

An Innovative Approach to Respiratory Hazard Control

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ABSTRACT

This paper describes a new approach for controlling inhalation exposure to chemical agents in the workplace using respiratory protective devices (RPDs), where such a risk remains after appropriate controls at source have been applied. It builds on the “risk banding” approach (COSHH Essentials) which has already been introduced in the UK for helping to control exposure to chemical agents at source.

Rather than relying on knowledge or understanding of occupational exposure levels (OELs) for assessing the potential for harm, and deciding the type of control and RPD required, this approach uses Hazard Risk Phrases (R-phrases), combined with potential for exposure based on the amount of substance used, and its dustiness / volatility. The R-phrases classification of hazardous substances is already well-established in Europe, and may in the future be adopted, with slight modification, as a Globally Harmonized System for classification and labeling of hazardous substances.

Proposals in the paper enable the user to identify the types of RPD capable of providing the right level of protection, and to begin selecting a suitable design for their application and wearer. This whole process is carried out using a formatted questionnaire – RPD Selector – enabling the user to provide the information necessary for correct RPD selection to their supplier.

Keywords: COSHH-Essentials; respiratory protective equipment; respiratory protective device, respirators, personal protective equipment; hazard banding

INTRODUCTION

During the last five decades various national and international authorities have developed generic approaches for controlling inhalation exposure to chemical agents in the workplace. This paper builds on a “control banding” approach which was developed in the United Kingdom (UK) specifically for use by small and medium sized enterprises (SMEs). The rationale for and development of this approach were discussed extensively at the London Control Banding Workshop in November 2002 (Oldershaw, 2003; Balsat *et al.*, 2003; Money, 2003; Swuste *et al.*, 2003; Tischer *et al.*, 2003).

The ‘Control of Substances Hazardous to Health Regulations’ (COSHH) set out the framework for the prevention or adequate control of exposure to substances (including chemical agents) that present risks to employees’ health (HSE, 2002a). As in many countries, the framework includes the role of occupational exposure limits (OELs) in assessing the adequacy of exposure control. There are around 600 chemicals substances in the current list of OELs (HSE, 2002b). However, there are approaching 3000 substances listed in the Approved Supply List (HSE, 2002c) and over 100,000 substances listed in

the European Inventory of New and Existing Chemical Substances (EINECS). The vast majority of these substances have neither official nor in-house OELs.

In the UK, there are several million SMEs and they employ a large proportion of the UK workforce. A significant proportion of these SMEs regularly use chemicals. Health and Safety Executive (HSE) research showed that industry's perception, knowledge and understanding of OELs were limited and that they played little part in workplace risk management (Topping *et al.*, 1998). The same research found that the use of personal protective equipment (PPE) featured highly as a control measure.

The COSHH regulations are supported by an Approved Code of Practice (ACoP) (HSE, 2002a), which interprets the law and gives guidance on how to comply with the law by "goal-setting", without restricting how this can be achieved. But a further research by HSE indicated that this goal-setting approach is not suitable for many SMEs (Hudspith and Hay, 1998; Russell *et al.*, 1998). SMEs needed a different, less nebulous and more clearly mapped out, approach to help them meet their duties under COSHH. In consultation with industry (unpublished HSE study), HSE identified the following criteria for developing and delivering new approaches that SMEs would be more likely to use successfully:

- the approach should deliver practical help to SMEs;
- the best use should be made of hazard information made available through material safety data sheets;
- the approach should be easy to use and understand; and
- the approach should be readily available to SMEs.

These criteria led to a number of developments including the approaches for control at source and the selection and use of respiratory protective device (RPD).

THE INNOVATIVE APPROACH

General

The new approach for inhalation exposure control is based on hazard and exposure bandings. The assessment of health hazard and potential exposure leads to advice for control at source and then, if necessary, selection of a suitable respiratory protective device.

