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Descripton Notes	Includes notes and calculations on various exposure scenarios. Items were filed in one folder labeled "Exposure Calculations"

ACGIH 8-hr TWA TLV for
2,4-D or 2,4,5-T

10 mg/m^3

If 2,4,5-T now has TCDD @
0.1 mg/Kg then the implied
std is

$$\frac{10\,mg\ 2,4,5\text{-}T}{m^3} \times \frac{0.1\,mg\,TCDD}{Kg\ 2,4,5\text{-}T} \times \frac{Kg}{10^6\,mg}$$

$$= 1 \times 10^{-6} \frac{mg\ TCDD}{m^3} = \frac{1\,ng\ TCDD}{m^3}$$

$$\frac{1\,ng\ TCDD}{m^3} \times \frac{1.8\,m^3}{hr} \times \frac{8\,hr}{day} = \frac{14.4\,ng}{day}$$

$$\frac{14.4\,ng}{day} \times \frac{man}{70\,Kg} = 0.21\,\frac{ng}{Kg}$$

Respiration rate for Average Man at work

{ 30 resp/min
500 ml/resp. }

$$\therefore \frac{30\ \text{resp}}{\text{min}} \times \frac{500\ \text{ml}}{\text{resp}} \times \frac{\text{m}^3}{10^6\ \text{ml}} \times \frac{60\ \text{min}}{\text{hr}} \times \frac{8\ \text{hr}}{\text{day}}$$

$$= 7.2\ \text{m}^3/\text{day}$$

Assume average man is 72 Kg

No TCDD was detected in air samples (See Ch 2)

Taking worst case of minimum detectable concentration (MDC) of ≤ 36 ng/m³ and assuming levels of TCDD were just equal to this MDC

$$\frac{36\ ng}{m^3} \times \frac{7.2\ m^3}{8\text{-hr Day}} = \frac{259.2\ ng\ TCDD}{8\text{-hr Day}}$$

Assume man is 72 Kg

$$\frac{259.2\ ng\ TCDD}{8\text{-hr Day}} \times \frac{Man}{72\ Kg\ Man} = \frac{3.6\ ng\ TCDD}{Kg \cdot Day}$$

Use worst case of 2,4,5-T noted at NCBC along with worst case of TCDD in 2,4,5-T as 94 mg TCDD/Kg 2,4,5-T, also use mean TCDD in 2,4,5-T as ~~4~~ mg/Kg

Worst Case: 79.62 ug 2,4,5-T/m^3 @ NCBC

$$\frac{79.62\ \text{ug}\ 2,4,5\text{-T}}{m^3} \times \frac{94\ \text{mg TCDD}}{\text{Kg}\ 2,4,5\text{-T}} \times \frac{\text{Kg}}{10^9\ \text{ug}}$$

$$= 7.48 \times 10^{-6}\ \frac{\text{mg TCDD}}{m^3}$$

$$= 7.48\ \frac{\text{ng TCDD}}{m^3}$$

Assuming unprotected worker respiring 30x/min @ 500 ml/resp = 7.2 m^3/day

∴ Total inhaled =

$$7.48\ \frac{\text{ng TCDD}}{m^3} \times \frac{7.2\ m^3}{\text{day}} \times \frac{\text{man}}{72\ \text{Kg}} = 0.748\ \frac{\text{ng}}{\text{Kg}\cdot\text{Day}}$$

∴ This is $<$ $\frac{1.0\ \text{ng}}{\text{Kg}\cdot\text{Day}}$

Using: 4 mg TCDD / Kg 2,4,5-T

high Mean 32.39 $\frac{ug\ 2,4,5\text{-}T}{m^3}$

StD Dev 21.02

95% Mean + 2 SD = 74.5 $\frac{ug}{m^3}$

HO — 32 $\frac{mg}{Kg}$ T

Inhalation exposures Direct Exposure to spray (Using RPAR approach)

(1) $\frac{0.067\ mg/m^3}{0.46\ \#/A} \times \frac{12\ \#\ 2,4,5\text{-}T}{A} = 1.748\ mg/m^3$

(2) Respirable fraction "worst case" is 1/6 (see RPAR) - 60μ size -

$(1.748\ mg/m^3)(1/6) = 0.291\ mg/m^3$

(3) at a respiration rate of $1.8\ m^3/hr$ and a duration of exposure of 2 hrs.

the total absorbed (assuming 100% absorption of all inhaled) would be

$\frac{0.291\ mg}{m^3} \times \frac{1.8\ m^3}{hr} \times \frac{2\ hr}{day} = 1.0476$ mg/day

④ Assume ~~4~~ cases

1) TCDD mean conc Purple max 94 mg/Kg
2) " " " " Mean 32 mg/Kg
3) " " " HO Max 14 mg/Kg
4 " " " " Mean 2 mg/Kg

then the TCDD exposures would be,

1) $\frac{1.0476 \text{ mg } 2,4,5\text{-T}}{\text{day}} \times \frac{94 \text{ ng TCDD}}{\text{mg } 2,4,5\text{-T}} = \frac{98.47 \text{ ng}}{\text{day}}$

2) " × 32 " = 33.52 "

3) " × 14 = 14.67 "

4) × 4 4.095 " (190)

⑤ Assuming a 70 Kg man the inhaled dose would be

2,4,5-T $1.0476 \frac{\text{mg}}{\text{day}} \times \frac{1}{70 \text{ Kg}} = \frac{15 \text{ ug } 2,4,5\text{-T}}{\text{Day Kg}}$

