

The technical basis for COSHH essentials: Easy steps to control chemicals



Introduction

1 This report summarises the technical basis of the generic risk assessment scheme used in the Health and Safety Executive's (HSE's) guide *COSHH essentials: Easy steps to control chemicals*.¹ It replaces the priced publication *The technical basis for COSHH essentials* (ISBN 978 0 7176 2434 8) and partly replaces publication HSG193.¹ It complements and updates the articles published in the *Annals of Occupational Hygiene*.^{2, 3, 4}

2 Part 1 is aimed at occupational hygienists and other specialists who want to:

- understand more of the background and technical issues;
- know how to apply *COSHH essentials* when there is more information about the toxicological hazard than is given by the R-phrase (CHIP⁵ classification) or the H-statement (CLP-GHS⁶ classification);
- know how to use *COSHH essentials* in less common situations; or
- extend it to cover additional tasks or process-generated hazards.

3 This report describes the basis for the generic risk assessment to identify a 'Control Approach', appropriate to control the risk. It explains the technical basis of the scheme and provides information when additional toxicological information is available. It does not cover validation of the scheme or its development, which the papers by Brooke³ and Maidment⁴ cover in some detail. The information here helps those with more specialist knowledge to adapt the scheme or develop guidance specific to their processes.

4 A subgroup of HSE's Advisory Committee on Toxic Substances (ACTS) developed the risk assessment scheme.

5 Part 2 explains the routines used in the Internet version of *COSHH essentials* (www.coshh-essentials.org.uk) and its application to some common situations.

6 The Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended)⁷ provide the main legislation in Great Britain to protect against health risks arising from hazardous substances used at work. Under COSHH, employers have a duty to carry out a suitable and sufficient risk assessment, and take steps to ensure exposure is prevented or adequately controlled. There is a detailed Approved Code of Practice.⁸

7 However, extensive market research showed that many small and medium-sized enterprises (SMEs) have difficulty with this approach.⁹ Responses to HSE's consultation document on small firms showed that SMEs want basic, readily available advice that sets out what they need to do.

8 *COSHH essentials* meets this need for many chemicals and products. It has two aspects:

- simple generic risk assessment producing advice on good control practice for common operations – ‘control guidance sheets’;
- control guidance sheets for certain industry-specific tasks or processes.

9 *COSHH essentials* has the status of ‘guidance’. Control guidance sheets are written in a straightforward style, for use by employers and others in SMEs who are unlikely to have skills in chemical risk assessment. *COSHH essentials* guidance is intended to inform but not to constrain occupational hygiene professionals.

Part 1: A generic risk assessment scheme

10 The scheme provides a practical route for selecting an appropriate Control Approach:

- general ventilation;
- engineering control – local exhaust ventilation, eg dust or vapour extraction;
- containment.

11 For some common operations (eg mixing, filling, weighing), the scheme indicates appropriate control guidance sheets that contain basic descriptions of control equipment and good practice.

Table 1 Generic (G) control guidance sheets

Unit Operation	Title	No.	Solid	Liquid
General tasks	General ventilation	G100	Y	Y
Storage	General storage	G101	Y	Y
	Open bulk storage	G102	Y	
Dust extraction	Removing waste from dust extraction unit	G103	Y	
General tasks	Local exhaust ventilation	G200	Y	Y
	Fume cupboard	G201	Y	Y
	Laminar flow booth	G202	Y	Y
	Ventilated workbench	G203	Y	Y
Dust extraction	Removing waste from dust extraction unit	G204	Y	
Transfer	Conveyor transfer	G205	Y	
	Sack filling	G206	Y	
	Sack filling	G207	Y	
	Sack emptying	G208	Y	
	Filling kegs	G209	Y	
	Charging reactors/mixers from a sack or keg	G210	Y	
	IBC filling and emptying	G211	Y	
	Drum filling	G212		Y
	Drum emptying (drum pump)	G213		Y
	Weighing	Weighing	G214	Y
Mixing	Mixing	G215	Y	
	Mixing	G216	Y	
	Mixing	G217		Y

Unit Operation	Title	No.	Solid	Liquid
Sieving	Sieving	G218	Y	
Screening	Screening	G219	Y	
Surface coating	Spray painting	G220		Y
	Spray painting	G221		Y
	Powder coating	G222	Y	
Lamination	Batch lamination	G223		Y
	Continuous lamination	G224		Y
Dipping	Pickling bath	G225		Y
	Pickling bath	G226		Y
	Vapour degreasing bath	G227		Y
Drying	Tray drying oven	G228	Y	Y
	Continuous drying labyrinth oven	G229		Y
Pelletising	Pelletising	G230	Y	
	Tablet press	G231	Y	
General tasks	Containment	G300	Y	Y
	Glove box	G301	Y	Y
Dust extraction	Removing waste from dust extraction unit	G302	Y	
Transfer	Transferring solids	G303	Y	
	Sack emptying	G304	Y	
	Drum filling	G305		Y
	Drum emptying	G306		Y
	IBC filling and emptying	G307	Y	
	IBC filling and emptying	G308		Y
	Tanker filling and emptying	G309	Y	
	Tanker filling and emptying	G310		Y
	Filling kegs	G311	Y	
	Transferring liquid by pump	G312		Y
	Packet filling	G313	Y	
	Bottle filling	G314		Y
Weighing	Weighing	G315	Y	
	Weighing	G316		Y
Mixing	Mixing	G317	Y	
	Mixing	G318		Y
Surface coating	Robot spray booth	G319		Y
	Automated powder coating	G320	Y	
Dipping	Vapour degreasing bath	G321		Y
Drying	Spray drying	G322	Y	Y
Special	General principles	G400		
	Health surveillance for occupational asthma	G402		
Skin or eye contact	General advice	S100		
	Selection of personal protective equipment	S101		

12 Appendix 1 contains an index to guide the selection of control guidance sheets.

13 Table 2 lists new sheets, some of which should be available as automatically-selected downloads from the *COSHH essentials* web tool.

