around 4,500 deaths per annum.

Mesothelioma Projected Deaths



The Current Problem

6m tonnes of imported fibre went into 30 or 40m tonnes of building products. Large numbers of buildings still contain asbestos.

1. Between 500,000 and 2m commercial premises
2. Around 2.5m domestic dwellings

Large potentially exposed population

1. 2m working in building trades
2. 20m general building users/occupants

Workers still don't know

1. What it looks like
2. Where it is
3. The risks from it

The Hidden Killer - HSE Campaign

Risk of Disease

The predicted total of 90,000 UK mesotheliomas between 1970 and 2050 will include around 15,000 carpenters. The particularly high risk to carpenters is thought to be due to exposure to amosite (brown asbestos) while cutting AIB.

In the 1960s the UK imported almost half of all amosite mined to put into AIB products. HSE estimates 20% of ceiling area of public buildings built between 1967 and 1973 are AIB (plus all the Boots, M&S, Woolworths premises)

Miscellaneous use of AIB is a bigger problem than lagging.

Nature's "Wonder Fibre"

Asbestos is the name for a group of naturally occurring fibrous mineral / silicates.
Amazing properties of:

1. Strength – stronger than steel
2. Flexibility – easily woven
3. Stability – will deteriorate only slowly
4. Thermal insulator
5. Fire retardant
6. Chemical and electrical resistance
7. But can be deadly...

Asbestos Facts

Fibrous silicate mineral:

Amphiboles:

The amphibole fibres are hydrophobic (water hating) and much better acid resistance than chrysotile.
Tremolite and actinolite form a 'solid-solution' series and have continuously variable composition depending on the source of the material.

a) Crocidolite (blue)
b) Amosite (brown)
c) Tremolite
d) Anthophyllite
e) Actinolite

Serpentine:

Chrysotile is a chain silicate that tends to be sharp, springy, (elastic) fibres. The fibres are hydrophilic (water loving and less acid resistant than amphiboles.

a) Chrysotile (white)

Asbestos Types

Chrysotile (white) – the most commonly occurring type of asbestos used in cement and textile products.

Crocidolite (blue) – best thermal properties. Used in insulation and spray coatings.

Amosite (brown) – a good all-rounder. Used in boarding products and ceiling tiles, but also insulation.

Brown and blue asbestos banned in UK 1985.
White asbestos finally banned in UK 1999.

Sprayed Asbestos

Sprayed asbestos ("Limpet") was a gun-applied mixture of hydrated asbestos-cement with up to 85% asbestos fibre content.

Used for fire protection in ducts, firebreaks and around structural steel work also as acoustic insulation in swimming pools/theatres.

Regarded as high risk due to high asbestos fibre content and high friability. Very rare in domestic housing.

Thermal Insulation Engineer applying fire protection to structural steel.

Sprayed coating applied to structural steel. Note damage around the electrical junction box.

Thermal Insulation

Generally regarded as high/medium risk depending on the fibre content. Medium to high content – highly variable from 15 to 80%. Usually a protective coating was used to guard against damage. Could contain blue, brown or white asbestos and the hard set insulation was mixed on site.
There are variable types and compositions such as pre-formed sections ("Caposite") lagging which was more uniform in nature.

Asbestos Insulating Board (AIB)

AIB is generally regarded as medium risk material because of the lower content – usually 15 to 25%.
The material is less friable as it is compressed and paint acts as protective coating.
Amosite (brown asbestos) was usually used.
AIB was mostly used internally for:

a) wall panels
b) ceiling tiles
c) fire breaks
d) packing and shuttering
e) door panels

Used extensively up to 1985.

Asbestos Cement Products

Asbestos Cement is generally regarded as low risk material due to;

a) lower content – usually 10 to 15%
b) low friability as very dense and fibres firmly bound in cement matrix
c) usually only white asbestos

Asbestos Cement is very resistant to weathering with a service life of up to 40 years or more.
Mainly used externally which means any fibre released would immediately diluted in atmosphere.

Miscellaneous Products

These products include:
Asbestos textiles e.g. fire protection clothing, gloves, overalls, fire-blankets and curtains.
Asbestos-bitumen products such as roofing felts and damp-proof courses.
Textured coating used on walls as well as ceilings.
Plastics e.g. Bakelite toilet cisterns and Flooring such as "Marley" floor tiles and roll linoleum with paper backing.

Section 2: Risks to Health

The Risk from Asbestos

Asbestos is only a problem if it is being disturbed and if fibres released become airborne. If the fibres are in your breathing zone and you actually inhale the fibres they then reach deep into your respiratory system. When they stay there and this happens repeatedly, then there may potentially be a problem.

The Main Diseases

- Asbestosis – scarring or fibrosis of the lung
- Mesothelioma – cancer of the pleura or peritoneum
- Asbestos related lung cancer – from dual exposure to ACM and tobacco

Health Effects

The following are benign conditions and will not in themselves cause death.

- Pleural plaques
- Pleural thickening and effusions
- Asbestos warts and corns

Defences Against Exposure

The Respiratory system defences are:

a) 'muco-ciliary escalator'
b) macrophages

Asbestos fibres have to be respirable in size - between 1 and 5 microns approx. It is known that cumulative and repeated exposure is more significant then single 'events'.
There are normal background levels that cause inevitable exposure but 1 fibre does not kill!

Section 3: Legislation, RPE and Control Limits

Health and Safety Legislation

UK H&S legislation has different layers, each with different legal status.

- *Acts of Parliament – legally binding*

1. Health and Safety at Work Act 1974

- *Regulations or Statutory Instruments – legally binding*

2. Control of Asbestos Regulations 2012

- *ACOPs – not legally binding, but must prove you did something at least equal*
- *Guidance – not legally binding, not obliged to follow it, but regarded as best practice*

The Regulations

- Includes ACOP and Guidance wording

Regulations – L143

- ***Regulation 1*** Citation and commencement
- ***Regulation 2*** Interpretation
- ***Regulation 3*** Application of these Regulations
- ***Regulation 4*** Duty to manage asbestos in non-domestic premises
- ***Regulation 5*** Identification of the presence of asbestos
- ***Regulation 6*** Assessment of work which exposes employees to asbestos
- ***Regulation 7*** Plans of work
- ***Regulation 8*** Licensing of work with asbestos
- ***Regulation 9*** Notification of work with asbestos
- ***Regulation 10*** Information, instruction and training
- ***Regulation 11*** Prevention or reduction of exposure to asbestos
- ***Regulation 12*** Use of control measures etc
- ***Regulation 13*** Maintenance of control measures etc
- ***Regulation 14*** Provision and cleaning of protective clothing
- ***Regulation 15*** Arrangements to deal with accidents, incidents and emergencies
- ***Regulation 16*** Duty to prevent or reduce the spread of asbestos

- ***Regulation 17*** Cleanliness of premises and plant
- ***Regulation 18*** Designated areas
- ***Regulation 19*** Air monitoring
- ***Regulation 20*** Standards for air testing and site clearance certification
- ***Regulation 21*** Standards for analysis
- ***Regulation 22*** Health records and medical surveillance
- ***Regulation 23*** Washing and changing facilities
- ***Regulation 24*** Storage, distribution and labelling of raw asbestos and asbestos waste
- ***Regulation 25*** Interpretation of prohibitions
- ***Regulation 26*** Prohibitions of exposure to asbestos
- ***Regulation 27*** Prohibition of the importation of asbestos
- ***Regulation 28*** Prohibition of the supply of asbestos
- ***Regulation 29*** Prohibition of the use of asbestos
- ***Regulation 30*** Labelling of products containing asbestos
- ***Regulation 31*** Additional provisions in the case of exceptions and exemptions
- ***Regulation 32*** Exemption certificates
- ***Regulation 33*** Exemptions relating to the Ministry of Defence
- ***Regulation 34*** Extension outside Great Britain
- ***Regulation 35*** Existing licences and exemption certificates
- ***Regulation 36*** Revocations, amendments and savings
- ***Regulation 37*** Defence

Guidance

HSG 247 Asbestos: The Licensed Contractors' Guide
HSG 248 The analysts' guide for sampling, analysis and clearance procedures

Guidance: Asbestos Essentials

This document is a task manual for building, maintenance and allied trades on non-licensed asbestos work. It contains guidance and task sheets on working safely with asbestos and is aimed at all workers who may come into contact with asbestos.

CAR Regulation 3 – Exemption

Licensing, notification and medicals shall not apply if:

- Work is "sporadic and low intensity" which is defined as not exceeding 0.6f/ml over 10 mins
- The Control Limit is also not exceeded

Sporadic and Low Intensity Work

Examples of sporadic and low intensity (ie non-licensed) work are described on the HSE Asbestos Essentials web pages.

a) Minor repairs to AIB or removal of single small boards
b) Cleaning and repairs to asbestos cement
c) Removal of asbestos cement or asbestos cement debris
d) Removal of vinyl floor tiles
e) Removal of asbestos fibre gaskets and rope seals
f) Laying cables in areas containing undamaged asbestos materials

Impact of Recent EU Ruling

The EU has ruled the HSE did not fully implement the EU Directive with respect to "sporadic and low intensity" work. Short non-continuous maintenance activities should only apply to work on non-friable materials.

Removal of ACM with fibres firmly linked should only be on non-degraded materials and without deterioration.

The HSE have now introduced a new category of notifiable non-licensable work (NNLW) eg floor tiles, textured coating.

Exposure Limits

The Control Limit for all types of asbestos in the UK is (CAR 2012) 0.10 f/ml (also written as cm^3) averaged over a continuous 4 hour period.

There is also a peak (or short term) exposure assessment of 0.6 f/ml over 10 minutes.

The clearance Indicator Level for Certificate of Reoccupation is 0.010 f/ml

Exceeding the Control Limit

When on assessment the control limit is liable to be exceeded the employer needs a licence from HSE to carry out this work.

The work must be notified to HSE / EHO and employees must be under medical surveillance and the employer must monitor exposures of employees.

The area they will be working in will be Identified as an 'asbestos area' and eating, drinking and smoking must be prevented.

Other facilities such as welfare must also be provided.

The employer must minimise number of people entering the area.

There must be emergency procedures for dealing with unplanned releases of asbestos in place.