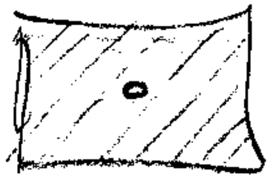
		(ug/Kg·Day)	
	0.012	0.0025	0.0007
	100% penet.	79% penet	6% penet
⑥ TCDD	Dermal +	Inhal	—

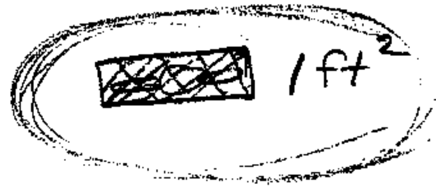
Case	TCDD (mg/Kg·Day)			
1	1.407	13.41	3.91	2.11
2	0.479	12.48	2.98	1.18
3	0.209	12.21	2.71	0.91
4	0.030	12.03	2.53	0.73

These calculations do not take into account the degradation that would occur in TCDD during application.

% dermal dose to Total

Case		Penetration —	100% P	79% P	6% P
1	Purple	94	89	64	33
2	"	32	96	84	59
3	HO	14	98	92	77
4	"	2	99	99	96





2

$$\frac{3.556 \text{ mg M}}{0.46 \text{ \# M}}$$

0.76 gal/Acre

$$\frac{(3.556 \text{ mg M})(0.76 \text{ gal } H_2O/A)}{0.46 \text{ \# M}} \times \frac{4 \text{ \# T}}{10 \text{ gal } H_2O/A}$$ RPAR

2.35 mg T

$$\frac{3.556 \text{ mg M } (0.76 \text{ gal } H_2O/A)}{0.46 \text{ \# M}} \times \frac{4 \text{ \# T}}{\text{gal } HO}$$ RUN

(23.5 mg T)

$$\frac{\frac{0.46 \text{ \# M}}{A} \times \frac{454 \text{ g}}{\text{\#}} \times \frac{1000 \text{ mg}}{\text{g}}}{43{,}560 \text{ ft}^2/A}$$ $4.8 \frac{\text{mg M}}{\text{ft}^2}$

i.e.,

A

Caplan et al. (167 in RPAR) working with aerially applied malathion in oil sprays applied at 0.46 pounds per 0.76 gallons water/acre, determined a dermal exposure to persons directly beneath the spray plane for bare skin (head, neck, shoulders, forearms, hands and thighs) of 3.556 mg malathion/day. Using these data, an equivalent dermal exposure for 2,4,5-T and TCDD, aerially applied at 12 pounds acid equivalent 2,4,5-T per 3 gallons of Herbicide Orange / acre can be determined

B

The following calculations will give the ~~daily~~ worst-case daily dermal exposure for 2,4,5-T and TCDD:

c)

1) $\frac{3,556 \text{ mg Mala}}{0.46 \#} \times 12 \# = \underline{92.8 \text{ mg } 2,4,5\text{-T}}$

2) With a TCDD worst case of 94 mg TCDD/Kg 2,4,5-T, the TCDD dermal exposure rate per day would be

$$92.8 \text{ mg } 2,4,5\text{-T} \times \frac{94 \text{ mg TCDD}}{\text{Kg } 2,4,5\text{-T}} \times \frac{\text{Kg}}{10^6 \text{ mg}}$$

$$= 8.72 \times 10^{-3} \text{ mg} = 8.72 \text{ ug TCDD}$$

3) Assuming 10% of materal is absorbed

2,4,5-T dermal exposure = 9.28 mg

TCDD dermal exposure = 0.87 ug

4) For 70 Kg man (w/o canopy cover)

(a) 2,4,5-T dermal dose rate = 0.133 mg/Kg

TCDD " " " = 0.012 ug/Kg

D)

See Ch 1

5) Assuming canopy penetration rate is 21%, the dermal dose rates are

(b) 2,4,5-T 0.0279 mg/Kg
TCDD 0.0025 ug/Kg

6) Assuming canopy penetration rate is 6%, the dermal dose rates are

(c) 2,4,5-T 0.0080 mg/Kg
TCDD 0.0007 ug/Kg

e)

1.8 m³/hr

Inhalation Exposure Aerial Application

$\frac{0.067 \text{ mg/m}^3}{.46 \#} \times 12 = 1.748 \text{ mg}$

$1.748 \times \frac{1}{6} = 0.291 \text{ mg/m}^3$

Resp Rate = 7.2 m³/day = 0.9 m³/hr

$\frac{.291 \text{ mg}}{\text{m}^3} \times \frac{0.9 \text{ m}^3}{\text{hr}} \times \frac{8 \text{ hr}}{\text{day}} = 2.09 \frac{\text{mg}}{\text{day}}$

~~$\frac{0.524 \text{ mg}}{2 \text{ hr}} \times \frac{8 \text{ hr}}{8 \text{ hr}}$~~

2,4,5-T $= \frac{2.09 \text{ mg}}{\text{day } 70 \text{ Kg}} = 0.029 \frac{\text{mg}}{\text{Kg} \cdot \text{Day}}$

Assuming 94 mg TCDD /Kg 2,4,5-T (ug/g) = (mg/mg)

$\frac{0.029 \text{ mg } 2,4,5\text{-T}}{\text{Kg-Day}} \times \frac{94 \text{ mg TCDD}}{\text{mg } 2,4,5\text{-T}} = 2.814 \frac{\text{mg}}{\text{Kg} \cdot \text{Day}}$

