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MEMORANDUM

TO: Chuck Andrews, Branch Chief
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HSM-99015

FROM: Tom Thongsinthusak, Staff Toxicologist [original signed by T. Thongsinthusak]
Worker Health and Safety Branch
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DATE: July 22, 1999

SUBJECT: Methyl Bromide: Potential Dermal Exposure and Correction of Exposure
Estimates

You asked me to respond to two comments from the Medical Toxicology Branch regarding the exposure assessment of methyl bromide (MB). Lori Lim listed a comment in her correspondence (July 15, 1999) to Gary Patterson and Keith Pfeifer on potential dermal exposure of workers wearing self-contained breathing apparatus (SCBA) in high MB concentration environment. Gary Patterson raised a question about potential correction for recovery deficiencies. The Worker Health and Safety Branch also received these comments from the Office of Health Hazard Assessment (OEHHA) before the meeting in Davis on July 16, 1999. Answers shown below will be incorporated into the MB exposure document (HS-1659).

1. Potential dermal exposure of workers wearing SCBA in high MB concentration environment

Based upon illness reports in the literature, there is the potential for significant dermal exposure of workers who wear SCBA in high MB concentration environment and work in the area for extended periods. Zwaveling *et al.* (1987) and Hezemans-Boer (1988) reported skin lesions in six workers eight hours after exposure for 40 minutes to high concentration of MB of approximately 40 g/m³ or 10,000 ppm during the fumigation of an enclosed building. These workers wore coveralls on top of normal daily clothing, PVC gloves, and work shoes. During the actual fumigation these workers breathed pressurized air from a portable container through a tight fitting facemask. The skin lesions consisted of sharply demarcated erythema with multiple vesicles and large bullae. The lesions were limited to parts of the skin that were relatively moist and/or subjected to mechanical stress such as the armpits, the groin, the labia, the vulva, the penis, the scrotum, the rima ani, the navel, and the skin under the waistbelt. The mean plasma bromide concentration for samples collected immediately after the exposure and 12 hours after the exposure were 95 ± 15 and 72 ± 24 µmol/L, respectively. It is possible that MB absorption is increased in this partly lipophilic (sebaceous glands) and partly hydrophilic (sweat glands) environment (Zwaveling *et al.*, 1987). The percentage of dermal absorption could not be determined. Healing of the skin lesions of these workers occurred in 2 weeks. Deschamps and Turpin (1996) reported illnesses of two experienced fumigators who wore a cartridge respirator with activated charcoal. They entered a building where the concentration of MB was 17g/m³.

Under the very high MB concentration environment, it is likely that the respirator was rapidly saturated with MB. It is for this reason that NIOSH does not recommend any air-purifying respirator for MB.

Dermal absorption of vapors of chemicals other than MB was studied. Four human volunteers (naked excepted shorts) were exposed to styrene vapors in the air within the concentration range of 1,300 to 3,200 mg/m³ for 2 hours (Wieczorek, 1985). These volunteers (3 men and 1 woman aged 25-35) breathed pure air from outside through a respirator. The results showed that dermal absorption of the styrene vapors contributed about 5% to the amount absorbed in the respiratory tract under the same conditions when the subjects did not wear a respirator. Riihimaki and Pfaffli (1978) studied percutaneous absorption of xylene, styrene, toluene, 1,1,1-trichloroethane, and tetrachloroethane vapors employing restricted numbers of human volunteers (n = 2-3 for each kind of vapor). The percutaneous absorption when the volunteers were exposed to moderate air concentrations of 300 and 600 ppm for 3.5 hours were about 0.1 to 2% of the amount estimated to be absorbed from the unprotected respiratory tract.

McDougal *et al.* (1985) studied dermal absorption of dibromomethane (DBM, 500 to 10,000 ppm) and bromochloromethane (BCM, 2,500 to 40,000 ppm) vapors in rats. The percentage of body burden, which was due to penetration of the skin, would be 5.8% for DBM and 4.2% for BCM. The observed permeability constants in rats for styrene, xylene, toluene, perchloroethylene, benzene, halothane, hexane, and isoflurane were estimated to be two to four times greater than the human permeability constants calculated from the available literature data (McDougal *et al.*, 1990). Based upon the difference in absorption of various chemical vapors in rats and humans, the percentage of body burden in humans was assumed to be 1.5 to 2.9% for DBM and 1.1 to 2.1% for BCM.

In conclusion, the dermal absorption of MB can be significant based upon reported illnesses of individuals with SCBA exposed to high concentration of MB for extended periods. Dermal exposures of other gases in humans such as styrene, xylene, styrene, toluene, 1,1,1-trichloroethane, tetrachloroethane, dibromomethane, and bromochloromethane can be in the range of 0.1-5% of the unprotected respiratory exposure. However, there is no chemical-specific dermal absorption study for MB; we cannot meaningfully estimate dermal exposure at this time.

2. Potential correction of MB exposure for recovery deficiencies

Most estimates in the MB exposure document were adjusted for the percentages of recoveries of 69% (majority), 71.4%, 88%, and 74-125%. I did not adjust the exposure estimates obtained from two studies – fumigation of dried fruits and tree nuts, and a brewery facility because there was no recovery study. I can adjust the estimates by using an appropriate percentage of recovery. Paul Gosselin mentioned at the meeting with OEHHA that DPR is waiting for comments on a recovery study conducted by Biermann and Barry (1999). A management decision will be made later if further adjustment for the offsite commodity and soil exposure estimates is necessary. It is my opinion that the Biermann and Barry study must be replicated under more rigorous conditions before any additional correction for recovery can be made.

Chuck Andrews

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cc: John Ross

(MB/CAndrews-MB1)