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SUBJECT: CALCULATION OF USE ADJUSTMENT FACTORS FOR 1,3-DICHLOROPROPENE WITH THE USE OF TOTALLY IMPERMEABLE FILM FOR BROADCAST SHANK APPLICATIONS

Chronic exposure to 1,3-Dichloropropene (1,3-D) is currently mitigated by restricting yearly township use. This model is predicated on the idea that long term concentrations are proportional to long term amounts of use or specifically levels of use density. This use restriction is called a township cap. The original restriction was determined by the Department of Pesticide Regulation (DPR) to be 9500 gallons of Telone II per year where all use was assumed to be deep shank. A deep shank study conducted in Salinas was the basis for quantifying volatilization (Knuteson et al. 1992). A variety of use-factors were developed starting in the mid-1990s to adjust the pounds of 1,3-D applied in order to reflect application methods which produce greater volatilization than the volatilization measured in the original Salinas study. Factors were also developed which attempted to account for meteorological impacts on air concentrations though these meteorological adjustment factors were only weakly supported. The factors are multiplied by the actual use pounds to calculate adjusted use pounds. It is these ‘adjusted’ use pounds of 1,3-D that are used to compare to any township restriction.

The use of Totally Impermeable Film (TIF) for field covering when 1,3-D is applied appears to significantly reduce volatilization for broadcast applications when the tarp remains in place for ten days. It is the purpose of this memorandum to develop 1,3-D adjustments factors for the use of TIF. I have reviewed much of the earlier documentation concerning development of use adjustment factors and have attempted in this memorandum to incorporate a set of use adjustment factors appropriate for the use of TIF which (1) reflect the lowered volatilization resulting from the use of TIF and (2) are consistent with the existing set of use adjustment factors.

The existing and proposed use adjustment factors are shown in Table 1. The right half of Table 1 shows the cumulative volatilization percentages which correspond to the factors on the left side. For example, the 1.0 factor corresponds to 35% volatilization. The 35% volatilization fraction requires some explanation. The prototype study was a deep shank injection (18 inches) conducted in Salinas in fall (Knuteson et al. 1992). A later study utilized a deep shank, bedded application technique conducted in spring (Knuteson et al. 1995). The fractions volatilized were 0.25 and 0.26, respectively and were considered to represent deep shank applications. These studies were conducted during relatively cooler seasons. For that reason, a summer time factor of 0.40 was assumed and was combined with 0.25 using a use-weighted average of two-thirds summer and one-third nonsummer applications (Calhoun et al. 1994, Johnson 1995, Houtman and Weinberg 1997). This resulted in a year-wide base estimate of 0.35 fraction volatilized for the deep shank application method.

In the original reintroduction conditions, all 1,3-D applications were at a depth of 18 inches. Subsequently, a study of shallower applications was initiated, but before that study was completed, Dow proposed a linear interpolation method to estimate the volatilization which would result from shallower applications. I discussed this method with Jim Knuteson of Dow and felt that it was reasonably conservative (Johnson 1996). The linear interpolation method assumed 100% volatilization at the surface and 40% volatilization at an 18 inch depth. This method estimated 66.5% volatilization from a 12 inch depth. The ratio between 66.5 and 35.0 is 1.9 and is the basis for the 1.9 factor for February through November shallow shank applications. Subsequently, two shallow studies (Gillis and Dowling 1998) measured 65% volatilization of 1,3-D at 12 and 14 inch depths.

Unfortunately, the January and December factors both within and outside the San Joaquin Valley (SJV) are not as clearly documented. The factor of 1.2 for January or December applications outside of the SJV is more difficult to verify. One possibility is the factor derived from simulation work conducted by Dow which determined that if 20% of deep applications occurred in January and December in the SJV, then the township allowance must be decreased by 20% (multiplied by 0.78) in order to achieve the 'benchmark' concentration (Houtman and Weinberg 1997). Or it may be related to modeling calculations that I did comparing January and December concentration distributions to February through November concentration distributions for a selected township in Kern County. This comparison indicated approximately 20% greater concentration at the 95th percentile for January and December compared to February through November concentrations. There were discussions at this time about the possibility that January and December air concentrations may be higher than other times of year both due to model specific mechanisms (greater F stability) and possibly to other mechanisms which the ISC model may not be taking into account (mixing height, fog, regional stability) (Johnson 1995b, 1998, Houtman and Weinberg 1997).

It is unclear to me how the 1.9 factor for December and January deep applications within SJV originated. Possibly this was a decision made by DPR management. The original Dow modeling upon which allowing December and January applications utilized only 10% of the applied mass in December and 10% in January (Houtman and Weinberg 1997). For this reason I recommended permit conditions which reflected that constraint (Johnson 1998). From the record, it is clear that there was concern both on my part and on the part of Dow personnel that January and December applications might result in greater concentrations than applications at other times of the year. In this light, the 1.9 factor for 18 inches or deeper applications in the SJV can be viewed as a factor designed to discourage such applications, more than an accurate reflection of meteorological enhancement of air concentrations. The shallow December and January factor for areas outside SJV probably was the product of 1.2 and 1.9.