The COSHH Essentials Approach

The advice for control at source was first published as "COSHH Essentials – easy steps to control chemicals" (HSE, 1999a; Russell *et al.*, 1998). COSHH Essentials is a generic approach for identifying suitable controls at source to reduce exposure by inhalation. The COSHH Essentials approach allots hazardous chemical substances to one of five Hazard Groups (Table I) using Europe-wide health risk phrases assigned through the Chemicals (Hazard Information and Packaging for Supply) Regulations (CHIP) (HSE, 2002c) and the Guide to Classification (HSE 1999b, HSE 1999c). These risk phrases describe the hazardous properties of substances in simple terms. Complex risks can be described by combining risk phrases. The International Labour Organisation (ILO) is considering a uniform approach to the classification of risk phrases. The Hazard Groups in Table I have been formulated with such a globally harmonized system in mind.

The paper version of COSHH Essentials was adapted for the Internet in 2002 (URL - <http://www.coshh-essentials.org.uk/>) and this is known as "e-COSHH Essentials". The potential for the extent of inhalation exposure is classified, through four 'physical property' bands and three 'amount (quantity) used' bands. The explanation for the amount of substance used is given in Table II; the descriptors for "dustiness" are given in Table III. In both these tables, users should normally adopt a cautious approach to estimating potential exposure when close to the indicative boundaries between classes, and opt for the higher level. The approach for categorizing "volatility" of vapours is shown in Figure 1. Gases are always classified as high volatility.

Table I. COSHH Essentials Hazard Groups (Exposure by Inhalation)

Group A	Group B	Group C	Group D	Group E
R 36 R 38 Other Risk Nos. and Unclassified	R 20 R 21 R 22	R 23 R 24 R 25 R 34 R 35 R 37 R 41 R 43 R 48/20 to /22	R 26 R 27 R 28 R 40 R 48/23 to /25 R 60 R 61 R 62 R 63	R 42 R 45 R 46 R 49 R 68 (was R40 mutagen.)

Table II. Amount of Substance Used

Amount of Substance Used	
Small	Grams or millilitres (a few ounces, around a cupful)
Medium	Kilograms or litres (1 to 100 kg, up to 55 gallon drums)
Large	Tonnes or cubic metres, tanker or lorry loads

Table III. Dustiness of Substance Used

Dustiness of Substance Used	
Low	Pellets, waxy flakes and pill-like solids that do not break up easily. No dust cloud produced and little or no dust in the area.
Medium	Crystalline granular solids and dust, (visible, settles quickly). Fume or mist formed close to the task but dissipates very quickly.
High	Fine powder, fume or mist. Dust cloud, fume or mist is formed and remains in the air for several minutes.

It is a fundamental principle that harmful exposures must be eliminated or controlled at source, where practicable, before considering use of personal protection. The Control Approach at source is allocated according to the Hazard Group and Exposure Band. There are four Control Approaches (control bands) for chemical substances and preparations (e.g., paints, epoxy resins): General ventilation; Engineering control (such as local exhaust ventilation); Containment (such as enclosure of the working process to isolate workers from the substance) and Special. Where "special" is indicated the user is recommended to seek professional help from an expert such as an occupational hygienist. These Control Approaches are summarized in Figure 2.

For a range of tasks, the Control Approach leads to good practice control advice sheets, termed "Control Guidance Sheets" (CGSs). These sheets set out, as simply as possible, just those elements that are essential to controlling inhalation exposure for a specified substance or preparation in a specified task. A typical control guidance sheet is shown in Appendix 1.