F

But Canopy penetration ~ 21%

2,4,5-T exposure

(.029 mg)(.21) = 6.09 µg / Kg Day

TCDD exposure

$\frac{2.814 \text{ mg}}{\text{Kg Day}}$ (.21) = 0.59 mg/Kg·Day

Cumulative exposure =

	2,4,5-T	TCDD
Skin =	27.9 µg /Kg	2.5 mg
+ Inhal =	6.09 µg/Kg	0.59 mg/Kg
	33.99 µg/Kg	3.09 mg/Kg
PEL	20 mg/Kg	30 mg/Kg

HP

Worst case

Herb. Purple $\bar{c}$ TCDD = 47 mg/Kg
10% skin absorption
100% canopy penetration
70 Kg man
1/6 respirable fraction 60 μ size
1.8 m³/h respiration rate, 100% abs.
2-hr exposure

Dermal Exposure

From RPAR

— $\frac{3.556 \text{ mg Malathion}}{0.46 \text{ \# Applied (malathion)}} \times 12\text{\# } 2,4,5\text{-T}$

= 93 mg 2,4,5-T

— 10% skin absorption = 9.3 mg 2,4,5-T

— TCDD
$9.3 \text{ mg } 2,4,5\text{T} \times \frac{94 \text{ mg TCDD}}{\text{Kg } 2,4,5\text{-T}} \times \frac{\text{Kg}}{10^6 \text{ mg}}$

= 0.87 μg TCDD

HP

Inhalation + Dermal Exposure

2,4,5-T

Inhal	1.05 mg
Dermal	9.3 mg
	10.35 mg

For 70 Kg man

$$\frac{10.35 \text{ mg T}}{70 \text{ Kg}} = 0.148 \frac{\text{mg T}}{\text{Kg}}$$

TCDD

Inhal	0.098 ug
Dermal	0.87 ug
	0.968

For 70 Kg man

$$\frac{0.968 \text{ ug TCDD}}{70 \text{ Kg}} = 0.014 \frac{\text{ug TCDD}}{\text{Kg}}$$

HP

Inhalation Exposure

From RPAR

$$\frac{0.067\,mg/m^3}{0.46\#} \times 12 = 1.75\,mg/m^3$$

Respirable fraction "worst case"

$$(1.75\,mg/m^3)\left(\frac{1}{6}\right) = 0.29\,mg/m^3$$

@ $1.8\,m^3/h$

$$\frac{0.29\,mg}{m^3} \times \frac{1.8\,m^3}{day} \times 2\,hr = 1.05\,\frac{mg}{day}$$

TCDD @ 94 mg TCDD/Kg 2,4,5-T

$$\frac{1.05\,mg\,T}{day} \times \frac{94\,mg\,TCDD}{Kg\,T} \times \frac{Kg}{10^6\,mg}$$

$$= 9.87 \times 10^{-5}\,mg\ TCDD$$

$$9.87 \times 10^{-2}\,\mu g$$

HP

Average Case for HP

TCDD = 32 mg TCDD/Kg T
10% skin abs
100% canopy penet.

2,4,5-T Same

Dermal	9.3 mg
Inhal	1.05 mg
	10.35 mg

For 70 Kg man $\frac{0.148 \text{ mg T}}{\text{Kg}}$

TCDD

Dermal $9.3 \text{ mg T} \times 32 \frac{\text{mg TCDD}}{\text{Kg T}} \times \frac{\text{Kg}}{10^6 \text{ mg}}$

$= 0.29\ \mu g \text{ TCDD}$

Inhal $1.05 \text{ mg T} \times \frac{32 \text{ mg TCDD}}{\text{Kg T}} \times \frac{\text{Kg}}{10^6 \text{ mg}}$

$= 3.36 \times 10^{-5}$
$= 3.36 \times 10^{-2}\ \mu g$

HP

Inhal + Dermal Expo:

2,4,5-T

$$\frac{10.35}{70} = 0.148 \frac{mg\ T}{Kg}$$

TCDD

Dermal 0.29 ug
Inhal 0.03
0.32 ug

$$\frac{0.32}{70} = 0.004 \frac{ug\ TCDD}{Kg}$$

HO

Worst Case for HO

TCDD = 14 mg TCDD / Kg T

2,4,5-T Same

$0.148 \frac{mg\,T}{Kg}$

TCDD

~~$0.148 \frac{mg\,T}{Kg} \times 14\ mg\ TCDD$~~

Dermal $9.3\ mg\,T \times \frac{14\ mg\,TCDD}{Kg} \times \frac{Kg}{10^6\ mg}$

$= 0.13\ \mu g$ TCDD

Inhal $1.05 \times \frac{14}{10^6} =$

1.47×10^{-5} mg

1.47×10^{-2} µg

HO

Inhal + Dermal

2,4,5-T

$$\frac{0.148 \text{ mg T}}{\text{Kg}}$$

TCDD

Dermal 0.13 Ug

Inhal 0.01

0.14 Ug TCDD

$$\frac{0.14 \text{ Ug TCDD}}{\text{Kg}}$$

* Gas Chromatographic estimate

	TCDD	DDT
Vapor Pressure	1×10^{-7} *	2×10^{-7}
Water Sol.	0.2 ppb	1.2 ppb
K_{oc}	(~200,000)	240,000
Octanol/water	1.4×10^{6}	1.6×10^{6}

