ESIG Risk Management Measures (RMM) Project

In 2007/8 ESIG initiated the development Generic Exposure Scenarios (GES) to support the REACH Chemical Safety Assessment (CSA) processes for the demonstration and communication of the safe use of Solvents. At this time the importance of using standard phrases in their development was recognised to ensure ready translation for use in Safety Data Sheets and consistent application in supply chain communications. These phrases included various Risk Management Measures (RMMs) required for safe use. Although such RMM phrases existed for frequently encountered exposure controls, such as extract ventilation, RMM phrases and efficiencies were not available for all common solvent exposure controls. In order to expand the validity and application of the RMMs applied in their GES, in 2014 ESIG commissioned the Fraunhofer Institute for Toxicology and Experimental Medicine (ITEM) to carry out a project aimed at characterizing the control effectiveness for airborne exposures of the different ESIG RMM phrases/control options.

The project consisted of two parts:

1. A literature review supplemented with interviews with various solvent users, and industry stakeholders such as drum pump manufacturers. This review showed that although a limited number of literature sources are available with exposure data, most contained datasets not representative of solvent exposure and were considered inadequate in the context of this project. Information gathered via interviews was of qualitative value only.

2. A series of controlled laboratory experiments intended to evaluate the effectiveness of various levels of containment, ventilation, use of drum pumps, and equipment draining and flushing techniques. This was done by comparing the concentration of solvent vapour emissions for each exposure control technology against a worst case baseline scenario. The study addressed a number of combinations of workplace controls with supporting RMM phrases, including some that had not yet been covered in existing ESIG advice.

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The overall goal was to underwrite the quantitative basis for the airborne exposure reduction efficiencies suggested by ESIG for typical Risk Management Measures (RMMs) used in solvent vapour control. In addition to the RMM phrases identified as part of the study and included in the report, further RMM phrases are available describing other control options with equivalent control efficiency. The results of the study are summarized in the table given below, together with all relevant supporting RMM phrases. The scenarios are grouped as follows:

1. Baseline (reasonable worst case transfer scenario) – benchmark against which the applied controls were compared.
2. Gravity transfer
3. Drum Pump transfer
4. Draining and flushing

Summary

The study results confirm that the advice previously given by ESIG on the effectiveness of recommended commonly encountered exposure control measures is reasonable where they are correctly applied and maintained.

Specifically, the findings indicate that gravity transfers of solvents under open conditions without controls produce worst case exposures, as expected. They also demonstrate that drum pumps, when correctly applied, provide a high level of exposure reduction efficiency. Restricting the openings of drums and the addition of local exhaust ventilation (lev) provide further exposure reduction, but do not deliver equivalency from a percent efficiency stand point. The findings also demonstrate that draining down and flushing plant equipment is also an effective means of reducing solvent exposures, for example, prior to maintenance.

The results show that the correct use of drum pumps can be an effective alternative to local exhaust ventilation for solvent transfer tasks. They also highlight the importance of procedural controls such as ‘draining and flushing’ when undertaking certain tasks involving potential exposure to solvents. These are important factors when selecting control measures and making cost benefit decisions.

The full report describing the work that was performed by Fraunhofer ITEM is available **http://www.esig.org/layout/uploads/2016/10/2015-12-15_ESIG_RMM_Final_report.pdf**

Table: Summary of Study Results

Exposure Control Technology	**ESIG Advised RMM Effectiveness** **(% effectiveness)**	**Findings of ITEM Study** **(% airborne exposure reduction against baseline)**	**Associated ESIG authored EuPhrac Phrases** **(also available within Cefic ESCom Phrase library)**	**General Comments**
1. Baseline (reasonable worst case transfer scenario) – benchmark against which the applied controls were compared				
No specific controls - Gravity transfer of solvent between open containers, with no enclosure, local exhaust or room ventilation.	Not applicable. Not generally recommended (for safety reasons).	n/a	n/a	Baseline scenario to establish worst case transfer emission level against which the applied controls were compared.
2. Risk Management Measures for gravity transfer scenarios				
Use of local exhaust ventilation at point(s) of emission Note 4	TRA suggests between 80-95% where LEV used as a primary RMM.	97.1	E54: Provide extract ventilation to points where emissions occur Or E66: Ensure material transfers are under containment or extract ventilation	
Decreasing the exposure by using extracted partial enclosure (e.g. fume cupboard not fully closed) of the operation or equipment Note 4	80 (professional)/ 90 (industrial). For PROC 8b 90 (professional) / 95 (industrial)	98.8	E60: Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings. Or E83: Handle in a fume cupboard or under extract ventilation Note 1 Or E66: Ensure material transfers are under containment or extract ventilation Note 1	