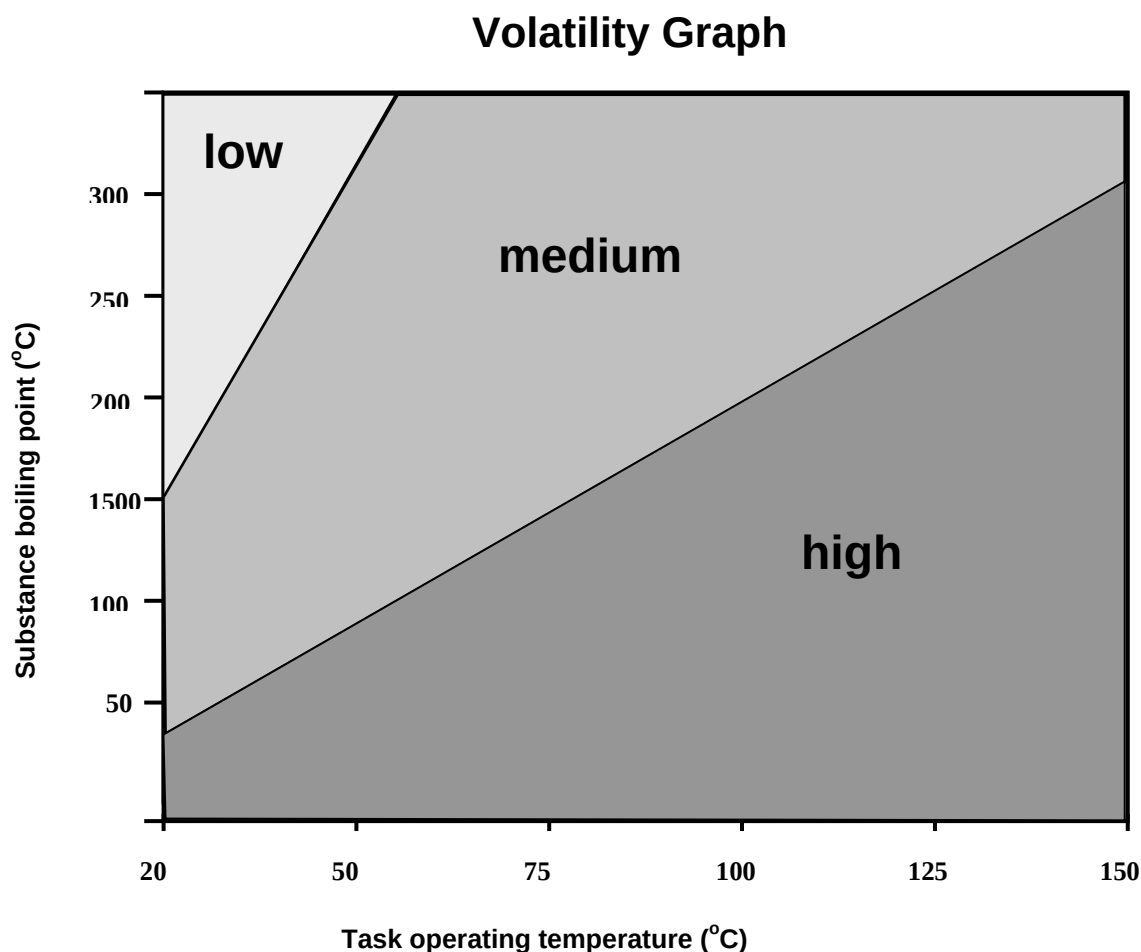


Figure 1. Volatility, task operating temperature and boiling point relationship for vapours (gases are always classified as high volatility).

To establish credibility and transparency, the generic approach of this kind has to be based on scientific underpinning. The technical basis underpinning the relationship between hazard bands, harm and upper boundary concentrations in air is described by Brooke (1998) and is summarised in Table IV.

Table IV. Inhalation Hazard Bands and Target Upper Boundary Concentrations in Air

Hazard Band	Dust Upper Boundary (mg/m ³)	Vapour Upper Boundary (ppm)
A	10	500
B	1	50
C	0.1	5
D	0.01	0.5
E	Seek special advice	

