**Supplemental Control Banding Section: Occupational Exposures to New Drycleaning Solvents: High-flashpoint Hydrocarbon or Butylal**

Three CB tools were selected to evaluate inhalation and dermal exposure hazards associated with (1) loading/unloading/hanging clothes from the drycleaning machine (Task 1) and (2) spraying clothes with a spot cleaning solution containing SolvonK4TM (Task 2).

The first CB method we used was the Control of Substances Hazardous to Health (COSHH) Essentials tool, a web-based tool (<http://www.hse.gov.uk/coshh/essentials/index.htm>), developed by the Health and Safety Executive in Great Britain. The health hazard band was assigned to one of five groups labeled A–E, with A being the least hazardous group and E the most hazardous group by determining risk phrases (R-phrases) of butylal. The R-phrases are defined by the European Union and are found internationally in safety data sheets. With the implementation of the globally harmonized system of classification and labelling of chemicals, hazard statements (H-hazards) will eventually replace the R-phrases; however, at this time the COSHH Essentials tool still uses the R-phrases. The exposure potential band was determined based on the volatility of the chemical and quantity used during the task. This tool then combines the results of health hazard band and exposure potential band and assigns the task to one of four control strategies (CSs) - CS1 General ventilation, CS2 Engineering control, CS3-Containment, and CS4-Special. Detailed information regarding the concept of the tool is described elsewhere.1-3

The second CB method we used was the Stoffenmanger tool, a web-based tool (<http://www.stoffenmanager.nl/>) developed by TNO (Netherlands Organization for Applied Scientific Research) and Arbo Unie (Work Safety Union) in the Netherlands. The Stoffenmanager tool allows both inhalation and dermal risk assessments. For the inhalation assessment, the health hazard was assigned to one of six classes (none, A-low, B-average, C-high, D-very high, and E-extreme) by determining R-phrases. The exposure potential is assigned to one of four classes, ranging from 1 (low) to 4 (very high), on the basis of the tasks and workplace environment. The tool then generates one of three risk classes, ranging from I (high) to III (low), and unlike the COSHH Essentials tool, this tool does not recommend a control method. For the dermal assessment, the health hazard of the material is obtained and assigned in the same way as the Stoffenmanager inhalation tool. Similarly, the exposure potential is assigned to one of six classes, ranging from 1 (negligible) to 6 (extreme) on the basis of answers to the task-related questions such as handling method of the material, amount of the material, duration of the activity, etc., and workplace environment-related questions. The tool then combines the outputs of health hazard and exposure potential to generate one of three risk classes, ranging from I (high) to III (low). The dermal tool generates two separate results, local effect upon contact and systemic effect after uptake through the skin. Detailed information regarding the concept of the tool is described elsewhere.4

The third CB method we used was the RISKOFDERM tool, developed for the European Union RISKOFDERM project. A free version of the tool is available at <http://www.eurofins.com/product-testing-services/services/research-development/projects-on-skin-exposure-and-protection/riskofderm-skin-exposure-and-risk-assessment.aspx>. On the basis of the R-phrases, the RISKOFDERM tool assigns the health hazard of the material to one of five classes: low, moderate, high, very high, and extreme hazard. The exposure potential class is determined only for a task assigned to one of six dermal operational units, handling contaminated objects, manual dispersion, hand tool dispersion, spray dispersion, immersion, and mechanical treatment. For each dermal operation unit, the exposure potential is assigned to one of six classes: negligible, low, moderate, high, very high, and extreme, based on the material characteristics and exposed body area. The RISKOFDERM tool then combines the outputs of health hazard and exposure potential to generate a risk score from 1 (no action required) to 10 (substitute, stop working). This tool generates two separate results: local effect upon contact and systemic effect after uptake through the skin. Each effect produces dermal risks of body and hands separately. Detailed information regarding the concept of the tool is described elsewhere.5-7

Several previous studies8-13 were done to evaluate COSHH Essentials tool but the findings of the previous studies were not always promising. In spite of the lack of validation of these tools, the tools are still useful for chemicals, which OELs do not exist (e.g., butylal in the present study), to confirm decisions made by occupational professionals based on exposure measurements.

**Control Banding Tool Inputs and Outputs**

Each tool’s responses to the input questions and outputs per task are summarized in Supplemental Tables III – VI. We used web-based tools for the COSHH Essentials tool and Stoffenmanager tool which are freely available. Although a web-based tool for the RISKOFDERM tool was available, due to conflicts for downloading the tool, we used a paper-version to perform dermal risk assessment. Supplemental Table I. Summary of the COSHH Essentials inhalation tool

|  |  |  |  |
| --- | --- | --- | --- |
| **Input question** | **Input response** | | **Output-Recommended Control**  **Task 1 and Task 2** |
| **Task 1A** | **Task 2B** |
| R-phrases | R38-Irritating to skin | R38-Irritating to skin | Control strategy (CS) 1 – General ventilation along with 3 control guidance sheets including G100-General ventilation, S100-General advice, and S101-Selection of personal protective equipment |
| State | Liquid | Liquid |
| Operating temperature | 25˚C | 25˚C |
| Boiling point | 180 ˚C | 180 ˚C |
| Hazardous group | A | A |
| Skin hazard | Yes | Yes |
| Quantity used | Small | Small |
| How many times a day? | 3 or 4 times a day | 3 or 4 times a day |
| How long does the task take? | 70-80 minutes | < 30 minutes |

ATask 1 = Loading/unloading/hanging clothes from the drycleaning machine. BTask 2 = Spraying clothes with a spot cleaning solution containing SolvonK4TM.

