Good Practice Guide for Safe Handling and Disposal of Metalworking Fluids

UKLA
UNITED KINGDOM LUBRICANTS ASSOCIATION

HSE

Disclaimer: This guidance has been developed by the United Kingdom Lubricants Association (UKLA) Metalworking Fluid Product Stewardship Group (MWFPSG) with support from the Health and Safety Executive (HSE) and other industry experts. The contents of the guidance represent UKLA members' current knowledge about good practice with advice from the HSE. This guide contains advice which should be considered together with your knowledge and the advice of your lubricant supplier. No warranty either express or implied is provided to users of this guidance by either both UKLA and/or HSE. This guidance provides advice to duty holders who ultimately have responsibility for protecting the health and safety of their employees. Future changes to this guidance may be required to address changes to technology and working practices.

The Health and Safety Executive (HSE) was involved with the UKLA MWFPSG in producing this guidance. HSE endorses the guidance, as it follows a sensible and proportionate approach to managing health and safety.

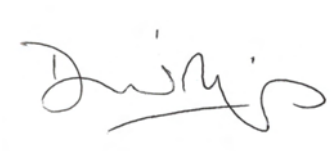
Version 1.0 on the 28th February 2018

Good Practice Guide for Safe Handling and Disposal of Metalworking Fluids

I am pleased to introduce the first guide on good practice for safe handling and disposal of metalworking fluid (MWF). This booklet provides a guide on how to maintain MWF to prevent ill health in machine workshops. It has been prepared by a panel of experts from the UK Lubricants Association (UKLA) Metalworking Fluid Product Stewardship Group (MWFPSG) and from the Health and Safety Executive (HSE) with additional advice from experienced workshop managers and medical experts.

The UKLA and HSE recognise the need for this guide to reflect current good practice in managing MWF to reduce the risks of ill-health in operators. The guide addresses the preparation, maintenance and eventual disposal of MWF and contributes towards a safe working environment. This is not a comprehensive guide, but sets out core good practices in managing the quality of MWF. The guide is aimed at those with the daily responsibilities for managing MWF and also provides advice for the operators. It has been published as a printed guide but is also available to download from the UKLA website.

This guide has been peer reviewed by experts from the MWF producers and from the engineering industry. Users of the guide may identify improvements that could be made to the advice statements, and therefore comments from users are welcomed. The UKLA and HSE will continue to review the accuracy and relevance of this guide to ensure it is based on the best available evidence.



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Director General of UKLA

Contents

1.0 Introduction

This booklet provides guidance about maintaining water-mix MWF to prevent ill health in machine workshops. Skin disease (dermatitis) and lung disease (occupational asthma and occupational hypersensitivity pneumonitis) can occur in operators, either because their skin is regularly in contact with MWF, or because they inhale MWF mist.

These risks to health increase as the composition of the MWF deteriorates in-use becoming contaminated by tramp oil, soluble metals, metal fines, and microorganisms (bacteria, yeast and fungi). Overuse of biocides to inhibit microorganisms in MWF may also present health risks to operators.

A list of terms and abbreviations can be found in Section 9.0.

1.1 What does the law require?

The Control of Substances Hazardous to Health Regulations 2002 (COSHH) require employers to carry out a suitable and sufficient risk assessment for those exposed to MWF. The risk assessment should identify the measures required to ensure that exposure is either prevented or adequately controlled (i.e., kept to a minimum). A guide to COSHH and risk assessment (Figure 1) can be found by following the web-links summarised at the end of this section.

Adequate control of exposure can be achieved by:

- Reducing skin contact with MWF
- Reducing inhalation of MWF mist to levels “as low as reasonably practicable” (ALARP)
- Applying COSHH principles of good control practice by:
  - Designing and operating procedures and activities to minimise emissions and contact with MWF.
  - Choosing control measures that are proportionate to the risk and are the most reliable in minimising the escape and spread of MWF mist.
  - Checking and reviewing all control measures to ensure their continuing effectiveness e.g. the performance of Local Exhaust Ventilation (LEV) to minimise exposure to MWF mist.
  - If exposure to MWF (either by mist or contact with skin) cannot be adequately controlled suitable Personal Protective Equipment (PPE) including Respiratory Protective Equipment (RPE) should be provided in combination with other control measures.
  - Informing and training all employees about the hazards and risks to health, and the use of control measures required to minimise exposure to MWF.

1.2 Health Surveillance

Where appropriate, COSHH requires that a suitable health surveillance programme is provided. For work with MWF this programme should cover both skin and lung disease.

1.3 Keeping records

- The COSHH requires that records of any inspections or checks etc., that relate to control measures (e.g. LEV, tramp oil, bacteria, MWF concentration and pH) are kept (paper or electronically) and retained for 5 years.
- It also requires that employee health records, and records of personal exposure are retained for 40 years.

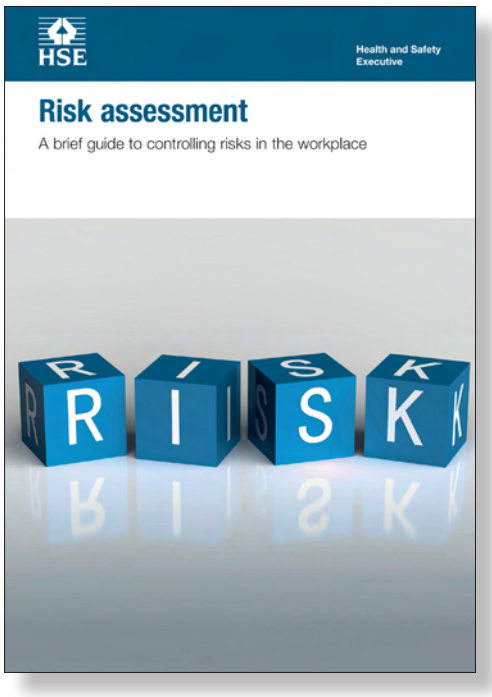


Figure 1: HSE guidance for COSHH and risk assessment

Links to relevant HSE website advice and guidance documents	
Guidance	Web link
HSE COSHH	http://www.hse.gov.uk/pubns/indg136.htm
HSE Risk assessment	http://www.hse.gov.uk/pubns/indg163.htm
HSE COSHH essentials	http://www.hse.gov.uk/coshh/essentials/

2.0 Health

2.1 Skin disease

Operators may develop dermatitis on their hands, arms and face caused by frequent contact with the water-mix MWF and neat oils. This is similar to the effects of frequent contact with soapy water which causes the skin to lose its natural oils. An early indication of dermatitis is itching and red patches in the skin. Other symptoms which may later develop include dry cracking skin, swelling, pain, and in some cases blisters and open sores. You could see one or all of these signs (Figure 2). Chemicals such as biocides and certain soluble metals in MWF can cause an allergic form of dermatitis. Dermatitis symptoms can be painful and debilitating and in the worst case may prevent an operator undertaking certain tasks.

2.1.1 Actions to minimise these risks

- The main concern should be for ‘wet work’ as a cause of dermatitis.
- Refer to the MWF supplier’s safety data sheet (SDS) to check for ingredients classified as substances causing irritation or an allergic skin reaction. In these circumstances either use alternative products or take appropriate measures to prevent skin contact and contamination of clothing.
- Use suitable control measures to minimise skin contact with the MWF before using suitable personal protective equipment.
- Close-fitting disposable gloves may be required to prevent MWF and chemicals from contaminating the skin. If disposable gloves (e.g. disposable nitrile) are required, they must easily tear to minimise risk of entanglement in moving machinery.
- Wash hands, arms and any other exposed skin before taking a break and at the end of a shift. It is essential to dry the skin well e.g. between the fingers where moisture can be retained.
- Use a good skin care regime which includes regular use of moisturising cream.
- Employers can encourage good practice by providing soap/moisturiser dispensers, disposable paper towels and hand cleaning charts.

For more information regarding advice and guidance on skin disease follow the links at the end of this section.

2.1.2 Health surveillance for dermatitis

- Regular skin checks should be part of an overall health surveillance programme undertaken by a competent person or health service provider.
- It is important that employees are trained to recognise symptoms of dermatitis and skin irritation that may be caused by their work.
- If an employee has unexplained skin symptoms then it is essential that the occupational health provider is informed. If occupational health services are not available, employees should be encouraged to make an appointment with their general practitioner (GP) and explain that their symptoms may be work-related.

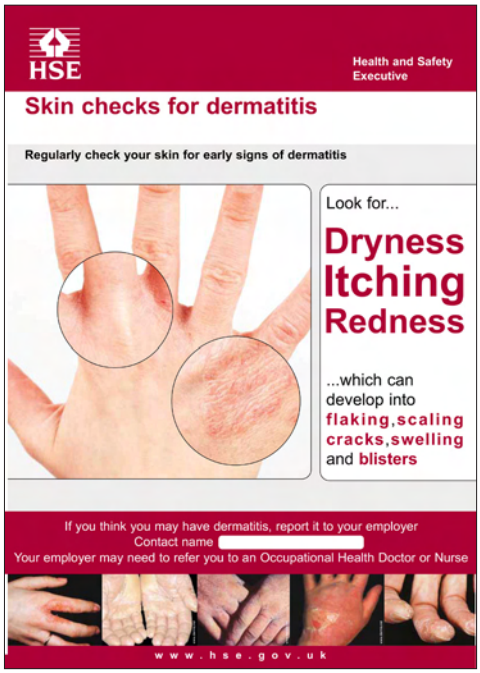


Figure 2: a) Photograph of hands affected by dermatitis showing dry flaking and cracked skin, **b)** HSE poster explaining how to check for signs of dermatitis

Links to relevant HSE website advice and guidance documents	
Guidance	Web link
HSE Dermatitis poster	http://www.hse.gov.uk/skin/employ/dermatitis.htm
HSE Skin checks for dermatitis	http://www.hse.gov.uk/skin/posters/skindermatitis.pdf
HSE COSHH essentials for machining with MWF	http://www.hse.gov.uk/pubns/guidance/mw02.pdf
HSE Choosing the right gloves to protect skin	http://www.hse.gov.uk/skin/employ/gloves.htm
HSE PPE at work	www.hse.gov.uk/pUbns/indg330.pdf

2.2 Lung disease

For operators exposed to MWF mist there is a risk of lung disease. Occupational hypersensitivity pneumonitis (OHP) and occupational asthma (OA) are the most commonly reported lung diseases in operators. From 1996 to 2015[A] there has been an increase from 2% to 45% in reported cases of OHP related to exposure. Inhaling MWF mist containing hazardous substances such as microorganisms may cause these diseases. Unexplained coughing, recurrent chest infections, breathing difficulty, and weight loss in an operator may be an early indication they are developing serious lung disease. These lung conditions are debilitating, impair quality of life and the capacity for work. However, the sooner the illness is recognised and the operator removed from exposure, the less likely permanent lung damage will occur. Those who already have asthma before working with MWF may be at risk of aggravating this condition if they inhale MWF mist.

Exposure to MWF mist should be minimised by enclosing the work processes where reasonably practicable and by, using LEV and mist filtration units. These engineering controls need to be maintained and checked on a regular basis (Section 6) .