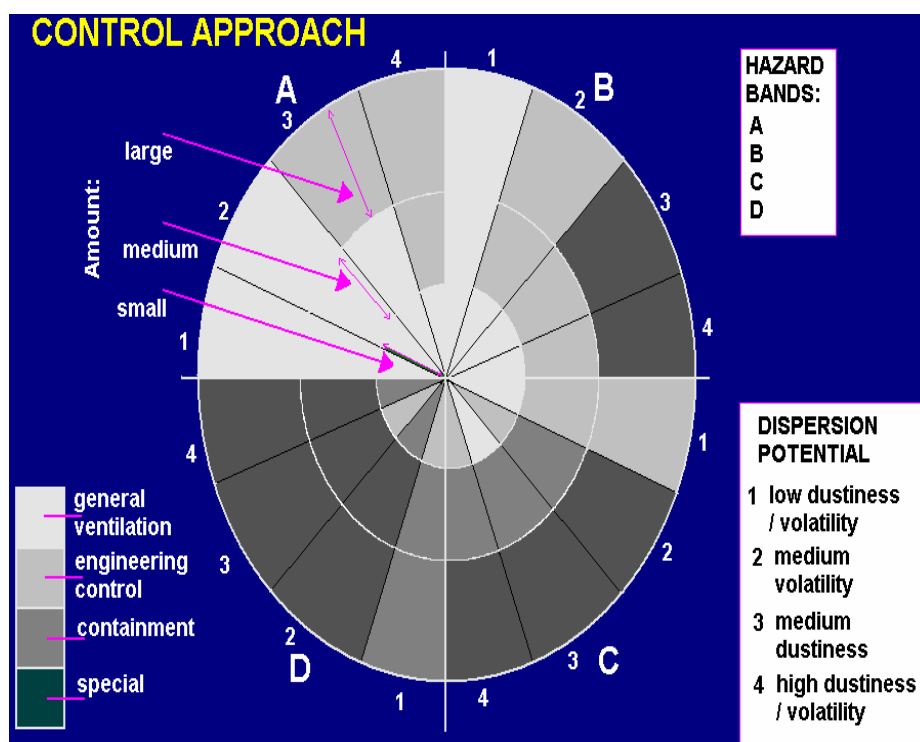


Figure 2. Control at source approaches to match the hazard and inhalation exposure bands.

As a general rule, the COSHH Essentials approach relies strongly on hazard risk phrases. Therefore, COSHH Essentials cannot be applied to chemical agents which are not subject to the CHIP regulations (e.g. process generated substances such as wood dust and welding fume). For process generated substances, some sector-based task-specific guidance has been developed, and more is being developed, to bridge the gap left by the absence of relevant R-phrases.

Application to respiratory protective device selection

Even after considering and applying controls at source, it may be necessary to consider RPDs as a control measure. For example, an RPD may be needed if an inhalation exposure risk (including potential oxygen deficiency) remains after other reasonable controls have been applied (residual risk); if exposures are short-term or infrequent and controls at source are not reasonably practicable; while installing other control measures (interim measure); if needed for emergency work or escape if the at-source control systems fail. There are also instances where prevailing legislation requires the use of appropriate RPDs.

At present, COSHH Essentials has no direct advice for the selection of adequate and suitable RPD. Instead, where appropriate, reference is made to the publication "The selection, use and maintenance of Respiratory Protective Equipment HSG53 (HSE, 1998). But in order to select adequate an RPD, the procedure described in HSG53 requires a knowledge and understanding of OELs, which defeats the objective of simplicity and goes against the research findings (Hudspith and Hay, 1998; Russell *et al.*, 1998). Therefore, a new approach has been developed for the selection and use of RPD which will be incorporated within e-COSHH Essentials, and a revised HSG53 which will be published in 2005, under the new title "Respiratory protective equipment at work – a practical guide".

Note: To use the procedure described in the old (1998) version of HSG53, the employer should measure or estimate airborne concentrations, and compare these against published OELs or to an in-house OEL to determine the minimum protection factor (MPF) required from RPD. The "protection factor" is an indication of how effective a RPD is likely to be at protecting the wearer, if used correctly. Higher values of protection factor indicate greater protection. This procedure cannot be applied where there is no OEL.

The calculated MPF is compared with protection factors listed in HSG53, to identify a range of potentially adequate RPD. From this range of devices, the employer will need to choose the "suitable" RPD by taking account of the wearer and workplace requirements.

The proposal is based upon the principles established for COSHH Essentials. It means that the approach will use the same inhalation Hazard Groups (Table I), potential exposure bands (*i.e.*, amount used, dustiness and volatility) (Tables II and III and Figure 1) and the upper boundary concentrations (Table IV) for assessing adequacy. For commonly encountered process-generated substances, health hazard groups have been assigned (Table V). In addition this innovative approach takes account of confined spaces and the potential for oxygen deficiency.