Supplemental Table II. Summary of the Stoffenmanager inhalation tool

|  |  |  |  |
| --- | --- | --- | --- |
| **Input question** | **Input response** | | **Output-Risk priority** |
| **Task 1A** | **Task 2B** |
| R-phrases | R38-Irritating to skin | R38-Irritating to skin | -Hazard class: A (low) for Tasks 1 and 2  -Exposure class using vapor pressure (VP) 79 Pa: 1 (low) for Tasks 1 and 2  - Exposure class using VP 250 Pa: 2 (average) for Task 1 and 1 (low) for Task 2  -Risk score: III (low) for Tasks 1 and 2 |
| Vapor pressure (Pa) at 20 ˚C | 79 – 250C | 79 - 250C |
| Activity | Handling of liquids on small surfaces | Handling of liquids where only small amounts of product may be released |
| Duration | 0.5 to 2 hours a day | 1 to 30 minutes a day |
| Activity frequency | 4-5 days a week | 4-5 days a week |
| Regular cleaning of work area | Yes | Yes |
| Regular inspection and maintenance | Yes | Yes |
| Activity in breathing zone | Yes | Yes |
| Multiple employees | No | No |
| Evaporation, drying or curing after activity | Yes | No |
| Work area volume | Volume 100-1000 m3 | Volume 100-1000 m3 |
| Work area ventilation | General ventilation (open windows and doors) | General ventilation (open windows and doors) |
| Control measures at the source | No control measures at the source | No control measures at the source |
| Segregation of employee | No | No |
| Employee protection | No protection | No protection |

ATask 1 = Loading/unloading/hanging clothes from the drycleaning machine. BTask 2 = Spraying clothes with a spot cleaning solution containing SolvonK4TM. C Due to various vapor pressures listed in the ECHA (European Chemicals Agency) at 20 ˚C, 79 Pa, < 138 Pa, and < 250 Pa, we used the minimum and maximum values for this tool.

Supplemental Table III. Summary of the Stoffenmanager dermal tool

|  |  |  |
| --- | --- | --- |
| **Input question** | **Input response for Task 2A** | **Output-Risk Priority** |
| R-phrases | R38-Irritating to skin | - Local effect – Risk priority II (middle) based on Hazard class B (average) and Exposure class 4 (high) (both VPs)  - Systemic effect – Risk priority III (low) based on no Hazard class and Exposure class 5(very high) (both VPs) |
| Dilution | >25% (selected from options) |
| Type of product | Like water, included foam |
| Task | Spray dispersion of product |
| Usage of product | Less than 0.9 L/quarter |
| Is the working space small and enclosed? | No, the room is not small and narrow |
| Height | Mostly at waist level |
| Airborne particles during spraying | No, during spraying no fine mist arises |
| Distance to source | One arm’s length, or less |
| Source ventilation | No, no local exhaust ventilation |
| Measurement of protection | No, unrestricted workspace |
| Work wear | No, normal clothing |
| Duration of task | 6 to 30 minutes a day |
| Exposure body parts | Both hands, Lower arms, and Head |

A Task 2 = Spraying clothes with a spot cleaning solution containing SolvonK4TM.

Supplemental Table IV. Summary of the RISKOFDERM dermal tool

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Input question** | | **Input response** | **Score based on input** | **Oppl et al., 2003 A** | **Output-Health risk score** |
| Dermal Exposure Operational Unit | | Spray dispersion |  | Table 4 |  |
| R-phrases | | R38-Irritating to skin | Moderate | Table 2 |
| Local effect | Activity time (AT) | 0.1 - < 0.5 hour/day | 0.1 for body and hands | Table 5 | -Body: 3 (moderate hazard score and moderate AE score)  -Hands: 4 (moderate hazard score and high AE score) (Table 9) |
| Peak actual exposure dose (AEDPEAK)B | Body | 0.1 | Table 6 |
| Hands | 0.3 |
| Exposure body area (EBA) | 501-2000 cm2C | 1 | Table 7 |
| Peak actual exposure (AE) D | Body | Moderate (> 0.02-0.2) | Table 8 |
| Hands | High (> 0.2-2) |
| Systemic effect | Activity time (AT) | < 0.5 hour/day | 0.1 for body and hands | Table 10 | -Body and hands: 2 (No risk hazard score and moderate IE score) (Table 14) |
| Exposure dose (ED) E | Body | 0.01 | Table 11 |
| Hands | 0.02054 |
| Exposure body area (EBA) | Body | 3744 | Table 12 |
| Hands | 820 |
| Internal exposure (IE) F | Body | Moderate | Table 13 |
| Hands | Moderate |

AThe selection of score was based on the tables in Oppl et al., 2003. B Peak actual exposure dose (AEDPEAK) = actual exposure rate (mg/cm2/h) x AT score, where actual exposure rate was calculated by following steps described in Goede et al. (2003). C Covers hands and lower arms or hands and head. D Peak actual exposure (AE) =AEDPEAK score x EAB score; EExposure dose (ED) score = actual exposure rate (mg/cm2/h) x AT score, where actual exposure rate was calculated by following steps described in Goede et al.. F Internal exposure (IE) score = ED score x EBA score.

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