Migration Tendency Soil Movement

Partitioning

WATER ⇄ Solids

Chemical	Koc
Dicamba	0
1,3-D	26
EDB -2,4,5-T	
Monuron	

WATER ⇄ Air at equilibrium

1,3-D	18
TCDD	115
DDT	130

Soil Volatility

Air ⇄ Water ⇄ Soil

TCDD = 9×10^{-5}

Physical and Chemical

Pertinent ^ Chemical Factors Affecting Exposure to Herbicide Orange AND Dioxin (TCDD)

1. WATER INSOLUBLE formulation (specific gravity = 1.28)
2. Concentrated Formulation (~~8.1~~ 8.6 lb ai/gal)
 LIQUID at Room Temperature, Oily consistency
3. VAPOR PRESSURE ~ 3.6×10^{-4} mm Hg
 at droplet surface 0.01263 dynes/cm²
4. Noncorrosive to metal. Deleterious to paints, rubber and neoprene
5. Viscous (43 at 23°C)
6. Long Shelve life

freezing point = 8°C

Flash point 46°C

These factors influence ① performance in application equipment ② interaction of the spray with the target ③ and final fate in the environment.

Pressure = dynes/cm²; $P = \frac{2T}{r}$

where T = dynes/cm

r = radius of drop

Ave = 350 micrometer

Viscosity of aerosol 0.0185 centipoise

Surface tension = –

Chloroform = 27.14 dynes/cm

Water = 73 dynes/cm

Butanol = 25 dynes/cm

Environment
Nash/Beall

15ppm formulation

TCDD on grass 1.83ppb Day 1 (10 Am)

Sunlight

↓

0.5 ppb 6 Hr (4 PM)

1800CT41
after 2,4-D/silvex

0.041 Day 2 (10 AM)

0.26 (86% degraded in 2 days) (4 PM)

7.5 ppm TCDD in Silvex

2,800 ppt Day 0
~~32~~ ppt Day 24

T½ = 4 days

micro ecosystem

LT Wilkinson

Reese

BS.
Chemistry

Dissemination

PARTICLE SIZE

Size	Percent
less than 100 μ	1.9
100 to 500 μ	76.2
greater than > 500	21.9

Rate of Fall 1 min (2.5 ft/sec) 150 feet. (~ 350 μ particle

30 min 200 μ — 25% collected as vapor 250 ft downwind

Typically — multicanopy forest

of 1000 gallons disseminated - on 346 acres
— 940 deposited on canopy
60 " at ground level

(94% intercepted)

actual ground level deposition
0.17 gal/A or 1.6 lbs 2,4-D/2,4,5-T per acre.

Aircraft Delivery   A/A 45Y-1   C-123

130 KIAS
150 ft altitude
Droplet size 100 μ to 500 μ
Swath 260 ft

1 cm = 10 mm = 1000 μ

average drop = 350 μ / 2 = 175 μ
1 cm = 1,000 μ

$$\frac{0.01263 \text{ dynes}}{cm^2} = \frac{2(T)}{0.0175 \text{ cm}}$$

$$\frac{(0.01263)(0.0175)}{2} = T$$

$$= T$$

$$\frac{0.000221}{2}$$

$$.000111 = T$$

1.1×10^{-4}

$2^3 = 8$ 1 ft = 30.48 cm

Average man = 70 Kg wt.
6' = 182.9 cm Height

Body Surface area =

$(W)^{0.425} \times (H)^{0.725} \times (0.07184)$

$(70)^{0.425} \times (183)^{0.725} \times (0.07184)$

$(6.08) \times 43.68 \times .07184$

$= 19.08\ m^2$

$1.5 - 2.0\ m^2$ for Fig 661

$30°C = 86°F$

Vapor Pressure at 20°C

NBE 2,4-D = ~~4.3 X 10^-5~~ 1.2×10^{-4}

NBE 2,4,5-T = 0.15×10^{-4}

Orangee - ~~30~~°C = 3.6×10^{-4} mm Hg.

at 30°C (D = 3.1×10^{-4}

T = 0.45×10^{-4}

3.55×10^{-4}

Days	T½
10	D
40	T
300	TCDD

20°C = 1×10^{-7} TCDD

= Orange =

T_0 = #1

T =

350 µ particle size

2-3 ft sec

150 ft 1 min

Viscosity - all fluids possess a definite resistance to change of form. This property, a sort of internal friction is called viscosity; it is expressed in

dyne-seconds/cm^2

usual units = centipoise

at 20 C	Chloroform	0.6
	water	1
	Butanol	3
	Orange	40
	Light Machine oil	40

gas - 100°C

Chloroform = 129 μp
Butanol = 140
Water = 125

at 20 C

Vapor Pressure - Mercury 0.0012 (1.2×10^{-3})
Water = 17.54 mm
#2 Diesel oil = 22 mm
3.6×10^{-4} mm

pressure exerted when liquid is in equilibrium with its own vapor

(1)

350 μ — 0.6 μl / 7 mm² 7

70 Kg man
180 cm = ht
Area 1.9 m² = 1.9 × 10⁶ mm²

$$\frac{0.6\,\mu l\ HO}{7\,mm^2} \times \frac{1.9 \times 10^6\,mm^2}{man} =$$

$= 1.63 \times 10^5\,\mu l\ HO$ on a nude man

= 0.16 l HO

.016 7.7 gms 2,4,-

~ 0.08 l T
+ 0.08 l D

Calculate TCDD using [TCDD] = 2 mg/Kg

$$2\ \frac{mg\ TCDD}{Kg\ HO} \times \frac{10.7\#}{gal} \times \frac{Kg}{2.2\#} \times \frac{gal}{3.785\,l} \times$$

$$= \frac{2.57\ mg\ TCDD}{l\ HO}$$

Worst Case – Nude

$$0.16\,l\ HO \times \frac{2.57\,mg}{l\ HO} = 0.41\,mg\ TCDD$$

For 70 Kg man
- this represents dose of

$$\frac{0.41 \text{ mg TCDD}}{70 \text{ Kg}} \times =$$

$$5.87 \times 10^{-3} \frac{\text{mg}}{\text{Kg}} = 6.0 \frac{\text{ug}}{\text{Kg}}$$