Clearance Indicator Level

This level is the lowest level reliably detectable above background but has no relation to "safety."

The limit of Quantification based on RICE counts on blank filters.

LOQ is still 20 fibres in 200 fields 0.01 f/ml for 480 litres and 200 fields counted.

LOQ must be quoted for each result.

Site Clearance

Control of Asbestos Regulations 2012

Regulation 17 relates to the cleanliness of premises and plant and states: "every employer shall ensure that the premises where work was carried out are thoroughly cleaned"

L143 ACOP states that "a thorough visual inspection to ensure all visible traces of asbestos and other dust and debris has been removed".

Also the completeness of removal of ACM and the presence of visible asbestos debris taken into consideration as to the presence of fine settled dust.

RPE

The Licensed Contractors' Guide states:

a) "You should not use RPE as your only control measure as RPE can only reduce exposure, not stop it."
b) "You must reduce asbestos fibre concentrations in air to a minimum before using RPE."

Disposable

RPE TYPE	Maximum Exposure	Daily Checks	Monthly Checks	6 Monthly Service
Disposable	2 f/ml	Fit Check	X	X

Half Mask or Ori-nasal

RPE TYPE	Maximum Exposure	Daily Checks	Monthly Checks	6 Monthly Service
Half Mask	2 f/ml	Recorded by User	Competent Person	X

Power Assisted

RPE TYPE	Maximum Exposure	Daily Checks	Monthly Checks	6 Monthly Service
Full Face Power Assisted	4 f/ml	Recorded by User	Competent Person	Service or maintenance centre

Maximum Dust Levels

Should not exceed 0.1 f/ml Control Limit multiplied by the Protection Factor

- Disposable FFP3 - 0.1 x 20 = 2 f/ml
- Orinasal - 0.1 x 20 = 2 f/ml
- Full face - 0.1 x 40 = 4 f/ml

In general analysts will use the types below;
P3 half mask which is suitable for most inspection, sampling and clearance procedures.
Full face power assisted respirator which is used for entry into live enclosure. May be use on spray coating jobs, and can be considered for complex 4 stage clearances involving lagging or AIB. A powered model may also be chosen for comfort and wear time restrictions.

RPE - Legal Requirements

RPE must be:

a) Be adequate and suitable for use
b) Provide effective protection
c) 'CE' marked
d) Selected, used and maintained by properly trained people
e) Correctly stored, maintained, examined and tested
f) Records of selection, maintenance and testing
g) Face fit test for the model issued

Fitting RPE

When using RPE the following checks must be carried out:

a) suitability of RPE (protection factors, filter type, etc.)
b) condition of RPE (straps, filters, mask body)
c) cleanliness
- ***Fit***

d) check position of straps – not twisted
e) check tension
f) hair not trapped under seal (full face)
- ***Check fit and seal***
- ***PPE - hood over straps (not straps over hood)***

Factors Affecting Performance

The guidance suggests that half mask RPE usage should not exceed 1 hour without a rest period. (HSE to review)

Also the following will affect the performance:

a) Not being clean shaven will affect the seal
b) Other facial hair may affect the seal
c) Check before and after use - by user
d) Check – filter/straps/visor/non-return valves/general condition.

Common Misuses of RPE

There are a number of common misuses of RPE which are listed below:

a) Facial hair
b) Failing to ensure that the RPE fits the wearer
c) Respirator left hanging around the neck
d) Using dirty, damaged or incomplete RPE
e) Failing to properly maintain the RPE
f) Leaving the mask lying around in the workplace

Face-fit Testing

Face-fit testing now applies to all users where RPE performance depends on the fit.

A test when first supplied and test for each RPE type/model.

A Re-test will be required if:

- *significant change in weight or*
- *major dentistry*
- *change of RPE type or manufacturer*

In HSG 247 it states that company policy could be retest between 1 or 2 years.

Quantitative fit testing – ori-nasal half masks and full face.

Qualitative – disposable masks

- *Simple pass/fail test using sweet tasting aerosol or odour*

Face-fit Testing – Quantitative

The 'Portacount' tester based on ambient aerosol counts is used (i.e. quantitative)

This requires activities during the test such as:

- normal and deep breathing
- turning head side to side and moving up and down
- physical exertion (e.g. bending - touching toes!)
- speaking (usually a set text passage)

Recent research shows up to 50% of all RPE does not offer the required level of protection as it simply does not fit!
www.Fit2fit.org is the competency scheme for Fit Test Providers.

Typical Questions from Unit 1

Q1. ***Briefly outline the requirements in regulation 4 (Duty to Manage Asbestos in Non Domestic Premises).***

Requires the dutyholder to identify asbestos locations, the type of asbestos present and its current condition. Then using the management plan ensure that potential exposure is kept to a minimum at least below the control limit, re-inspect on a regular basis to constantly assess the material and its likelihood of fibre release.

Q2. ***List two checks you would carry out on a half face filtering respirator.***

Check the elasticity of the harness
Check the inhalation and exhalation valves.

Q3. ***What is the maximum protection in f/ml a full face power assisted respirator gives?***

4f/ml

Q4. ***What is the minimum number of fields examined when reading slides for 4 stage re-occupation certification?***

200

Q5. ***List 5 properties of Crocidolite.***

It's blue in colour, hydrophobic, sharp springy elastic fibres, highly acid resistant.

UNIT 2

The theory of Air Sampling, Fibre Counting and Four Stage Clearance Procedures

Section 1: Asbestos Removal and Remediation

Plans of Work (POW)

A Plan of Work is a key safety document and should cover the following:

a) Names and address of the person you are contracted to.
b) Name, job title and telephone number of all relevant contacts (including supervisors).
c) Number of employees on site at any time.
d) When the work will be taking place including nights and weekends.
e) The names of any other license holder involved
f) Who will carry out the 4 stage re-occupation test and who are they contracted to.
g) How often will the supervisor be on site?
h) How viewing panels/Close Circuit Television (CCTV) will be used on site.
i) Who is allowed to amend the POW
j) Provide any survey details.
k) A written description of the work, its location and the removal method.
l) State the type, form, quantity and condition of the asbestos.
m) Provide details of any other precautions and risks.
n) Expected exposure levels during the removal exercise
o) Steps taken to reduce exposure
p) Provide a sketch plan showing, size of enclosure, position of viewing panels/CCTV,
q) Negative Pressure Units (NPU's), 'H' Type vacs, position of Decontamination Unit (DCU), transit/waste routes, position of bag locks/airlocks.
r) Volume of enclosure, size and number of NPU's and the air changes per hour.
s) Types of respirator used
t) Air monitoring and smoke testing arrangements.
u) How control measures are maintained and checked.
v) State tools and other equipment used (wet injection for pipe work) etc.
w) Entry & exit procedures, welfare facilities, waste disposal and emergency procedures.
x) Version of companies Standard Operating Procedures (SOP) in use.

Work cannot commence on site without a Plan of Work.

ASB5 notification

When licensed asbestos work is undertaken then notification to the enforcing authority is made at least 14days prior to the work commencing using the ASB5 notification form.
Notification is one of the conditions of owning an asbestos license.
The 14 day notification period can be waived by the HSE in certain circumstances. E.g. emergency situations.

Enclosures

Enclosures are required to:

a) Prevent the spread of asbestos (Reg. 16 2012 Control of Asbestos Regulations) 2012
b) To prevent the exposure of others (employees and others) who may be affected by the work. (Reg. 11 2012 Control of Asbestos Regulations) 2012
c) Enclosures are required for work on the most hazardous forms of asbestos.
d) Whenever there is a likelihood of spread of asbestos or surface contamination.
e) An enclosure will be required in most situations with the exception of minor activities described in 'Asbestos Essentials'.
f) Enclosures may not be required if the level of risk is low, the location is extremely remote, the work is at height and an enclosure is not practical due to the height or complexity of the structure.
g) Where there are practical difficulties in obtaining an effective seal on the structures or cleaning up of minor contamination.
h) Must be strong enough to withstand NPU pull and must include viewing panel or CCTV.
i) Airlocks should have weighted flaps on the inside of each section and must be at least 1m x 1m x 2m high unless inside housing and have a VP in the inner stage.
j) Separate baglock if space allows, must also have Vision Panel (VP) in inner stage

k) Three part warning notice on front of airlock/baglock.
l) Consideration to:
   i. *Pre-clean and protection of plant etc*
   ii. *Access provision*
   iii. *Transit routes*
   iv. *Other H&S risks eg heat stress, heights.*

   When checking against POW:
   - *Much can be done from outside the enclosure*
   - *Observe and validate against Plan of Work*
   - *Don't put yourself at risk*

Removal Techniques

The aim is to minimise exposure and prevent spread, so controlled wet removal is the key.

Dry stripping may be justified if fibre-release is otherwise controlled at source Local Exhaust Ventilation (LEV).

RPE should always be treated as the last line of defence.

Enclosures are about dealing with contingencies and preventing spread. Effective dust control is essential even though an enclosure is in place.

AIB should be removed whole if possible or with minimal controlled breakage.

Wet injection is the most effective way of controlling fibre release but operatives must be trained.

Wrap and cut methods are also acceptable but must be planned first.

Wet Removal (Injection)

There are a number of things that must be considered when wet injecting and these are listed below:

- Adequate soak time required
- Appropriate needles required
- Multi-point needle systems, at low pressure
- Proper dilution of wetting agent

Wet Removal (Spray)

This method of fibre control is used where injection is inappropriate. Spraying will generally wet the outer surface with minimal penetration but can be used in conjunction with other dust controlled techniques on:

- Thin sprayed coating.
- AIB removal
- Debris

Other Fibre Control Options

These include wrap & cut and glove bags.

Local exhaust ventilation (shadow vacuuming) can be used in conjunction with mist spraying on AIB.

Hydration gels used for textured coating removal.

Enhanced air management or better air flow is a very effective way of keeping fibre levels down during asbestos removal.

Encapsulation coating / injection is used where the asbestos is being left in situ but does make the asbestos insulation safer.

Blast Methods

Blast methods are not used for the removal part of the job but can be very effective when used to clean difficult surfaces such as porous concrete. Spray coating, lagging residue, boiler room walls are examples.