2.2.1 Health Surveillance for lung disease

- A suitable health surveillance programme should be in place for allergic diseases such as OA or OHP, clearly linked to workplace exposure to MWF mist (See web links to published guidance on page 7). Health checks may include a simple questionnaire and lung function test (Figure 3a).
- It is important that employees are trained to recognise symptoms described above and to report them to the appropriate supervisor or occupational health service provider.
- If an employee has unexplained respiratory symptoms or chest infection it is essential that the occupational health provider is informed. Alternatively the employee should see their GP and explain that their symptoms may be work related.
- A health practitioner who suspects an employee of having OA or OHP, should make an early referral to a respiratory physician with expertise in these conditions.
- If a case of OA or OHP has been diagnosed the occupational health provider should carry out, with informed consent, a survey of all exposed employees to identify if other operators are at risk.

[A]Data reported to the UK Survey of work—related and occupational respiratory disease (SWORD) scheme.

(Barber CM et al: Epidemiology of occupational hypersensitivity pneumonitis; reports from the SWORD: Occup Environ Med. (2017) 74(7) 528-530.

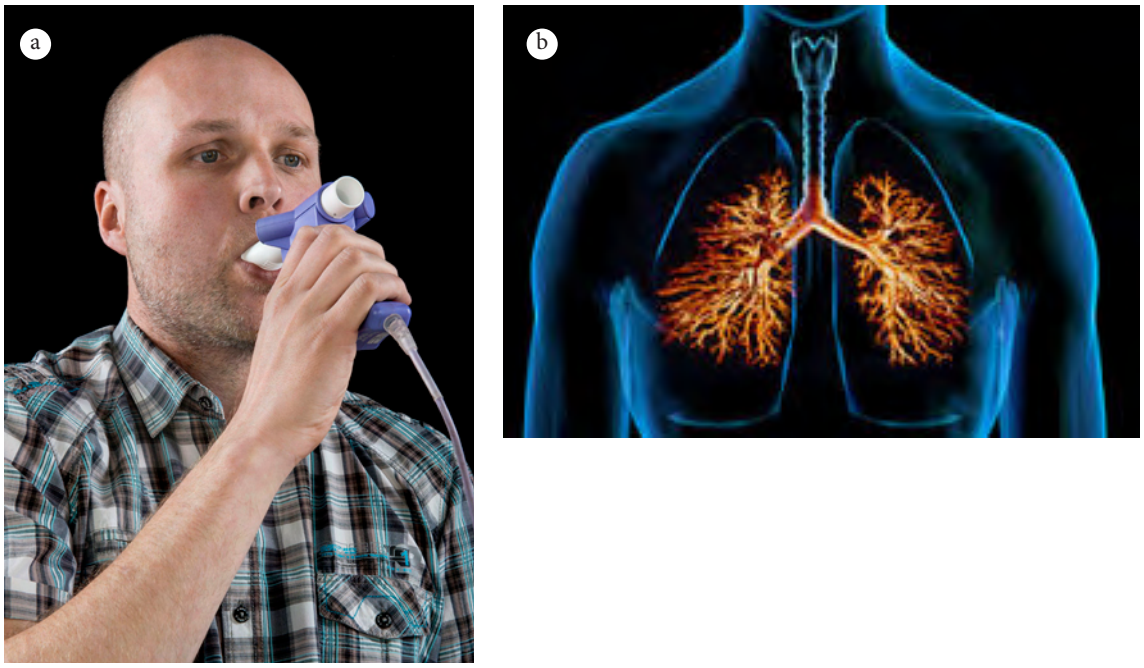


Figure 3: **a)** A picture of a patient using a spirometer, which is the equipment used to test lung function. **b)** Illustrates the fine airway structures of the human lung. This is where small MWF mist particles may penetrate and deposit into the lung when inhaled.

Published guidance on health surveillance	
Guidance	Web link
HSE Health surveillance	www.hse.gov.uk/health-surveillance/
HSE Health surveillance decision making map	www.hse.gov.uk/health-surveillance/decision-making-map.htm
HSE Metal working fluids COSHH essentials MW0: Advice for managers	www.hse.gov.uk/health-surveillance/resources.htm#particular-hazards
HSE Health surveillance for occupational asthma COSHH essentials G402	www.hse.gov.uk/pubns/guidance/g402.pdf

3.0 Storage of MWF

3.1 Environmental conditions

It is important to manage the environmental storage conditions for MWF to maintain quality and performance. For specific storage advice refer to the SDS.

- MWF concentrate should be stored indoors (between 5 °C and 40 °C) in drums or using an Intermediate Bulk Container (IBC).
- If stored outside, these containers should be placed under covers as a minimal precaution to avoid extremes of temperature.
- If there is a risk of exposure to rain or condensation, either store upright with the lids covered, or on their side to prevent water collecting around the outlets.
- Rotating the stock ensures that concentrates are not stored longer than recommended by the supplier.
- Do not use MWF concentrate beyond the expiry date set by the supplier.
- Ensure that hazard warning labels are visible on all storage containers.

3.2 Storing diluted MWF

- Refer to the supplier's instructions for storing diluted MWF.
- Do not exceed any storage life or temperature recommendations.
- If in doubt, consult the MWF supplier for advice about the conditions of storage and durability of diluted stocks.

Links to relevant HSE website advice and guidance documents	
Guidance	Web link
The Oil Storage Regulations	https://www.gov.uk/guidance/storing-oil-at-a-home-or-business#exempt-oil-storage-containers

4.0 Preparing working dilutions from the MWF concentrate

4.1 Mixing the MWF

It is important to mix the MWF correctly to ensure optimum quality and performance. Ensure that the supplier's guidance is followed for each specific MWF. The preferred method is to use a mixing (dosing) unit to prepare emulsions; always seek advice from the supplier.

- Ensure that PPE[B] is available and used (e.g. protective overalls, gloves and glasses) (Figure 4a and 4b)
- Please refer to the suppliers SDS. This contains information about the hazards of the MWF concentrate, including precautions for safe handling.
- Always add the concentrate to water to ensure that the emulsion is formed correctly
- Before using the MWF check that the pH and concentration are within the recommended limits.
- Where possible prepare MWF in a designated and well-ventilated area to avoid inhalation of volatile respiratory irritants. These can accumulate at the top of sealed drums containing the concentrate.

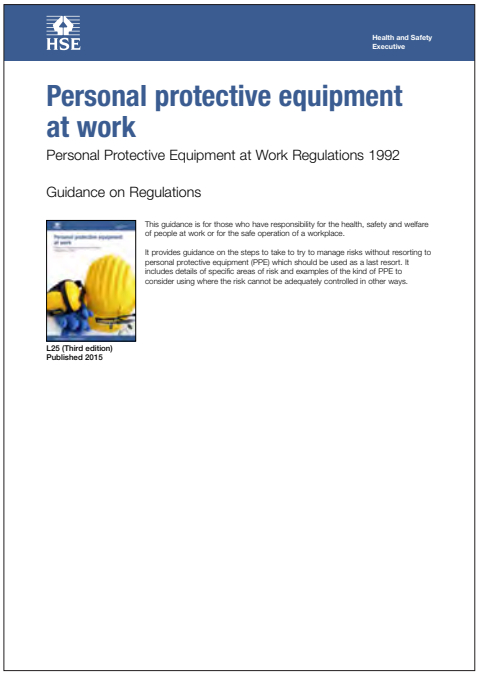
4.2 Water quality

The quality of the water used to prepare the working emulsion is important to ensure stability and performance.

- It is recommended to consult the MWF supplier about suitable water quality requirements (e.g. hardness and pH).
- It is advisable to check the water source for the levels of bacteria, yeast or fungi. For example, use a dipslide to test the water supply.
- The use of stored water (rather than direct mains) may increase the risk for bacterial contamination of the MWF. Weekly inspections of water storage tanks and water filtration apparatus should be undertaken to ensure they are kept clean to prevent the formation of biofilm.
- If it is necessary to store water it is best practice to keep records of regular weekly checks on the water microbial quality.

[B]PPE (and RPE) has to comply with the PPE Directive (89/686/EEC) and UK PPE Regulations 2002 (SI 2002/1144) and be kite marked to the relevant EN Standards.

a



b

Figure 4: a) HSE guide to the selection and use of personal protective equipment and **b)** Examples of basic PPE that should be used by a machine operator

Links to relevant HSE website advice and guidance documents	
Guidance	Web link
HSE PPE at work	www.hse.gov.uk/pUbns/indg330.pdf
HSE Choosing the right gloves to protect skin	http://www.hse.gov.uk/skin/employ/gloves.htm

Technical advice about water hardness and electrical conductance

Water hardness: This is most commonly measured using water hardness test strips and kits that can be obtained from a variety of manufacturers with instructions on how to use them.

Water hardness test kits provide a reading as parts per million (ppm) which can also be expressed as a degree of water hardness related to calcium carbonate ($CaCO_3$) content.

The ideal hardness of water to use with MWF ranges from 80 to 125 ppm. This can vary dependent on formulation and fluid use.

If the water hardness is too low this can cause an increase in foaming and if too hard this could cause insoluble soaps to form which could block pipes and/ or filters.

Conductivity tests: Conductivity is a measure of the electrical conductance (expressed in microsiemens) of a MWF and is influenced by the amount of dissolved materials and salts. Conductivity of a MWF generally increases over time and thus may lead to insoluble residues, an unstable emulsion, and loss of operating performance.

5.0 Maintaining MWF

It is important to maintain the MWF quality according to the supplier's recommendations to minimise risks to health (skin and lung disease) and to ensure good fluid performance. Indications of microbial contamination in MWF include changes in appearance and odour (e.g. a rotten eggs smell). Over a longer period a visible biofilm can form on the inner surfaces of sumps and supply pipes (Figure 5). Fungal growth can be found on the inner and outer surfaces of machines and pipes and the surface of the MWF sumps. The following factors influence MWF quality and are summarised in Table 1.

Table 1: Factors to consider that affect the quality of water mix MWF

MWF concentration: During use MWF may increase in concentration and foam due to evaporative loss of water. There may be an increased risk of misting. Diluting the MWFs below recommended concentrations may increase the risk of bacterial contamination and corrosion, resulting in poor cutting performance, shorter sump life and increased cost.
MWF pH: The pH should be maintained within the suppliers recommended range. Corrosion and microbial growth can occur when the pH of a MWF drops below the recommended operating range (i.e., becomes more acidic). If the MWF pH increases too much there is an increased risk of skin irritation.
Tramp oil: Contamination of the MWF with tramp oil above a 2% concentration may increase the risk for dermatitis in operators and encourage microbial growth in the MWF. It will cause the emulsion to become discoloured and to separate and foam which may increase the release of mist. An increase in the suspension of solids may also occur which reduces filtration efficiency and tool life.
Metal contamination: Allowing the concentration of metal contaminants to increase causes poor cutting performance, reduces sump volume, promotes microbial growth and also increases disposal costs. Metal fines and swarf increase skin abrasion and cuts and the risk of dermatitis.
Operating temperature
Water-mix MWF: Operating MWF at temperature above 30 °C creates optimal conditions for microbial growth and increases MWF concentration through evaporation.
Neat oil: The operating temperature can affect the viscosity and cooling properties. Consult the MWF supplier about the appropriate temperature range for their product.
Agitation and flow: Maintain agitation and flow of MWF to prevent stagnation. This discourages the growth of anaerobic microorganisms and the formation of noxious gases and volatile compounds.
Biocides: In some circumstances biocides are needed to prevent microbial growth. The incorrect use of biocides may lead to the development of biocide resistant organisms and may be harmful to the operator.

5.1 Maintaining MWFs

Specific actions and checks are required to maintain the MWF. Tables 1 to 9 summarise actions and checks that need to be undertaken to maintain the quality of MWF.

