



Inhalable Exposure Assessment in a Web Offset Printing Facility: A case study from Australia

Dr Sue Reed,

School of Natural Sciences

University of Western Sydney, Australia



Introduction

Workers in the printing industry are exposed to a range of airborne contaminants the most common being:

- airborne dust including the potential for bound chemicals, such as carbon black;
- volatile organic compounds (VOCs).



Background

- Bælum, Andersen and Mølhave (1982) reported that printers reported a higher prevalence of irritation of the eyes and airways. They documented 32 different airborne VOC substances.
- Lee, Kelsey and Hashimoto (1997) found that printers reported a higher prevalence of respiratory symptoms than pre-press (compositors) staff even though there was no significant difference in their spirometry results.
- Crouch and Gressel (1999) reported dust concentrations in a print works ranging from ~ 0.10 to 0.85 mg m^{-3} with most of the exceeding 0.200 mg m^{-3} .



Background (VOC's)

- Crouch and Gressel (1999) reported that cleaning solutions used commonly in small printers could contain over 20 VOC components.
- Gioda and Aquino Neo (2007) identified toluene as the major VOC present in the air in print works with ave conc of 7.8 mg m^{-3} . 69% of the workers considered the air quality unsatisfactory and many reported symptoms of dry throat, itchy or watery eyes and blocked nose.
- A European study by Hautamäki et al (2006) showed that the Chemical Exposure Index ranged from 0.11 to 0.43 for printers using naphtha based cleaning agents and 0.05 to 0.11 for printers using vegetable oil-based cleaning agents. The major solvents identified included propanol, decane methylcyclohexane, nonane, decane, dodecane, heptane.



Aim

The aim of the project was to measure worker exposure in the print press section to inhalable dust, carbon black and VOC's and determine if the exposures had the potential to impact adversely on their health.



Methods

- 45 workers monitored over four 12 hour shifts in May 2008; 30 printers, 10 reel hands, 3 stackers and 2 general hands;
- Personal inhalable dust samples were collected using IOM sampling heads attached to sampling pumps set at a flow rate of 2 L min⁻¹ (AS3640-2004);
- Dust samples were collected on pre-weighed filters (GLA5000) supplied by Queensland SIMTARS Analytical Laboratory.



Methods (cont)

- The gravimetric determination of the dust levels and carbon black analysis was undertaken at SIMTARS Analytical Laboratory according to Method LP0046 - Procedure for Weighing Fine Particulate Matter Filters (SIMTARS, n.d.) and OSHA Method ID-196 - Carbon Black in Workplace Atmospheres.
- The personal VOC samples were collected according to using SKC diffusive badges. (AS2986.2-2003).
- Samples were analysed at the NSW WorkCover Analytical Laboratories using method WCA 207 which analysed each of the diffusive badge samples for 73 volatile organic components. (Testsafe Australia, 2006)



Results

| Location and Job Type | Inhalable Dust Concentration (\pm SE) (mg m ⁻³) | Carbon Black Concentration (\pm SE) (mg m ⁻³) | Chemical Exposure Index (\pm SE) |
|-------------------------------|--|--|-------------------------------------|
| <i>ASCC Exposure Standard</i> | 10 | 3 | 1.0 |
| Press 1 Printers (N=4) | 0.48 (0.12) | 0.18 (0.05) | 0.0036 (0.0013) |
| Press 2 Printers (N=7) | 0.33 (0.16) | <LOR | <LOR |
| Press 2 Reel Hands (N=2) | 0.15 (0.01) | ND | <LOR |
| Press 2 Stackers (N=2) | 0.32 (0.08) | ND | <LOR |
| Press 3 Printers (N=5) | 0.6 (0.36) | 0.11 (0.03) | <LOR |
| Press 3 Reel Hands (N=3) | 0.22 (0.04) | ND | <LOR |
| Press 4 Printers (N=5) | 0.39 (0.16) | ND | <LOR |
| Press 4 Reel Hands (N=2) | 0.15 (0) | ND | <LOR |
| Press 4 Stacker (N=1) | 0.29 (0) | ND | <LOR |
| Press 5 Printers (N=4) | 0.24 (0.07) | ND | 0.0019 (0.0006) |
| Press 5 General Hands (N=2) | 0.08 (0) | ND | 0.0029 |
| Press 6 Printers (N=5) | 0.32 (0.18) | 0.13 (0) | 0.0024 |
| Press 6 Reel Hands (N=3) | 0.14 (0.02) | ND | <LOR |