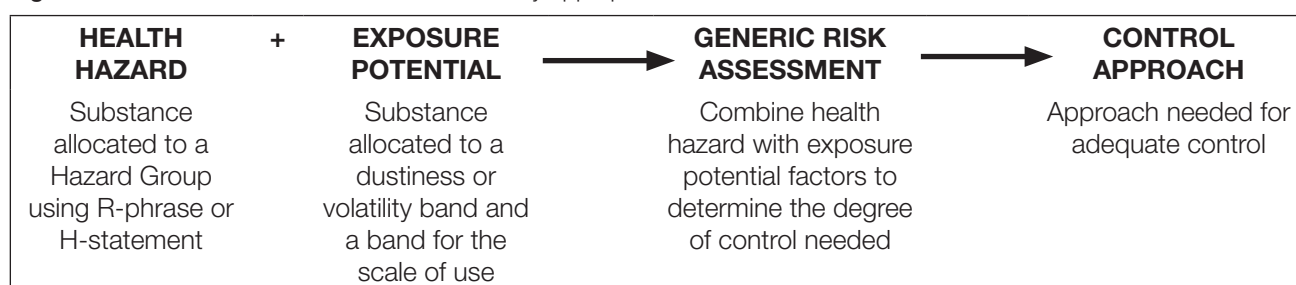
Table 2 New guidance sheets for skin and eye contact; respiratory protective equipment (RPE); and generic special advice

Topic	Title	No.
Skin and eye	Skin or eye contact	S100
	Selecting protective gloves	S101
	Selecting personal protective equipment (PPE)	S102
	Skin or eye contact	S200
RPE	UK Standard Assigned Protection Factor 4 (APF4)	R1
	UK Standard Assigned Protection Factor 10 (APF10)	R2
	UK Standard Assigned Protection Factor 20 (APF20)	R3
	UK Standard Assigned Protection Factor 40 (APF40)	R4
	Breathing apparatus with UK Standard Assigned Protection Factor 40	R5
	UK Standard Assigned Protection Factor 2000 (APF2000)	R6
Special	Health monitoring for chronic obstructive pulmonary disease	G401
	Health surveillance for occupational dermatitis	G403
	Health surveillance – exposed to respirable crystalline silica (RCS)	G404
	New and existing engineering control systems	G406
	Urine sampling for isocyanate exposure measurement	G408
	Exposure measurement – air sampling	G409

14 Generic risk assessment takes account of the chemical's or product's health hazard, and the exposure potential.

- The health hazard is represented by the R-phrases assigned to substances during classification by suppliers under CHIP⁵ or the CLP-GHS.⁶
- The exposure potential is represented by physical properties of the substances (dustiness for solids, volatility for liquids) and the amount used in an operation or batch process.

Figure 1 Factors used in risk assessment to identify appropriate control measures



15 Note: this generic risk assessment applies to liquids and solids only: it does not apply to gases or to liquids used above their boiling point.

16 The generic risk assessment scheme (**which is not intended for use as an exposure model**):

- defines 'adequate control' for different hazards in exposure ranges;
- identifies exposure ranges associated with Control Approaches for different situations; and
- considers ways to link these.

17 The four steps involved in the scheme's development are covered in paragraphs 18 to 36:

Step 1: Group the hazards that have 'adequate control' at similar airborne concentrations.

Step 2: Group the 'physical properties' with 'amounts used' that show similar potentials for exposure.

Step 3: Assess the anticipated exposure from each Control Approach, for each combination of physical property and amount.

Step 4: Link Step 1 with Step 3, to form the generic risk assessment scheme.

Step 1: Grouping hazards

Notes to Table 3

1 Units – parts per million (ppm), and milligrams per cubic metre (mg/m³).

2 R-phrase combinations, eg R20/21/22 means R20, R21, R22 and combinations thereof. Examples of other combinations include R42/43. Modifiers R39/, R48/ and R68/ change the emphasis of the subsequent R-numbers.

18 Hazards were allocated to one of five groups, A to E, by the R-phrases given in CHIP, and in the H-statements in the CLP-GHS by analogy. Table 3 gives the ranges assigned to each group and the associated R-phrases or H-statements. Brooke's paper states the rationale for this grouping. Appendix 3 lists the R-phrases and H-statements used in *COSHH essentials*.

19 Groups A, B, C and D cover a logarithmic concentration range for dusts and vapours. The upper boundary for Group A represents levels that should not be exceeded regularly, in accordance with good control practice: 500 parts per million (ppm) for vapours and 10 mg/m³ (milligrams per cubic metre) for dusts.

20 Hazards (R or H) were assigned to one of the Groups A to D where an airborne concentration range could be identified as providing adequate control. Where no such airborne range could be identified, eg for serious health effects such as cancer, the hazard was assigned to Group E.

Table 3 Allocation of R-phrase or GHS phrase to Hazard Group; concentration range

Hazard Group	Type	Concentration range	Units	R-phrases	H-statements
A	Dust	>1 to 10	mg/m ³	R36, R38 and all R-numbers not otherwise listed	H303, H304, H305, H313, H315, H316, H318, H319, H320, H333, H336 and all H-numbers not otherwise listed
	Vapour	>50 to 500	ppm		
B	Dust	>0.1 to 1	mg/m ³	R20/21/22 and R68/20/21/22	H302, H312, H332, H371
	Vapour	>5 to 50	ppm		
C	Dust	>0.01 to 0.1	mg/m ³	R23/24/25, R34, R35, R37, R39/23/24/25, R41, R43, R48/20/21/22, R68/23/24/25	H301, H311, H314, H317, H318, H331, H335, H370, H373
	Vapour	>0.5 to 5	ppm		
D	Dust	<0.01	mg/m ³	R26/27/28, R39/26/27/28, R40, R48/23/24/25, R60, R61, R62, R63, R64	H300, H310, H330, H351, H360, H361, H362, H372
	Vapour	<0.5	ppm		
E	Dust	-	mg/m ³	R42, R45, R46, R49, R68	H334, H340, H341, H350
	Vapour	-	ppm		

Hazard Group S – skin and eye exposure

21 Group S was triggered by risk-phrase numbers R21, R24, R27, R34, R35, R37, R38, R41, R43, and R21, R24 or R27 in combination with R39, R48 or R68. However, since most substances and products can irritate or penetrate the skin, there is nearly always a skin risk.

Step 2: Grouping physical properties and amounts

22 The ‘determinants of exposure’ in COSHH essentials are physical property and ‘amount in use’.

23 The physical property for solids is a subjective assessment of the material’s dustiness. Simple descriptors of dustiness put a substance into a high, medium or low dustiness band.