The recommended frequency of the checks in Tables 2 to 9 are considered good practice. A different frequency of checks may be relevant taking into account the type of MWF, machining and other circumstances. The frequency of checks adopted needs therefore to be supported by historical records demonstrating that the MWF quality has been maintained consistently. This also needs to be explained in your risk assessment.

Table 2: MWF odour and appearance

Actions
• Ensure that the MWF is effectively maintained, failure to do so might lead to changes in its appearance, odour and the stability of the MWF emulsion.
Checks
• That the MWF has not dramatically changed in colour or clarity. • For signs of foaming, and for levels of fines and swarf, tramp oil and separation of the emulsion. • For unusual odours which can indicate growth of bacteria and stagnation of the MWF. • For obvious signs of biofilm on the visible surfaces of the sump tanks and filters (Figure 5).
Explanation
• Stagnant MWF may smell rancid or sulphurous
Frequency
Daily

Table 3: MWF operating temperature

Actions
• Ensure that the MWF operating temperature is within the supplier's specification to maintain optimal product and machining performance. • It is recommended that the MWF operating temperature does not rise above 30 °C unless required for the performance of the MWF. • For larger sumps, a heat exchanger may be used to manage the fluid temperature.
Checks
• It is recommended to check the temperature of the MWF in the sump regularly. • Leave temperature probes in the sump for several minutes to obtain a stable reading.
Explanation
• Warm conditions promote the growth of microorganisms and water evaporation can increase the MWF concentration.
Frequency
Weekly

Figure 5: Biofilm deposits on the inside of MWF supply trunk.

Table 4: Tramp oil

Actions
• Maintain machines and other equipment to minimise tramp oil leakage. • Tramp oil contamination should always be kept to a minimum level (recommended below 2 %). • When tramp oil leaks occur these should be removed using mechanical skimmers, mobile oil coalescers, or vacuum systems. • For advice about dealing with tramp oil in neat oils refer to the MWF supplier.
Checks
• Frequently check tramp oil contamination (Figure 6a) • Tramp oil contamination may appear as discoloured patches of oil on the sump surface or discolouration of the MWF (Figure 6b) • Record the checks on tramp oil leaks and the consumption of the machine oil supply. • Ensure that operators are trained to promptly report any leaks to the work supervisor.
Explanation
• Tramp oil is likely to promote microbial growth, affect air quality and MWF performance.
Frequency
At least weekly

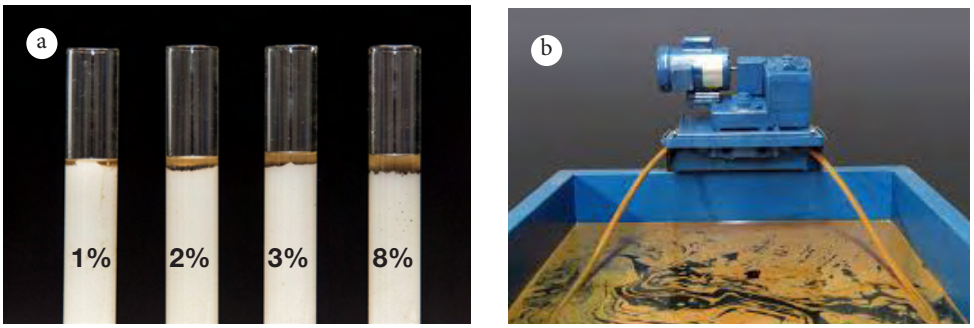


Figure 6: a) Represents the different concentrations (1%, 2%, 3%, and 8%) of tramp oil estimated by leaving a small volume of the MWF to settle overnight in clear test tubes. The darker circles at the top of the MWF is where the tramp oil has settled and the amount can be estimated. **b)** tramp oil (light brown) floating on the surface of a sump.

Table 5: MWF pH

Actions
• Ensure that the pH of the MWF stays within the suppliers recommended range (Figure 7a). • Adjust to the required operating pH by adding fresh coolant or a suitable additive recommended by your MWF supplier.
Checks
• Check the pH using test strips (Figure 7a) or a calibrated pH meter. • Keep a record of pH readings to identify changes and trends in the MWF (Figure 8).
Explanation
• pH measurements give an indication of fluid quality, a sharp drop in pH may indicate high bacteria levels, and a sharp increase in pH may indicate possible chemical contamination (e.g. alkaline cleaning solutions). • An explanation of how to undertake a pH test using a calibrated meter is given on the next page.
Frequency
At least weekly

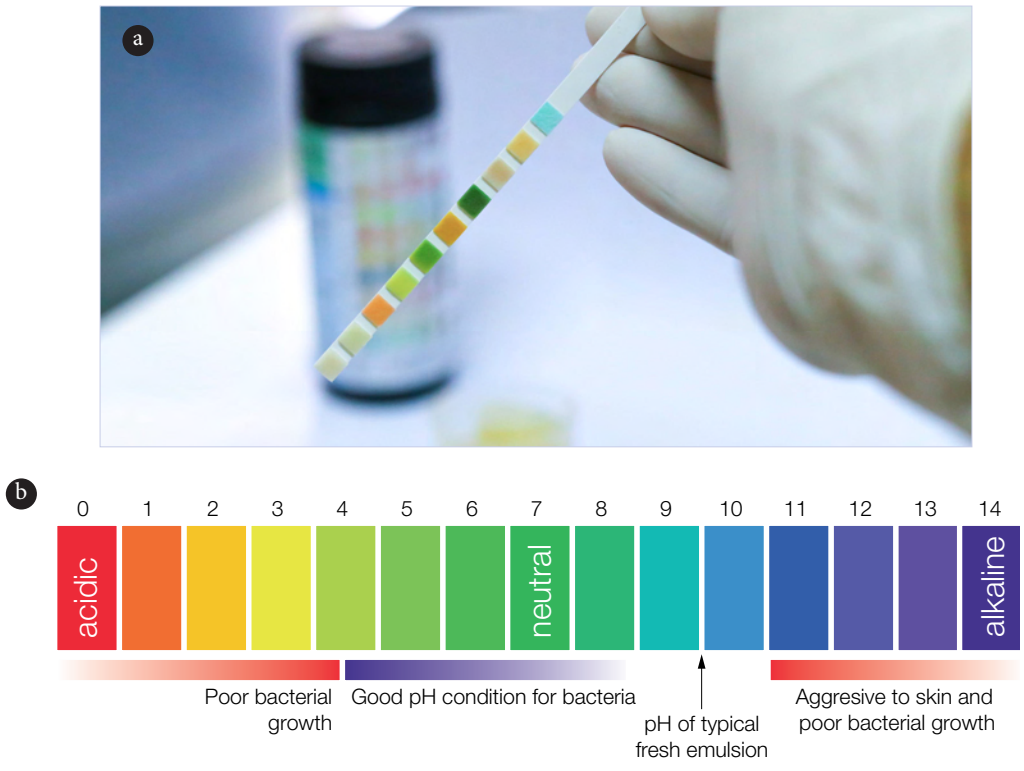


Figure 7: a) pH test strips used to determine sample pH in comparison with the pH colour scale; **b)** the pH scale

Technical advice about measuring MWF pH

pH paper: pH paper is commonly used. Dip the indicator strip into the MWF for a few seconds. Remove and compare the strip colour to the indicator guide (Figure 7b).

Electronic pH probes: There are different types of electronic pH probes and meters. Therefore, always read the manufacturer's instructions as to their proper use. The following is a generalised account of how to use this equipment.

Equipment: pH probe, pH buffer standard solutions (pH 4.0 , 7.0 and 10.0), distilled water and 0.1M hydrochloric acid. Keep buffers in sealed containers to minimise contamination.

Calibration:

1. Allow the pH meter, probe and sample buffers time to equilibrate to room temperature.

2. If the MWF operating pH is expected to range between pH 8.0 to 10.0, select the pH 7.0 and pH 10.0 buffer standards to calibrate the equipment.

3. Place the probe in the pH 7.0 standard and after a minute when the reading stabilises, if required, adjust the meter to read pH 7.0. Wash the pH probe in distilled water and using a clean tissue wipe the probe to remove the surface water.

4. Repeat this adjustment for the pH 10.0 standard.

5. 6. After calibration the probe is cleaned as in step 3 and the sample pH determined.

Maintaining electronic pH probes: pH probes should be cleaned to remove MWF contaminants and stored in pH 7.0 buffer. To remove tramp oil:

1. Soak the probe in 0.1M hydrochloric acid for ~3 minutes (5 minutes for heavy contamination), rinse thoroughly with distilled water and dry the sensor using lint-free tissue. Return the probe to a pH 7.0 buffer solution. Calibrate before use.

2. pH probes should be cleaned at least every two weeks and when the probe head appears dirty.

Safety: Wear suitable eye protection and disposable gloves to protect skin and eyes from hazardous chemicals when using and cleaning the pH meter.

Figure 8: Example checklist for recording variables when monitoring the quality of MWF. Note the shaded areas can be added to highlight each MWF operating range or condition.

Figure 8 continued: Example check list for recording variables when monitoring the quality of MWF. Note the shaded areas can be added to highlight each MWF operating range or condition.