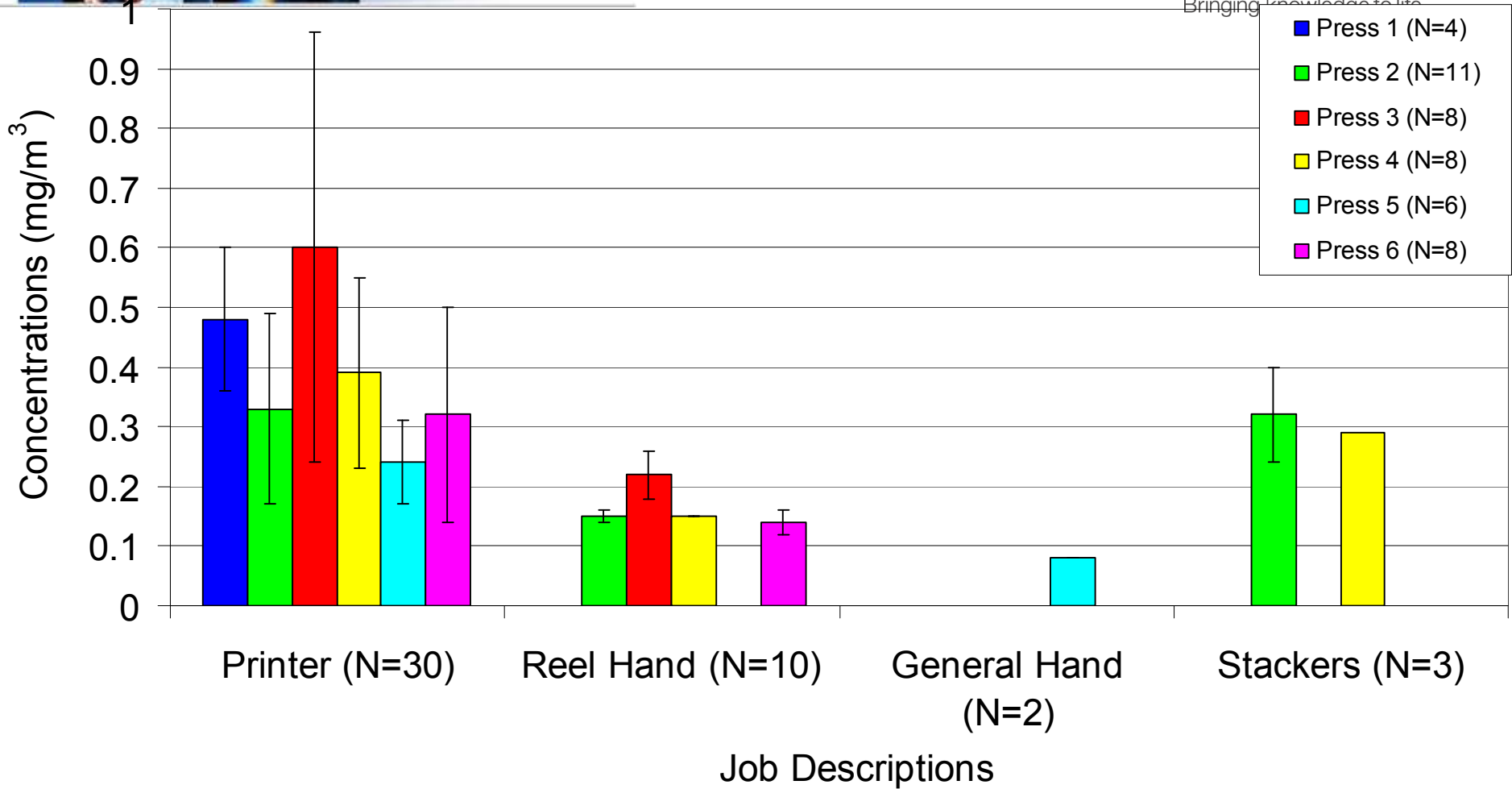
Inhalable Dust

- Printers arithmetic mean concentration was 0.39 mg/m^3 (SD=0.42) with a geometric mean of 0.26 mg/m^3 (GSD=2.48).
- Higher than a similar study by Reed & Hedges, (2008) in a range of Australian printing facilities with arithmetic mean of 0.26 mg/m^3 (SD=0.21) and geometric mean of 0.18 mg/m^3 (GSD=2.71).
- The estimated arithmetic mean upper 95% limit is 1.93 mg/m^3 which is similar to other studies.