The use of TIF in a broadcast tarp application resulted in cumulative emissions of about 10.5% when the holding period was 10 days (Ajwa and Sullivan 2012, Johnson 2012). For shorter holding periods, there is variability in volatilization fractions and appears to be no systematic way to characterize the result. Therefore, I recommend treating shorter holding periods as defaulting to the upper part of Table 1, representing the current use adjustment factors. For ten day holding periods with broadcast TIF, I propose the lower half of Table 1. In this case, the February through November deep or shallow applications receive a factor of 0.3, based on 0.105/0.35=0.3. Spurlock et al. (2013) found no improvement in matching Hydrus 2D/3D to flux and soil concentrations by using temperature dependency for the TIF. Therefore, I have ignored possible seasonal temperature effects on the TIF. The January and December factors are double the February through November factors, analogous to the 1.9 deep factor for SJV in January and December in trying to account for meteorological effects which may increase air concentrations.

In addition, I believe that the permit conditions should include a restriction that the total number of adjusted pounds of 1,3-D applied in each of January and December per township. The purpose of such a restriction would be to avoid greater use in those months prone to stable conditions in order to take advantage of the reduced use adjustment factor for TIF. For example, if all applications in the high use townships utilize TIF from February through November, then 90250/0.3=300833 pounds (lbs) could theoretically be used in that township during the February through November time period. Because of the reduced emissions, the air concentrations would be expected to be comparable to 90250 pounds applied at 18 inch depth. If, say, half of the mass of 300833 lbs is applied during Feb-Nov, then the adjusted pounds contributing to the township cap would be 45,125 adjusted pounds (=0.5*300833*0.3). Half of the adjusted pound limit (45,125 lbs) would be leftover for application in December. With use of the TIF this amounts to 75, 212 actual (unadjusted) lbs which could be applied in December (=45,125/0.6). This would represent approximately one-third of the total yearly mass being applied in December (=75212/[75212+150417]), which I believe is undesirable, even with the TIF. The reason for being cautious in December and January is the possibility of enhanced air concentrations due to stable meteorological conditions during that time period. There is some evidence for these concerns in the recent monitoring study conducted in Merced, which is still being evaluated (Rotondaro and Wesenbeeck 2012). Rotondaro and Wesenbeeck (2012) document higher concentrations during December. These concentrations exceed predictions by the SOFEA model (Wesenbeeck, 2013). It is somewhat arbitrary to pick a restrictive amount for each of December and January. A 10% restriction would mean 9025 adjusted pounds in each of January and

December. This is equivalent to 15,042 unadjusted pounds with the use of TIF each month, or at 9 lbs of 1,3-D per gallon of Telone II, 1671 gallons of Telone II per township per month. At 12 gallons per acre, this is equivalent to 139 acres per township per month. At this time, we do not have a quantitative tool to determine a December and January use restriction that would make sense with respect to the meteorological conditions.

The original intent of the use adjustment and township cap approach was to account for differences in cumulative flux densities between different application methods (deep versus shallow, shank versus drip). However, historically these adjustment factors came to be used to adjust for higher concentrations due to winter meteorological conditions. The adjustments for meteorological conditions are not as well founded as the adjustments for cumulative flux. When the ambient air monitoring study from Merced (Rotondaro and Wesenbeeck 2012) has been completed and reviewed, perhaps we will be able to formulate a method for estimating a restriction that accounts for higher concentrations in December and January.

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Table 1. Proposed 1,3-D use adjustment factors incorporating use of totally impermeable film (TIF) adjustment factors. SJV=San Joaquin Valley

Existing Shank Application 1,3-D township cap adjustment factors												
							Expressed as percent offgass, base is 35%					
	Jan or Dec			Feb-Nov				Jan or Dec			Feb-Nov	
	Deep	Shallow		Deep	Shallow			Deep	Shallow		Deep	Shallow
In SJV	1.9*	Prohibited		1.0	1.9		In SJV	66.5	Prohibited		35.0	66.5
Outside SJV	1.2	2.3		1.0	1.9		Outside SJV	42.0	80.5		35.0	66.5
Broadcast Tarp TIF adjustment factors												
	Jan or Dec			Feb-Nov				Jan or Dec			Feb-Nov	
	Deep	Shallow		Deep	Shallow			Deep	Shallow		Deep	Shallow
In SJV	0.6*	0.6*		0.3	0.3		In SJV	21.0	21.0		10.5	10.5
Outside SJV	0.6	0.6		0.3	0.3		Outside SJV	21.0	21.0		10.5	10.5
*May consider Dec/Jan use restriction.												