Assume absorption @ 2%

$$\frac{1 \text{ ng}}{\text{Kg}}$$

$$\boxed{\frac{120 \text{ ng}}{\text{Kg} \cdot \text{Day}}}$$

which is 12.0 X PEL

(3)

Put clothing on him such that exposed skin is only 10% of Total

∴ on skin is

$0.41 \text{ mg TCDD} \times 0.1$

$= 0.041 \text{ mg}$

$\frac{0.041}{70} = 5.87 \times 10^{-4} \text{ mg/Kg}$

$\sim 0.6 \text{ ug/Kg}$

assume 2% absorpt

$600 \frac{\text{mg}}{\text{Kg}} \times .02 = 12 \frac{\text{mg}}{\text{Kg}}$

mean deposition → 3 gal H_2O / acre

$\frac{3.556 \text{ mg Mal}}{0.46 \text{ \# : Acre}}$ — $\frac{X \text{ mg 2,4,5-T}}{12\text{\# Acre 2,4,5-T}}$

$X = \frac{(3.6)(12)}{.46}$ ✓ $\frac{93 \text{ mg 2,4,5-T}}{\text{\#}}$

assume 10% absor

9.3 mg 2,4,5-T

Dose would be

$\frac{9.3}{70}$ $\frac{0.13 \text{ mg T}}{Kg}$

Worst case
for TCDD is 94 $\frac{\text{mg TCDD}}{Kg\ T}$

$\frac{0.13 \text{ mg T}}{Kg \text{ Man}} \times \frac{94 \text{ mg TCDD}}{Kg\ T} \times \frac{Kg}{10^6 \text{ mg}}$

$= 1.25 \times 10^{-5}$ mg

1.25×10^{-2} ug

= ~~ng~~ $12.5 \frac{ng}{Kg \cdot Day}$

range of deposit
was $\frac{1 \text{ gal HO}}{A}$ →

from Tuckerly's data
worst case (Ch 1)
@ 1-31
use 21% penetration

∴

Using RPAR approach:

HO applic rate

$\frac{4\ \#}{10\ gal}$

10 gal

assume $\frac{40\ \#\ ac\ 2,4,5T}{10\ gal\ HO}$

assume. 10% of

We applied $\frac{12\ \#\ T}{acre}$

Calculations of TCDD exposures

Assumptions:

Concentration of TCDD in HO -

Mean of 2.0 mg/Kg

Concentration of TCDD in 2,4,5-T

Mean of 4.0 mg TCDD/Kg 2,4,5-T

According to Ramsey, Lavy & Braun worker exposure to 2,4,5-T as MIXER in a 10 hour period is:

$$\frac{0.13 \text{ mg } 2,4,5\text{-T}}{(\text{Kg B.W})(10 \text{ hours})}$$

$$\frac{0.13 \text{ mg T}}{\text{Kg BW } 10\text{hrs}} \times \frac{4 \text{ Ng TCDD}}{\text{mg T}} = \frac{.052 \text{ Ng TCDD}}{\text{Kg BW} \cdot \text{Hour}}$$

	Hours	TCDD Exposure (Ng/Kg)
Thalken	1056	54.9
Tremblay	1046	54.4
Young	6608	343.6

Assuming 10% of B.W. is fat
& 10% of Exposure dose is deposited

$$\frac{54.9 \text{ Ng TCDD}}{\text{Kg BW}} \times \frac{.1 \text{ BW}}{\text{BF}} \times \frac{\text{Deposited}}{.1 \text{ Exp}}$$

$$= 54.9 \text{ Ng TCDD / Kg B.F.}$$

i.e. ~55 ppt Thalken
55 " Tremblay
344 " Young

95% Conf. Limits $\quad s = 0.046$

$n = 8 \quad v = N-1 = 7$

95% Upper limit $\quad z_c = 1.90$

90 " " $\quad z_c = 1.42$

$$\bar{x} = z_c\, s/(\sqrt{N-1})$$

$$95\% = \bar{x} + \frac{(1.9)(.046)}{\sqrt{7}} \qquad \overline{2.645}$$

$$\bar{x} + 0.033$$

$$0.073 + 0.033 = 0.106$$

$$90\% \quad \bar{x} + \frac{1.42\,(.046)}{\sqrt{7}} = \overline{2.6457}$$

$$\bar{x} + 0.024 \qquad = .097$$

at a conc of 4 Ng TCDD / mg 2,4,5-T

$$\frac{0.2 \text{ mg } 2,4,5\text{-T}}{\text{Kg BW} \cdot \text{Hour}} \times \frac{4 \text{ Ng TCDD}}{\text{mg}} = \frac{0.8 \text{ Ng TCDD}}{\text{Kg BW} \cdot \text{hour}}$$