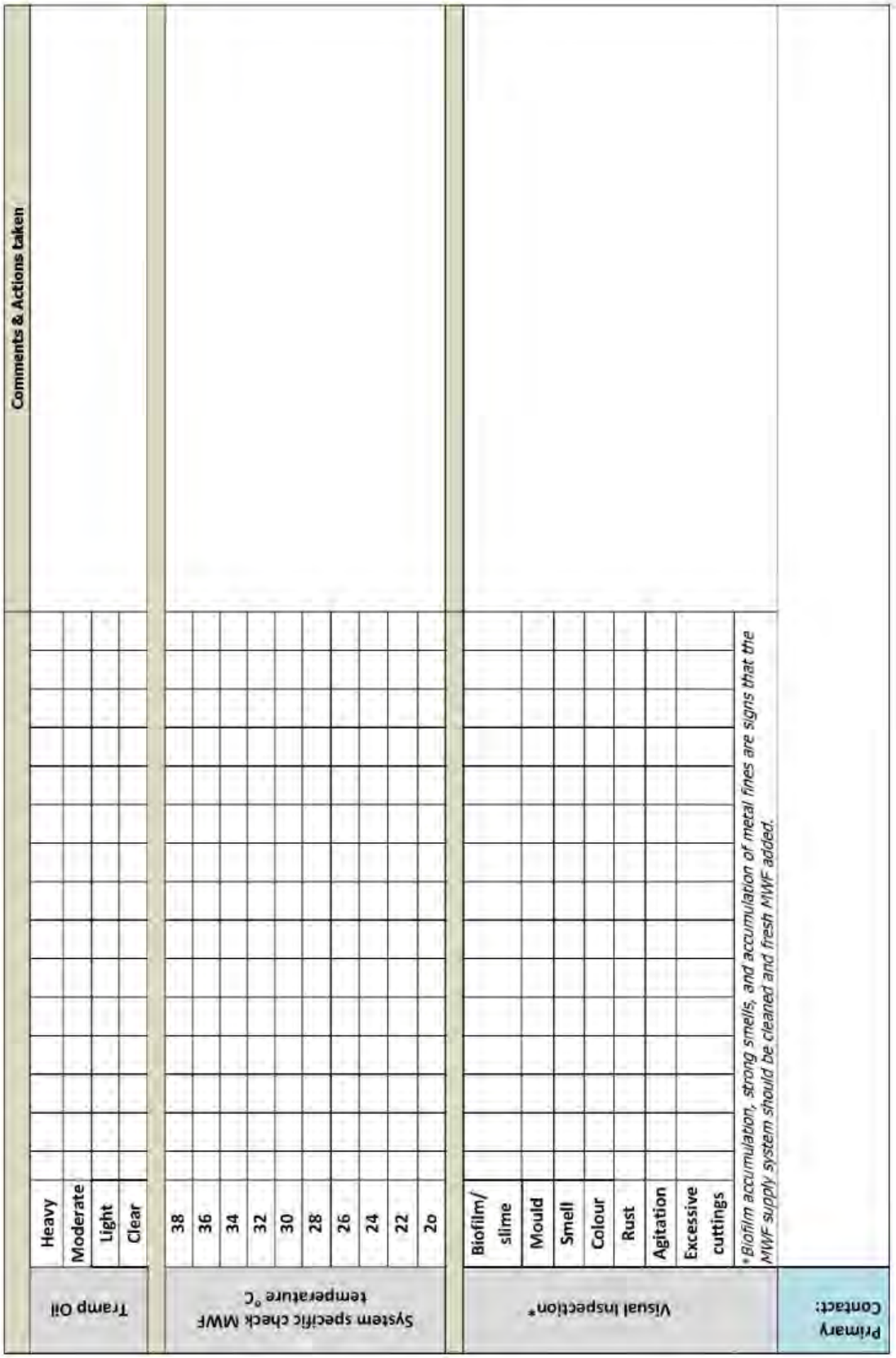


Table 6: MWF concentration

Actions
• Use the correct MWF concentration recommended by the supplier. • Adjust MWF concentration using a higher or weaker strength pre-mixed MWF. In most circumstances it is advisable not to use water or the concentrate stock directly.
Checks
• Check the concentration of the MWF. This can be carried out with a refractometer (Figure 9 and 10) • For quality purposes it is good practice to perform these checks as frequently as possible. • For some MWFs it may be necessary to carry out these checks more frequently than stated. • Record refractometer readings (e.g. using a chart, Figure 8) to identify changes and trends in the MWF concentration. Retain copies of these checks.
Explanation
• Refractometers are an effective shop floor tool to monitor the concentration of the MWF. There are other methods to measure MWF concentration, seek advice from your supplier as to the most suitable materials. • A refractometer reading is not a direct measure of concentration. Product-specific factors must be applied, ask your supplier if in doubt.
Frequency
At least weekly

Technical advice about refractometers

A refractometer is a handheld optical instrument to measure the working concentration of a MWF based on the refractive index. The operator reads a number through the eyepiece of the instrument (Figure 10) which needs to adjusted by a product specific factor to determine the MWF concentration. If not at the specified working concentration, the MWF can then be adjusted.

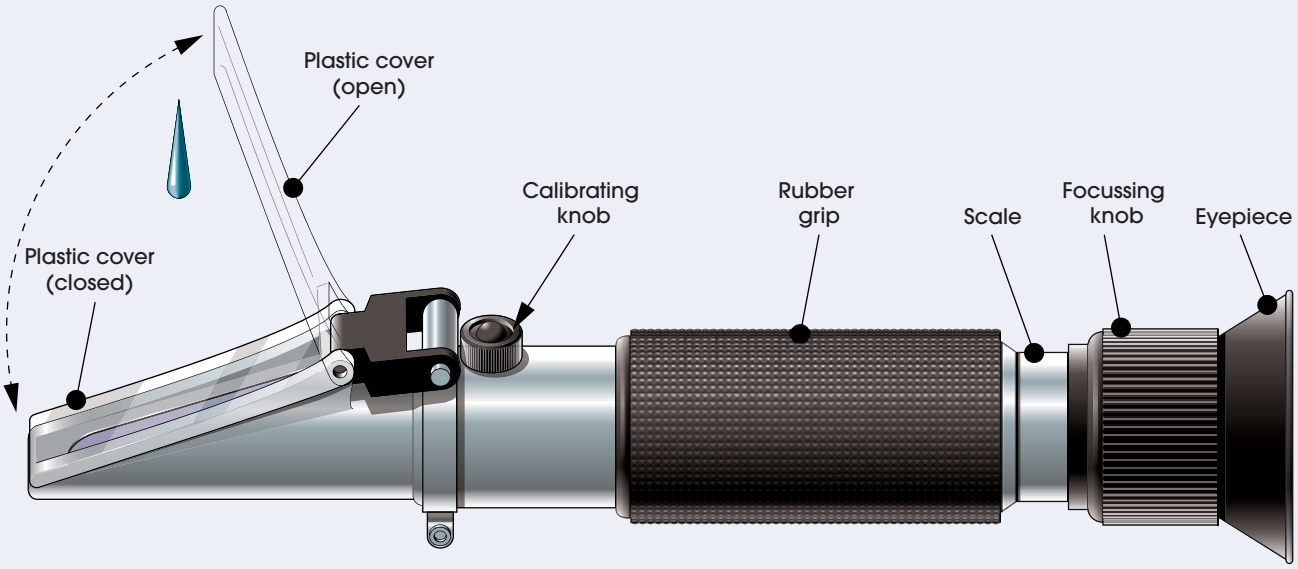


Figure 9: A schematic diagram of a refractometer

Calibration: The accuracy of a refractometer is dependent on temperature and the instrument. The pure water used to calibrate the instrument and the MWF sample must be at an ambient temperature before calibration is carried out.

1. Ensure that the refractometer is calibrated to zero reading on the water sample at ~20°C.
2. Do not carry the refractometer in your pocket or leave in direct sunlight.
3. Place a few drops of the pure water (used for the mixture) between the plastic cover and the prism.
4. Hold the refractometer horizontally and point it at a light source.
5. Look into the eyepiece and adjust the scale calibrating dial until the boundary line which separates the light and dark areas of the scale is aligned with the zero line on the scale.

Technical advice about using a refractometer

Lift the plastic cover and dry the prism with a clean cloth.

1. Place one or two drops of the MWF on the prism and close the plastic cover.
2. Note the refractometer scale reading at the point where the boundary line separates the light and the dark areas on the scale.
3. Determine the concentration by multiplying the scale reading by the adjustment factor of your soluble metalworking fluid (see note below)
4. Clean the refractometer prism and plastic cover with a clean cloth and store in the carrying case.

Note: *Soluble metalworking fluid concentration (%) = refractometer reading x adjustment factor for the MWF**

*contact your supplier for the adjustment factor for the specific MWF

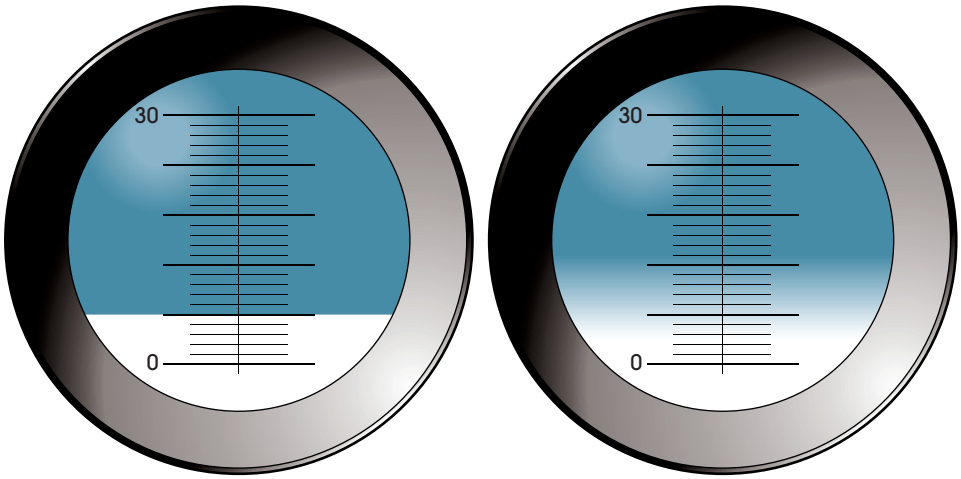


Figure 10: The view through the eyepiece of a refractometer, the right panel depicting a hazy line when tramp oil contamination is present in an old MWF.

Table 7: Agitation and flow of the MWF

Actions
• Keep the MWF circulating with pumps to prevent fluid stagnation in the sumps and pipes. • Undertake cleaning of the sumps to ensure that the MWF can circulate effectively to prevent stagnation.
Checks
• To ensure effective MWF circulation, check for the accumulation of swarf, deposits, biofilms in the sump and supply systems, and 'dead-ends' (Figure 11).
Explanation
• Blockages increase MWF supply pressure causing foaming, misting and reducing performance of the MWF.
Frequency
At least weekly

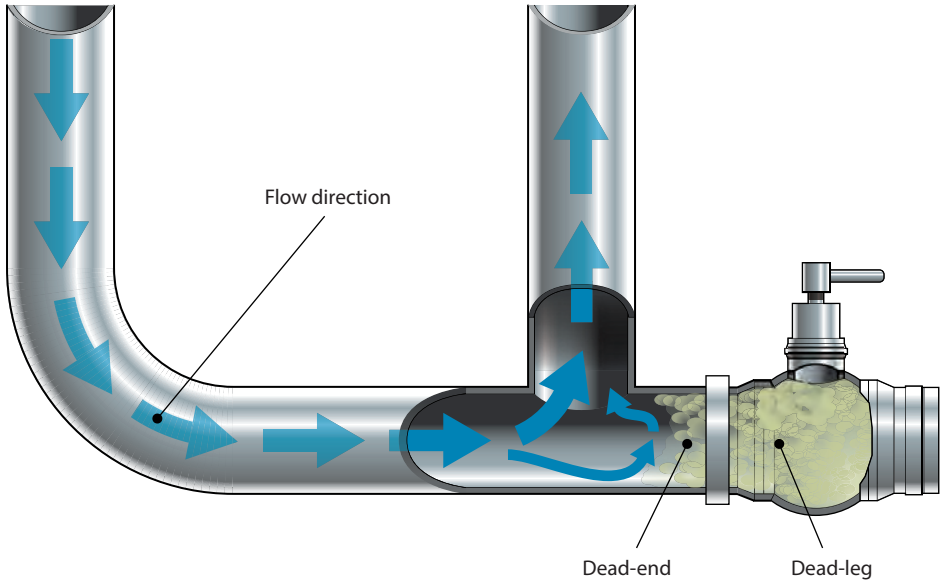


Figure 11: A diagram of part of a fluid supply system demonstrating where stagnation of the MWF and biofilm formation can occur in dead-legs and dead-ends.

