Department of Pesticide Regulation

Brian R. Leahy
Director

Edmund G. Brown Jr.
Governor

M E M O R A N D U M

TO: Shelley DuTeaux, PhD, MPH, Chief
Human Health Assessment Branch
Department of Pesticide Regulation

VIA: Svetlana E. Koshlukova, PhD, Senior Toxicologist
Risk Assessment Section *[original signed by S. Koshlukova]*
Human Health Assessment Branch

FROM: Andrew L. Rubin, PhD, DABT, Staff Toxicologist
Risk Assessment Section *[original signed by A. Rubin]*
Human Health Assessment Branch

DATE: June 1, 2017

SUBJECT: 1,3-DICHLOROPROPENE: REVISION OF HUMAN EQUIVALENT CONCENTRATIONS, MARGINS OF EXPOSURE, AIR UNIT RISK AND CANCER RISK VALUES FOR OCCUPATIONAL SEASONAL, ANNUAL AND LIFETIME EXPOSURE SCENARIOS

I. Introduction

DPR's risk characterization document for 1,3-dichloropropene (1,3-D) dated December 31, 2015 (http://www.cdpr.ca.gov/docs/risk/rcd/dichloro_123115.pdf) contains a small systematic error in the calculation of occupational seasonal, annual, and lifetime human equivalent concentrations (HECs). This impacted the margin of exposure (MOE) calculations for those scenarios, as well as the determination of occupational cancer air unit risks (AUR) and cancer risk values. The error involved the insertion of a factor of 5/7 (*i.e.*, 0.71)---representing 5 animal exposure days per week divided by the anticipated human weekly exposure of 7 days per week---into the conversion calculation (see Table IV.4 of the RCD). While this factor was appropriate for non-occupational exposure scenarios, the occupational scenarios are assumed to occur on a 5-days-per-week basis. In those cases, the appropriate weekly exposure factor is 5/5 (*i.e.*, 1), which effectively removes it from the calculation.

The purpose of this memorandum is to present revised occupational HECs, MOEs, AURs and cancer risk values for occupational subchronic, chronic and lifetime 1,3-D exposure scenarios.

II. Revision of the subchronic and chronic occupational HECs

In order to convert the effective laboratory animal air concentration to an HEC, the following equation was used in the RCD:

$$HEC = (POD) \times (\text{formulation purity}) \times (D_a / D_h) \times (W_a / W_h) \times RGDR$$

POD: point of departure
D_a: duration of animal exposure (hr/day)
D_h: duration of anticipated human exposure (hr/day)
W_a: duration of animal exposure (days/wk)
W_h: duration of anticipated human exposure (days/wk)
RGDR: regional gas dose ratio

As noted, the W_a / W_h term was set to 5 days / 7 days in the RCD for occupational scenarios. Since it actually was 5 days / 5 days, or 1, this term should be removed from the equation:

$$HEC = (POD) \times (\text{formulation purity}) \times (D_a / D_h) \times RGDR$$

The revised seasonal and annual occupational HEC calculations are as follows:

Seasonal (occupational):
HEC = (16 ppm*) x (0.91) x (6 hr / 8 hr) x (0.115) = **1.26 ppm**
*BMCL based on incidence of hyperplasia of the nasal respiratory epithelium in rats (Stott *et al.*, 1984)

Annual (occupational):
HEC = (6 ppm*) x (0.92) x (6 hr / 8 hr) x (0.198) = **0.82 ppm**
*BMCL based on incidence of hyperplasia of the nasal respiratory epithelium in mice (Stott *et al.*, 1987)

III. Revision of seasonal and annual occupational MOEs

Revised MOEs for seasonal and annual occupational exposures to 1,3-D appear in Tables 1 and 2 below (table numbers in the original RCD were IV.13 and IV.14). Revisions are highlighted.