Examples of the types of blast methods are:

- *TORBO which is "The original dustless blasting solution" - blast abrasive mixture (80% blast media and 20% water) and extra water is metered as required*
- *Quill the "Precision dustless blasting system combines the simplicity of conventional dry blasting with the effectiveness of ultra high pressure jetting without the associated hazards and complications"*
- *Ice blasting which is similar to Quill but uses dry ice as the blasting media.*

The blasting medias vary depending on what system is used. Examples of which are: garnet /silicates/glass beads/ice.

The final finish is very good 'back to brick and slab' according to the manufactures. But It all needs to be cleaned up Including all the blasting media.

The problems with the systems are suitability of area for visual afterwards e.g. excessive moisture

The men carrying out the work may need air fed respirators for protection as excessive moisture may destroy the paper based filter normally used. There may also be a problem with excessive noise and hearing protection is usually mandatory on this type of work.

Decontamination

See Unit 4 for details.

Section 2: Fibre Counting and Air Sampling

Phase Contrast Microscopy (PCM)

The PCM method has been used since mid 1960s. It depends on difference in the refractive Index between particle and filter mountant (eg triacetin).

The PCM method was chosen because it is cheap, quick and easy, but…..

- Many fibres are too fine to be resolved
- No fibre identification possible
- Subjective interpretation of rules
- Poor accuracy and precision at low levels

Fibre Counting

A membrane filter is used made up of mixed cellulose ester. (eg Millipore)

Air is then drawn over filter via sampling head for the allotted time period necessary for that sample.

The filter is then cleared using acetone vapour.

The filter is mounted onto a glass microscope slide using triacetin.

Fibre Definitions – WHO Rules

Below are the World Health Organisation counting rules used at present.

a) Length > 5 µm; Width < 3 µm; L : W > 3 : 1
b) Touching particles – count fibre as if particle does not exist
c) Take 'average width' along the length of the fibre
d) Area of particulates and/or fibres ≤ one eighth of area - subjective estimate
e) Split fibres count as single fibre
f) Bundles – count fibres if distinct

Phase Contrast Microscopy (Technique)

This technique is used to make small, colourless, transparent objects visible (particularly at the limit of an optical microscope).

Phase contrast converts small phase shifts, introduced by the difference in RI between sample and liquid, into visible differences in the brightness of an image.

Setting up a microscope

Listed below are the requirements for setting up a microscope:

a) Kohler or Kohler Type illumination
b) Focussing of phase telescope
c) Walton-Beckett graticule
d) Stage micrometer
e) HSE/NPL test slide

Specification for a microscope

The specification starts with the microscopes ability to produce Koehler illumination. It does this by using a sub-stage assembly incorporating an Abbe or achromatic phase-contrast condenser in a centring focusing mount. The phase contrast centring adjusting must be independent of the condenser centring mechanism.

A 40x positive phase contrast objective with a numerical aperture of 0.65-0.70 and phase ring absorption range of 65-85% is also necessary.

Compensating eyepieces, preferably wide field, to give a total magnification of the microscope of at least 500x must also be in place.

With the eyepieces at least one eyepiece shall be independently focusing from that of the microscope, whilst the right hand eyepiece shall have a Walton-Beckett graticule engraved upon it.

Koehler Illumination

Koehler illumination is the procedure for setting up and adjusting the microscope to achieve the best possible combination of contrast and resolution. This system is used to provide illumination of variable area and aperture which is accurately centred to the optical axis of the microscope.

Achieving Koehler Illumination

Firstly, adjust the inter-pupilary spacing of the eyepieces to suit your eyes, which is best done by first focusing on an object on a slide. Use a previously mounted and counted slide, NOT any of the calibration slides provided for setting up the microscope.

The condenser will usually have settings of 0, 10, 20, 40 100 (or Ph1, Ph2, Ph3, Ph4, etc.) These indicate the annuli corresponding to the magnification of the various objectives. '0' is for 'open' or bright-field illumination

Set the sub-stage condenser to '0' setting and move it up to its highest setting beneath the microscope stage just not touching the slide. The markings may vary, but the objective will always be marked with the phase annulus that it is to be used with e.g. '10' correspond with 10x objective and '40' corresponds with 40x objective

Place the 10x objective in place for use with the '0' phase (bright field) annulus. Focus on the slide deposit and adjust the lamp brightness to a comfortable level and then close the field iris and focus its image by adjusting the condenser focus via the control beneath the microscope stage.

At this point centre the image of the field iris by using the centring adjustments provided to the field iris (or for some microscopes to the sub-stage iris).

Then open the field iris until the field of view is just fully illuminated, but no further.

When this has been done turn the phase ring to 10 or pH1.

To check the phase rings you replace one of the eyepieces with a phase telescope. At this point you should be looking at the back focal plane of the objective and you should see a dark phase ring objective.

It will be necessary to focus the phase telescope which is achieved by turning the telescope body.

Then close the aperture or sub-stage iris, seen in the back focal plane of the objective, by using the phase telescope to about two thirds of the diameter of the back focal plane.

Ensure that the dark phase ring and bright phase annulus are concentric (i.e. lie centrally within). Use adjustment screws or by manual manipulation of the phase annuli only. Do not move the sub-stage condenser, as appropriate for that microscope. Then replace the telescope with the eyepiece to restore the image of the sample.

Then ensure that the image of the field iris is just out view.

At this point Koehler illumination has now been achieved.

Then adjust focus and lamp brightness if required. Adjust focus and lamp brightness if required and ensure that the field iris is open sufficiently for it to be JUST outside the field of vision at all times during fibre counting.

During the process of setting-up, checking and slide counting the focus of the field iris should be refocused between each slide.

Walton-Beckett Graticule

This graticule is specified in the method and it should be placed in the focusable eyepiece and brought into sharp focus.

The graticule must to be between 98 and 102 microns and calibrated at 50 x 2 microns. Place the micrometer onto the stage and locate the 'target' area (can be located more easily under 10x magnification).

Superimpose the image of the stage micrometer over the graticule and read the diameter from the stage micrometer to the nearest micron. The left hand edge of the 'target' should be placed over the 0 value. The value of the graticule taken from the number/line beneath the right hand edge.

The diameter of the graticule should be between 98 and102microns, if not the graticule cannot be used.

HSE Test Slide

The slide contains lines that are shallow v-shaped grooves made by engraving with diamond stylus and then reproduced in plastic replicas.

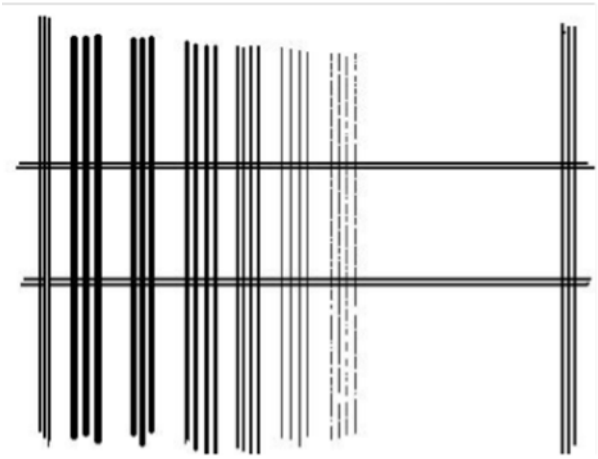
Extra weight on stylus increases depth and width of lines. There are:

- Aspect ratio (width : depth) = 10 : 1
- Width of band 5 is 0.44 µm
- but finest visible fibres are 0.2 - 0.3 µm (depends on difference in RI)

New (Mark 3) slides may be either

- Band 4 (red label)
- Band 5 (green label)

Place the HSE test slide onto the stage then locate the 'Tram Lines' which run across the slide and hold the bands to be viewed. This can done by focusing onto the slide surface and gently focusing up and down until the lines come into view whilst gently moving the slide in either X or the Y direction.



HSE Test Slide

There is a Handy Tip! - Once the bands have been located the analyst may record the position of these bands from readings given on the x-y stage.

If the analyst has difficulty in locating thebands, view the Test Slide under 10x magnification but The bands and tram lines will be seen as light upon a dark background.

The first set of bands of lines to viewed will be found to the left of the slide adjacent to a set of lines (3 in number) which are of the same thickness as those of the tram lines. There is another set of these lines at the right side of the set of bands.

Obtain the sharpest focus on the first set of bands refocusing the field iris and if necessary adjust the brightness of the lamp if this helps to provide the sharpest image.

If Band 5 cannot be seen then the microscope is not sensitive enough and the analyst may under-count the number of fibres present.

If Band 6 or above can be fully seen then the microscope is too sensitive and the analyst may then over count the number of fibres present.

All test slides are now certified by the Health & Safety Laboratories (HSL) and should be checked and re-certified on a regular basis.

WHO Counting Rules

A countable is defines as any object which is longer than 5µm with a width less than 3µm and a length: width (aspect) ratio greater than (>) 3:1.

Graticule

HOW MANY COUNTABLE FIBRES?

A countable fibre with both ends inside the graticule area counts as a single fibre.

A countable fibre with only one end inside the graticule area counts as half a fibre.

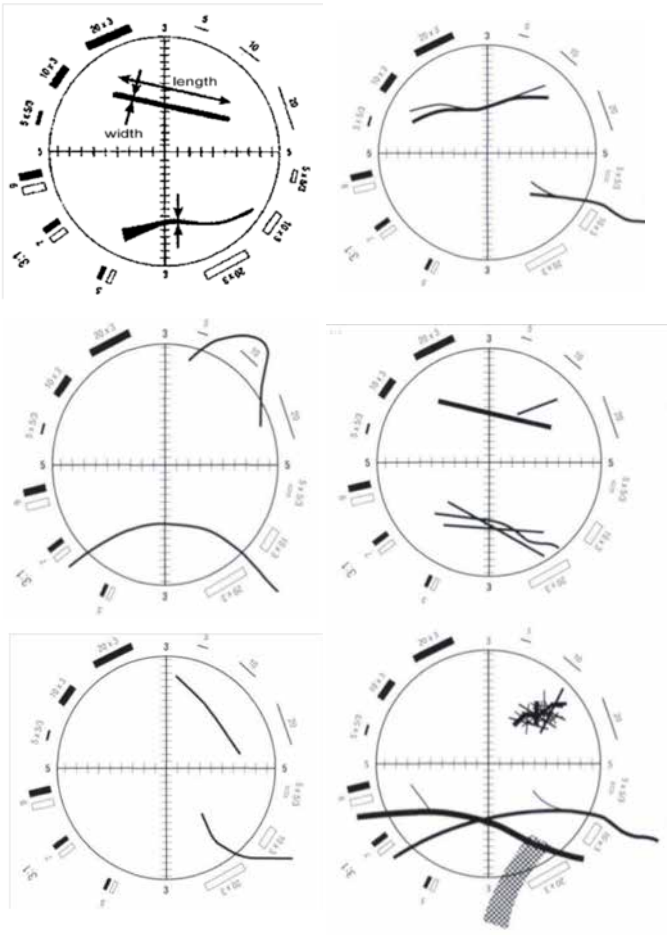
A fibre which passes through the graticule area but which does not have an end in the area is not counted.