24 The physical property for liquids is volatility at the process temperature. A chart relating boiling point to process temperature allocates a substance into a high, medium or low volatility band.

25 The other determinant is the amount in use for the task. Table 4 describes these determinants.

Table 4 Exposure potential

Determinant	Solid Dustiness	Liquid Volatility
Low	Pellet - does not break up	
Medium	Granular or crystalline	
High	Fine solid and light powder	
Determinant	Amount	Amount
Small	Grams	Millilitres
Medium	Kilograms	Litres
Large	Tonnes	Cubic metres

26 The ACTS subgroup used professional judgement to allocate combinations of physical property and amount into one of four ‘Exposure Predictor Bands’. These EP bands are shown in Table 5.

Table 5 Definitions of Exposure Predictor Bands from amount and exposure potential

Low dustiness	Medium dustiness	High dustiness	Exposure Predictor Band
Grams	Grams		EP1 Solid
Kilograms and tonnes		Grams	EP2 Solid
	Kilograms	Kilograms	EP3 Solid
	Tonnes	Tonnes	EP4 Solid
Low volatility	Medium volatility	High volatility	Exposure Predictor Band
Millilitres			EP1 Liquid
Litres and cubic metres	Millilitres	Millilitres	EP2 Liquid
	Litres and cubic metres	Litres	EP3 Liquid
		Cubic metres	EP4 Liquid

Note: Table 7 associates these EP bands with exposure bands

27 A third factor, duration of exposure, influences exposure potential. This was not included in the generic risk assessment scheme. However, *COSHH essentials* contains a filter for activity with a total time below 15 minutes per day. An explanation for 'Time' is in Part 2, in the 'Cut-off values' section.

Step 3: Predicting exposures using Control Approaches

28 There are four basic Control Approaches used in *COSHH essentials* generic risk assessment.

Table 6 Four Control Approaches

Control Approach	Type	Relative efficacy	General description
1	General ventilation	1	A good standard of general ventilation and good working practices.
2	Engineering control	10-fold reduction	Local exhaust ventilation ranging from well-positioned capturing and receiving hoods to effective partial enclosing hoods.
3	Containment	100-fold reduction	Full enclosures and containment, where small-scale breaches may be expected.
4	Special	-	Expert advice is required to select appropriate control measures.

Note: The efficacy estimate is, in many cases, precautionary and relative to general ventilation (=1).

29 The ACTS subgroup applied professional judgement to determine, for each Exposure Predictor Band EP1 to 4 (solid or liquid) in Table 5, the exposure levels that would result from applying Control Approach 1, 2 or 3 in Table 6.

30 Table 7 presents the outcome of ACTS judgement.

Table 7 Relating Exposure Predictor Bands to Control Approach

Predicted exposures for dust in air, milligrams per cubic metre (mg/m³)			
Exposure Predictor Band	Control Approach 1	Control Approach 2	Control Approach 3
EP1 Solid	0.01 to 0.1	0.001 to 0.01	<0.001
EP2 Solid	0.1 to 1	0.01 to 0.1	0.001 to 0.01
EP3 Solid	1 to 10	0.1 to 1	0.01 to 0.1
EP4 Solid	>10	1 to 10	0.1 to 1

Predicted exposures for vapour in air, parts per million (ppm)			
Exposure Predictor Band	Control Approach 1	Control Approach 2	Control Approach 3
EP1 Liquid	<5	<0.5	<0.05
EP2 Liquid	5 to 50	0.5 to 5	0.05 to 0.5
EP3 Liquid	50 to 500	5 to 50	0.5 to 5
EP4 Liquid	>500	5 to 500	0.5 to 5

Step 4: Linking the hazard's 'acceptable exposure' with predicted exposure

31 The final step to complete the risk assessment scheme is to relate the target airborne exposure range for each Hazard Group (Table 3) to the Exposure Predictor Bands (Table 7).

Box 1

Method

For a given Exposure Predictor Band:

- Does general ventilation (Control Approach 1) give exposures within or below the Hazard Group concentration range (Table 3)? If so, CA1 is appropriate: otherwise it is not.
- Does engineering control (Control Approach 2) give exposures within or below the Hazard Group concentration range? If so, CA2 is appropriate: otherwise it is not.
- A similar analysis applies for Control Approach 3.

If none of these approaches is able to give sufficiently low exposures, specialist advice is recommended (Control Approach 4).

32 Table 8 shows the allocation of hazard bands to Table 7.

Table 8 Relating Exposure Predictor Bands and Control Approach to Hazard Group

Predicted exposure ranges for dust in air, milligrams per cubic metre (mg/m³)				
Exposure Predictor Band	Control Approach 1	Control Approach 2	Control Approach 3	Control Approach 4
EP1 Solid	0.01 to 0.1	0.001 to 0.01	<0.001	
Hazard Groups	A, B, C	D	-	-
EP2 Solid	0.1 to 1	0.01 to 0.1	0.001 to 0.01	
Hazard Groups	A, B	C	D	-
EP3 Solid	1 to 10	0.1 to 1	0.01 to 0.1	
Hazard Groups	A	B	C	D
EP4 Solid	>10	1 to 10	0.1 to 1	
Hazard Groups	-	A	B	C, D
Predicted exposure ranges for vapour in air, parts per million (ppm)				
Exposure Predictor Band	Control Approach 1	Control Approach 2	Control Approach 3	Control Approach 4
EP1 Liquid	<5	<0.5	<0.05	
Hazard Groups	A, B, C	D	-	-
EP2 Liquid	5 to 50	0.5 to 5	0.05 to 0.5	
Hazard Groups	A, B	C	D	-
EP3 Liquid	50 to 500	5 to 50	0.5 to 5	
Hazard Groups	A	B	C	D
EP4 Liquid	>500	5 to 500	0.5 to 5	
Hazard Groups	-	A, B	C	D

33 These predictions were validated and refined either by comparison with published exposure data, or where this has not been available, by extensive peer review. Maidment's paper⁴ provides further information on the development and validation of Steps 2 and 3. Independent validation of some general ventilation and engineering control scenarios was undertaken based on BAuA data.¹⁰ Validation of containment scenarios continues.