Table 1. 1,3-D exposure estimates and resultant MOE values, occupational scenarios: subchronic / seasonal risk (*Revision of RCD, Table IV.13**)

Exposure scenario	Air concentration (ppm)	***Revised* HEC (ppm)**	***Revised* MOE**	Target MOE
Subchronic / seasonal exposures				
Applicator (shallow shank w/o tarp)	0.032	1.26	39	30
Applicator (shallow shank with tarp)	0.10	1.26	13	30
Applicator (deep shank w/o tarp	0.068	1.26	19	30
Applicator (deep shank with tarp)	0.22	1.26	6	30
Applicator (drip w/o tarp)	0.039	1.26	32	30
Applicator (drip with tarp)	0.018	1.26	70	30
Applicator (injection auger)	n/a	1.26	n/a	30
Loader (shallow shank)	0.062	1.26	20	30
Loader (deep shank)	0.13	1.26	10	30
Tarp remover (shallow shank)	3.9	1.26	0.32	30
Tarp remover (deep shank)	8.3	1.26	0.15	30
Tarp remover (drip)	2.6	1.26	0.48	30
Reentry worker (shallow shank)	0.015	1.26	84	30
Reentry worker (deep shank)	0.032	1.26	40	30
Reentry worker (drip)	0.010	1.26	126	30
Occupational bystander (shallow shank w/o tarp)	0.0012	1.26	1050	30
Occupational bystander (deep shank w/o tarp)	0.0012	1.26	1050	30
Occupational bystander (drip with tarp)	0.0012	1.26	1050	30

* Original tables from 2015 Risk Characterization Document are found in **Appendix C**.

Table 2. 1,3-D exposure estimates and resultant MOE values, occupational scenarios: chronic / annual risk (*Revision of RCD, Table IV.14**)

Exposure scenario	Air concentration (ppm)	***Revised*** **HEC (ppm)**	***Revised*** **MOE**	Target MOE
Chronic / annual exposures				
Applicator (shallow shank w/o tarp)	0.0096	0.82	85	30
Applicator (shallow shank with tarp)	0.032	0.82	26	30
Applicator (deep shank w/o tarp	0.042	0.82	20	30
Applicator (deep shank with tarp)	0.14	0.82	6	30
Applicator (drip w/o tarp)	0.013	0.82	63	30
Applicator (drip with tarp)	0.0060	0.82	137	30
Applicator (injection auger)	n/a	0.82	n/a	30
Loader (shallow shank)	0.019	0.82	43	30
Loader (deep shank)	0.082	0.82	10	30
Tarp remover (shallow shank)	1.2	0.82	0.68	30
Tarp remover (deep shank)	5.2	0.82	0.16	30
Tarp remover (drip)	0.85	0.82	0.96	30
Reentry worker (shallow shank)	0.0064	0.82	128	30
Reentry worker (deep shank)	0.024	0.82	34	30
Reentry worker (drip)	0.0044	0.82	186	30
Occupational bystander (shallow shank w/o tarp)	0.00062	0.82	1323	30
Occupational bystander (deep shank w/o tarp)	0.00062	0.82	1323	30
Occupational bystander (drip with tarp)	0.00062	0.82	1323	30

* Original tables from 2015 Risk Characterization Document are found in **Appendix C**.

IV. Revision of air unit risk values for portal of entry and systemic modes of oncogenic action

As with the calculation of HECs for occupational seasonal and annual exposure scenarios, a 5/7 factor was applied in error to convert laboratory animal concentrations to HECs in order to calculate AURs (which were based on the formation of bronchioloalveolar tumors). Table 3 presents the revised occupational HECs and resultant revised AURs. Figure 1 presents the benchmark dose modeling curves used to determine the revised AURs. Outputs from both multistage cancer modeling runs appear in the Appendix to this memorandum.

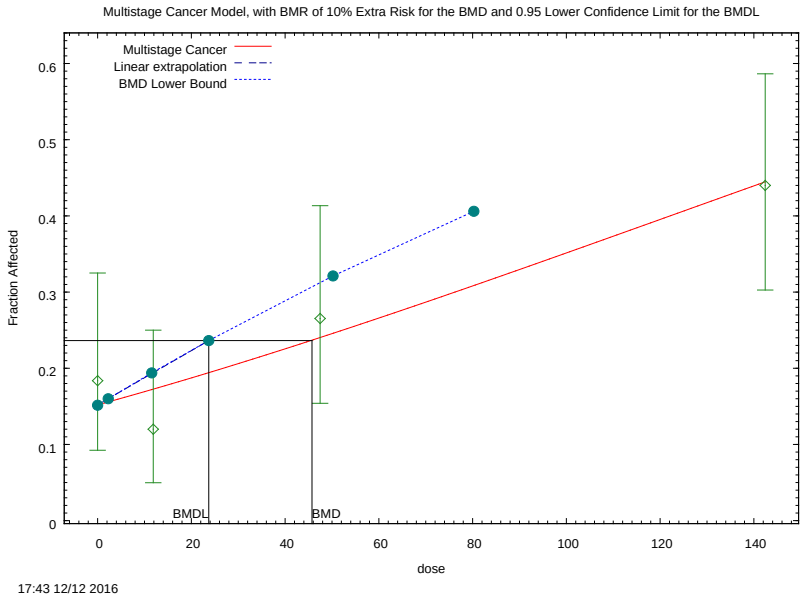
Table 3. Human equivalent doses and incidence rates used to model the dose responsiveness of 1,3-D-induced bronchioloalveolar adenomas in male mice (Stott *et al.*, 1987) (*Revision of Table IV.6**)