Table 8: Monitoring microbial growth

Actions
• Implement a regular monitoring programme for checking microbial growth in water-mixed MWF. This is often done using dipslides, which can detect live bacteria, fungi and yeast (Figure 12) as colony-forming units (CFU) which provides a measure of the number of live bacteria, fungi and yeast. • Other methods may be used to identify specific microorganisms and you are recommended to consult your MWF supplier about these procedures. • Bacterial growth is indicated when dipslide results are consistently above **10,000 CFU/ml (10^4 CFU/ml)** (Figure 12). • **Immediate actions** are required if the MWF is heavily contaminated with bacteria above **1,000,000/CFU (10^6 CFU/ml)**; if it releasing noxious odours; if the pH has lowered below the recommended range; or it is heavily discoloured. Appropriate actions may be the disposal of the MWF and a complete system clean (Section 7.0) but seek advice from your supplier. • For each fluid supply system record using a chart (Figure 8) the results of the dipslide tests to identify trends in the number of live bacteria. This will indicate when to apply appropriate control measures to prevent further microbial growth.
Checks
• Test the MWF using dipslides to determine the number of colony forming bacteria. • Undertake weekly dipslide tests unless you can demonstrate that the controls in place are keeping bacteria growth consistently below **10000 CFU/ml (10^4 CFU/ml)**. • Inspect the machine, machine enclosure, and surface of the sump for visible signs of fungal growth. • If uncertain how to implement a suitable test regime for microbial growth, consult the MWF supplier.
Explanation
• Follow the advice provided with the dipslide kit manufacturer to determine the CFU/ml by incubating the slides under the appropriate conditions. • For the optimal dipslide methods for fungi and yeast seek advice from your supplier.
Frequency
At least weekly

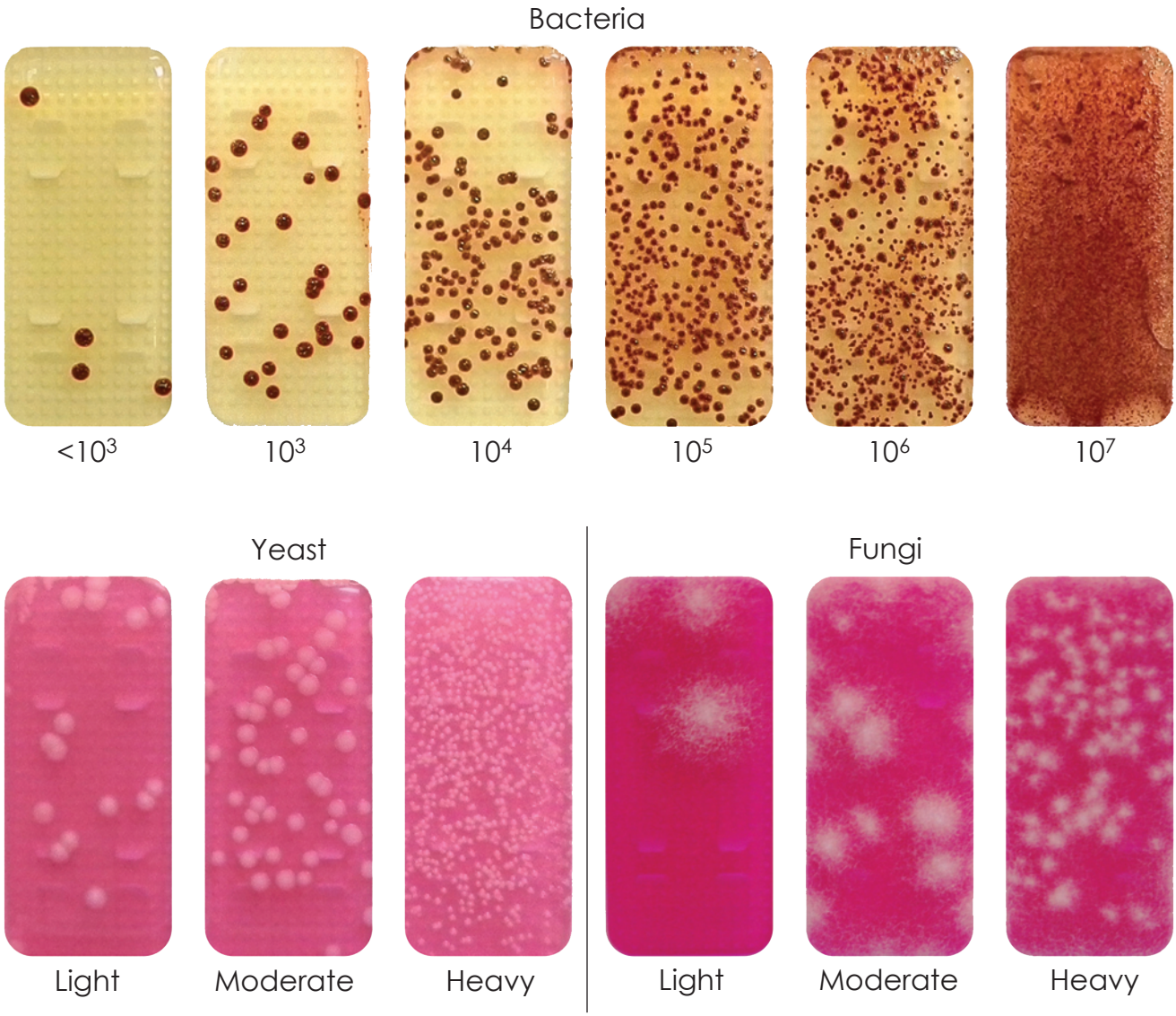


Figure 12: Dipslides showing in upper panel from left to right, increasing number of bacterial colony-forming units (CFU/ml). In the lower panel the yeast (left) and fungi colonies (right) are recored as light, moderate and heavy contamination.

Published guidance on managing MWF sumps.	
Guidance	Web link
HSE MW5 - Managing sumps and bacterial contamination	http://www.hse.gov.uk/pubns/guidance/mw05.pdf

Technical advice about using dipslides to monitor bacteria, fungi and yeast.

Refer to the manufacturer's instructions for dipslides, which are designed for the detection of bacteria, fungi or yeast.

1. Wash your hands and use disposable single-use gloves to handle the dipslide and MWF sample.

2. Remove the dipslide from the storage and incubation tube. Do not allow the dipslide agar (the jelly type substance on each side) to hit the edge of the clear plastic tube.

3. Place the dipslide directly into the sample being tested. Ensure that a dipslide is also used on the water supply as a control. Make sure the dipslide agar is fully submerged for approximately 10-15 seconds.

4. Place the dipslide into the sterile plastic tube taking care not to damage the agar.

5. Place the dipslide tube into a dipslide incubator. The temperature and duration of the incubation period will vary depending on the type of organism (bacteria, fungi or yeast) and you should consult the supplier if in doubt. Generally results are readable around 24-48 hours of incubation for bacteria.

6. Compare the number of colonies of bacteria, fungi or mould on the dipslide against the comparison chart provided by the dipslide manufacturer (Figure 12). Note that the shape and colour of bacterial, fungal and mould colonies differ. The supplier's chart will provide you with an estimate of the CFU/ml.

Table 9: Biocides

Actions
Where dipslide test results exceed 10,000 CFU/ml (10^4 CFU/ml) then: • Ensure that all good practice checks and actions are being applied to maintain the quality of the MWF (concentration, pH, tramp oil content, metal contamination, operating temperature and agitation and flow) • If after applying these measures the growth of bacteria, yeast and fungi cannot be stopped a biocide may be required. Follow the supplier's recommended dosing regime to minimise the risk of biocide resistant bacteria forming. • Add biocides into the sump system to ensure that adequate mixing with the MWF is achieved. To add the appropriate amount of biocide consider the sump volume and always ensure the sump is topped up to the correct level before treatment. • Always refer to the supplier's SDS when checking the hazardous properties of any biocide and for advice about PPE requirements. • **Immediate actions** are required if the MWF is heavily contaminated with bacteria above **1,000,000/CFU (10^6 CFU/ml)** which may require disposal of the MWF and a complete system clean.
Checks
• Ensure that all additions of biocide are noted and records kept
Explanation
• Do not overuse biocides as this may cause dermatitis and asthma. • Only use biocides at the doses recommended by your MWF supplier • Overuse of biocides may increase the risk of developing biocide resistant organisms.
Frequency
Only add biocide when other corrective actions have been taken but microbial growth continues

Table 10: Monitoring microbial growth

Actions
• Ensure that metal swarf and fines (Figure 13) are kept to a minimum in the MWF supply. • Metal fines can be removed continuously using filtration units or a vacuum line. • Consult the supplier about setting good practice levels for metal fines in specific MWFs and machining tasks.
Checks
• Undertake visual checks for accumulation of metal fines, in the MWF supply and sumps.
Explanation
• The amount of metal fines that accumulates in the MWF is highly dependent on the type of metal being machined, the machining processes and the cutting / grinding speed. It is therefore important to reduce the amount of fines to a minimum consistent with the metal and machining processes being applied. • Machining with some metals may cause adverse health effects (Figure 14). • These considerations should be addressed in the risk assessment that is prepared. • If you have concerns about the risks for allergic lung disease caused by sensitising metals seek specialist medical advice, for example, from an occupational health provider.
Frequency
At least weekly

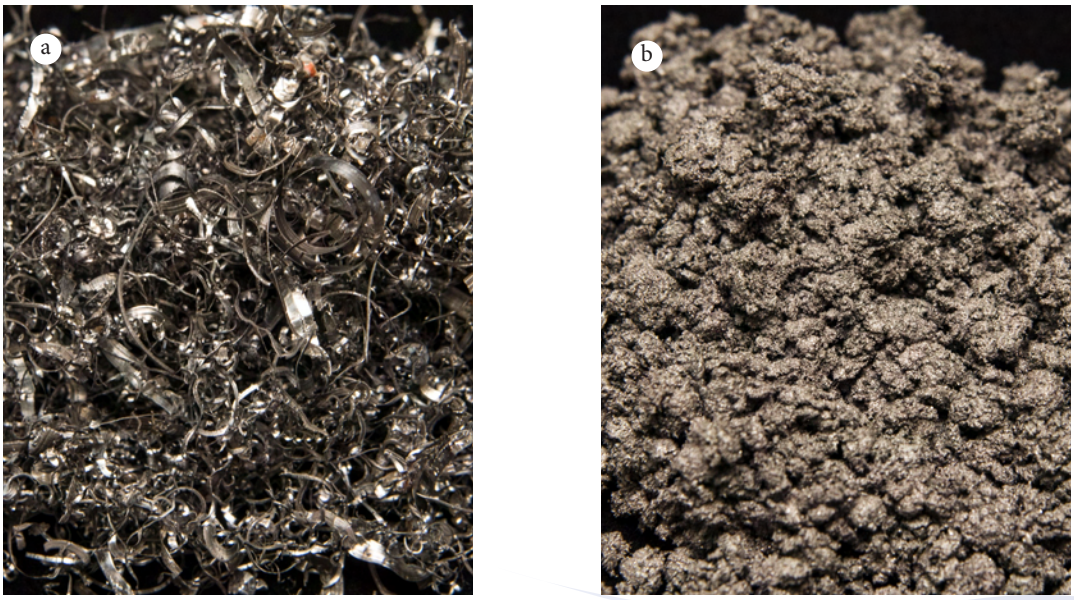


Figure 13: a) Metal fines **b)** swarf from a grinding machine.