Box 2

Example: a solid in Hazard Group B

Hazard Group B: target exposure range = 0.1 to 1 mg/m³ of dust.

Gram quantities

EP1, low/medium dusty solid → 0.01 to 0.1 mg/m³ with general ventilation

- Below target range of 0.1 to 1 mg/m³: CA1 is adequate.

EP2, high dusty solid → 0.1 to 1 mg/m³ with general ventilation

- Within target range of 0.1 to 1 mg/m³: CA1 is adequate.

Kilogram quantities

EP3, medium dusty material → 1 to 10 mg/m³ with general ventilation

- Outside target range of 0.1 to 1 mg/m³ with CA1.
- With CA2 → 0.1 to 1 mg/m³ is within target range. CA2 is adequate.

Tonne quantities

EP4, medium dusty material → >10 mg/m³ with general ventilation

- Outside target range of 0.1 to 1 mg/m³ with CA1.
- Outside target range of 0.1 to 1 mg/m³ with CA2 (1 to 10 mg/m³).
- With CA3 → 0.1 to 1 mg/m³ is within target range. CA3 is adequate.

34 Table 9 rearranges the information in Table 8 to relate the Hazard Group directly to the Control Approach. The exposure ranges are unnecessary information.

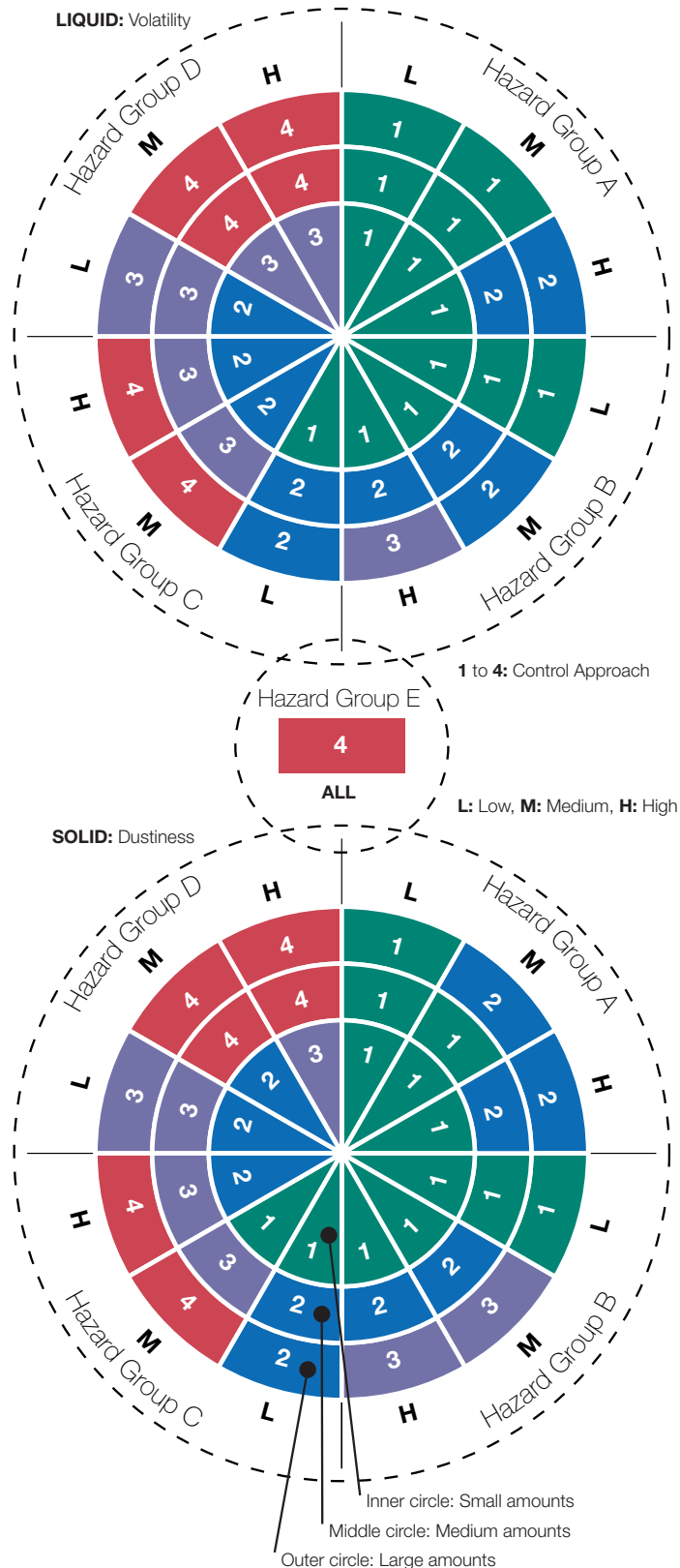
Table 9 Control Approaches (CAs) needed for each Hazard Group

Hazard Group and phase	Exposure Predictor Band			
	EP1	EP2	EP3	EP4
A solid	CA1	CA1	CA1	CA2
A liquid	CA1	CA1	CA1 *	CA2
B solid	CA1	CA1	CA2	CA3
B liquid	CA1	CA1	CA2	CA2
C solid	CA1	CA2	CA3	CA4
C liquid	CA1	CA2	CA3	CA3
D solid	CA2	CA3	CA4	CA4
D liquid	CA2	CA3	CA4	CA4
E solid	CA4	CA4	CA4	CA4
E liquid	CA4	CA4	CA4	CA4

Note: * CA1 for EP3, Hazard Group A liquid. Subsequent validation tests found that large-scale use of medium-volatility liquid required Control Approach 2.

35 Table 9 was refigured and published as reproduced in Appendix 2, part of HSG193 (ISBN 0 7176 2737 3). Figure 2 re-expresses this table.

Figure 2



36 There are three differences between Table 9 and Figure 2:

- As noted in the footnote to Table 9, a medium amount of high-volatility liquid in Hazard Group A takes Control Approach 2.
- A precautionary difference compared with Table 9, a large amount of high-volatility liquid in Hazard Group B takes Control Approach 3 rather than 2.
- A precautionary difference compared with Table 9, a large amount of medium-volatility liquid in Hazard Group C takes Control Approach 4 rather than 3.