Table V. Process Generated Substances

Process / Substance	For Selecting RPE – Use Health Hazard Group	Health Hazard Group for COSHH Essentials Engineering Control
Flour dust	A	E (CGS*)
Grain dust	A	E (Specialist advice)
Wood dust	A	E (CGS*)
Poultry house dust	A	E (Specialist advice)
Cotton dust	B	B
Wool process dust	A	A
Rubber process dust	B	E (CGS*)
Rubber fume	C	E (CGS*)
Chimney sweeping (domestic)	A	E (Specialist advice)
Mineral oil mist (except used engine oil)	B	B
Ferrous foundry dust	A	E (CGS*)
Welding/cutting – mild steel	B	B
Welding/cutting – stainless steel	D	D
Lead-based dust or fume (e.g. removal of lead paint)	D	D
Solder flux fume	D	E (CGS*)
CGS* = Control Guidance Sheet available		

The recommendation of MPF is based on hazard and exposure bands together with the assigned protection factors (APFs) developed by the British Standards Institution (BSI, 1997). (These APFs are accepted in the UK as the values which should be adopted when predicting the level of protective performance in use of different types of RPD.) The MPF table for selecting adequate RPD was assembled using the experience and expert opinion from RPD manufacturers, occupational hygienists and HSE and is shown in Table VI. The proposal is not dependant on knowledge and understanding of OELs and does not require the measurement of workplace airborne concentrations. There is only a limited set of APF values (4, 10, 20, 40, 200, and 2000) assigned to different classes of RPD and the MPFs in Table VI were set at these protection factor values, each of which corresponds to one or more types of RPD.

In principle, the numerical values given here are relatively unimportant. They only serve to identify a specific performance level. Any six discrete identifiers (*e.g.*, **a** to **f**) could be substituted. In practice, the

same type / class of RPD is used for similar applications in different countries, where differing numerical APFs may have traditionally been used. Adopting non-numerical discrete identifiers would greatly assist international harmonization, but this is an area for possible future development.

Table VI. Decision Table to Select "Minimum Protection Factor" for RPD

Hazard Group	Amount involved in task requiring RPE	Minimum Protection Factor Recommended (MPF) ¹			
		Low dustiness or volatility	Medium volatility	Medium dustiness	High dustiness or volatility
A Skin, eye irritants, etc.	Small	-	-	-	-
	Medium	-	-	4	10
	Large	4	10	10	20
B Harmful	Small	-	-	4	4
	Medium	-	10	10	20
	Large	10	10	20	40
C Toxic, corrosive, etc.	Small	-	10	4	10
	Medium	10	20	10	20
	Large	20	20	40	40BA ²
D Very toxic, toxic to reproduction, etc.	Small	10	10	20	40
	Medium	20	20	40	40BA
	Large	20	40BA	40BA	2000
E Causes cancer, asthma, etc.	Small	10	20	40	40
	Medium	20	40BA	40BA	200
	Large	20	40BA	40BA	2000

¹ These figures refer to Protection Factors listed in HSG53.

² BA – breathing apparatus.

The user will identify MPF and suitability factors using the RPE Selector shown in Figure 3. Working through the RPD selector, the task for which RPD is required is defined, its use is justified, the required level of protection is decided, and task- and wearer-specific factors are identified which will affect the final choice of suitable equipment. On completion, the RPD Selector form can be shown to the RPD supplier, or a health and safety professional, who will use the information it contains to offer a selection of suitable RPD, and from which the user can make the purchase, subject to a final assessment of individual suitability (e.g., fit testing on the end user). The key elements in this form will be adopted for e-COSHH essentials.

It is important to remember that selection of an adequate and suitable RPD is only a part of the process of limiting exposure using this form of control. A complete RPD programme must also be put in place to cover appropriate training for all those involved in the process, cleaning, maintenance and storage regimes for the equipment, proper supervision of its use, and appropriate record keeping, all of which are legal requirements.

It is important to test this proposal to assure a high degree of applicability. The MPF recommended from Table VI must be capable of controlling exposure at or below the upper boundary concentration for the relevant substance and Hazard Band.