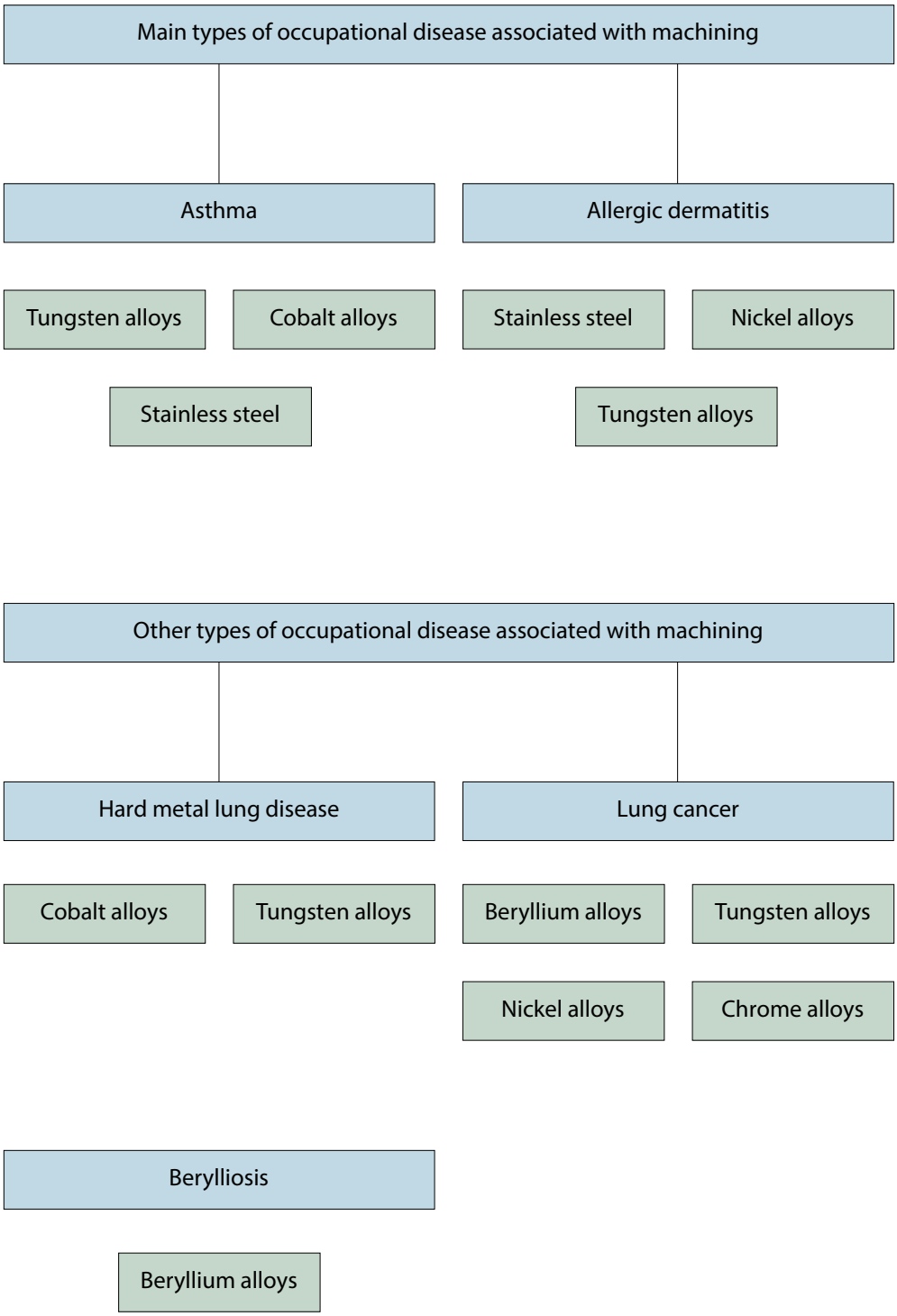


Figure 14: Occupational illness associated with examples of metals and machining that can cause these conditions.

6.0 Controlling exposure to MWF mist

Used MWF may contain hazardous substances and microorganisms. Therefore, proportionate and effective control measures are required to reduce exposure to MWF mist and important factors to consider are:

- Effective design and provision of engineering control solutions such as LEV and mist filtration systems
- Where practicable avoid using compressed airlines for removing MWF
- Checking the performance of all the control measures
- Provision of information, instruction and training to employees
- Provision of appropriate PPE and RPE

6.1 Engineering control solutions

- Where practicable enclose machining processes.
- Where practicable, add time-delays on door openings and leave enclosure doors closed until the mist inside the machine has sufficiently cleared. A smoke pen or tube can be used to visually confirm suitable enclosure door timing (Figure 15a and 15b).
- Ensure that the MWF delivery variables (e.g. volume and rate of flow to the tool, operating temperature and cutting tool speed) are appropriately set.
- Stop the MWF delivery when machining is completed.
- Ensure that all routine checks and unexpected incidents with engineering control systems are recorded and these records retained.

6.2 Effective design and provision of LEV

- It is of paramount importance to provide adequate LEV to remove MWF mist from machine enclosures.
- It is essential that these systems are fitted and operated effectively.
- For recirculated air filtration systems ensure that the most appropriate equipment is used. Consult the supplier if in doubt.

6.3 Checking the performance of LEV

- Ensure that a preventative programme is in place to maintain control measures such as LEV.
- Operators should check and promptly report any problems with the performance of LEV.
- Daily visual inspection of engineering control systems, for example the Magnehelic airflow pressure gauges during startup operations, should be carried out.
- Thorough examination and testing of LEV systems must be carried out at least once every 14 months (a statutory requirement) by a competent ventilation engineer.

Smoke pens and tubes (Figure 15a and 15b) are a practical means to check clearance times (Figure 16a and 16b) inside machines and to look for leaks in the ventilation and extraction system. Back-lighting equipment is inexpensive and a practical means to visualize smoke particles leaking from equipment.

6.4 Compressed airlines

The use of compressed air to blow down components increases the risk for inhaling MWF mist and splash contamination of skin and clothing (Figure 17a and 17b). Alternative methods which reduce the use of hand-held compressed airlines, should be considered, for example enclosed component cleaning systems fitted with LEV, vacuum lines, absorbent materials, or degreasing/washing methods. When there is no practical alternative to their use;

- Provide LEV for work with compressed air.
- Reduce compressed airline pressure to a level as low as practical for effective cleaning and to minimise mist emissions.
- Use compressed airlines designed to reduce exposure to MWF mist, for example with longer handles, with different nozzle designs, or fitted with shields to minimize splash back on the operator.
- Do not use compressed airlines close to the face or body of the operator.

6.5 Provision of information, instruction and training

Provide information and training to employees on the risk of exposure to MWF mist and the use of preventive control measures.

6.6 Provision of appropriate PPE and RPE

Use appropriate RPE but only when all other actions have been taken to contain and control exposure to MWF mist.

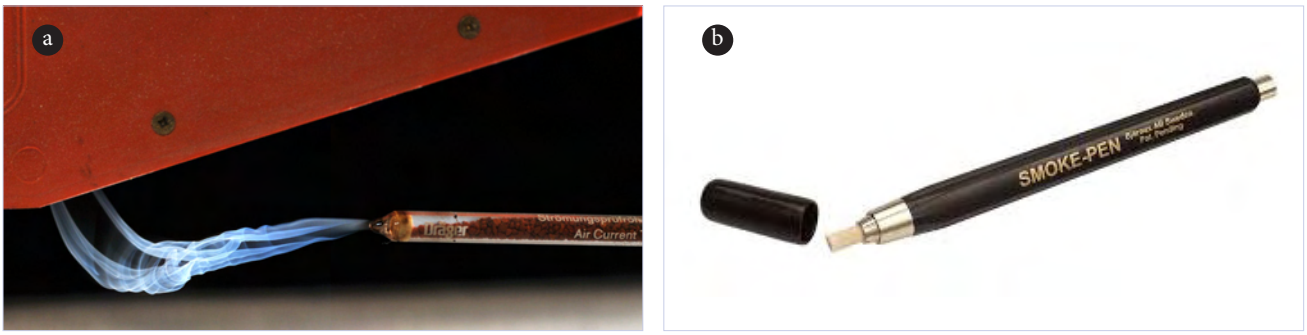


Figure 15: a) Shows a smoke tube, **b)** a smoke pen. These devices can be used to visualise any leakages in the equipment. Leakages would be detected by the release of smoke around the seals of equipment using back-lighting

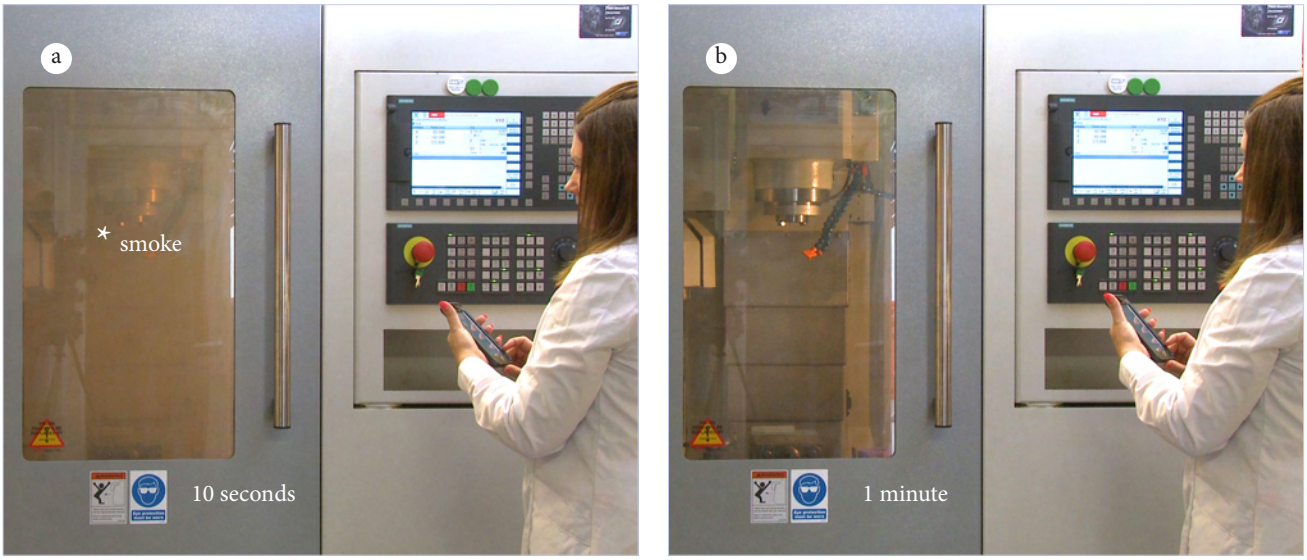


Figure 16: a) Back-lit photograph of smoke generated inside a machine enclosure after 10 seconds, **b)** shows clearance of the smoke within a minute. Note, this is an example of a clearance time, which may differ under other circumstances.

HSE guidance on establishing clearance times using smoke aerosols and for guidance on the design, operation and testing of LEV.	
Guidance	Web link
HSE: Measuring clearance times using smoke generated from a glycerol aerosol.	http://www.hse.gov.uk/mvr/bodyshop/cleartime.htm
HSE: Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV)	http://www.hse.gov.uk/pubns/books/hsg258.htm