Further information on how to use *COSHH essentials*

37 *COSHH essentials* provides simple control advice for many commonly occurring situations, using information from Part 15 of the safety data sheet. The system makes no attempt to cover every possible exposure scenario, or explain just how to use additional toxicological information. In any case, REACH¹¹ safety data sheets should stipulate risk management measures for exposure scenarios, so *COSHH essentials*, in its generic form, is likely to fall into disuse over the next decade.

38 The schemes in *COSHH essentials* can be used for other purposes, for example:

- to compare substances and help in making decisions on substitution;
- to suggest the degree of control required of a control system.

39 This section provides further information for the more specialist user.

Toxicological information

40 Only some CHIP classification criteria take account of potency. 'Potency' is the strength of a substance's ability to cause a specified health effect. Examples where potency is part of classification are for single or repeated exposure effects, such as R20 to R28, R34 and R35, the R48 combinations.

41 Classification criteria that do not involve consideration of potency include respiratory tract irritation (R37), respiratory sensitisation (R42) and skin sensitisation (R43). The classification is based simply on a committee's yes/no decision. For carcinogens and substances toxic to reproduction, classification is based on strength of evidence that does not take potency into account.

42 R-phrases that do not involve consideration of potency (which may vary considerably) were assigned to Hazard Groups on the basis of:

- the seriousness of the health effect; and
- whether an exposure range could be identified to represent adequate control.

43 Consequently, the ACTS group allocated each of these R-phrases in such Hazard Groups as they considered would not lead to health risks, even if exposure were at the upper end of the range for the most potent substance with that R-phrase. The subgroup felt strongly that this precautionary approach was appropriate for a generic risk assessment scheme.

44 Where it was impossible to identify an exposure range representing adequate control for an R-phrase, it was allocated to Hazard Group E. This meant that the substance so classified required individual and expert consideration.

45 When an expert has access to toxicological information, eg the dose-response relationship, for an effect of a particular substance with no 'potency delimiter', *COSHH essentials* allows allocation to another Hazard Group. (See 'Reduction of Hazard Group' section.) This is usually a lower Hazard Group, for example a substance assigned R37 (respiratory tract irritation) from Group C to Group B, or R60-R63 (effects on reproduction) from Group D to Group C.

46 Substances assigned R45, R46 and R49 (Group E) are subject to the *Carcinogens Approved Code of Practice*⁸ and must not be assigned to another group. Other R-phrases in Group E are associated with serious health effects: allocation to another group is not recommended.

47 For substances for which the lead health effect is skin sensitisation (R43), allocation to a lower group may be appropriate if there is evidence to show that sensitisation is unlikely to result from contact with the airborne substance. However, any substance labelled R43 is a candidate for health surveillance (skin).

Part 2: Routines for mixtures within the Internet version of *COSHH essentials*

48 The routines for mixtures in *COSHH essentials* are:

- If any component is in Hazard Group 'S', then the mixture is Hazard Group S.
- If any component is in Hazard Group 'E', then the mixture is Hazard Group E.
- If any component is in Hazard Group 'D' at $\geq 0.05\%$ then the mixture is Hazard Group D.
- If any component is in Hazard Group 'C' at $\geq 0.5\%$ then the mixture is Hazard Group C.
- If any component has a classification 'R43' then see subsidiary R43 rules (below).
- If any component is in Hazard Group 'B' at $\geq 10\%$ then the mixture is Hazard Group B.
- Otherwise the mixture is Hazard Group A.

Subsidiary R43 rules for mixtures

49 Where any component of the mixture has R43 at or above 0.1% but less than 0.5%, classing the mixture as Hazard Group C results in an over-precautionary Control Approach. The volatility or dustiness should relate to the **major** component of the mixture (Hazard Group A or B). The following matrix replaces the look-up table on page 15 of HSG193 for substances in Hazard Groups A and B that contain 0.1% to less than 0.5% of an R43 component.

Table 10 R43 mixture rules

	Low dustiness/ volatility	Medium volatility	Medium dustiness	High dustiness/ volatility
Amount	Substance with $\geq 0.1\%$ to $<0.5\%$ of a component with R43 and no other mixture component giving Hazard Group C or D			
Small	CA1	CA2	CA1	CA2
Medium	CA1	CA2	CA2	CA2
Large	CA2	CA3	CA3	CA3

Note: CA1, CA2 and CA3 are Control Approaches.

The option for stipulating water as a mixture ingredient is not implemented (water, by default, is Hazard Group A). However for mixtures of solid in water, the volatility may be assumed as 'low' rather than medium (ie boiling point $>150^{\circ}\text{C}$, not 100°C).

Summary of the rules, conversion factors and default values in *COSHH essentials*

Hazard Grouping

The Hazard Group according to the CHIP R-phrases is as set out in Appendix 3, with the exception of R39 in combination with 20, 21 or 22, which is rarely used.

Reduction of Hazard Group based on specific toxicological information

R-phrases R34, R35 and R37

The R-phrases R34 or R35 (corrosive) normally require Hazard Group C because of concerns for respiratory tract irritation. R-phrase R37 (respiratory tract irritancy) normally falls into Hazard Group C.

The expert can consider allocating substances with these R-phrases to Hazard Group B when there are no other R-phrases that require the substance to be assigned to Hazard Group C, D or E, and when:

- respiratory tract irritation has been quantitatively studied in humans in good-quality investigations and there is clear evidence from these studies that the threshold concentration for respiratory tract irritancy is $> 0.1 \text{ mg/m}^3$ for dusts or $> 5 \text{ ppm}$ for vapours.

The expert can consider allocating them to Hazard Group A when there are no other R-phrases that require the substance to be assigned to Hazard Group B, C, D or E, and when:

- respiratory tract irritation has been quantitatively studied in humans in good-quality investigations and there is clear evidence from these studies that the threshold concentration for respiratory tract irritancy is $> 1 \text{ mg/m}^3$ for dusts or $> 50 \text{ ppm}$ for vapours.

R-phrases R62 and R63

The R-phrase R62 (Category 3, impaired fertility) normally falls into Hazard Group D. The expert can consider allocating a substance with R62 into Hazard Group C when there are no other R-phrases that require the substance to be assigned to Hazard Group D or E, and when:

- the lowest observed adverse effect level (LOAEL) for reproductive toxicity, obtained from good-quality animal studies, is $> 5 \text{ mg/kg/day}$ oral; or $> 10 \text{ mg/kg/day}$ dermal; or 0.025 mg/l/6hr day inhalation.