STEP 1					
Company			Department		
Date of assessment			Section		
Performed by			Location		
Work details			Work duration		
			Work frequency		

STEP 2												
Control measures			Reason for using RPE Residual risk ☐ Short duration work ☐ Emergency escape ☐ Interim measure ☐ Emergency work/rescue ☐									
Confined space working Confined space? Risk of oxygen deficiency? Substance release? Seek specialist advice	Unsure No Yes <table border="1" style="margin: 0 auto;"> <tr><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td><td style="width: 30px; height: 20px;"></td></tr> </table>										Comply with Confined Spaces Regulations. Use only breathing apparatus with PF of 40, unless a higher PF is indicated in Step 3	
← ↓ →		Go to Step 3										

STEP 3					
Substance	Risk phrase	HHG	Amount	Dust/Vol	PF
Highest PF required					

STEP 4																											
Task related factors <table style="width: 100%;"> <tr> <td style="width: 50%; vertical-align: top;"> <table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td><td>Work rate Heavy, Medium, Light</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Wear time <1 hr, >1hr</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Abnormal temperature or humidity</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Power tools used, list below</td></tr> </table> <table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> </table> </td> <td style="width: 55%; vertical-align: top;"> <table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td><td>Clarity of vision critical</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Clarity of communication critical</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Congested work area</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Potentially explosive area</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Mobility critical</td></tr> </table> </td> </tr> </table>				<table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td><td>Work rate Heavy, Medium, Light</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Wear time <1 hr, >1hr</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Abnormal temperature or humidity</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Power tools used, list below</td></tr> </table> <table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> <tr><td style="width: 30px; height: 20px;"></td></tr> </table>		Work rate Heavy, Medium, Light		Wear time <1 hr, >1hr		Abnormal temperature or humidity		Power tools used, list below					<table style="width: 100%;"> <tr><td style="width: 30px; height: 20px;"></td><td>Clarity of vision critical</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Clarity of communication critical</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Congested work area</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Potentially explosive area</td></tr> <tr><td style="width: 30px; height: 20px;"></td><td>Mobility critical</td></tr> </table>		Clarity of vision critical		Clarity of communication critical		Congested work area		Potentially explosive area		Mobility critical
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Select RPE using this information and Part 2, or show this form to your supplier / specialist advisor. Involve the wearer and provide a choice of RPE. RPE selected BA type: _____ Respirator type: _____ Filter: _____																											

STEP 5 Fit test tight fitting RPE, and implement RPE use in the workplace.	Signature of assessor: _____
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Figure 3. RPE Selector.

Table VII presents a few worked examples to illustrate the applicability of the proposal. These worked examples produce required levels of protection which are consistent with more rigorous assessment of the type of RPD needed in these situations, shown in the final column of the table. This process has been carried out for a large number of different scenarios, and the simplified selection approach consistently indicates sensible levels of protection. Formal validation of this selection procedure will be a complex and lengthy task, but should emerge over time as experience with the approach develops.

Table VII. Examples to Illustrate Proposal on RPE Selection

Task	Substance	R-phrases	CE Hazard Group	Amount used	Dustiness / volatility	MPF	Upper Boundary concentration	Workplace experience
Rubber coating of cotton fabrics using a coating machine	Rubber coating mix, rubber paste in toluene	Toluene, R20	B	Medium, 35kg/day	Medium BP, 110 °C	10	50ppm	Half mask respirator with organic vapour filter
Spray painting car bodies	Two part paint, xylene and isocyanates	Xylene, R20/21; R38 Isocyanate, R42	B E	Medium, 3kg of paint	Medium BP, 140 °C	10 40 BA	50ppm Not assigned	Compressed airline BA with visor
Changing chlorine cylinders in water treatment plant	Chlorine	R23; R36/37/38; R50	C	Small, few ml may leak	High Gas	10	5ppm	Half mask respirator with acid gas filter and eye protection
Wood treatment by brush application	Polychlorinated biphenyl in Toluene /xylene	R33 R20/21; R38	A B	Medium, 5l	Medium BP, 110 °C	10 10	500ppm 50ppm	Half mask respirator with organic vapour filter

DISCUSSION

The principle used in COSHH Essentials for control at source will cover over 3000 substances and a large proportion of the preparations used in the workplace. Process generated substances or hazardous natural substances that do not carry a CHIP classification are outside the general scope of COSHH Essentials. However, sector-specific approaches have been developed to help SMEs in these cases.

The new approach for the selection of adequate and suitable RPD covers substances with health risk phrases, process generated substances and oxygen deficiency. The approach could be used for selecting RPD against asbestos and lead. However, it is currently unsuitable for selecting RPD against biological agents or radioactive substances, owing to the absence of accepted R-phrases and appropriate classifications of "amount". Adaptation may be possible for biological agents in the future, but radioactive substances are more problematic.