- Printers working Press 3 had the highest exposure with a arithmetic mean of 0.6 mg/m^3 .
- Exposures for printers of three of the presses (2, 3 & 6) showed individual results exceeded 1 mg/m^3 .
- The mean exposure (AM) of the reel hands was 0.17 mg/m^3 (SD=0.05) with a geometric mean of 0.16 mg/m^3 (GSD=1.30).
- The stackers mean exposure (AM) was 0.31 mg/m^3 (SD=0.08) with a geometric mean of 0.30 mg/m^3 (GSD=1.31) and general hands was 0.15 mg/m^3 (SD=0.02).

Average Personal Inhalable Dust Concentration Measured by Job Type and Press Number (\pm SE)



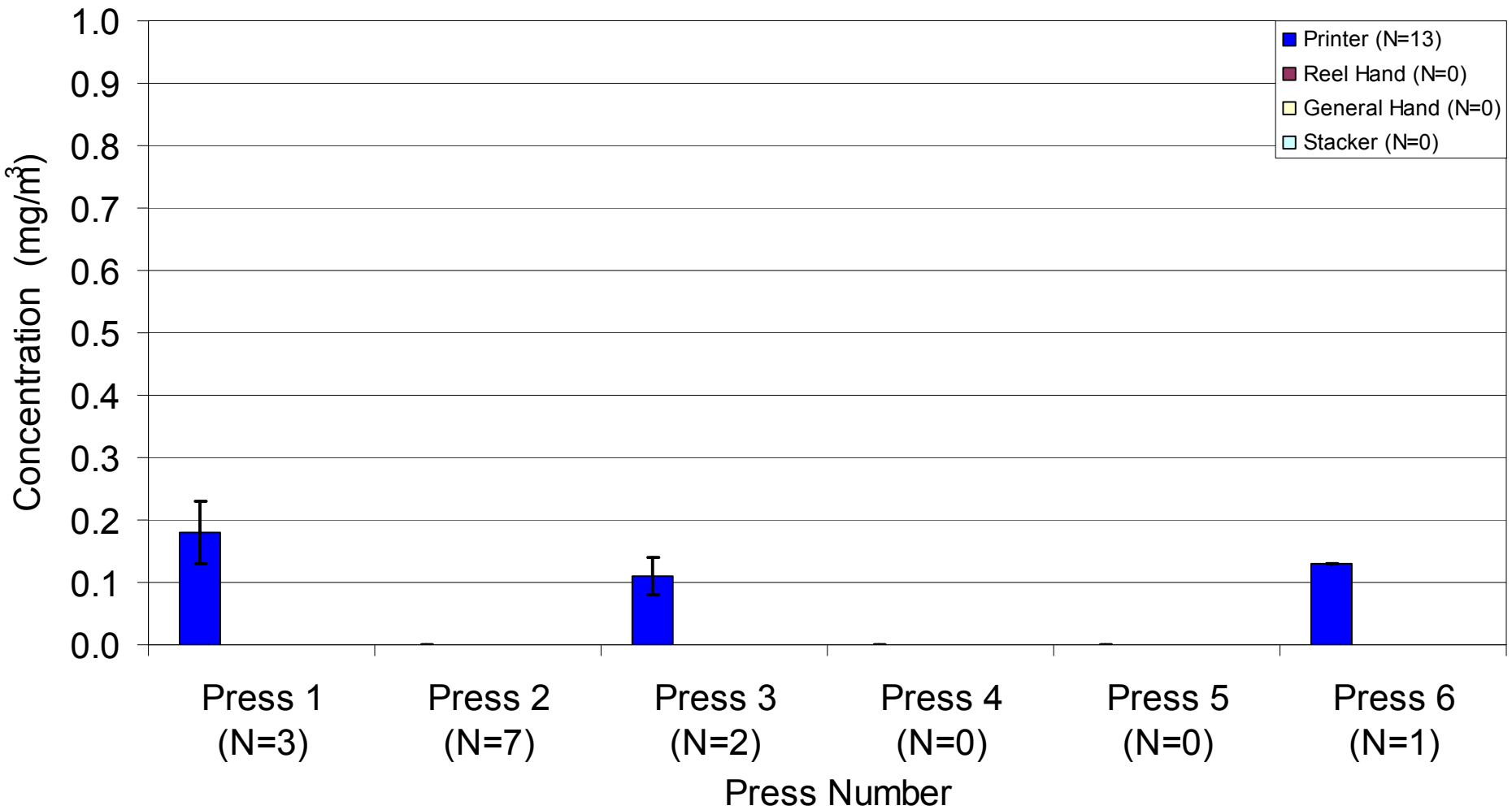


Carbon Black

- 73% of the 15 samples analysed were below the level of detection (LOD=0.1 mg/m³)..
- maximum concentration measured was 0.3 mg/m³ during maintenance on Press 1.
- The 3 inhalable dust samples (Printers on Presses 3 & 6) which were higher than 1 mg/m³ were analysed for carbon black.
- Only 2 of these recorded levels above LOD with results of 0.14 & 0.13 mg/m³ respectively.



Average Concentrations Carbon Black Bound to Inhalable Dust by Press Number and Job Type (\pm SE)