There is no upper limit to fibre length.

A split fibre is taken to be one countable fibre if it meets the above definition otherwise it should be ignored.

A split fibre is defined as an agglomerate of fibres which at one or more points on its length appears to be solid and undivided but which at other points appears to be divided into separate strands.

The width of a split fibre is measured at the undivided part, not the split part.



Fibres in a bundle are counted individually if they can be distinguished and meet the definition above.

If no fibres can be distinguished, then the bundle is taken to be countable fibre provided that the bundle as a whole meets the definition above.

This means in most cases a bundle will not be countable.

If the width of the fibre varies along its length, a representative average width should be considered.

If more than one-eighth of the graticule area is obscured by an agglomerate of fibres and/or particles, the graticule area must be rejected as uncountable and another field is to be counted.

Where the filter contains too much particulate (greater than one eighth of the graticule area), the number of rejected fields should be counted and the result annotated accordingly if the number of rejected fields exceeds 10% of the counted fields.

If the analyst judges the slide to be biased or uncountable this should also be noted on the final report.

Graticules areas for counting are chosen at random within the exposed filter area to avoid bias in counting.

Where bulges of resin, for example, are seen on the fibres, the average diameter of the fibre should be taken.

Fields lying within 4mm of the filter edge (or 2mm of a cutting line) should not be counted.

Fields should also be rejected if a filter grid line obstructs all or part of the field of view.

The microscopist judges that fibres are so obscured that they cannot be counted reliably.

In the case of compliance air testing: at least 100 fibres must be counted or 100 graticules inspected which ever is reached first.

And at a minimum at least 20 graticules must be inspected even these contain more than 100 fibres.

For Clearance, background, leakage and reassurance testing 200 graticules must be inspected for a 480 litre sample volume (The current Regular Interlaboratory Counting Exchange (RICE) scheme rules specify 100 fibres or 200 fields, whichever is reached first, with a minimum of 20 fields).

Calculations

Density is expressed as f/mm^2 (no volume required).

Concentration is expressed as f/ml of air (volume required).

Remember - f/cm^3 is the same as f/ml.

There are two ways in which results of fibre counts are expressed, firstly as fibre density on the filter in fibres/mm^2 .

This would be used for example for RICE slides or internal quality control slides where we do not know (or are not interested in) the actual sampled volume of air and we only want assess a counters ability to produce an accurate result.

We need to calculate the observed graticule area from the measured diameter.

- Graticule area, $A = \frac{\prod d^2}{4}$
- where d = measured diameter of the graticule in millimetres, therefore we need first to convert our measurement made in microns
- $\prod$ = pi = 3.14
- d = 100 µm = 0.1mm
  1,000
- Hence $A = \frac{3.141 \times 0.12}{4}$

So A = 0.00785 mm^2

If the graticule diameter is measured and found not to be exactly 100 µm then the area must be calculated as above using that measured diameter.

Q: Calculate the graticule area corresponding to the measured diameter for the following $(A = \frac{\prod d^2}{4})$:

- Diameter (µm) Area (mm^2)
  98
  99
  100 0.00785
  101
  102

Calculations – Fibre Density

The total area examined is then the number of graticule areas counted multiplied by the number of graticule areas.

- Density = (No. of Fibres)
  (No. of Fields x Graticule Area)
- Expressed as f/mm^2
- e.g. for a slide with 102 fibres counted in 41 fields, and a graticule diameter of 102 µm, (A=0.00817mm^2), the fibre density would be;
- Density = $\frac{102}{(41 \times 0.00817)}$ = 304.5
- e.g. for a slide with 32 fibres counted in 200 fields, and a graticule diameter of 100 µm, (A=0.00785mm^2), the fibre density would be:
- Density = $\frac{32}{(200 \times 0.00785)}$ = 20.4

Q: Calculate the following fibre densities

- 1. Fibres counted =11, fields = 200 and graticule diameter = 98µm
- 2. Fibres 63, fields = 200 and graticule diameter = 102µm
- 3. Fibres =100.5, fields = 84 and graticule diameter = 100µm

Limit of Quantification (LOQ)

- LOD = 0.01 x 200 x 480
  (No. of grats. x Vol.)

Or for the calculator finger:
= 0.01 x 200 x 480 ÷ No. grats. ÷ Volume

Based upon samples being evaluated in an environment free from contamination, otherwise the LOQ may differ

Sample Volume	*No. of Fields*	*LOD f/ml*
480l	200	0.01
40l	200	0.12
40l	100	0.24

Based upon samples being evaluated in an environment free from contamination, otherwise the LOQ may differ

Calculations – Concentration

Alternatively, we can express the amount of fibres as a concentration in fibres/ml.
We need to know the observed filter diameter (D) in millimetres and the sampled volume (V) in litres.
The Analysts' Guide states;

- $\frac{1{,}000 \times N \times D^2}{V \times n \times d^2}$ = f/ml

Where:
N = No. fibres
D = Diameter of exposed filter(mm)
V = Volume (l)
n = Number of graticules
d = Diameter of graticule(µm)

Q: Calculate the concentration of fibres from the following data:

Fibres = 16.5, fields = 200, exposed filter dia.= 22.5mm, graticule diameter = 102µm and volume 480l

Q: Calculate the concentration of fibres from the following data:

Fibres = 23, fields = 200, exposed filter dia. = 23.7mm, graticule diameter = 98µm and volume 480l

Q: Calculate the concentration of fibres from a personal test based upon the following data:

Fibres = 17, fields = 100, exposed filter = 22.5, graticule diameter = 100µm and volume 40l

What is the limit of detection for this test?

How would you report the above result?

Results to be reported as:

- Below 0.01 f/ml = <0.01f/ml
- 0.010 to <0.015f/ml = report to 3rd decimal place

- >0.015 f/ml = report 0.02, 0.03 etc. as appropriate
- When a result comes to exactly a mid-point value
- i.e. 0.25, then the number should be rounded either up or down to the nearest even number

Limitations of the method

This method of fibre counting can lead to large inter observer differences in results.

Tests have repeatedly shown large differences between;

- laboratories apparently using the same method
- between counters within the same laboratory
- between results from counters at different times

Counting precision depends on the number of fibres counted and the uniformity of the fibre distribution on the filter.

Microscopists generally undercount dense deposits.

When sampling fibres in atmosphere relatively free from interfering particulates, the density range for optimum accuracy should be in the range of 100-650 fibres mm^2, but can be stretched to 1000f/mm^2

Densities above this may result in under estimates.

In mixed dust situations, the presence of other fibres and particles may interfere with the accuracy of results.

Quality Control

The external scheme (RICE) is administered by Health & Safety Laboratories (HSL) and compares different counters at different laboratories.

Internal scheme

1. Reference slides
2. Replicate counts

With the Regular Interlaboratory Counting Exchange RICE scheme a Category I laboratory is one where > 75% of reported results are in band A (range of results to be within 0.65 - 1.55).

A Category II laboratory is one where >75% of results are in either band A or B.

Otherwise Category III – classed as "unsatisfactory".

The sources of possible error can be attributed as follows:

a) Equipment - microscope, graticule
b) Materials - membrane filters
c) Operator
d) Sampling
e) Environment

Equipment

Clearly the optical performance of the microscope is of paramount importance. At the start of each counting session, check:

a) Condenser focus and centring
b) Phase ring alignment
c) Graticule diameter
d) HSE Test Slide performance

Before each slide, quickly recheck the condenser focus and centring.

Maintenance of Equipment

Microscopes must to be serviced every year.

Master flowmeter to be calibrated yearly.

The Rotameter/flowmeter to be calibrated monthly.

Sampling pumps to be calibrated every 6 months.

Tally Counters to be calibrated every 6 months.

Stage micrometer to be calibrated every 6 months.

Master stage micrometer to be calibrated every 5 years

Materials - Filters

Particularly when working at the limit of detection blank filter fibre levels may be quite significant and therefore checked for each new batch of filters by selecting 4 filters from each new batch (or a minimum of 1% from larger batches).

Typical levels of blanks should not be more than 3 fibres per mm^2 or 2.5 fibres per 100 fields.

Field blank - subjected to site treatment normally for each job.

Materials - Liquids

Acetone and triacetin should be checked periodically to ensure that they are free of contaminating particles and that the triacetin is not breaking down due to hydrolysis (odour of acetic acid).

Operator

Inter and Intra-laboratory counting performance checks are essential. External schemes such as RICE check that laboratories are all counting to the same standard.
Internal schemes are needed to check the performance of individual operators and should be based on a proportion of work slides as well as reference slides.

Sampling

Errors in sampling mostly be derived from inaccuracies in the measurement of flow rate and (to lesser extent) sample times. Contamination of filters can potentially be introduced by the use of dirty filter heads and O-rings. These must be cleaned after use and before reloading. As a check, one filter head in 25 should be loaded and taken to the sampling site but not used. It should then be mounted and counted as a blank to check for the absence of contamination.

The blank count should typically not exceed 2.5 fibres per 100 fields.

Environment

When sampling and counting on site it is important to undertake air tests to ensure that any airborne fibres in the area set aside for microscopy are not likely to contaminate the filter and enhance the overall results.

Filters should loaded and unloaded in a clean environment to reduce the risk of contamination.