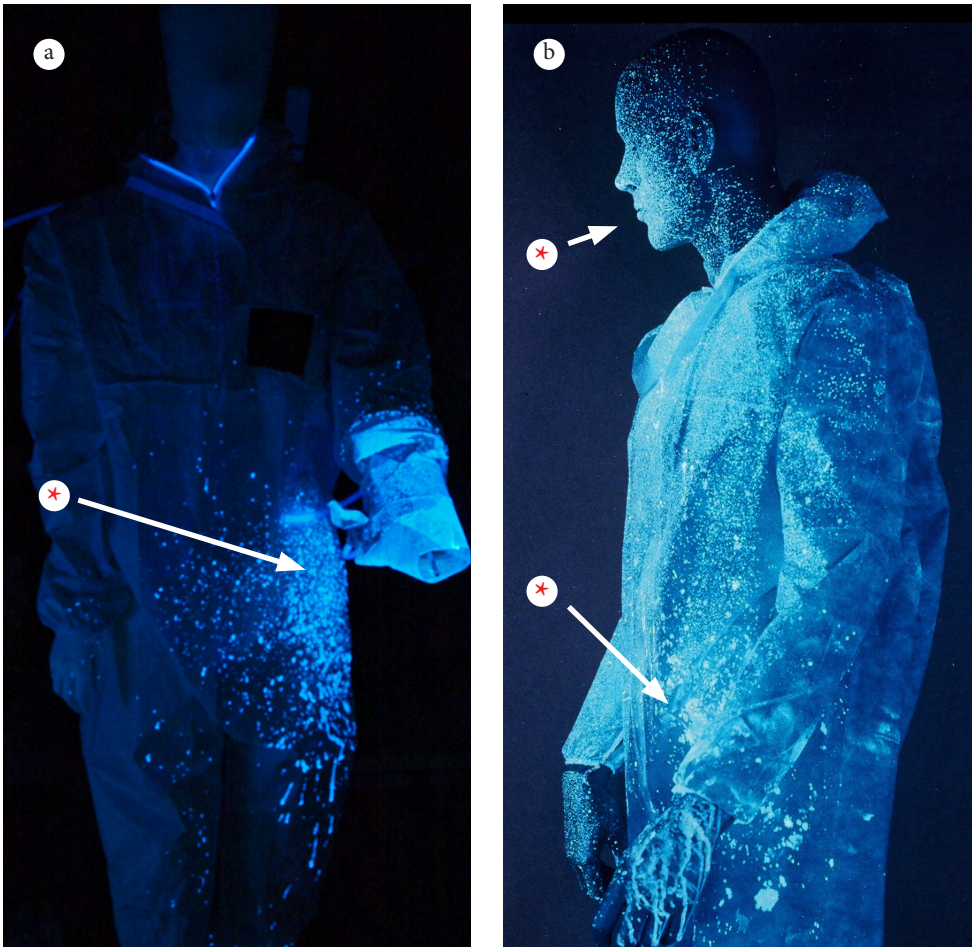


Figure 17: a and b) Photographs of MWF contamination on the torso and face (of a manikin) showing the effects of using a compressed airline and splash back onto the operator (The asterisk marks the spots / deposits on the face and arm visualised by adding a fluorescent blue dye to the MWF [C]

[C]Mists created by the use of compressed airlines for the removal of metalworking fluids

Assessment of the possible exposure health risks: HSE RR904 Research Report (2011) www.hse.gov.uk/research/rrpdf/rr1043.pdf.

HSE guidance on working safely with MWF (a guide for employees) and HSE guidance on selection of RPE	
Guidance	Web link
HSE Working Safely with MWF (a guide for employees).	http://www.hse.gov.uk/pubsns/indg365.pdf
HSE: Respiratory protective equipment at work HSG53 (Fourth edition, published 2013).	http://www.hse.gov.uk/pUbns/priced/hsg53.pdf

7.0 Cleaning MWF Systems

It is recommended to undertake a system clean when changing the MWF. There are specific risks to health that may occur when cleaning out used MWF and supply systems. These include the exposure to mist, sprays and fumes from vigorous cleaning methods (such as compressed airlines and hoses) and to chemicals used to clean and decontaminate the supply system. For large supply systems there may also be a risk of operators working in a confined space.

7.1 Risks associated with cleaning out a MWF system

- Inhalation of contaminated MWF mist when cleaning out biofilm and metal fines from filters
- Hazardous substances in system cleaning fluids, and use of biocidal products may cause skin disease and asthma (refer to the supplier's SDS for advice)
- With large sumps the potential for work in a confined space. This applies if the space is substantially or totally enclosed and there is a risk of loss of consciousness or asphyxiation arising from gas, fume, vapour or a lack of oxygen.

HSE guidance on working in confined spaces	
Guidance	Web link
HSE Confined spaces web pages	http://www.hse.gov.uk/confinedspace/
HSE Confined spaces legislation (1997)	http://www.legislation.gov.uk/uksi/1997/1713/contents/made

7.2 Cleaning out MWF systems

The frequency with which a water-mix MWF machine supply is changed will depend on your monitoring results, the type of the MWF, the volume of the sump system, or the type of work undertaken. For small or stand-alone sumps regular replacement of the MWF may be a safer and more cost-effective method which reduces overuse of biocides. If in doubt, consult your MWF supplier. A system clean should be undertaken when some of these conditions apply:

- Dipslide tests continue to show heavy contamination with bacteria above 1,000000 CFU/ml (10^6 CFU/ml).
- Visual signs of microbial growth such as biofilm and fungal growth on the internal and external surfaces of the machine. There may also be noticeable odours.
- An unstable emulsion is evident and there is heavy contamination with tramp oil and other contaminants.

For water-mix MWF the appropriate control measures include using suitable RPE and PPE during all cleaning activities. The main steps in the process are outlined in Figure 18 and web links to sources of advice can be found at the end of this section.

7.2.1 Cleaning procedures for water mix MWF

- If the previous MWF had high levels of bacteria and biofilm it may be necessary as the first action to add an appropriate biocide directly into the sump. Consult your supplier about when to add this biocide.
- Follow the supplier's instructions about using system cleaner concentrates and how they should be diluted and added to the MWF system.
- Allow sufficient time for the system cleaner to circulate and work, consult your supplier if in doubt about the optimal circulation conditions.
- After the system is drained carry out a thorough inspection of the sump and flexible hoses and connections. Ensure they are free from debris and that any sludge is removed.
- After biocide treatment ensure that the MWF supply system is flushed out with a 'top up' dilution of MWF.
- Ensure that those sections of the supply system such as bottle-necks and dead-legs have sludge removed before the 'top up' MWF is flushed through the system.
- Undertake a pH check on the 'top up' MWF to ensure that the system cleaner and other chemicals have been removed. If not continue rinsing with 'top up' MWF.
- It is recommended to undertake dipslide tests (or other microbiological tests) following a system clean and about a week after the system has been refilled with fresh MWF.
- Plain water should not be used because of potential corrosion of metal surfaces.
- If in doubt about how to undertake a system clean, consult your MWF supplier.

7.2.2 Removing metal waste

- Use suitable tools e.g. brushes and shovels to remove swarf and wear suitable cut resistant protective gloves to prevent injury when handling swarf.
- Be aware of the potential for emission of noxious gases from certain metals (e.g. cast iron).
- When cleaning out metal fines and swarf consider ignition risks from flammable metals (e.g. titanium, magnesium, aluminium).

7.2.3 Cleaning out sumps for neat oils

- The recommended procedure for cleaning a system containing neat oil is outlined in Figure 19.
- Remove swarf, debris, and oil using scrapers or suction pumps, etc.
- Areas of accumulated dirt or oily residues should be physically removed and adequate precautions taken to wear appropriate PPE.

COSHH essentials guidance on cleaning sumps	
Guidance	Web link
HSE MW3 COSHH essentials sheet: Sump cleaning: water-mix fluids	http://www.hse.gov.uk/pubns/guidance/mw03.pdf
HSE MW4 COSHH essentials sheet: Sump cleaning: neat oils	http://www.hse.gov.uk/pubns/guidance/mw04.pdf

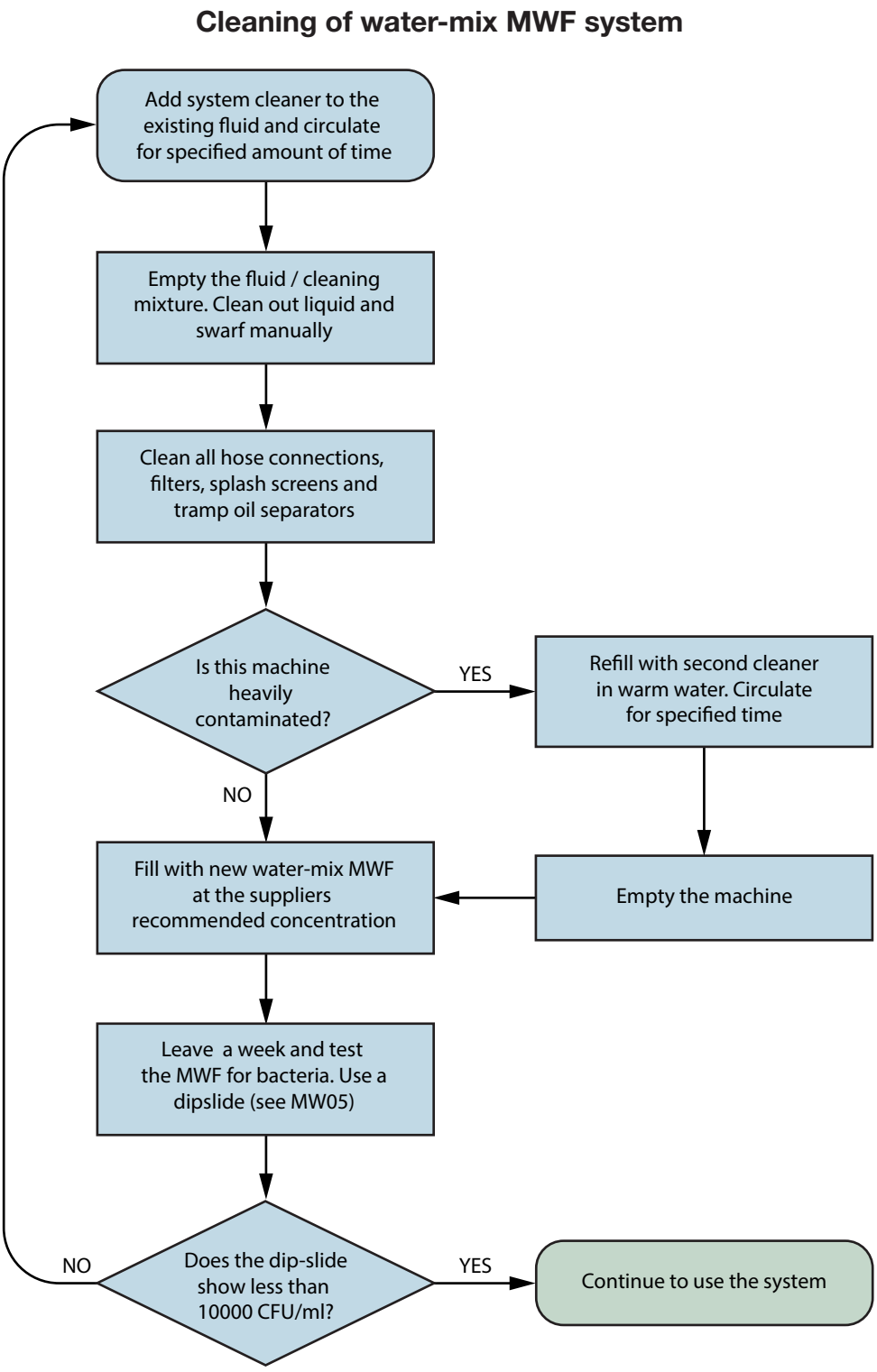


Figure 18: Decision chart outlining key steps in cleaning out a water-mix MWF system.