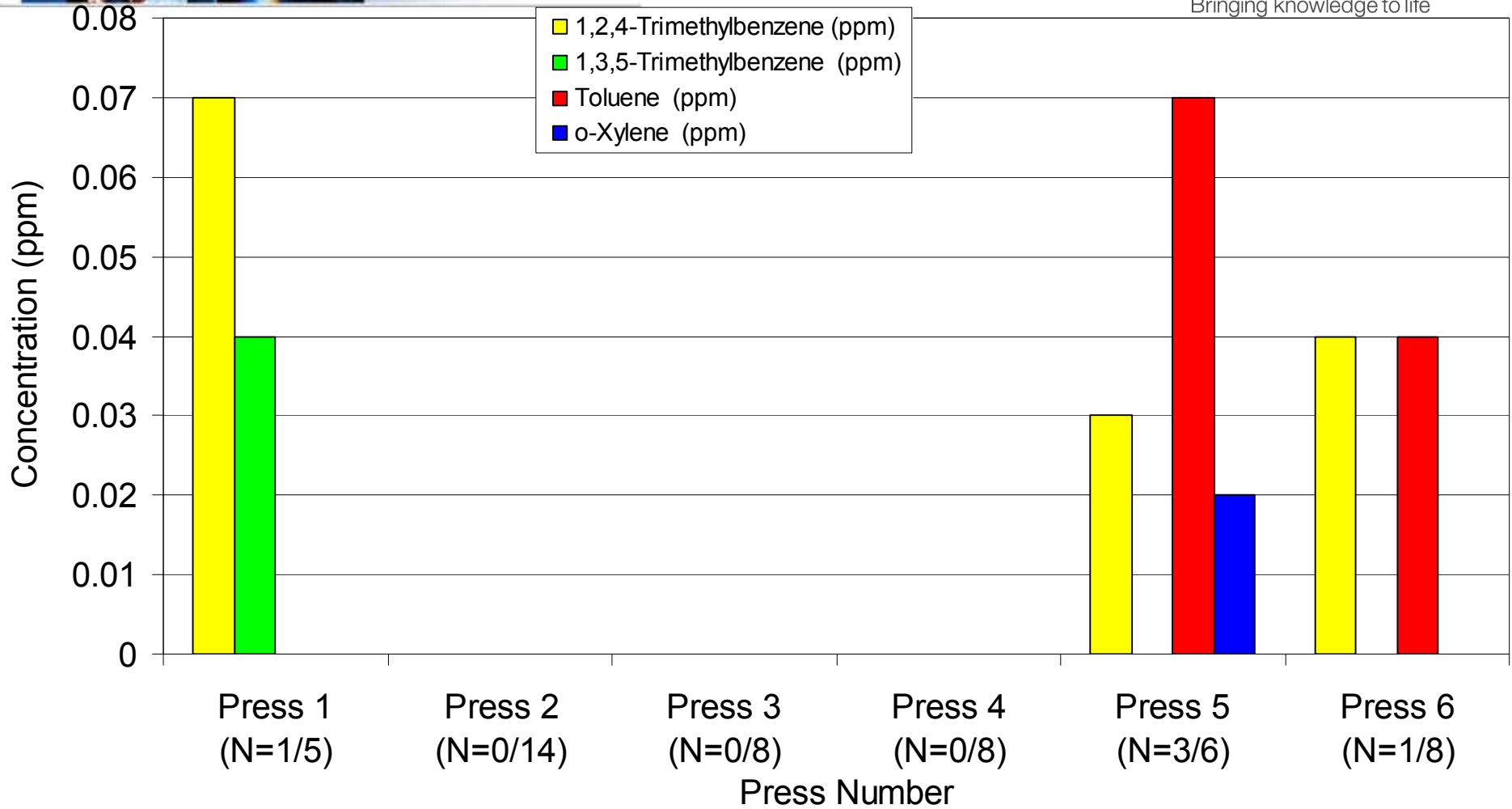




Volatile Organic Compounds

- Concentration of TVOC's were very low with 90% of samples below the level of detection.
- Each of the compounds identified were <0.5% of the exposure standard (ES), which were:
 - toluene (ES=50ppm),
 - xylene (ES=80 ppm), and
 - 1,2,4-Trimethylbenzene & 1,3,5-Trimethylbenzene (combined ES = 25 ppm).
- Highest Exposure Index (EI) calculated was 0.0056 which is well below recommended standard of 1.

Concentrations of Individual VOC Components and Press Number





Conclusion

- All exposures measured were within current exposure standards
- The highest exposure monitored was for inhalable dust.
- The current personal exposure to carbon black was not a significant risk. It should be noted that the dust samples collected were to measure inhalable dust concentrations.
- VOC exposures were very low. Similar results were obtained in other print works of similar size.



References

- ACGIH, 2001 *Carbon Black: TLV Chemical Substances 7th Edition Documentation*, American Conference of Governmental Occupational Hygienists, Cincinnati, USA
- ACGIH, 2008 *2008 TLV's and BEI's: Threshold Limit Values for Chemical Substance and Physical Agents & Biological Exposure Indices*, American Conference of Governmental Occupational Hygienists, Cincinnati, USA
- AS2986.2-2003 *Workplace air quality - Sampling and analysis of volatile organic compounds by solvent desorption/gas chromatography - Diffusive sampling method*, Standards Australia, Sydney
- AS3640-2004 *Workplace atmospheres - Method for sampling and gravimetric determination of inhalable dust*, Standards Australia, Sydney
- ASCC, 2008, *Hazardous Substances Information System: Exposure Limits*, (<http://hsis.ascc.gov.au/SearchES.aspx>, accessed 31/03/09)