Obtaining accreditation under ISO 17025 for the test procedure further ensures that the level of training, the quality of equipment and materials, and the implementation of internal and external quality schemes (e.g. RICE) will provide results of the highest quality and consistency for that test methodology.

Counting audits where a counters result is checked by another approved counter(s) also gives another means by the quality of issued results can be maintained/checked.

A United Kingdom Accreditation Service (UKAS) accredited laboratory must keep counted slides for 6 months after being analysed. A UKAS accredited laboratory must keep all documents associated with analysis for 5 years.

If the analysis was in relation to personal/compliance sampling then these documents must be kept for 40 years along with the main medical records for that individual.

Air Sampling Procedure

Samples are taken by drawing of a known flow rate of air through a filter for a measured time collecting airborne particles.

The filters are then prepared for examination under the microscope.

A known fraction of the filter is examined using 500x phase contrast microscopy and counting fibres in accordance with given rules.

Open-faced filter holder fitted with an electrically conductive cylindrical cowl exposing a circular area of filter at least 20mm in diameter.

The cowl should extend 1.5-3.0 times of the effective filter diameter to protect the sampling filter from the impact of large particles.

The exposed area/diameter of filter must be known and measured to the nearest millimetre (±5%) for each type of cowl or O-ring in use.

Air Sampling – Membrane Filters

The filters used should be 25mm in diameter with a printed grid. Printed grids are on the sampling side of the filter and will be in the same plane as the particles collected.

The filters must be of mixed esters of cellulose or cellulose nitrate, of pore size 0.8 to 1.2 µm (optically clear grade).

Air Sampling – Sampling Pumps

Must have the ability to give a smooth airflow being capable of to be set to within ±10% for flow rates <2l/min and within ±5% for flow rates >2l/min. They must maintain this flow rate to within ±10% during the whole period of sampling.

Air Sampling – Flowmeters

The flowrate ust be measured by a working flowmeter (aka rotameter), sufficiently sensitive to be capable of measuring the appropriate flow rate to within the values specified (±5% or 10% of required value). This has been calibrated against a primary standard (up to 16 l/min is permitted).

Air Sampling – Equipment

Under normal operating conditions, small changes in temperature and/or pressure will only make small difference to the uncertainty. With Temperature changes of 30ºC between calibration and use will affect flow rates by about +5% .

Pressure changes of +40 millibars between calibration and use will affect flow rates by about -2%.

Air Sampling – Procedure

The equipment used is as follows:

a) Acetone/triacetin hot block method
b) Slides: conventional type: i.e. approx. 76mm x 25mm and 0.8mm to 1.0mm thick
c) Coverslips - 25mm diameter or about 25mm^2
d) must be Size 1.5 (or 0.16) to 0.19mm thickness.

Filters must be loaded in a clean atmosphere using tweezers to prevent possible contamination. Use a 'dummy' filter to set the flow rate of the pump to the required rate, where possible to produce a fibre density of 100-650 fmm^2; although this can be extended up to 1,000 fmm^2.

The filter is then capped and taken to the sampling point.
At the start of the sampling period, the protective cap must be removed from the filter holder, the pump started and the time noted. Flow rate should be measured and recorded at the start and end of the sampling period.

The sampling period must be measured to within ±2.5% .

The average flow should be calculated.

Where there are variations in flows between the start and the finish of the sampling period should not exceed ±10% or the sample shall be rejected.

It is important to the test result that:

a) flow rates are set and recorded as accurately as equipment permits
b) time of sampling is recorded as accurately as equipment permits
c) temperature and pressure are recorded as accurately as equipment permits.

Sampling Situations

Types of Static sampling:

a) background (e.g. prior to work beginning)
b) leak (at the start of work) - often with reduced volume
c) pre-entry enclosure checks?
d) clearance (with dust disturbance)
e) reassurance (post removal of enclosure)

Personal sampling

a) compliance with Control Limits
b) health surveillance exposure records
c) check suitability of RPE
d) check effectiveness of controls (eg wet stripping)
e) future risk assessments

Background and Reassurance:

a) Distribution of measurement points should cover likely sources of fibres and areas of frequent occupation.
b) To achieve the quantification limit (0.01 f/ml) each measurement must be from a total of at least 480 litres in volume.
c) Fewer measurements may be generated for sampling for certification of reoccupation

Leak Testing

a) Determines whether the integrity of the enclosure
b) Supports initial smoke test and frequent visual inspections of enclosure during removal work
c) Sample locations
   i) by airlocks and baglock
   ii) near NPU exhaust
   iii) in (or near) occupied areas
   iv) by vulnerable areas

Flow rates and volumes

a) flow rate as high as possible (up to 16 l/min)
b) sample volume up to 480 litres if possible
c) short sample time needed to take rapid action if needed
d) Sample at head height (approximately)
e) No dust disturbance (outside the enclosure)

Personal Sampling

Locate on the lapel within 200mm of breathing zone on higher concentration side. Ask the operative if he is left-handed / right-handed. The sampling head must be away from exhaust from RPE and ensure that sampling tubing will not snag in use.
The sampling head must point downwards and measure concentrations not corrected for protection factor for RPE.
Compliance samples must be at 1 l/min over 4 hours. Other personals at suitable flow rate and time may be used.

Sampling for Site Reoccupation Certification

Sampling for site reoccupation only takes place when the enclosure is dry and a visual inspection confirms free from debris and dust. Sampling equipment to be distributed throughout the enclosure with at least half the samplers close to, or underneath where the asbestos was removed.

4 Stage Clearance Procedure:

Sampling heads should be located at a height of between 1-2 m from the floor, filter holders pointing downwards. In tall enclosures (e.g. vertical pipework or lift shafts), samplers should be placed at representative heights.

There must be at least two measurements (unless the volume of the enclosure is less than 10m^3, in which case one is adequate).

With that overriding condition, the number of samples should be at least, the integer next below (A1/3 - 1) where A is determined as follows;

If the enclosure is less than or equal to 3m in height, or in enclosures which are higher than 3m but where exposure is likely to be at ground level only, A is the area of the enclosure in square metres.

In other cases, A is one third of the enclosure volume in cubic metres; if there are large items of plant (such as boilers) in the enclosure, their volumes may be subtracted from the enclosure volume before calculating A.

Each measurement must of a sample volume of at least 480 litres.

Q: An office has AIB ceiling tiles. The enclosure measures 20m by 30m. What is the minimum number of samples that can be taken during clearance?

Q: An enclosure to a boiler room measures 30m by 25m with a height of 8m. What is the minimum number of clearance tests required to be taken by the analyst?

It is permissible to achieve a measurement by pooling two or more simultaneous or consecutive samples to give a total of at least 480 litres.

Pooled samples should be taken within 1m of each other and are regarded as a single measurement with the volume and fibre counts being pooled together.

When pooling samples the fibre count and the volume sampled will be combined.

The other parameters remain the same for each test i.e. filter area, graticule area, and number of graticules counted. Where a differing number of graticules and fibres are counted from each sample then these must be brought together under a common denominator e.g. for compliance monitoring to Control of Asbestos Regulations 2006 where 100 fibres are counted in 91 fields and 101 fibres in 95 fields, then:

$$\frac{95 \times 100}{91} = 104.4 \text{ fibres in 95 fields}$$

Therefore total number of fibres counted

= 104.4 + 101 = 205.4 in 95 fields

Section 3: Procedures for Site Clearance

The Legal Requirement

The Control of Asbestos Regulations 2012:

1. Reg 17 – cleanliness of premises and plant 'every employer shall ensure that the premises where work was carried out are thoroughly cleaned'

2. L143 ACOP – "a thorough visual inspection to ensure all visible traces of asbestos and other dust and debris have been removed".

Completeness of removal of ACM and the presence of visible asbestos debris also presence of fine settled dust.

L143 ACOP – 4 stage clearance and Certificate of Reoccupation.

Stage 1 – Site Inspection

Check Plan of Work

a) Is there one on site?
b) Is it specific to the work and accurate?
c) Does the plan match the site set up?

Check DCU is connected, clean and working then Inspect general condition of enclosure including sheeting, airlock flaps notices. Check the negative pressure unit on and working and the routes from airlocks/baglocks to skip and DCU are clearly marked.

Check for presence of obvious asbestos debris by Inspecting the enclosure through viewing panel looking for waste, debris, adequate lighting, dry and non asbestos hazards.

Stage 2 – Visual Inspection

CAR Reg 17 – cleanliness of premises and plant.

A thorough visual inspection to ensure all visible traces of asbestos and other dust and debris have been removed looking for:

a) Completeness of removal of ACM
b) Presence of visible asbestos debris
c) Presence of fine settled dust

HSG 248 - repeats the above 3 requirements.

All stripped surfaces and enclosure must be inspected thoroughly and methodically by starting at first stage of airlock.

Use enhanced inspection methods such as a torch, screwdriver or mirror.

Check for areas sheeted out inside enclosure for signs of debris. Also check evidence of PVA sealant on stripped surfaces.

Any asbestos not being removed must be sealed and in good condition.

Plant Room Enclosures

Areas to concentrate on when carrying out a visual inspection are as follows:

a) Backs of pipes and vessels
b) Support brackets and clamps on pipes and vessels
c) Nuts and bolts or flanges and hatches of vessels and pipework
d) Screw holes, or around nails and battens for AIB tiling
e) Cable trays and conduits, especially if they have a metal mesh construction
f) All horizontal ledges, shelves, window sills etc
g) The undersides of boilers and tanks, either attached or loose
h) Rough porous brickwork, eg breeze block and rough concrete
i) Holes in walls etc, where pipes, cables or steelwork pass through

j) Drains, sumps and culverts
k) NPU on during visual inspection
l) Access to all areas in enclosure including high levels
   i) tower platform or step ladder must be present if needed
   ii) torch or good lighting, scraper, mirror, wipes
m) All other equipment and waste removed before visual
n) Area must be clean and dry
o) Natural water may have to be accepted

Stage 2 – Problem Areas

When carrying out stage 2 there may be problems such as:

Dirt floors.

Remove top layer, inspect and then seal
'Limpet' on concrete or with bitumen layer
Inspect - and if not reasonably practicable to do more, then seal and continue.

Wet areas

Get plumber (under supervision) to fix leaks once area virtually clean and free of asbestos.