The expert can consider allocating to Hazard Group B when there are no other R-phrases that require the substance to be assigned to Hazard Group C, D or E, and when:

- the lowest observed adverse effect level (LOAEL) for reproductive toxicity, obtained from good-quality animal studies, is $> 50 \text{ mg/kg/day}$ oral; or $> 100 \text{ mg/kg/day}$ dermal; or 0.25 mg/l/6hr day inhalation.

The R-phrase R63 (Category 3, harm to unborn child) normally falls into Hazard Group D. The expert can consider allocating to Hazard Group C when there are no other R-phrases that require the substance to be assigned to Hazard Group D or E, and when:

- the lowest observed adverse effect level (LOAEL) for developmental toxicity, obtained from good-quality animal studies, is $> 5 \text{ mg/kg/day}$ oral; or $> 10 \text{ mg/kg/day}$ dermal; or 0.025 mg/l/6hr day inhalation.

The expert can consider allocating to Hazard Group B when there are no other risk phrases that require the substance to be assigned to Hazard Group C, D or E, and when:

- the lowest observed effect level (LOAEL), for developmental toxicity, obtained from good-quality animal studies, is > 50 mg/kg/day oral; or > 100 mg/kg/day dermal; or 0.25 mg/l/6hr day inhalation.

Conversion factors

Temperatures

Celsius to Kelvin: °K = °C + 273. Room temperature (default) is taken as 25°C.

For activities at room temperature, low volatility means a boiling point above 150°C, medium volatility a boiling point between 50°C and 150°C, and high volatility a boiling point at or below 50°C. There is no conversion from Fahrenheit to Celsius, °C = 5/9 x (°F – 32).

Where heating or cooling is applied, for process temperature (PT) the volatility band is determined as follows:

If boiling point ≤ 2 x PT + 10, then volatility = high.

If boiling point between 2 x PT + 10 and 5 x PT + 50, then volatility = medium.

If boiling point ≥ 5 x PT + 50, then volatility = low.

Pressures

1 atmosphere = 760 mm mercury (mm Hg) or 760 torr
= 101.325 kPa = 101325 Pa (Pascals)
= 0.98 Bar = 980 mBar

The values used in *COSHH essentials* to allocate high, medium and low volatility are given in Table 11.

Table 11 Volatility and vapour pressures

Volatility band	Vapour pressure
Low	Less than 500 Pa
Medium	500 to 25 000 Pa
High	More than 25 000 Pa

Calculation of vapour pressure at one temperature for data quoted at another temperature

This calculation combines the Clausius-Clapeyron equation with the Trouton Rule, as described in Horvath A L (*Molecular design*, Elsevier 1992 p.285). It is an approximation that is acceptable given the precautionary nature of *COSHH essentials*.

$L_n P_{atm} = -10.6 \times (T_{bp} / T - 1)$ where L_n is the natural logarithm, P is in atmospheres, and T_{bp} (boiling point) and T (temperature of the process) are in Kelvin.

The quoted value for the vapour pressure at a specified temperature is used to calculate a notional boiling point. Substituting this value in the equation with the temperature at which you use the substance will produce the vapour pressure at that temperature.

Cut-off values

Temperature and pressure

A lower temperature cut-off for boiling point = 20°C. A cut-off for vapour pressure was set at 1 atmosphere. Such substances will be in the vapour phase at room temperature (a gas), and *COSHH essentials* cannot currently deal with gases.

Frequency and duration of use (time-weighting)

A threshold of 15 minutes' use per day was built in to the electronic *COSHH essentials*, below which the Control Approach drops from 3 (containment) to 2 (engineering control), or from 2 to 1 (general ventilation). The superficial reason for this is that *COSHH essentials* is task-based and precautionary.

The HSC Advisory Committee on Toxic Substances judged that the level of control needed for (undefined) short-term activity did not hold the same degree of 'reasonable practicability' as the level of control for prolonged use.

The hypothesis underlying *COSHH essentials* is that an increase in Control Approach (1 to 2, or 2 to 3) affords at least a 10-fold increase in protection from dusts and vapours. Were you to exceed an 8-hour limit value ten-fold over 30 minutes, with no further exposure, that would equate to the limit value over 300 minutes, ie less than 8 hours.

New rules for producing guidance on exposure on or via the skin

Control Approach 4	S200
Control Approach 3	S100 + S101 + S102
Control Approach 3 – maintenance	S200 + S101 + S102
Control Approach 2	S100 + S101 + S102
Where R43 classification appears	G403

New rules for producing guidance on RPE

Table 12 is taken from *Respiratory protective equipment at work*.¹²

Table 12 Selection of an RPE standard with *COSHH essentials* input data

Hazard Group	Amount	Dustiness or volatility		
		Low	Medium	High
A	Small	-	-	-
	Medium	-	APF = 4	APF = 10
	Large	APF = 4	APF = 10	APF = 20
B	Small	-	APF = 4	APF = 4
	Medium	-	APF = 10	APF = 20
	Large	APF = 10	APF = 20	APF = 40
C	Small	-	APF = 4	APF = 4
	Medium	APF = 10	APF = 10	APF = 20
	Large	APF = 20	APF = 20	APF = 40
D	Small	APF = 10	APF = 20	APF = 40
	Medium	APF = 20	APF = 40	APF = 40
	Large	APF = 20	APF = 40	APF = 2000
E	Small	APF = 10	APF = 20	APF = 40
	Medium	APF = 20	APF = 40	APF = 40
	Large	APF = 20	APF = 40	APF = 2000

Note: Assigned protection factors are based on those in BS 4275.

New rules for producing other guidance

Control Approach 2 and 3 G406 (LEV care)
All Control Approaches G409 (air sampling)

Less common situations and *COSHH essentials*

The following paragraphs give advice for:

- solutions (dissolved substance);
- aerosol generation;
- volatile solids.