- Bælum, J, Andersen, I & Mølhave, L 1982, 'Acute and subacute symptoms among workers in the printing industry', *British Journal of Industrial Medicine*, vol.39, pp.70-75.
- Crouch, KG & Gressel, MG 1999, 'The Control of Press Cleaning Solvent Vapors in a Small Lithographic Printing Establishment', *Applied Occupational and Environmental Hygiene*, vol. 14, pp.329-338.
- Gioda, A & Aquino Neto, FR 2007, 'Prevalence of Symptoms Associated with Elevated Total Volatile Organic Compounds (TVOCs) Levels in Workers at a Printing Facility', *Indoor Built Environ*, vol. 16, no. 4, pp. 371-375
- Hautamäki, M, Kalliokoski, P, Hyttinen, M, Pasanen, P, Laitinen, J, Kangas, J, Luukkonen, R & Batterman, S 2006, 'Evaluation of the Use of Low Flow Passive Sampling Technique in Offset Printing Plants', *International Journal of Occupational Medicine and Environmental Health*, vol. 19, no. 4, pp. 228 - 34.
- Lee, BW, Kelsey, KT & Hashimoto, D 1997, 'The prevalence of pulmonary and upper respiratory tract symptoms and spirometric test findings among newspaper pressroom workers exposed to solvents', *J Occup Environ Med*, vol. 39, pp. 960-969.
- OSHA 2007 OSHA Method ID-196 - Carbon Black in Workplace Atmospheres.
(<http://www.osha.gov/dts/sltc/methods/inorganic/id196/id196.pdf>, accessed 31/03/09)
- Reed, S. & Hedges, K. 2008 *Benchmarking of Exposures in Selected Australian Workplaces.*, Office of the Australian Safety & Compensation Council (ASCC). (Research Report)
- Simtars, nd, LP0046 - Procedure for Weighing Fine Particulate Matter Filters
- Testsafe Australia, 2006, *CHEMICAL ANALYSIS BRANCH HANDBOOK*, 6th Ed., NSW WorkCover 2006,
(http://www.testsafe.com.au/docs/chemical_analysis_branch_handbook_550.pdf, accessed 31/03/09)