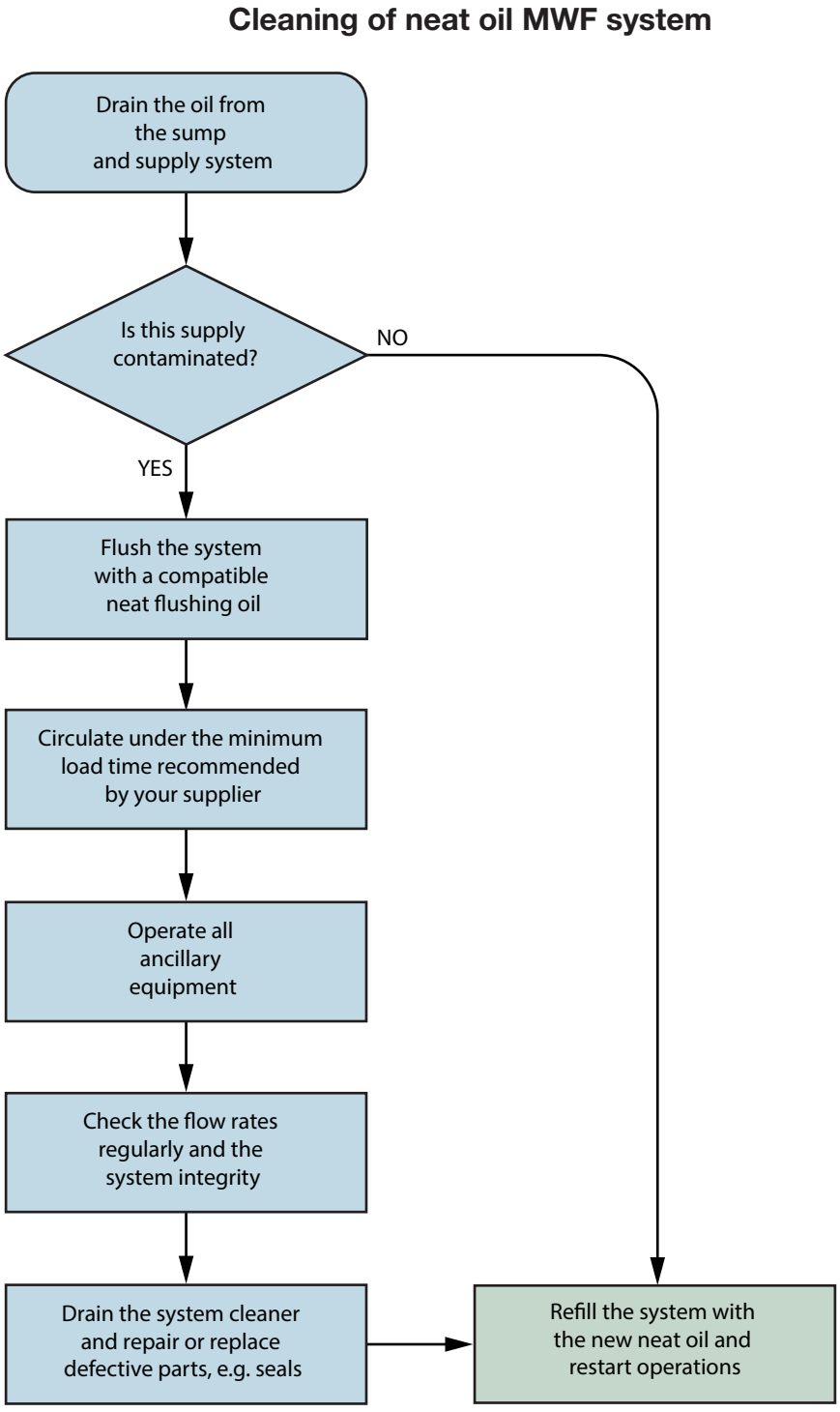


Figure 19: Decision chart outlining key steps in cleaning out a supply system containing neat oil MWF system.

7.3 Additional guidance

- Ensure that the risk assessment for this work considers all of the key safety and health-related concerns.
- Ensure that staff wear suitable PPE to ensure that cleaning solutions and biocides do not contact the skin and eyes.
- If high pressure water hoses are used to clean sumps ensure that operators are provided with suitable PPE and RPE.
- Restrict access to places where this cleaning work is carried out.
- Do not return recovered MWF to the sump without first obtaining evidence that its quality is acceptable for further use. This will ensure that microorganisms and other contaminants are not reintroduced into the MWF, reducing operational life and performance.
- Be aware of protective treatments which may have been applied to newly commissioned machinery which may contribute to bacterial growth. It is recommended to clean out this machinery thoroughly before adding the MWF.
- During preventive maintenance and shutdown periods ensure that MWF supplies are regularly circulated and not left to stagnate in sumps and supply systems.

8.0 Safe Disposal of Used MWF

8.1 Emergency spillage procedures

- Ensure that all health and safety risks have been considered and take appropriate precautions for MWF spillages.
- Ensure that a relevant operating procedure and spill kit (i.e., absorbent materials) are in place for dealing with spillages. If in doubt refer to the product SDS.
- Raise awareness of spillages using proper signage and barriers.
- Ensure that correct PPE is worn by staff cleaning spills of MWF (refer to the product SDS and Figure 4b).
- Do not return spilled and contaminated MWF back to the sump supply.
- Ensure a system is in place to record spillages and leaks from machines.

8.2 Disposal of used MWFs

- Used MWF needs to be disposed safely so follow appropriate guidance from the MWF supplier and industry best practice advice (Figure 20). For more information regarding the disposal of MWF see web-links at the end of this section.
- Ensure used MWF does not enter the general environment or create a risk to health during storage or transport.
- All MWF should be disposed of in accordance with national and local legislative requirements and an approved waste disposal contractor should be used.

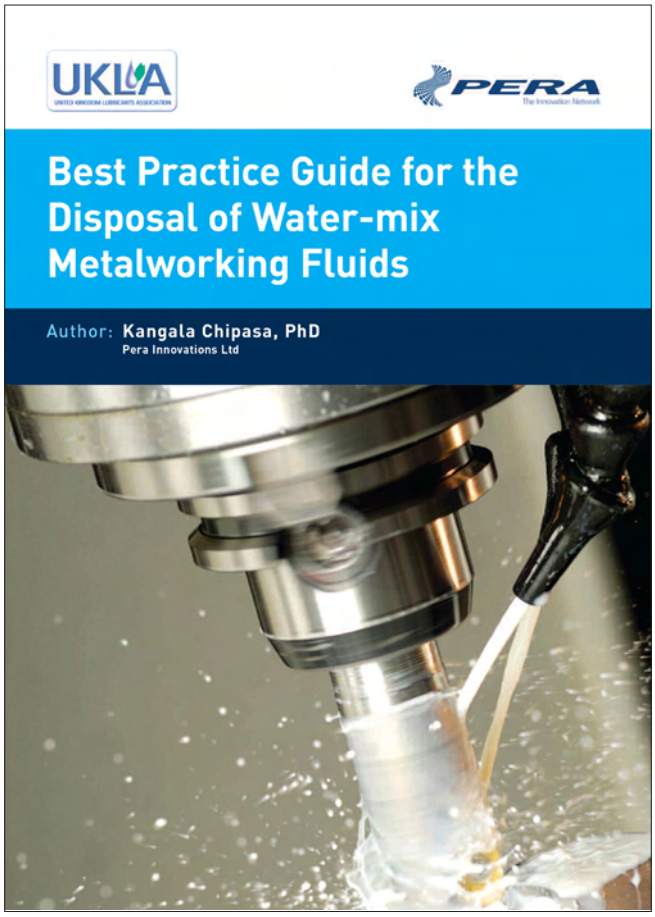


Figure 20: The UKLA best practice guide for the disposal of water mix-metal working fluids

UKLA and industry guidance on safe disposal of water mix MWF	
Guidance	Web link
UKLA Best practice guide for the disposal of water-mix metal working fluids	http://www.ukla.org.uk/wp-content/uploads/UKLA-PERA-Best-Practice-Guide-for-the-Disposal-of-Water-mix-Metalworking-Fluids.pdf
The Oil Care Campaign	http://oilcare.org.uk/

9.0 Abbreviations and acronyms

Term	Explanation
Aerobic / anaerobic	Microorganisms in metal working fluid that require oxygen (aerobic) to grow / grow with no oxygen (anaerobic)
ALARP	Exposure is reduced to as low “a level as is reasonably practicable”
Asthma	A chronic inflammatory disease of the lung characterised by episodes of shortness of breath, wheezing, chest tightness and cough
Biocide	A substance or mixture of substances used to kill microorganisms
Biofilm	Bacteria and other microorganisms, embedded in a visible protective slimy layer attached to the inner surface of a sump or pipe.
CFU	Colony forming unit, the number of individual bacteria capable of dividing to form a visible colony
Confined space	A confined space is a place which is substantially enclosed (though not always entirely), and where serious injury can occur from hazardous substances or conditions within the space or nearby (eg lack of oxygen)
COSHH	Control of Substances Hazardous to Health Regulations 2012
Dead-ends	A section of the MWF supply system that is sealed at one end preventing continuous flow through and causing stagnation
Dead-leg	Dead-leg pipes refers to fittings through which water passes infrequently or to redundant legs of pipework
Dermatitis	Inflammation of the skin caused by allergens or irritants
Dipslide	A sterile layer of agar coating on both sides of a plastic slide. This is used to determine the number of growing bacteria, fungi and yeast in the MWF
Fines	Metal (particles which may be small and invisible to the naked eye)
LEV	Local exhaust ventilation is extraction at source removing air contaminated with hazardous substances
Magnehelic gauge	An instrument used to measure the air pressure (positive, negative or differential) in a local exhaust ventilation system

9.0 Abbreviations and acronyms

Term	Explanation
Mechanical skimmers	A device to remove tramp oil from the surface of a metal working fluid supply
Microorganisms	This term includes bacteria, yeast and fungi
MWF	Metal working fluid: either soluble (emulsion in water), semi-synthetic, synthetic or neat 'straight' oils
MWF mist	An airborne cloud of very small droplets typically caused by high speed rotation of cutting machines or release of MWF under pressure (eg from the use of compressed airlines)
OA	Occupational asthma
OHP	Occupational Hypersensitivity Pneumonitis: an inflammation of the lung caused by MWF inhalation. This may also be called Extrinsic allergic alveolitis (EAA)
Oil coalescers	A device to separate tramp oil from MWF by coalescence
PPE	Personal protective equipment
pH	Expressed as a number between 1 and 14 to indicate how acidic or alkaline the MWF is. Values below 7 are increasingly acidic, 7 is neutral, and values higher than 7 are progressively alkaline.
pH meter	An instrument to measure acidity or alkalinity in a MWF
Refractometer	An optical device to determine the concentration of MWF by measuring the way that it bends light
RPE	Respiratory protective equipment
SDS	Safety data sheet
Smoke pens/tubes	A device for releasing non-hazardous particles as a visible smoke to monitor clearance and leakage from containment systems
Swarf	Metal shavings removed by a cutting or grinding tool
SWORD	A GB national survey of work-related and occupational respiratory disease
System clean	Removing the MWF supply to clean the circulation system and sump
Tramp oil	Any unwanted oil contaminating the MWF from external sources (eg leaking hydraulic fluid)
UKLA	United Kingdom Lubricants Association
VOCs	Volatile organic compounds

10.0 Membership of the Advisory Panel

Chair: Jenny Skeldon	HSE
Andrew McClean	Pennine Lubricants
Ian Harris	Houghton PLC
Stephen Rushton	Houghton PLC
Matt Bloomer	Q8Oils UK
Stuart Duff	Q8Oils UK
Jennifer Smith	Fuchs Lubricants (UK) PLC
Gareth S Evans	HSE
Paul Smith	HSE

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HSE Health surveillance planning

HSE COSHH essentials G402: Health surveillance for Occupational Asthma

HSE Dermatitis awareness poster

HSE Personal protective equipment at work

HSE COSHH Essentials

HSE Controlling airborne contaminants at work: A guide to local exhaust ventilation

HSE working safely with metal working fluids (a guide for the employer)

HSE COSHH MW3 guidance: Sump cleaning water-mix MWF

HSE COSHH MW4 guidance: Sump cleaning neat oils

HSE COSHH MW5 guidance: Managing sumps and bacterial contamination

UKLA best practice guide for the disposal of water-mix MWF