Solutions of a solid in a liquid

COSHH essentials produces different controls for dusts and vapours. It cannot deal with both at once. The most common situation is mixing a solid and liquid. The controls are considered separately for transfer into the mixing container. Once in a liquid, dustiness is not relevant. So in the assessment:

- Treat solids dissolved or dispersed in water as liquid with low volatility (despite water having a boiling point that normally causes it to be 'medium volatility').
- Treat solids dissolved or dispersed in a solvent as solid-in-liquid. Take the volatility as that of the main solvent.

Where a substance is classified R43, retain this classification unless there is less than 0.1% of that substance in the solvent.

Aerosol formation and generation

Where a task is likely to generate an aerosol, there is a significant increase in the exposure potential. It can be difficult to estimate the amount of aerosol, so it is precautionary to consider the 'amount' as the total amount of substance in use.

Aerosols form in:

- spraying and printing;
- electroplating with gas generation;
- hot vapour condensation (fume);
- dispersal through contact with fast-moving machinery;
- decompression, such as a pre-packaged hand-held aerosol spray product.

Specific control guidance sheets are available for some aerosol-generating tasks (Appendix 1). Otherwise, the precautionary principle is advised: to adopt a more stringent control approach than indicated by *COSHH essentials*.

COSHH essentials was never designed to assess gases. For hand-held aerosol sprays, the propellant is considered as a gas by *COSHH essentials* and the assessment halts. The solution is to ignore the propellant, to take the boiling point as that of the lowest boiling ingredient in the product, and the amount as small or, if several cans are used (as in artwork), medium.

Volatile solids

Few solids have an appreciable vapour pressure (eg iodine, benzoquinone, paraformaldehyde, naphthalene). For such substances, their dustiness may not

show their full exposure potential: it may also be necessary to consider volatility. The safety data sheet or supplier should give information on volatility.

For such substances, compare the Control Approaches for the solid and for the vapour. The more stringent Control Approach takes precedence. The vapour pressure bands in Table 11 apply. However, it is unlikely that many solids have volatility above 0.5 kPa (4934 ppm) at room temperature.

Appendix 1: Index to generic series Control Guidance Sheets

Control Approach 1 General Ventilation

Unit Operation	Sheet title	Solids			Liquids		
		Small	Medium	Large	Small	Medium	Large
General tasks	General ventilation	G100	G100	G100	G100	G100	G100
Storage	General storage	G101	G101	G101	G101	G101	G101
	Open bulk storage			G102			
Dust extraction	Removing waste from dust extraction unit	G103	G103	G103			

Control Approach 2 Engineering Control

Unit Operation	Sheet title	Solids			Liquids			
		Small	Medium	Large	Small	Medium	Large	
General tasks	Local exhaust ventilation	G200	G200	G200	G200	G200	G200	
	Fume cupboard	G201			G201			
	Laminar flow booth		G202			G202		
	Ventilated workbench	G203			G203			
Storage	General storage	G101	G101	G101	G101	G101	G101	
Dust extraction	Removing waste from dust extraction unit	G204	G204	G204				
Transfer	Conveyor transfer		G205	G205				
	Sack filling		G206	G207				
	Sack emptying		G208					
	Filling kegs		G209					
	Charging reactors/mixers from a sack or keg	G210	G210					
	IBC filling and emptying			G211				
	Drum filling					G212		
	Drum emptying (drum pump)					G213		
	Weighing	Weighing	G201	G214		G201		
	Mixing	Mixing	G201	G215	G216	G201	G217	G217
Sieving	Sieving (+ filtering)	G218	G218					
Screening	Screening			G219				
Surface coating	Spray painting				G220	G221		
	Powder coating		G222	G222				
Lamination	Batch lamination					G223	G223	
	Continuous lamination					G224	G224	
Dipping	Pickling bath					G225	G226	
	Vapour degreasing bath					G227	G227	
Drying	Tray drying oven		G228			G228		
	Continuous drying labyrinth oven					G229	G229	
Pelletising	Pelletising		G230	G230				
	Tablet press		G231					

Control Approach 3 Containment

Unit Operation	Sheet title	Solids			Liquids		
		Small	Medium	Large	Small	Medium	Large
General tasks	Containment	G300	G300	G300	G300	G300	G300
	Glove box	G301			G301		
Storage	General storage	G101	G101	G101	G101	G101	G101
Dust extraction	Removing waste from dust extraction unit	G204	G204	G302			
Transfer	Transferring solids		G303	G303			
	Sack emptying		G304				
	Drum filling					G305	G305
	Drum emptying					G306	
	Infrequent charging reactors/mixers from a sack or keg	G210	G210				
	IBC filling and emptying			G307			G308
	Tanker filling and emptying			G309			G310
	Filling kegs		G311			G213	
	Transferring liquid by pump					G312	G312
	Packet filling	G301	G313	G313			
	Bottle filling				G301	G314	G314
Weighing	Weighing	G301	G315	G315	G301	G316	G316
Mixing	Mixing	G301	G317	G317	G301	G318	G318
Surface coating	Robot spray booth					G319	G319
	Automated powder coating		G320	G320			
Dipping	Vapour degreasing bath				G321	G321	G321
Drying	Spray drying		G322	G322		G322	G322
Pelletising	Tablet press		G231				

Control Approach 4 Special

Sheet No	Title
G400	General principles
G402	Health surveillance for occupational asthma

Control Approach S Chemicals causing harm by skin contact

Sheet No	Title
S100	Skin or eye contact
S101	Selecting personal protective equipment

Appendix 2: HSG193 look-up table

Look-up table to select Control Approach according to Hazard Group, amount, and dustiness or volatility (reproduced from HSG193)¹

Amount used	Low volatility or dustiness	Medium volatility	Medium dustiness	High volatility or dustiness
	Hazard Group A substances			
Small	1	1	1	1
Medium	1	1	1	2
Large	1	1	2	2
	Hazard Group B substances			
Small	1	1	1	1
Medium	1	2	2	2
Large	1	2	3	3
	Hazard Group C substances			
Small	1	2	1	2
Medium	2	3	3	3
Large	2	4	4	4
	Hazard Group D substances			
Small	2	3	2	3
Medium	3	4	4	4
Large	3	4	4	4
	Hazard Group E substances			
All amounts	4	4	4	4

Note: the values in the box give the Control Approach: Exposure Predictor Band

The colour convention is carried through to *COSHH essentials* control guidance sheets, with the addition of:

R

where the control is principally RPE in addition to other measures.