Friable dusty surfaces

Air test without sealant first; if it fails again, seal after inspection, but only on instruction by the analyst.

ACM remaining

Seal and make note in Certificate of Reoccupation.

Factors affecting the visual process

a) Experience of the analyst
b) The removal process – ie blasting and problems associated with it
c) Size of area
d) Access equipment
e) Time pressures
f) Contractor

Stage 3 – Clearance Sampling

The NPU is normally capped and then switched off before starting air sampling.

Enhanced dust disturbance methods must be employed such as:

- brushing is now required standard method
- with broom if > 20 m^2
- wafting clipboard, overalls or using hand is insufficient
- HSE found leaf blower was most effective method but hardly practical or realistic

Dust disturbance must be for at least 1½ minutes around each sampling pump.

Sample numbers based on enclosure size are as follows:

- whole number next below (A1/3 - 1)
- where A is area in m^2 - or ⅓ volume in m^3 if height > 3m
- use 'area' if all exposure at floor level
- allowed to deduct volume of sheeted out plant,
- one sample only if volume < 10 m^3 (use pooled samples?)

The sample volume must be at least 480l per sample. Pooled samples within one metre of each other are accepted.

The enclosure cannot be removed until air test passed with at least 80% samples must be < 0.01 f/ml. None of the samples should be > 0.015 f/ml.

If <5 samples have been taken then all results must be < 0.01 f/ml.
The 80% rule applies only if:

- at least 80% samples must be <0.010 f/ml
- none > 0.015 f/ml
- So if 4 samples or less, all results must be < 0.010 f/ml
- If 5 samples, 1 result can be between 0.010 and 0.015 f/ml
- If 10 samples, results can be between 0.010 and 0.015 f/ml
- And so on

Stage 4 – Post Removal inspection

When the air test has passed and the enclosure has been removed a thorough visual must be conducted concentrating on and including transit and waste routes. Check for debris trapped in sheeting or under floor. The Type-H vacuum must be present during this process to deal with any potential dust or debris.

In worst cases, contractor may be required to reinstate enclosure!

Air sampling may be appropriate, or stipulated by client during the removal of the enclosure.

Once all 4 stages have been completed to satisfaction of the analyst the "Certificate for Re-occupation" can be issued to contractor and to client.

The inspection must be conducted by a 'Competent Person' with adequate training, qualification and experience and must be independent of contractor.

Hygiene Unit Inspection

When the 4 stage reoccupation test is complete then the DCU must be tested.

A thorough visual inspection should be conducted together with air sampling in both the shower and dirty end section of the DCU.

You may use 1 sample with door propped open between the sections if floor area < 10 m^2. It must be clean and dry - stages 2 and 3 only. The inspection is not needed if the DCU is moved to another area on same site. Also the test is not needed if unit moved for security reasons.

Typical Questions from Unit 2

Q1. ***List 5 things you would expect to see in a Plan of Work.***

A. Start and finish times
B. What is being removed?
C. Removal techniques in use
D. Who will be conducting the 4 stage reoccupation test?
E. Who is allowed to amend the Plan of Work?
F. A plan drawing of the work with transit/waste routes, DCU location.

Q2. ***List 5 things you would expect to see on a working asbestos enclosure.***

A. Airlock/Baglock
B. Appropriate warning signs
C. Vision panels/CCTV
D. Working NPU
E. Type-H vacuum cleaners

Q3. ***What is the most appropriate removal technique for the removal of pipe work insulation?***

Multipoint Needle Injection.

Q4. ***Give 2 examples when an enclosure for asbestos removal would NOT be necessary.***

A. If the work will generate fibre levels below Sporadic Low Intensity as defined. (0.6f/ml over 10 mins).
B. If it is not practicable to build an enclosure. E.g. remote location.

Q5. ***What is the WHO definition of a respirable fibre?***

A. A fibre that is >5microns in length.
B. A fibre that is <3microns in width.
C. A fibre with an aspest ratio of 3:1.

Q6. ***What is the purpose of the Stage Micrometer?***

To measure the Walton-Beckett graticule located in the microscope eyepiece.

Q7. ***What instrument would you use to check the phase rings on your microscope are in alignment?***

Phase Telescope

Q8. ***List 5 things you would expect to see on a fully operational Decontamination Unit (DCU).***

A. Dirty End and Clean End
B. Self closing doors
C. Warning sign on the Dirty End door
D. Gas Certification
E. Air test from the last time it was used.

UNIT 3

Practical Air Sampling, Fibre Counting and 4 Stage Certificate Reoccupation

Section 1: Carry out air sampling and fibre counting

The Sampling Equipment used are as follows:

Filter heads

- 'cowled' to protect filter and produce even deposit
- extending between 1.5 – 3 x exposed filter diameter
- elutriation effect of cowl very small – if any
- PTFE O-ring (not black neoprene)

Filters

- Nominally 25 mm diameter
- Exposed diameter should be 22-23 mm but must be at least 20mm

When measuring the exposed diameter from dusty filter you can use:

- stage verniers on microscope
- vernier callipers on slide

The open face filter-heads are now not permitted and the filter heads must be cleaned between samples with a wet-wipe. The cowls themselves must be conductive black plastic or aluminium (not anodised). The caps or bungs must be made of conductive material. The sampling heads must be sealed in transit to and from the sampling point.

Flow Measurements

When measuring flow rate a rotameter (flowmeter) is used. The sampling head is placed over the top of the flowmeter and the flow measured by reading the top of the rotameter. The rotameter must be spinning and the white spot on the side of the rotameter is there to show it is spinning.

Some sampling pumps have built in flowmeters. These can only be used as indicators.

The measurement scale must be sufficiently sensitive e.g. up to 16 l/min for high flow pumps only and a more sensitive flowmeter for personal sampling exercises.

The calibration of the flowmeters are as follows:

- Calibrate reference rotameter annually
- Calibrate working rotameters - monthly or quarterly

The flow must be measured at start of sampling either at airlocks or in enclosure (check your procedures!) and at the end of sampling period before switching the pump off. Intermediate flow checks at hourly intervals can also be taken if sampling for longer periods of time.

You take the sample flow rate as an average of initial and final flow rates (if change <10%). If the flow rate change is > 10% then the sample is rejected.

The temperature and pressure readings are also measured at sampling position.

Sampling Pumps

There are a number of different types of sampling pump in use such as:

- Low/medium flow - 1 to 4 litres/minute
- High flow - 5 to 16 litres/minute

The higher flow pumps require larger battery therefore they are much heavier.

Pumps must be able to maintain stable flow (± 10%) over sampling period and flow controlled to allow for changing pressure across filter.

Also, they must be pulse-free (damped?) and allow flow to be set to ±10% (± 5% if > 2 l/min), also be independent of orientation (for personal samplers).

Static samples should be carried out between 1 - 2 m above floor which represents the breathing zone.

When Sampling is not Appropriate

Sampling may not be appropriate when there are good reasons to expect levels will be well below the relevant control limit or when removal work has been done externally e.g. soffits (without enclosure?)

Also single short events where the detection limit would be above control limit and where adequate information is already available. Sometimes RPE/PPE provided is such good standard that highly improbable any measurement could demand a better standard e.g. breathing apparatus.

Section 2: Carry out 4 Stage Certificate of Reoccupation

Enclosures

An enclosure is a physical barrier erected around the asbestos work area which is sealed to minimise leakage, so that, (as far as reasonably practicable):

a) spread of asbestos is reduced or prevented (CAR Reg 16)
b) exposure to asbestos is reduced or prevented (CAR Reg 11)

Design of Enclosures

Enclosures should be designed with a view to consider:

a) Site clearance and reoccupation
b) The size and shape of the work area
c) Ensuring the enclosure is as air tight as possible
d) To have sufficient and uniform negative pressure within the enclosure
e) Sufficient air movement through the enclosure
f) Safe and easy access for personnel, equipment and waste
g) Robust for the conditions
h) Ensure where machinery cannot be isolated that it is adequately protected
i) Security and prevention of damage
j) Provision of vision panels or other methods of viewing the works i.e. CCTV units
k) Actions to take in an emergency
l) Reduction of temperature within the enclosure (shading from sun, radiant heat)
m) Create a series of small enclosures rather than a single unit where possible
n) Exclude ventilation ducting if possible
o) Exclude smoke alarms
p) Not obstruct fire exits
q) The enclosure should be designed and constructed to ensure that asbestos materials are not disturbed until construction of the enclosure is complete

When is an Enclosure Required?

An enclosure is required for Work on the most hazardous forms of asbestos or whenever there is a likelihood of spread of asbestos or surface contamination.

They will also be required whenever there is a likelihood of exposure to asbestos.

With asbestos removal, an enclosure will be required in most situations with the exception of minor activities described in Asbestos Essentials.

When is an Enclosure Not Required?

Enclosures are not always required and listed below are some examples:

a) The level of risk is low
b) If the location is extremely remote;
c) The work is at height and an enclosure is not practical due to the height or complexity of the structure
d) Where there are practical difficulties in obtaining an effective seal on the structures
e) Cleaning up of minor contamination

Site Set Up

The DCU should be set up and operational prior to the work starting.

The site supervisor must carry out pre-work inspection of the planned enclosure area, surrounding places such as transit and waste routes and the area immediately next to the enclosure.

He then assesses the extent of pre-cleaning of the area to be enclosed and the immediate surrounding areas.

The work area has to be free from items of plant, equipment and furniture as far as possible so all mobile or portable items should be removed. The items that have been pre-cleaned should be protected to prevent contamination.

All boiler flues should be sealed and all live operating machinery Isolated within the enclosure.

The floor area should be covered impervious layer, eg double-sheeted polythene or "Corex"

Airlocks and Baglocks

Construction of Airlocks

Airlocks must be:

a) 1M x 1M x 2M in dimension
b) Made from 1000 gauge polythene
c) Have weighted flaps on the inside that close

Smoke testing

Before work commences a smoke test of the enclosure must be carried out with the NPU switched off and the enclosure must be examined regularly, as a minimum at the start and finish of each shift.

Standard of material

Polythene

1000 gauge polythene (how do you know) or flame retardant (fire retardant?).

Tape

Four inch cloth tape 75mm width.

