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MEMORANDUM

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SUBJECT: TOTAL MASS LOSS ESTIMATES FOR CHLOROPICRIN TOTALLY IMPERMEABLE FILM TARP APPLICATIONS

Current volatile organic compound (VOC) regulations have estimates of Application Method Adjustment Factors (AMAFs) that were derived by California Department of Pesticide Regulation (CDPR) in 2007 from Emission Factors (EFs) for various application method and tarp combinations (Barry et al., 2007). The Chloropicrin Manufacturer's Task Force (CMTF) submitted a document entitled "Analysis of chloropicrin emissions in the San Joaquin Valley in 1990 and 2004." That document presented a set of EFs that offered a refinement of the 100% chloropicrin mass loss assumed previously to calculate VOC contributions from chloropicrin applications. The CMTF document used four studies submitted to CDPR to argue that the EFs were appropriate. Those studies were: Beard et al. (1996; vol 199-072), Gillis and Smith (2002; vol 199-093), Lee et al. (1994: vol 199-079), and Rotondaro (2004; vol 199-112).

The original CMTF proposed EF values, and the CMTF rationale for the EF values for no tarp, Low Density Polyethylene (LDPE), and High Density Polyethylene (HDPE), are shown below (see Barry et al., 2007 for details):

- Shallow Injection (6-15 in.), broadcast, no tarp = 62% emissions (EF=0.62)[1]
- Shallow Injection (6-15 in.), broadcast, LDPE tarp = 62% emissions* (EF=0.62)[2]
- Shallow Injection (6-15 in.), broadcast, HDPE tarp = 37% emissions (EF=0.37)[3]
- Deep injection (20+ in.), broadcast, no tarp = 62% emissions (EF = 0.62)[4]
- Deep injection (20+ in.), broadcast, LDPE tarp = 62% emissions* (EF = 0.62)[4]
- Deep injection (20+ in.), broadcast, HDPE tarp = 37% emissions (EF = 0.37)[4]
- Drip-application, surface or buried, HDPE tarp = 9% emission (EF = 0.09)[5]

[1] Direct from Beard et al. (1996)
[2] No LDPE studies were available. CMTF assumes LDPE mass loss will be the same as untarp.
[3] This mass loss is from: Salinas CA (15%; Lee et al, 1994), Yakima, WA (34%; Beard et al, 1996), Bradenton, FL (37%; Beard et al, 1996), and Phoenix, AZ (63%; Beard et al, 1996).
[4] No studies on the effect of injection depth were available so no reduction was proposed
[5] This mass loss is from buried drip (3%; Gillis and Smith (2002) and surface-drip (15%; Rotondaro, 2004).

Upon review, CDPR rejected Lee at al. (1994) and Gillis and Smith (2002). After final review and analysis, the current CDPR AMAF's were derived from the acceptable EF values in the database. The chloropicrin EF values shown in Table 1 (from Barry et al., 2007).

Table 1. Summary of chloropicrin emission estimates. Table 4 from Barry et al. (2007).

Reference	**Application Method**	**Location**	**Emissions (%)**	**Average (%)**	**CV (%)**
Beard (1996)	Broadcast/No Tarp	Arizona	62.5	64.2	6.0
Beard (1996)	Broadcast/No Tarp	Arizona	61.4		
Beard (1996)	Bed/Tarp	Arizona	68.6		
Beard (1996)	Broadcast/Tarp	Arizona	62.3	44.2	35.6
Beard (1996)	Broadcast/Tarp	Washington	33.8		
Beard (1996)	Broadcast/Tarp	Florida	36.5		
Rotonardo (2004)	Drip/tarp	California	15	11.8	27.2
Knuteson et al. (2000)	Drip/tarp	California	8.6		
van Wesenbeeck and Phillips (2000)	Drip/tarp	Georgia	12.3	12.3	

Based on the emission data shown above and assumptions discussed in Barry et al. (2007), the current chloropicrin AMAF's are:

- Shallow injection w/ high permeability tarp or no tarp-broadcast 64%
- Shallow injection w/ low permeability tarp-broadcast 44%
- Shallow injection w/ high permeability tarp or no tarp-bed 64%
- Shallow injection w/ 3 water treatments 43%
- Shallow injection w/ low permeability tarp-bed 64%
- Deep injection w/ high permeability tarp or no tarp-broadcast 64%
- Deep injection w/ low permeability tarp-broadcast 44%
- Deep injection w/ 3 water treatments 43%
- Drip w/high permeability tarp 12%
- Drip w/low permeability tarp 12%

CDPR now has in the chloropicrin data base mass loss data from 14 Totally Impermeable Film (TIF) tarp applications (Barry, 2013). Two applications included a five day tarp cutting interval but the tarp cutting interval is anticipated to be longer than five days so those two applications were omitted from this analysis. Two applications used the TIF tarp together with potassium thiosulfate amendment. Because the effect of TIF tarp alone couldn't be evaluated these two applications were removed. Data from the remaining ten applications was used to estimate the mean total mass loss from applications made by various combinations of application type and tarp type (Table 2). MINITAB (2010) statistical software was used for data summaries. The mean total mass loss for each group can be used as the AMAF value for that group.

Table 2. Summary of the total mass loss (%) for TIF tarps in the chloropicrin database. See Barry (2013) for full details. (n = sample size).

Application Type	**TIF Tarp**	
Bed	Mean	3.0
	Median	3.0
	n	2
Broadcast	Mean	8.7
	Median	8.6
	n	4
Broadcast/Deep	Mean	9.4
	Median	9.4
	n	1
Strip/Deep	Mean	17.9
	Median	17.9
	n	1
Symmetry	Mean	1.6
	Median	1.6
	n	1
Drip	Mean	3.0
	Median	3.0
	n	1
All	Mean	7.3
	Median	4.1
	n	10

References

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