Appendix 3: CHIP Risk (R) phrases and CLP-GHS Hazard (H) statements

CHIP R-phrases

R-no	Phrase	Group	Note
20	Harmful by inhalation	B	
21	Harmful in contact with skin	B	
22	Harmful if swallowed	B	
23	Toxic by inhalation	C	
24	Toxic in contact with skin	C	
25	Toxic if swallowed	C	
26	Very toxic by inhalation	D	
27	Very toxic in contact with skin	D	
28	Very toxic if swallowed	D	
34	Causes burns	C	
35	Causes severe burns	C	
36	Irritating to eyes	A	
37	Irritating to respiratory system	C	1
38	Irritating to skin	A	
39	Danger of very serious irreversible effects	-	2
40	Limited evidence of a carcinogenic effect	D	3
41	Risk of serious damage to the eyes	C	
42	May cause sensitisation by inhalation	E	
43	May cause sensitisation by skin contact	C	4
45	May cause cancer	E	
46	May cause heritable genetic damage	E	
48	Danger of serious damage to health by prolonged exposure	+1	5
49	May cause cancer by inhalation	E	
60	May impair fertility	D	1
61	May cause harm to the unborn child	D	1
62	Risk of impaired fertility	D	1
63	Possible risk of harm to the unborn child	D	1
64	May cause harm to breastfed babies	D	1
65	Harmful: may cause lung damage if swallowed	A	
66	Repeated exposure may cause skin dryness or cracking	A	
67	Vapours may cause drowsiness and dizziness	A	
68	Possible risk of irreversible effects	E	6

Notes: All phrases now considered a risk on or via the skin.

- 1 Based on evidence, experts can reduce Group from D to C or from C to B.
- 2 Combination phrase. No impact of header number - use the Group for the other R-numbers.
- 3 Old data sheets have R40 as a combination phrase. If so, treat as (2).
- 4 As (1), but retain skin sensitisation in mixtures to a concentration of 0.1%.
- 5 Combination phrase. Group for R-numbers in combination rises from B to C or from C to D.
- 6 If a combination phrase, as (2); otherwise Group E.

CLP-GHS Hazard (H) statements

H-stmt	Phrase	Group
300	Fatal if swallowed	D
301	Toxic if swallowed	C
302	Harmful if swallowed	B
304	May be fatal if swallowed and enters airways	A
310	Fatal in contact with skin	D
311	Toxic in contact with skin	C
312	Harmful in contact with skin	B
314	Causes severe burns and eye damage	C
315	Causes skin irritation	A
317	May cause an allergic skin reaction	C
318	Causes serious eye damage	C
319	Causes serious eye irritation	A
330	Fatal if inhaled	D
331	Toxic if inhaled	C
332	Harmful if inhaled	B
334	May cause allergy or asthma symptoms or breathing difficulties if inhaled	E
335	May cause respiratory irritation	C
336	May cause dizziness or drowsiness	A
340	May cause genetic defects (<i>route if relevant</i>)	E
341	Suspected of causing genetic defects (<i>route if relevant</i>)	E
350	May cause cancer (<i>route if relevant</i>)	E
351	Suspected of causing cancer (<i>route if relevant</i>)	D
360	May damage fertility or the unborn child (<i>effect if known, route if relevant</i>)	D
361	Suspected of damaging fertility or the unborn child (<i>effect if known, route if relevant</i>)	D
362	May cause harm to breast-fed children	D
370	Causes damage to organs (<i>organ if known, route if relevant</i>)	C
371	May cause damage to organs (<i>organ if known, route if relevant</i>)	B
372	Causes damage to organs through prolonged or repeated exposure (<i>organ if known, route if relevant</i>)	D
373	May cause damage to organs through prolonged or repeated exposure (<i>organ if known, route if relevant</i>)	C
EU66	Repeated exposure may cause skin dryness or cracking	A
EU70	Toxic by eye contact	E
EU71	Corrosive to the respiratory tract	C

References and further information

- 1 *COSHH essentials: easy steps to control chemicals (second edition)* HSG193 HSE Books 2002 ISBN 0 7176 2737 3 – no longer available in hard copy, web-only version at www.coshh-essentials.org.uk
- 2 Russell RM, Maidment SC, Brooke IM et al 'An introduction to a UK scheme to help small firms control health risks from chemicals' *Annals of Occupational Hygiene* August 1988 42(6) 367-376
- 3 Brooke IM 'A UK scheme to help small firms control risks to health from exposure to chemicals: toxicological considerations' *Annals of Occupational Hygiene* August 1988 42(6) 377-390
- 4 Maidment SC 'Occupational hygiene considerations in the development of a structured approach to select chemical control strategies' *Annals of Occupational Hygiene* August 1988 42(6) 391-400
- 5 CHIP: Chemicals (Hazard Information and Packaging for Supply) Regulations 2002 – see HSE's CHIP web pages www.hse.gov.uk/chip/index.htm
- 6 CLP: Regulation (EC) No 1272/2008 on classification, labelling and packaging using GHS: United Nations Globally Harmonised System of Classification and Labelling of Chemicals – see HSE's GHS web pages www.hse.gov.uk/ghs/index.htm
- 7 Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) – see HSE's COSHH web pages www.hse.gov.uk/coshh/index.htm
- 8 *Control of substances hazardous to health (Fifth edition). The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance L5 (Fifth edition)* HSE Books 2005 ISBN 978 0 7176 2981 7
- 9 Topping MD, Williams CR, Devine JM 'Industry's perception and use of occupational exposure limits' *Annals of Occupational Hygiene* August 1988 42(6) 357-366
- 10 Tischer M, Bredendiek-Kamper S, Poppek U 'Evaluation of the HSE COSHH essentials exposure predictive model on the basis of BAuA field studies and existing substances exposure data' *Annals of Occupational Hygiene* August 2003 47(7) 557-569
- 11 REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals. See HSE's REACH web pages www.hse.gov.uk/reach/index.htm
- 12 *Respiratory protective equipment at work: A practical guide* HSG53 (Third edition) HSE Books 2005 ISBN 978 0 7176 2904 6

Further information

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This document contains notes on good practice which are not compulsory but which you may find helpful in considering what you need to do.

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