Most contractors use 50 x 50mm (what happened to good old 4" by 2"?). The vertical supports no greater than 1.5m apart, ideally 1.2m.

DCU Signage

The Clean end of the DCU has to display "CLEAN END" and "Black Hand" signage.

The Dirty end of the DCU has to display "DIRTY End" and, "Black Hand" and 2 part PPE signage.

The Shower compartment coming in from clean end has to show 2 part PPE signage.

There are a number of optional signs that have been uses such as:

a) prohibiting smoking/eating/drinking
b) no towels in shower,
c) RPE on door from shower to dirty

Air Extraction Equipment

The air extraction equipment is used to minimise fibre release from the enclosure, purge the air lock system and to change the air in the enclosure thus creating good air flow.

Calculation of Air Extraction Rate

To calculate the total volume of the enclosure the following formula is used:

a) Width x Length x Height in metres
b) Multiply by 8 (air changes per hour)
c) CFM being phased out

This will give you an indication of what size NPU to use. NUP's should be rated in metres/hour.

This applies to enclosures over 120m^3 in size if <120m^3, 1000m^3/h negative pressure must be applied to the enclosure.

Negative Pressure Unit (NPU) Performance

Smoke testing can reduce the pressure differential which can usually be restored by replacing pre-filter.

The temperature may affect the NPU performance – as air temperature falls, air density increases and negative pressure drops.

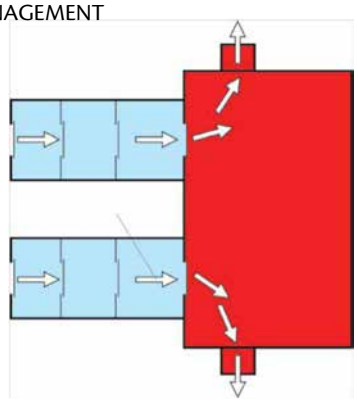
Moisture and metal fume may also have a detrimental effect on High Efficiency Partical Arrestor (HEPA) filter (no protection by pre-filter).

The wind can also cause problems and the NPU exhaust should be screened from effects of wind (beware windows, doors, lifts).

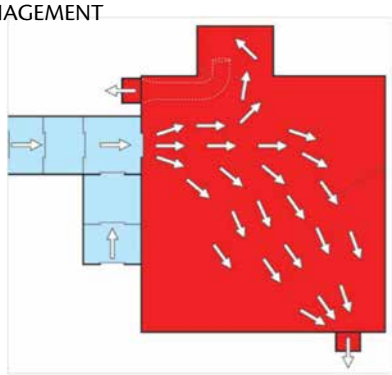
The electric supply on site can change and supplies can be variable. Long 110v leads can result in Voltage drops.

The hosing length and the number of bends and type of ducting (polythene or grey flex) can cause 10 to 20% loss or air flow.

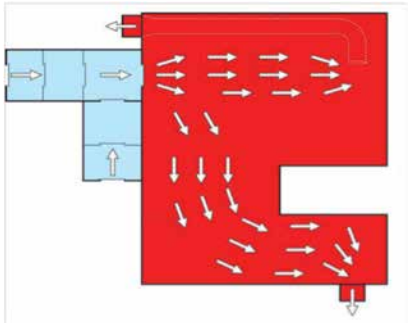
POOR AIR MANAGEMENT



GOOD AIR MANAGEMENT



GOOD AIR MANAGEMENT



Hazardous Waste Regulations 2005

The main aim of HWR is to:

a) Define hazardous waste (>0.1% w/w)
b) Make sure it is properly managed and regulated.

We still define waste as hazardous waste in England and Wales but in Scotland it is defined as Special Waste.

The regulation requires Producers or Consignors of hazardous waste to notify (register their premises) and it restricts mixing and requires separation of waste.

They make sure that companies document the movement of hazardous waste and require the Consignees to keep thorough records and submit to the Environment Agency (EA) on a quarterly basis.

Waste Disposal

All asbestos waste regardless of whether it is licensable or non-licensable must be;

a) transported by a registered carrier (ie the contractor)
b) disposed of at a licensed disposal site or waste transfer station
c) suitably packaged in accordance the regulations

Asbestos Waste Packaging

UN approved packages are used which have been subjected to tests to ensure suitability to withstand handling associated with road transport.

They should also indicate maximum weight to be placed in the package.

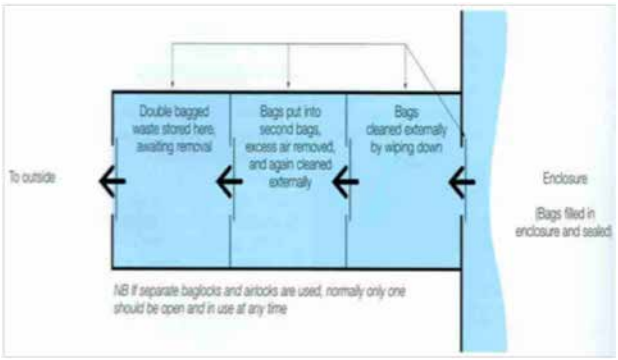
The packages must contain signs and codes as shown.

For loose fibrous waste or small fragments double plastic bags are suitable. It is important that the inner bag is not overfilled, especially when the debris is wet, and each bag should be capable of being securely tied or sealed.

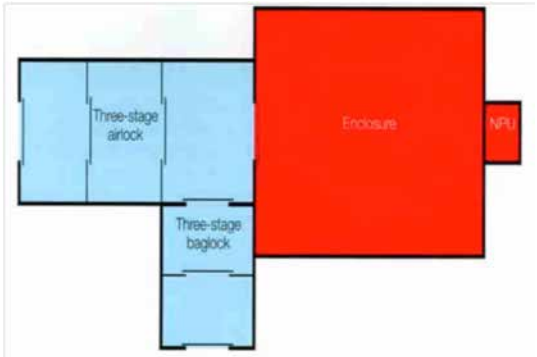
Air should be excluded from the bag as far as possible before sealing.

Strong containers are necessary if the waste contains sharp metal fragments or other materials liable to puncture the bag.

Using a Baglock



Alternative Baglock Design



Transferring Asbestos Waste

The contractor must ensure the skip or vehicle used to transport waste is as close to the enclosure as possible. The Skip must be clean on arrival and lockable. If the waste is transported in a van the tools and other equipment stored in van should be segregated to prevent bags being punctured during transit.

Waste packages should never be thrown in to the skip or vehicle and under no circumstances should asbestos waste be stored in an enclosure, air lock or DCU.

Controlled Stripping Techniques

The Control of Asbestos Regulations 2012 state that:

1. Regulation 11 - prevent or reduce exposure to asbestos
2. Regulation 16 - prevent or reduce spread of asbestos
3. Uncontrolled dry stripping requires high degree of reliance on RPE
4. RPE must not be the first line of protection in the workplace

Typical Exposure Levels

There is no typical level, but in general terms;

1. Uncontrolled removal – up to 1000f/ml
2. Controlled removal – less than 1f/ml and even down to less than 0.1f/ml for sprays and lagging and less than 0.01f/ml for AIB

Dust Control Methods

There are a number of dust control methods available and they are listed below:

- Controlled Wet Stripping
- Local Exhaust Ventilation
- Air Management
- Glove Bags
- Wrap and Cut
- Handling Techniques
- Vacuum Transfer

Removal Techniques

Selection of correct stripping technique will depend on a number of factors such as:

a) Location, condition and composition of the asbestos containing material
b) Type and surface treatment of asbestos containing material - i.e. sprayed coating; lagging; board or tiles
c) Surface temperature of the plant from which the asbestos is being removed
d) Future use of the plant, i.e. is it being demolished?
e) Proximity of electrical installations and other safety considerations

Controlled Wet Stripping

Controlled wet stripping is the preferred way to remove asbestos and is suitable for:

- Sprayed coating and lagging
- Asbestos material with hard outer coating

Advantages

The advantages are that when asbestos is thoroughly wetted it will suppress fibre release. An additional benefit is the reduction in cleaning time of the enclosure.

Limitations

There are limitations to this particular method which are highlighted below:

a) Not suitable for boards or tiles,
b) Needs operator training and experience
c) Risk of creating unmanageable slurry
d) Hard cement-like finish may require pre-drilling
e) Potential health hazard of wetting agent

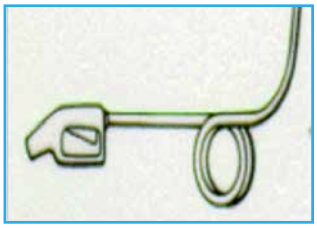
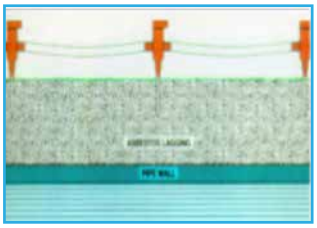
Use of Wetting Agents

Chrysotile is (hydrophilic) water loving and fibres are easily coated with water but Crocidolite and amosite asbestos are (hydrophobic) do not absorb water as easily therefore wetting agents are used to help break down the surface tension and allow the fibres to be suspended in water.

There are special wetting agents required for temperatures above 75°C where water based surfactants would evaporate.

The liquid is applied at as a low pressure injection (less than 50 psi) as it wets by capillary action instead of being forced in.

Controlled Wetting Methods

Single Point Injection	Multi Point Injection
	
Multi Needle Injection Board	**Surface Spray Wetting**
	

Multi-Point Injection Needles

The needles, when applied should penetrate the full depth of the ACM and wetting should be by controlled capillary action and NOT forced delivery.
When wetted correctly the asbestos should be a putty-like consistency.

Advantages

The advantages of multipoint needle injection are:

a) Allows more comprehensive wetting of the material than a single-point system
b) Less time consuming
c) Some needles have adjustable taps, less risk of creating a slurry
d) Injection point spacing is set by the manufacturer

Limitations

This method has limitations especially where a hard outer covering of asbestos material may damage the needles after period of use.

Limitations of Wet Stripping

There are obvious limitations to wet stripping such as live electrical equipment that cannot be isolated or protected from ingress of water.

Consideration should be taken with fire or generation of toxic fumes due to risk of contact between water/wetting agent and other chemicals.