Portal of entry scenario				
Nominal dose	**RGDR**	**HEC dose (resident-bystander-ambient)**	***Revised* HEC dose (occupational)**	**Incidence rate**
0 ppm	3.44	0 ppm	0 ppm	9/49 (18%)
5	3.44	2.83	11.87	6/50 (12%)
20	3.44	11.30	47.47	13/49 (27%)
60	3.44	33.91	142.42	22/50 (44%)
Air unit risk – upper confidence limit (ppm^{-1})		0.018	0.0042	n/a
Systemic scenario				
0 ppm	1	0 ppm	0 ppm	9/49 (18%)
5	1	0.82	3.45	6/50 (12%)
20	1	3.29	13.80	13/49 (27%)
60	1	9.86	41.40	22/50 (44%)
Air unit risk – upper confidence limit (ppm^{-}		0.062	0.0145	n/a

* Original tables from 2015 Risk Characterization Document are found in **Appendix C**.

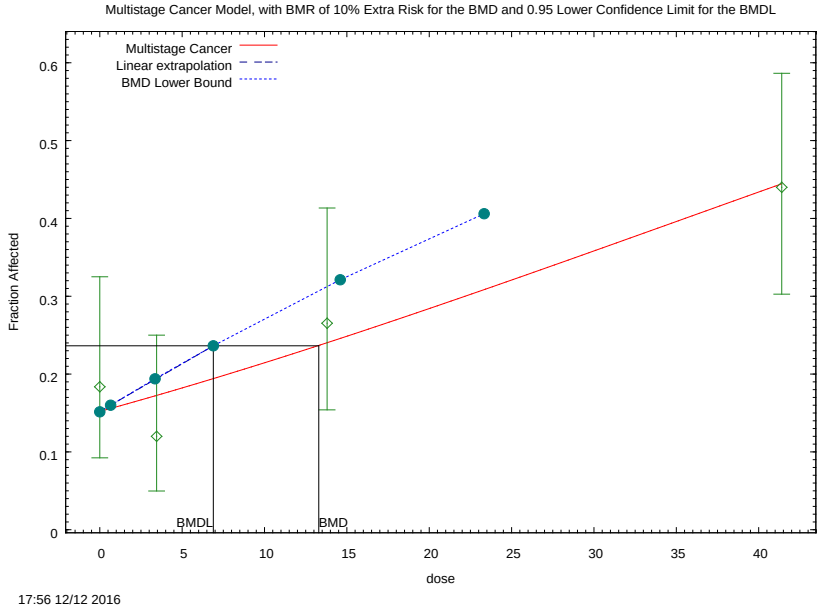
Figure 1. Bronchioloalveolar tumor formation as a function of 1,3-D air concentration: occupational scenarios

A. Portal of entry mode of action



Air unit risk = 0.00421761

B. Systemic mode of action



Air unit risk = 0.0145089

V. Revision of occupational cancer risk values

Occupational cancer risk values were revised using the AUR values calculated in section IV. They appear in Table 4 below along with the non-occupational values (which remain as expressed in the RCD).