Exposure Control Technology	ESIG Advised RMM Effectiveness (% effectiveness)	Findings of ITEM Study (% airborne exposure reduction against baseline)	Associated ESIG authored EuPhrac Phrases (also available within Cefic ESCom Phrase library)	General Comments
Decreasing exposure using full enclosure of process or equipment with ventilation - inside closed fume cupboard Note 4	90 (professional) / 95 (industrial)	>99	E61: Minimise exposure by extracted full enclosure for the operation or equipment	
3. Drum Pump transfers and additional Risk Management Measures				
Use of a drum pump Note 2 for solvent transfer without local exhaust or room ventilation	80%	93.5	E53 : Use drum pumps And E68: Restrict area of openings to equipment	E68 phrase: Restricted openings should be standard practice when transferring flammable liquids with a drum pump Note 3
Use of a drum pump Note 2 for transfer in a room with enhanced room ventilation (ACH >10)	Not currently advised on by ESIG	96.4	E53: Use drum pumps And E68: Restrict area of openings to equipment And E40: Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	E68 phrase: Restricted openings should be standard practice when transferring flammable liquids with a drum pump Note 3 Despite no recommended removal efficiency currently advised, ESIG is aware of users having calculated removal efficiencies by combining the efficiencies of two separate RMMs e.g. a removal efficiency of 96% is obtained for 'restricting the size of the openings to equipment' and 'using a drum pump' by applying 80% + 80%

Exposure Control Technology	ESIG Advised RMM Effectiveness (% effectiveness)	Findings of ITEM Study (% airborne exposure reduction against baseline)	Associated ESIG authored EuPhrac Phrases (also available within Cefic ESCom Phrase library)	General Comments
Use of a drum pump [Note 2] for solvent transfer with LEV at drum opening [Note 4]	No phrase currently indicated by ESIG. TRA suggests between 80-95% where LEV used as a primary RMM.	98.9	E53 : Use drum pumps And E68: Restrict area of openings to equipment And E54: Provide extract ventilation to points where emissions occur Or E66: Ensure material transfers are under containment or extract ventilation.	E68 phrase: Restricted openings should be standard practice when transferring flammable liquids with a drum pump [Note 3]
Use of a drum pump [Note 2] for transfer inside extracted partial enclosure (e.g. fume cupboard not fully closed) [Note 4]	Not currently advised on by ESIG	99.5	E53 : Use drum pumps And E68: Restrict area of openings to equipment And E66: Ensure material transfers are under containment or extract ventilation Or E60: Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [Footnote 1] Or E83: Handle in a fume cupboard or under extract ventilation [Note 1]	E68 phrase: Restricted openings should be standard practice when transferring flammable liquids with a drum pump [Note 3]

Exposure Control Technology	ESIG Advised RMM Effectiveness (% effectiveness)	Findings of ITEM Study (% airborne exposure reduction against baseline)	Associated ESIG authored EuPhrac Phrases (also available within Cefic ESCom Phrase library)	General Comments
4. Draining and flushing				
Draining down system prior to equipment break-in or maintenance	80%	Not evaluated in ITEM study	E65: Drain down system prior to equipment break-in or maintenance Or E81: Drain or remove substance from equipment prior to break-in or maintenance	
Draining down and flushing system prior to equipment break-in or maintenance	90% (industrial only)	95%.	E55: Drain down and flush system prior to equipment break-in or maintenance	

Table Notes:

Note 1: Additional phrase identified subsequent to the survey indicating alternative control options with similar % effectiveness as specified within the ECETOC TRA modelling tool.

Note 2: Assumes accurate use of a drum pump limiting splashing via 'submerged' liquid transfer.

Note 3: It is standard practice to supply solvents in sealed metal drums with access via a capped bung hole to allow transfer. Thus, the use of the phrase E68 'Restrict area of openings to equipment' does not need to be specified as it is integral to the drum design. For solvent handling it is assumed by the phrase E53 'Use drum pumps'.

Note 4: For the scenarios involving extract ventilation, general ventilation was also in place to provide supplied air to prevent the build-up of negative pressure in the room. This has not been accounted for as it is not expected to materially reduce emission levels due to the short duration over which measurements were taken for each simulation and the fact that the room outlet for the general ventilation was closed focusing air removal via the extract ventilation system under test.

ESIG Generic Exposure Scenario Task Force
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