		(Ng TCDD/Kg BW)
Thalken	1056 hrs	844
Tremblay	1046	837
Young	6608	5,286

Assuming 10% of B.W. is fat
& 10% of exp. dose is
deposited

Thalken	844 ppt
Tremblay	837 "
Young	5,286 "

Job ~~Mixer~~	Max 2,4,5-T Dose (mg/Kg) 1st	2nd
Backpack Mix	0.014	0.017
" Spray	0.132	0.085
Tractor (mist) Mix.	0.086	0.053
" Oper.	0.041	0.054
Helic (Micro) Mix	0.092	0.081
Pilot	0.002	0.012
Helic (Rain) Mix	0.086	0.156
Pilot	0.046	0.049

Calculations of TCDD

x mg 2,4,5-T / Kg body wt / 10 hr exposure

$$\frac{4\ \text{mg TCDD}}{\text{Kg } 2,4,5\text{-T}} = \frac{\mu g}{g},\ \frac{ng}{mg}$$

using data from study on 2,4,5-T by Ramsey, Lavy & Braun for [mixer of herbicides]

$$\frac{0.13\ \text{mg } 2,4,5\text{-T}}{\text{Kg BW} \cdot 10\ \text{hrs}} \times \frac{4\ \text{ng TCDD}}{\text{mg } 2,4,5\text{-T}}$$

$$\frac{0.52\ \text{ng TCDD}}{\text{Kg BW} \cdot 10\ \text{hrs}}$$

Assume Thalken 1056 hr

$\therefore$ Total dose = $10.56 \times \frac{52\ \text{ng}}{\text{Kg BW}} = \frac{549\ \text{ng TCDD}}{\text{Kg BW}}$

Assume 10% of BW = Body fat

Then, in body fat will have

5 490 ng/kg or 5.49 μg/Kg B.F.

For Young 6,608

$66.08 \times \frac{52\ \text{ng}}{\text{Kg BW}} = 3436\ \text{ng/Kg}$

3,000

Assume 10% of BW = Body Fat

30 ng/Kg}

Then: 34 μg/Kg BF

at 10% retention

BF should contain 34 ppt

Dermal Exposure: Inhalation

	Total Skin mg 2,4,5-T/Kg	Exp Skin	mg 2,4,5-T/Kg
Spray Super / mix	0.2	0.03	0
Tractor // mix	11.7	1.624	0.000191
Microfoil, 13 Mix	0.95	0.122	0
Raindrop, 18 Mix	0.40	0.042	0
	13.25	1.818	
Mean $\frac{mg\ T}{Kg\ BW}$	3.31	0.45	~0

Exposure time was 2-3 hours

∴ Based on Dermal exposure of

$$\frac{0.5 \text{ mg } 2,4,5\text{-T}}{\text{Kg BW} \cdot 2.5 \text{ hours}}$$ for exposed skin

$$\frac{0.2 \text{ mg } 2,4,5\text{-T}}{(\text{Kg} \cdot \text{BW})(\text{hour})}$$

Al, Pls see me about these materials. V 12

Assume that in walking thru an area just treated that a man would have his feet, & calfs exposed to HO. (24% of total body skin surface) The level would be based on his reaching equilibrium w amt deposited / m^2

3
.06
.18

1 Acre = 4,047 m^2

Application rate = 3 gal HO/Acre

Penetration to ground = 10% = 0.30 gal/acre

~~0.18 gal / 3.785 l~~

2,4,5-T = 4 #/gal = 1.2 #/acre

$$\frac{0.55\ Kg}{acre} \times \frac{acre}{4{,}047\ m^2} = 1.35 \times 10^{-4} \frac{Kg}{m^2}$$

$1.35 \times 10^{-1} g/m^2 = 0.135 g/m^2$

Average man has $1.9 m^2$

Skin area affected $= 0.46 m^2$
24% of $1.9 m^2$

∴ The 2,4,5-T on skin would be

$$\frac{0.135 g\ T}{m^2} \times 0.46 m^2 = \frac{62 mg\ T}{man}$$

Assume 10% absorption

$(0.1)(62) = 6.2 mg\ T$

70 Kg man mg/Kg						
0.18	TCDD	@ 2 mg/Kg	ug/g	ng/mg	12.4 mg/man
0.89		@ 10			62 "
1.77		@ 20			124 "
8.3		@ 94			582 "

With a mean droplet diameter of 350 μ one can determine from Hurtt report that a total of 0.6 μl of HO would cause an area of approximately 7.0 mm². For an average man of 70 Kg, height of 180 cm the total skin surface area would be 1.9×10^6 mm² (~~DuBois~~ Guyton)

$$\left(\frac{0.6\ \mu l}{7.0\ mm^2}\right)\left(\frac{1.9\times10^6\ mm^2\ Skin}{whole\ man}\right)\left(\frac{0.1\ whole\ man's\ Skin}{affected\ skin}\right)$$

$= 1.63 \times 10^4\ \mu l$ HO = 16 ml HO

$$\frac{16\ ml\ HO}{man}\times\frac{gal}{3785\ ml}\times\frac{4\#\ 2,4,5\text{-}T}{gal}\times\frac{Kg}{2.2\#} = 7.69\times10^{-3}\ Kg$$

$$= \frac{7.69\ g\ 2,4,5\text{-}T}{affected\ Skin}$$

Assuming 21% penetrates cover:

$$(7.69)(.21) = \frac{1.615\ g\ 2,4,5\text{-}T}{Affected\ Skin}$$

Assuming 10% absorbed

$$(1.615)(.1) = \frac{0.162\ g\ 2,4,5\text{-}T}{man}$$

Assuming 70 Kg Man

$$\left(\frac{0.162}{70}\right) = 0.023\ g = 23\ mg/Kg$$

with TCDD = $\frac{94 \text{ mg TCDD}}{\text{Kg T}}$

~~0.023 g / Kg~~

absorbed

$\frac{0.162 \text{ g } 2,4,5\text{-T}}{\text{man}} \times \frac{94 \text{ mg TCDD}}{\text{Kg T}} \times \frac{\text{Kg}}{1000 \text{ g}} \times \frac{\text{man}}{70 \text{ Kg}}$