Table 4. 1,3-D exposure estimates and resultant oncogenic risk values: occupational scenarios assuming both portal of entry and systemic modes of action *(Revision of Table IV.15*)*

Exposure scenario	Air conc. (ppm)	AUR (ppm^{-1}) [a]		Oncogenic risk		Target onco. risk [b]
		Portal of entry	Systemic	Portal of entry	Systemic	
Applicator (shallow shank w/o tarp)	0.0054	0.0042	0.0145	$2.3x10^{-5}$	$7.8x10^{-5}$	$1x10^{-6}$
Applicator (shallow shank with tarp)	0.017	0.0042	0.0145	$7.1x10^{-5}$	$2.5x10^{-4}$	$1x10^{-6}$
Applicator (deep shank w/o tarp	0.023	0.0042	0.0145	$9.7x10^{-5}$	$3.3x10^{-4}$	$1x10^{-6}$
Applicator (deep shank with tarp)	0.072	0.0042	0.0145	$3.0x10^{-4}$	$1.0x10^{-3}$	$1x10^{-6}$
Applicator (drip w/o tarp)	0.0070	0.0042	0.0145	$2.9x10^{-5}$	$1.0x10^{-4}$	$1x10^{-6}$
Applicator (drip with tarp)	0.0032	0.0042	0.0145	$1.3x10^{-5}$	$4.6x10^{-5}$	$1x10^{-6}$
Applicator (injection auger)	n/a	0.0042	0.0145	n/a	n/a	$1x10^{-6}$
Loader (shallow shank)	0.0100	0.0042	0.0145	$4.2x10^{-5}$	$1.5x10^{-4}$	$1x10^{-6}$
Loader (deep shank)	0.044	0.0042	0.0145	$1.8x10^{-4}$	$6.4x10^{-4}$	$1x10^{-6}$
Tarp remover (shallow shank)	0.66	0.0042	0.0145	$2.8x10^{-3}$	$9.6x10^{-3}$	$1x10^{-6}$
Tarp remover (deep shank)	2.8	0.0042	0.0145	$1.2x10^{-2}$	$4.1x10^{-2}$	$1x10^{-6}$
Tarp remover (drip)	0.46	0.0042	0.0145	$1.9x10^{-3}$	$6.7x10^{-3}$	$1x10^{-6}$
Reentry worker (shallow shank)	0.0034	0.0042	0.0145	$1.4x10^{-5}$	$4.9x10^{-5}$	$1x10^{-6}$
Reentry worker (deep shank)	0.013	0.0042	0.0145	$5.5x10^{-5}$	$1.9x10^{-4}$	$1x10^{-6}$
Reentry worker (drip)	0.0024	0.0042	0.0145	$1.0x10^{-5}$	$3.5x10^{-5}$	$1x10^{-6}$
Occupational bystander (shallow shank w/o tarp)	0.00033	0.0042	0.0145	$1.4x10^{-6}$	$4.8x10^{-6}$	$1x10^{-6}$
Occupational bystander (deep shank w/o tarp)	0.00033	0.0042	0.0145	$1.4x10^{-6}$	$4.8x10^{-6}$	$1x10^{-6}$
Occupational bystander (drip with tarp)	0.00033	0.0042	0.0145	$1.4x10^{-6}$	$4.8x10^{-6}$	$1x10^{-6}$

[a] The air unit risk was determined as described in section IV.A.3.c.

[b] Target oncogenic (onco) risk values were set at the generally accepted "negligible oncogenic risk" value of $1x10^{-6}$.

* Original tables from 2015 Risk Characterization Document are found in **Appendix C**.

VI. Conclusions

The revised HECs for occupational seasonal, annual and lifetime 1,3-D exposure scenarios expressed in this memorandum are greater by a factor of 7/5 (*i.e.*, 1.4) than those expressed in DPR's risk characterization document. Consequently, the resultant MOEs are greater by that factor. In addition, the occupational cancer risk values are also slightly lower. These recalculated values should be used in efforts to mitigate human health risks.

VII. References

Stott, W. T., Johnson, K. A., Calhoun, L. L., Weiss, S. K., and Frauson, L. E. 1987. Telone* II Soil Fumigant: 2-year inhalation chronic toxicity-oncogenicity study in mice. (DPR Vol. No. 50046-0029, Record No. 060675).

Stott, W. T., Young, J. T., and Calhoun, L. L. 1984. Telone II soil fumigant: a 13-week inhalation study in rats and mice. (DPR Vol. No. 50046-038, Record No. 71713).