In common with all control banding approaches, there are advantages and disadvantages of this simplified new approach. The concern is that oversimplification of the assessment may compromise reliability and safety. Available information on the COSHH Essentials approach (Tischer *et al.*, 2003)

suggests that in the great majority of instances where full validation studies have been carried out, safety has not been compromised. The significant advantage lies in the comparative simplicity of the assessment, with the consequently increased likelihood that SMEs will use the method.

The Control Approaches for inhalation (Figure 2) are associated with progressive 10-fold reductions in the predicted exposure. Control Approach 3 (containment) is expected to give 100-fold reduction over Control Approach 1 (general ventilation). Consequently, dealing with a deliberate or accidental breaching of containment would require RPD with a minimum APF of a similar magnitude, within the constraints of what is available on the market. The accepted APF values ≥ 100 are 200 and 2000, corresponding to air-fed full suits and demand valve breathing apparatus respectively.

It is important to note that the proposals in this paper do not deal with useful life of a respirator cartridge. However, based on research findings (Aitken *et al.*, 2002), HSE has recommended the following approach for gas/vapour filters. Where the filters have been classified as Filter Capacity 1 (according to the European Standard system described in EN 14387), they should be changed at least every two days (unless the filter is being used against a carcinogen or sensitiser, when it should be changed at least daily) or as instructed by the manufacturer. Filters with EN 14387 Filter Capacity 2, should be changed at least once a week or as instructed by the manufacturer. Filters for use with fan-assisted respirators should be changed as instructed by the manufacturer.

CONCLUSIONS

The COSHH Essentials approach shows that it is feasible to band hazardous substances and the potential for exposure and give advice on the control of inhalation exposure including the residual inhalation exposure risks through RPD. The selection of suitable RPD can be achieved by assessing adequacy based on banding principles followed by a structured suitability assessment. RPD selection is a specialised task, but the user can be prompted to provide their supplier with the necessary information using the RPD Selector.

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Appendix 1 – Example of a Control Guidance Sheet



This guidance sheet is aimed at employers to help them comply with the requirements of the Control of Substances Hazardous to Health Regulations 1999 (COSHH) by controlling exposure to chemicals and protecting workers' health.

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

This sheet provides good practice advice on filling kegs, and can be applied to tasks involving medium quantities of solids. It describes the key points you need to follow to help reduce exposure to an adequate level.

It is important that all the points are followed.

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

For certain processes your local authority or the Environment Agencies will impose emission limits under the Environmental Protection Act 1990. Air cleaning equipment may therefore be necessary before discharging some emissions into the atmosphere.

Control guidance sheet

Filling kegs

Engineering control

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Access

- ✓ Restrict access to the work area to authorised staff only.

Design and equipment

- ✓ Ensure the kegs and filling equipment are compatible and well maintained.
- ✓ Provide suitable seals between the keg and filling head.
- ✓ Provide keg liners compatible with the material(s) being handled.
- ✓ Provide a ventilated hood around the filling point with an inward air flow of at least 1 metre per second.
- ✓ Where there is manual check weighing and/or weight adjusting, this should be done within a ventilated enclosure.
- ✓ Ensure the filling head doesn't discharge dust when the keg is removed.
- ✓ Provide a tray or grid below the filling point to minimise the spread of material.
- ✓ Provide good lighting. It should be suitable for the chemical(s) and task(s), eg dust tight or flameproof.
- ✓ Consider providing handling aids to minimise manual handling.
- ✓ Clean the outside of the keg by vacuum or wet wiping.
- ✓ Where possible, locate the work area away from doors, windows and walkways to stop draughts interfering with the ventilation and spreading dust.
- ✓ Provide an air supply to the workroom to replace extracted air.
- ✓ Keep ducts short and simple, and avoid long sections of flexible duct.
- ✓ Provide an easy way of checking the control is working, eg a manometer, pressure gauge or tell-tale.
- ✓ Discharge extracted air to a safe place away from doors, windows and air inlets.
- ✓ You can re-circulate clean, filtered air into the workroom.