In hot environments it produces steam and risk of heat stress in hot environments also wetting agent can freeze inside lagging/coating in cold weather.

Poor Wetting of ACM

Incomplete saturation of ACM can result in dry patches with exposure levels up to 100 f/ml.

Over saturated ACM can fall off under the weight and a slurry can occur which can releases fibres when dry.

'Controlled' Wetting by Spraying

Spray wetting is only suitable:

a) Where injection is impracticable or prior to injecting
b) Where ACM are thin, unsealed and porous
c) Removal of AIB and Asbestos Cement
d) In conjunction with local exhaust ventilation and glove bags
e) Removal of residues during fine cleaning of stripped surfaces

Local Exhaust Ventilation

This method is where air is extracted as close to the working position as possible to capture the released fibres at source; "shadow Vacuuming".

This method is Suitable for:

- Removal of AIB intact
- Especially where controlled wetting cannot be used
- Complement to air management systems

The method does have limitations such as:

- Does not prevent fibre release at point of removal
- Limited area of control
- Asbestos debris may fall on the floor
- Requires two operatives

Dust Suppression Summary

a) Uncontrolled dry stripping of asbestos must not be undertaken
b) Controlled wet stripping techniques minimises the release of asbestos fibres and contain the spread of contamination
c) Improved rates of wetting are achieved by the use of wetting agents
d) Combination of controlled stripping techniques is often needed for effective control
e) Controlled stripping techniques require disciplined work practices and appropriate training.

Typical Questions from Unit 3

Q1. ***What would indicate the flowmeter was working correctly when checking sampling pump flow rates?***
The rotameter would be free and turning.

Q2. ***Briefly describe how asbestos waste is removed from an enclosure.***
The waste is placed into red UN approved polythene bags.
The bags are vacuumed and wiped down and placed into the middle section of the baglock.
The red bag is then placed into clear UN approved polythene bags.
Remove from the baglock and transfer to a locked asbestos skip via the waste route.

Q3. ***What would be the expected fibre concentration generated from removing asbestos containing spray coatings dry?***
1000f/ml

Q4. ***Why is a wetting agent (surfactant) used in the removal of pipework insulation?***
Because amphibole asbestos fibres are hydrophobic and need the wetting agent to get them wet.

Q5. ***Give two instances when wet removal techniques are not appropriate.***
When on or around live electrical equipment.
When removing insulation on hot pipes.

Q6. ***What is the most appropriate removal technique for the removal of asbestos insulating Board (AIB) ceiling tiles?***
Shadow vacuum, mist spraying and careful removal techniques.

UNIT 4
Decontamination Units and Type-H Vacuums

Section 1:
Set up and use of DCUs

Decontamination

HSG 248 describes two levels of decontamination;

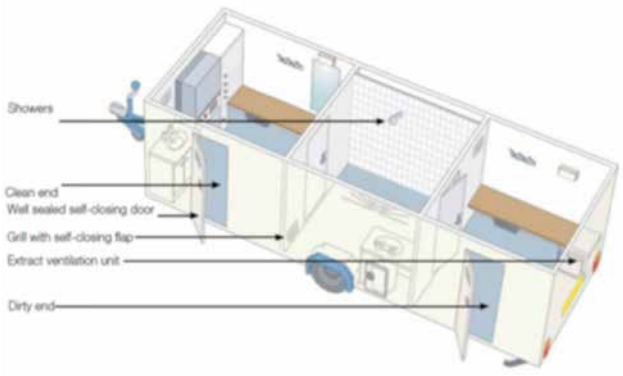
1. Preliminary (following minor contamination) – clean, remove and dispose of PPE
2. Full (after significant contamination) – use of DCU

Preliminary decontamination

With preliminary decontamination the following sequence must be adhered to:

a) RPE and PPE – vacuum or wipe down where necessary in work area
b) Footwear – wipe down in inner stage
c) Overalls – remove in middle stage
d) RPE – exit airlock, remove and place in bag
e) Sampling equipment – wipe down in inner stage

Figure 8.1 General layout of a hygiene unit



Full Decontamination – DCU

With full decontamination the DCU must comply with the following.

The DCU not usually attached to work area so via transit arrangements. The DCU can be a modular unit but must comply with Approved Code of Practice (ACOP).

The DCU must be easy to clean and have self closing doors, hand basin, lockers, and mirror in clean end.

A NPU is cited in the dirty end of the unit to draw air from clean to dirty end.

The external doors labelled 'clean end' and 'dirty end' with correct signage.

They:

a) Must be on site, connected to services and functioning before work begins
b) Either attached or unattached, ie via transit
c) Modular units acceptable but must comply with ACOP
d) 1 shower per 4 users maximum
e) Easy to clean, self closing doors, hand basin, lockers, mirror in clean end
f) HEPA unit to draw air from clean to dirty end
g) External doors labelled 'clean end' and 'dirty end' with correct signage
h) Water heater must be GAS SAFE tested
   Adequate balanced flue and Carbon Monoxide (CO) detectors
   Generator powered should not be used inside unless flue is extended and vented outside
i) RCD protection on power inlet
j) Earth strap or spike
k) Stable and level when in use
l) Roadworthy

Transit Arrangements

Entering enclosure

Take RPE into hygiene unit via clean end door.

↓

Inspect and check RPE.
Undress.

↓

Put on clean PPE. Put on RPE using mirror.
Carry out fit check.

↓

Pass through shower area (without showering) into the dirty end.
Dress in transit coveralls and footwear.

↓

Pass through door of dirty end and walk to transit facilities via designated transit route.

↓

Enter outer stage of transit airlock and remove transit coveralls and footwear, place in container/on hooks provided. Do not leave on the floor.

↓

Pass into middle stage of transit airlock.

↓

Pass through the inner stage and into the enclosure.

Leaving enclosure

Vacuum all visible dust and fibres from PPE, RPE and footwear at the edge of the enclosure. Leaving enclosure and go into inner stage of transit airlock. Brush footwear in footbath. Sponge down or wipe RPE.

↓

Pass into middle stage of airlock. Remove coveralls and footwear worn in enclosure and place in waste bag (or store if re-entry required).
Do not remove RPE.

↓

Pass into outer stage. Put on transit overalls and trtansit footwear.
Walk to hygiene facility via designated transit route.

↓

Enter dirty end of hygiene facility. Take off all footwear, PPE and underwear and place in storage or disposal bags. Do not remove RPE.

↓

Move to shower area with respirator on.
Shower and use a sponge to clean RPE.

↓

Once RPE has been cleaned, remove it and shower yourself thoroughly.
Remove or cap used filters (place in waste bag for disposal, if appropriate).

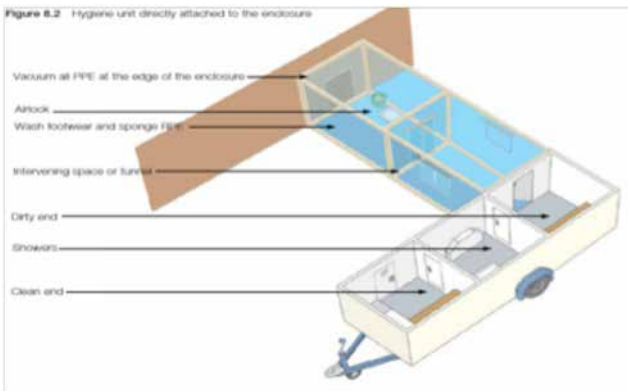
↓

Start drying off.
Place towel in bag for disposal or laundering.

↓

Pass through into clean end carrying RPE and complete drying with different towel(s). Dress.

DCU - Direct Connection



DCU Certification

A Check on the water and power must be made before use.
If the DCU is provided by a contractor there will be checks carried out whilst on site.

If the unit is hired in the certification is provided by the hirer.

The paperwork required is as follows:

- Six monthly DOP test on the NPU
- Clearance air test from last site
- Annual electrical and gas test certificate

Waste Water

The DCU water filtration system should filter to 5 microns and all waste water passes through the filter.

When the work is complete the filter is disposed of asbestos waste.

Any waste water from buckets in airlocks should be disposed of through the filtered drainage system in the shower in the DCU.

Waste water should be directed into foul drain not sewer.

Vacuum Cleaning Equipment

Known in the industry as Type-H or Class-H, H= HEPA filter – high efficiency particulate arrestor.

The vacuum cleaners must be approved to BS 8520.

The same certification is required whether they are provided by contractor or hired in.

They should carry a six monthly test certificate for the HEPA filter (DOP) and electrical test certificates.

Checks before taking to site and before use must be made and recorded.

Type-H vacuums should be used for cleaning fine dust and debris and not for rubble and large objects which will block the hose.

Cleaning in an enclosure should be from top down to bottom and always work towards NPU where possible.

Attention must be made to steelwork, flanges, pipework, valves, bolt heads, enclosure walls and ledges.

Decontamination of operatives uses the 'Buddy system'.

Vacuums and attachments must be bagged when transporting from site into two clear bags with all hoses sealed and exhaust caps reinstated.

BS 8520 sets out standard for manufacture and performance of:

- Controlled wetting equipment
- Negative pressure units
- Type-H vacuums

All new equipment should be manufactured to this standard. All the established manufacturers are doing this so beware of unfamiliar makes.

Correct Use of NPUs and Vacuums

NPU's and vacuum cleaners must be inspected prior to each use including the vacuum cleaner waste bag which must be inspected under controlled conditions before use.

The vacuum cleaners must be examined and tested thoroughly every 6 months and a record of inspection, examination, maintenance and defects remedied must be kept for a minimum of 5 years.

Typical Questions from Unit 4

Q1. ***List 2 practical uses of an Type-H vacuum cleaner in relation to asbestos removal.***
Shadow vacuum (LEV) when removing ceiling tiles.
Used for fine cleaning inside an enclosure.

Q2. ***When fully decontaminating where would your respirator be removed after leaving an enclosure?***
In the shower section of the decontamination unit after initially wetting it under the shower.

Q3. ***What would be the minimum amount of time spent under the shower when fully decontaminating?***
5 minutes

Q4. ***When the Decontamination Unit is directly connected to the enclosure where would you remove your overalls after leaving the enclosure?***
The Dirty End of the decontamination Unit.