Appendix A

1,3-D: Occupational exposure, portal-of-entry mode – corrected AUR calculation (12.20.16)

```
 ================================================================
        Multistage Model. (Version: 3.4;  Date: 05/02/2014)
        Input Data File: C:/USEPA/BMDS260/Data/msc_Dax_Setting.(d)
        Gnuplot Plotting File:  C:/USEPA/BMDS260/Data/msc_Dax_Setting.plt
                                              Tue Dec 20 15:55:49 2016
 ================================================================

 BMDS_Model_Run
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

   The form of the probability function is:

   P[response] = background + (1-background)*[1-EXP(
                 -beta1*dose^1-beta2*dose^2)]

   The parameter betas are restricted to be positive


   Dependent variable = Effect
   Independent variable = Dose

 Total number of observations = 4
 Total number of records with missing values = 0
 Total number of parameters in model = 3
 Total number of specified parameters = 0
 Degree of polynomial = 2


 Maximum number of iterations = 500
 Relative Function Convergence has been set to: 1e-008
 Parameter Convergence has been set to: 1e-008



                  Default Initial Parameter Values
                     Background =      0.14781
                        Beta(1) =    0.0025275
                        Beta(2) = 3.04982e-006


           Asymptotic Correlation Matrix of Parameter Estimates

             Background      Beta(1)      Beta(2)

Background            1         -0.6         0.47

   Beta(1)         -0.6            1        -0.95

   Beta(2)         0.47        -0.95            1
```

Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
Background	0.151501	0.0422355	0.0687214	0.234281
Beta(1)	0.00198852	0.00289404	-0.00368371	0.00766074
Beta(2)	6.89523e-006	2.08974e-005	-3.4063e-005	4.78534e-005

Analysis of Deviance Table

Model	Log(likelihood)	# Param's	Deviance	Test d.f.	P-value
Full model	-104.36	4			
Fitted model	-105.156	3	1.59138	1	0.2071
Reduced model	-111.888	1	15.0568	3	0.001769

AIC: 216.311

Goodness of Fit

Dose	Est._Prob.	Expected	Observed	Size	Scaled Residual
0.0000	0.1515	7.424	9.000	49.000	0.628
11.8700	0.1721	8.605	6.000	50.000	-0.976
47.4700	0.2398	11.752	13.000	49.000	0.418
142.4200	0.4442	22.210	22.000	50.000	-0.060

Chi^2 = 1.53 d.f. = 1 P-value = 0.2169

Benchmark Dose Computation

Specified effect = 0.1

Risk Type = Extra risk

Confidence level = 0.95

BMD = 45.7323

BMDL = 23.7101

BMDU = 97.7285

Taken together, (23.7101, 97.7285) is a 90 % two-sided confidence interval for the BMD

Cancer Slope Factor = 0.00421761

Appendix B

1,3-D: Occupational exposure, systemic mode – corrected AUR calculation (12.20.16)

```
 ================================================================
        Multistage Model. (Version: 3.4;  Date: 05/02/2014)
        Input Data File: C:/USEPA/BMDS260/Data/msc_Dax_Setting.(d)
        Gnuplot Plotting File:  C:/USEPA/BMDS260/Data/msc_Dax_Setting.plt
                                            Tue Dec 20 15:46:16 2016
 ================================================================

 BMDS_Model_Run
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

   The form of the probability function is:

   P[response] = background + (1-background)*[1-EXP(
                 -beta1*dose^1-beta2*dose^2)]

   The parameter betas are restricted to be positive


   Dependent variable = Effect
   Independent variable = Dose

 Total number of observations = 4
 Total number of records with missing values = 0
 Total number of parameters in model = 3
 Total number of specified parameters = 0
 Degree of polynomial = 2


 Maximum number of iterations = 500
 Relative Function Convergence has been set to: 1e-008
 Parameter Convergence has been set to: 1e-008



                  Default Initial Parameter Values
                     Background =      0.14781
                        Beta(1) =   0.00869438
                        Beta(2) = 3.61032e-005


           Asymptotic Correlation Matrix of Parameter Estimates

             Background      Beta(1)      Beta(2)

Background            1         -0.6         0.47

   Beta(1)         -0.6            1        -0.95

   Beta(2)         0.47        -0.95            1
```

Parameter Estimates

Variable	Estimate	Std. Err.	95.0% Wald Confidence Interval Lower Conf. Limit	Upper Conf. Limit
Background	0.151501	0.0422344	0.0687227	0.234279
Beta(1)	0.00684054	0.00995559	-0.0126721	0.0263531
Beta(2)	8.16041e-005	0.000247303	-0.000403102	0.00056631