$= 2.18 \times 10^{-4} \text{ mg} = 2.18 \times 10^{-1} \text{ ug}$

$= \frac{0.22 \text{ ug}}{\text{Kg} \cdot \text{Day}}$

$\frac{220 \text{ ng}}{\text{Kg} \cdot \text{Day}}$

$0.008\ell \quad \frac{3.785\ell}{gal}$

A-2

1) $\frac{0.6\ \mu\ell}{7.0\ mm^2} \times \frac{1.9 \times 10^6\ mm^2}{man} = 1.63 \times 10^5\ \mu\ell$ HO

$= 1.63 \times 10^2$ ml HO

$= 0.016\ \ell$ HO

2) with a TCDD worst case of 47 mg TCDD/Kg HO

$\frac{47\ mg\ TCDD}{Kg\ HO} \times \frac{10.7\#}{gal} \times \frac{Kg}{2.2\#} \times \frac{gal}{3.785\ell}$

$= 60.39$ mg TCDD/ℓ HO

3) TCDD dermal exposure

$60.39 \frac{mg\ TCDD}{\ell\ HO} \times 0.16\ell$ HO $= 9.66$ mg

4) 2,4,5-T dermal exposure:

0.016ℓ HO $\times .5 = 0.08\ell$ 2,4,5-T

$0.008\ell = 2.11 \times 10^{-3}$ gal

2.11×10^{-3} gal $\times 4 \frac{\#\ ae\ 2,4,5\text{-}T}{gal} = 8.454 \times 10^{-3}\ \#$ 2,4,5T

5) ~~8.454×10^{-3} # 2,4,5-T $\times \frac{Kg}{2.2\#}$~~

~~$= 3.84 \times 10^{-3}$ Kg~~ $=$ 3.84g 2,4,5-T

$0.016\ \ell\ HO \times \frac{gal}{3.785\ell} \times \frac{4\#\ 2,4,5\text{-}T}{gal} \times \frac{Kg}{2.2\#}$

$= 7.686 \times 10^{-3} \frac{Kg\ 2,4,5\text{-}T}{man} = 7.68 \frac{g\ 2,4,5\text{-}T}{man}$

Checking TCDD exposure

~~$\frac{7.68g\ 2,4,5\text{-}T}{man} \times \frac{94mg\ TCDD}{Kg} \times \frac{Kg}{10^3 g}$~~

~~$= \frac{0.721\ mg\ TCDD}{man}$.~~

Assuming only 10% of body (head, shoulders, neck, forearms, hand & thighs) ~~are~~ is affected,