Analysis of Deviance Table

Model	Log(likelihood)	# Param's	Deviance	Test d.f.	P-value
Full model	-104.36	4			
Fitted model	-105.155	3	1.59118	1	0.2072
Reduced model	-111.888	1	15.0568	3	0.001769

AIC: 216.311

Goodness of Fit

Dose	Est._Prob.	Expected	Observed	Size	Scaled Residual
0.0000	0.1515	7.424	9.000	49.000	0.628
3.4500	0.1721	8.605	6.000	50.000	-0.976
13.8000	0.2398	11.752	13.000	49.000	0.417
41.4000	0.4442	22.210	22.000	50.000	-0.060

Chi^2 = 1.52 d.f. = 1 P-value = 0.2169

Benchmark Dose Computation

Specified effect = 0.1

Risk Type = Extra risk

Confidence level = 0.95

BMD = 13.2941

BMDL = 6.89233

BMDU = 28.4084

Taken together, (6.89233, 28.4084) is a 90 % two-sided confidence interval for the BMD

Cancer Slope Factor = 0.0145089

Appendix C

Original Tables from 2015 1,3-Dichloropropene Risk Characterization Document *in order of corrections listed in this memo*

See following pages

Table IV.13 1,3-D exposure estimates and resultant MOE values, occupational scenarios: subchronic / seasonal risk

Exposure scenario	Air concentration (ppm)	HEC (ppm)	MOE	Target MOE
Subchronic / seasonal exposures				
Applicator (shallow shank w/o tarp)	0.032	0.90	28	30
Applicator (shallow shank with tarp)	0.10	0.90	9	30
Applicator (deep shank w/o tarp	0.068	0.90	13	30
Applicator (deep shank with tarp)	0.22	0.90	4	30
Applicator (drip w/o tarp)	0.039	0.90	23	30
Applicator (drip with tarp)	0.018	0.90	50	30
Applicator (injection auger)	n/a	0.90	n/a	30
Loader (shallow shank)	0.062	0.90	15	30
Loader (deep shank)	0.13	0.90	7	30
Tarp remover (shallow shank)	3.9	0.90	0..23	30
Tarp remover (deep shank)	8.3	0.90	0.11	30
Tarp remover (drip)	2.6	0.90	0.35	30
Reentry worker (shallow shank)	0.015	0.90	60	30
Reentry worker (deep shank)	0.032	0.90	28	30
Reentry worker (drip)	0.010	0.90	90	30
Occupational bystander (shallow shank w/o tarp)	0.0012	0.90	750	30
Occupational bystander (deep shank w/o tarp)	0.0012	0.90	750	30
Occupational bystander (drip with tarp)	0.0012	0.90	750	30

Table IV.14 1,3-D exposure estimates and resultant MOE values, occupational scenarios: chronic / annual risk

Exposure scenario	Air concentration (ppm)	HEC (ppm)	MOE	Target MOE
Chronic / annual exposures				
Applicator (shallow shank w/o tarp)	0.0096	0.59	61	30
Applicator (shallow shank with tarp)	0.032	0.59	18	30
Applicator (deep shank w/o tarp	0.042	0.59	14	30
Applicator (deep shank with tarp)	0.14	0.59	4	30
Applicator (drip w/o tarp)	0.013	0.59	45	30
Applicator (drip with tarp)	0.0060	0.59	98	30
Applicator (injection auger)	n/a	0.59	n/a	30
Loader (shallow shank)	0.019	0.59	31	30
Loader (deep shank)	0.082	0.59	7	30
Tarp remover (shallow shank)	1.2	0.59	0.49	30
Tarp remover (deep shank)	5.2	0.59	0.11	30
Tarp remover (drip)	0.85	0.59	0.69	30
Reentry worker (shallow shank)	0.0064	0.59	92	30
Reentry worker (deep shank)	0.024	0.59	25	30
Reentry worker (drip)	0.0044	0.59	134	30
Occupational bystander (shallow shank w/o tarp)	0.00062	0.59	952	30
Occupational bystander (deep shank w/o tarp)	0.00062	0.59	952	30
Occupational bystander (drip with tarp)	0.00062	0.59	952	30

Table IV.6 Human equivalent doses and incidence rates used to model the dose responsiveness of 1,3-D-induced bronchioloalveolar adenomas in male mice (Stott *et al.*, 1987)

Portal of entry scenario				
Nominal dose	**RGDR**	**HEC dose (resident-bystander-ambient)**	**HEC dose (occupational)**	**Incidence rate**
0 ppm	3.44	0 ppm	0 ppm	9/49 (18%)
5	3.44	2.83	8.48	6/50 (12%)
20	3.44	11.30	33.91	13/49 (27%)
60	3.44	33.91	101.73	22/50 (44%)
Air unit risk – upper confidence limit (ppm^{-1})		0.018	0.0059	n/a
Systemic scenario				
0 ppm	1	0 ppm	0 ppm	9/49 (18%)
5	1	0.82	2.46	6/50 (12%)
20	1	3.29	9.86	13/49 (27%)
60	1	9.86	29.57	22/50 (44%)
Air unit risk – upper confidence limit (ppm^{-1})		0.062	0.020	n/a

Table IV.15 1,3-D exposure estimates and resultant oncogenic risk values: occupational scenarios assuming both portal of entry and systemic modes of action

		AUR (ppm^{-1}) [a]		Oncogenic risk		
Exposure scenario	**Air conc. (ppm)**	**Portal of entry**	**Systemic**	**Portal of entry**	**Systemic**	**Target onco. risk [b]**
Applicator (shallow shank w/o tarp)	0.0054	0.0059	0.020	$3.2x10^{-5}$	$1.1x10^{-4}$	$1x10^{-6}$
Applicator (shallow shank with tarp)	0.017	0.0059	0.020	$1.0x10^{-4}$	$3.4x10^{-4}$	$1x10^{-6}$
Applicator (deep shank w/o tarp	0.023	0.0059	0.020	$1.4x10^{-4}$	$4.6x10^{-4}$	$1x10^{-6}$
Applicator (deep shank with tarp)	0.072	0.0059	0.020	$4.3x10^{-4}$	$1.4x10^{-3}$	$1x10^{-6}$
Applicator (drip w/o tarp)	0.0070	0.0059	0.020	$4.1x10^{-5}$	$1.4x10^{-4}$	$1x10^{-6}$
Applicator (drip with tarp)	0.0032	0.0059	0.020	$1.9x10^{-5}$	$6.4x10^{-5}$	$1x10^{-6}$
Applicator (injection auger)	n/a	0.0059	0.020	n/a	n/a	$1x10^{-6}$
Loader (shallow shank)	0.0100	0.0059	0.020	$5.9x10^{-4}$	$2.0x10^{-4}$	$1x10^{-6}$
Loader (deep shank)	0.044	0.0059	0.020	$2.6x10^{-4}$	$8.8x10^{-4}$	$1x10^{-6}$
Tarp remover (shallow shank)	0.66	0.0059	0.020	$3.9x10^{-3}$	$1.3x10^{-2}$	$1x10^{-6}$
Tarp remover (deep shank)	2.8	0.0059	0.020	$1.7x10^{-2}$	$5.6x10^{-2}$	$1x10^{-6}$
Tarp remover (drip)	0.46	0.0059	0.020	$2.7x10^{-3}$	$9.2x10^{-3}$	$1x10^{-6}$
Reentry worker (shallow shank)	0.0034	0.0059	0.020	$2.0x10^{-5}$	$6.8x10^{-5}$	$1x10^{-6}$
Reentry worker (deep shank)	0.013	0.0059	0.020	$7.67x10^{-5}$	$2.6x10^{-4}$	$1x10^{-6}$
Reentry worker (drip)	0.0024	0.0059	0.020	$1.4x10^{-5}$	$4.8x10^{-5}$	$1x10^{-6}$
Occupational bystander (shallow shank w/o tarp)	0.00033	0.0059	0.020	$1.9x10^{-6}$	$6.6x10^{-6}$	$1x10^{-6}$
Occupational bystander (deep shank w/o tarp)	0.00033	0.0059	0.020	$1.9x10^{-6}$	$6.6x10^{-6}$	$1x10^{-6}$
Occupational bystander (drip with tarp)	0.00033	0.0059	0.020	$1.9x10^{-6}$	$6.6x10^{-6}$	$1x10^{-6}$

[a] The air unit risk was determined as described in section IV.A.3.c.
[b] Target oncogenic risk values were set at the generally accepted "negligible oncogenic risk" value of $1x10^{-6}$.