$\frac{7.68g\ 2,4,5\text{-}T}{man}$ $\underline{(0.1)\ Skin}$

Exposure Data

25 OCT 1979

25 OCT 1979

ALVIN L. YOUNG, Major, USAF
Consultant, Environmental Sciences

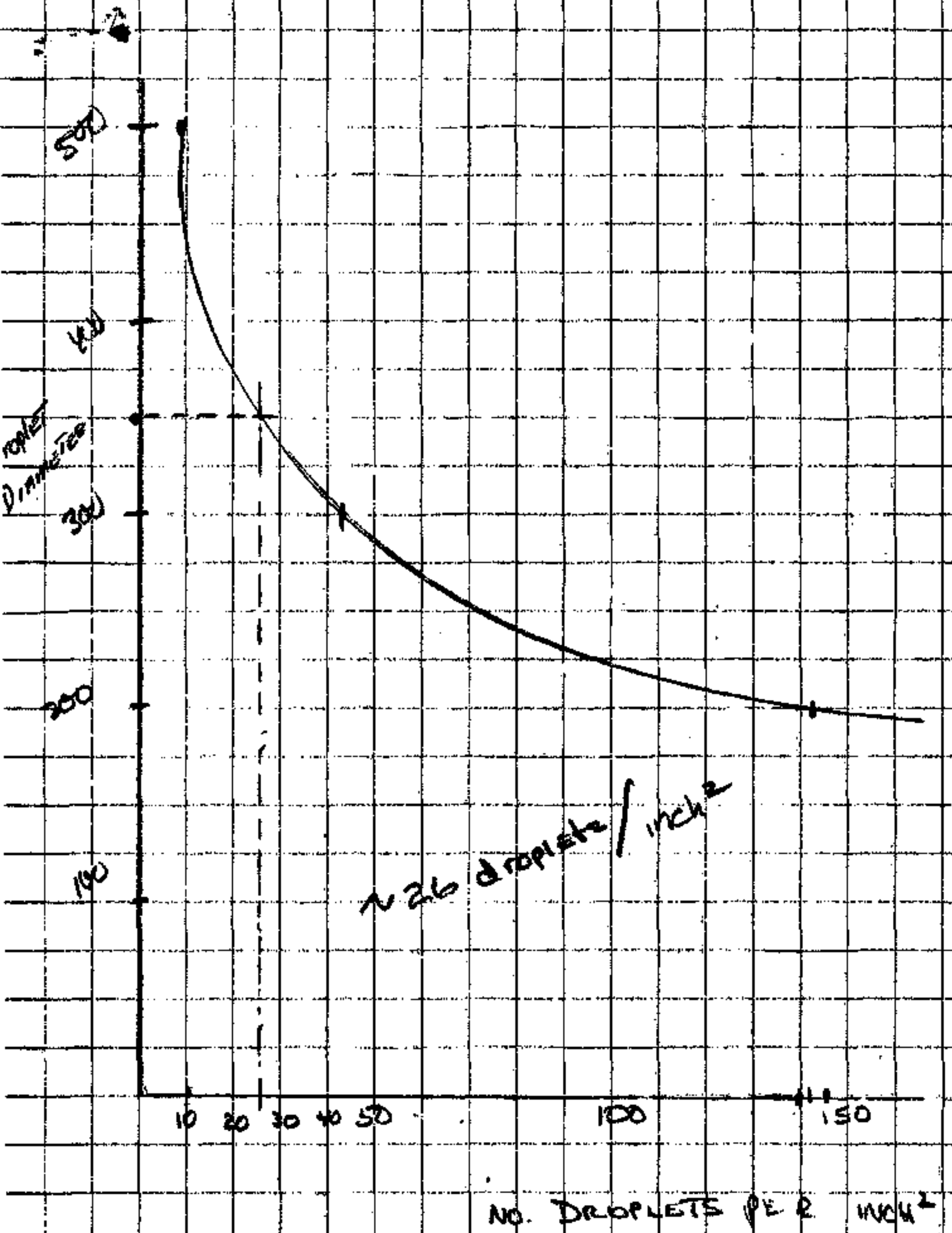


TABLE 1. Effect of Atomization on Coverage (a). Rate of Application — 1 gallon per acre.

Droplet Diameter (microns)	**No. spray droplets per square inch**
10	1,148,000
20	143,000
50	9,224
100	1,164
200	142
300	43
500	9

(a) from Himel (1969) p. 920

sect control was the effect of low relative humidity. When the humidity dropped below 70%, insect control declined. In 1977, a comparatively humid year, excellent insect control was obtained with all of the standard insecticides. It was determined that rapid evaporation of the smaller, insecticidally effective droplets was a major factor in poor insect control.

Droplet size is of major importance in insect control. Very fine droplets (less than 50 microns or 1/500th inch in diameter) of short residual insecticides appear to be highly effective in controlling insects. These small droplets impinge on the setae and other parts of the insect's body. A larger droplet may strike the pest causing mortality; however, the smaller droplets increase the probability of hitting the target pest. According to Himel and Moore[1], 93 percent of the mortality of tobacco budworm (*Heliothis virescens*), cabbage looper (*Trichoplusia ni*) and boll weevil (*Anthonomus grandis*) was caused by droplets less than 50 microns in diameter. Later, Himel[2] reported that if the optimum droplet size is around 20 microns, then our present spray efficiency is about 1% or less.

Of almost equal importance is the effect of droplet size on coverage and penetration of the canopy. Higher volumes of spray are generally recommended in an effort to obtain more complete coverage and better penetration of the plant canopy. It is true that increasing volume will increase numbers of droplets and, therefore, coverage. However, since coverage is primarily a function of numbers of droplets, a more practical way to increase it is to break the spray up into small drops. Each time the average drop size is divided in half, the number of drops is increased approximately 8 times. These data are presented in Table 1. Thus, one gallon of spray per acre divided into 50 micron drops will produce the same coverage as 64 gallons applied in 200 micron drops.

A third major advantage of very fine droplet sprays is their ability to penetrate through very small openings in the bud tissues and beneath bracts enclosing squares and bolls where the bollworm and boll weevil live and feed. Additionally, fine droplets, because of their tendency to float on air currents, penetrate plant canopies more efficiently, are deposited on the undersides of the leaf, and deliver more insecticide to the lower portions of the plant. This gets the insecticide out of the sunlight and slows the rate of ultraviolet degradation. This in turn, extends the efficacy and increases the control of the bollworm and budworm moths that spend the day down in the canopy.

Since mites and whiteflies live almost exclusively on the undersides of the leaf, only fine droplet sprays can reach them.

Larger drops, due to their greater verticle velocity, tend to impinge on the upper surface of the leaves.

Despite the many important advantages of small particle sprays, there are a number of serious disadvantages. The most serious of these is the rapid rate of evaporation of the insecticide carriers. In practice, this is almost universally water. Seymour and Byrd[3] projected that an 80 micron water droplet falling through air at 70% relative humidity will disappear in approximately 8.5 seconds. During that time, the 80 micron drop will fall less than 2 feet! A 50 micron drop will last only about 2 seconds. Figure 1 shows this relationship. Boise[4] reports that evaporation and liquid density are often overlooked as factors contributing to the drift of sprays. A spray mixture that is 95% water will evaporate readily, with a 100 micron diameter drop being reduced to a 40 micron drop in about 15 seconds when the air temperature is 80°F and relative humidity is 50%.

Even though the solvents and emulsifiers in the insecticidal formulations reduce the rate of evaporation somewhat, it is still extremely difficult to get an appreciable percentage of the applied insecticide into a cotton crop in an effective droplet size range as long as water is used as the principal carrier. Thus, evaporation can be reduced by using low-volatile spray carriers in lieu of water.

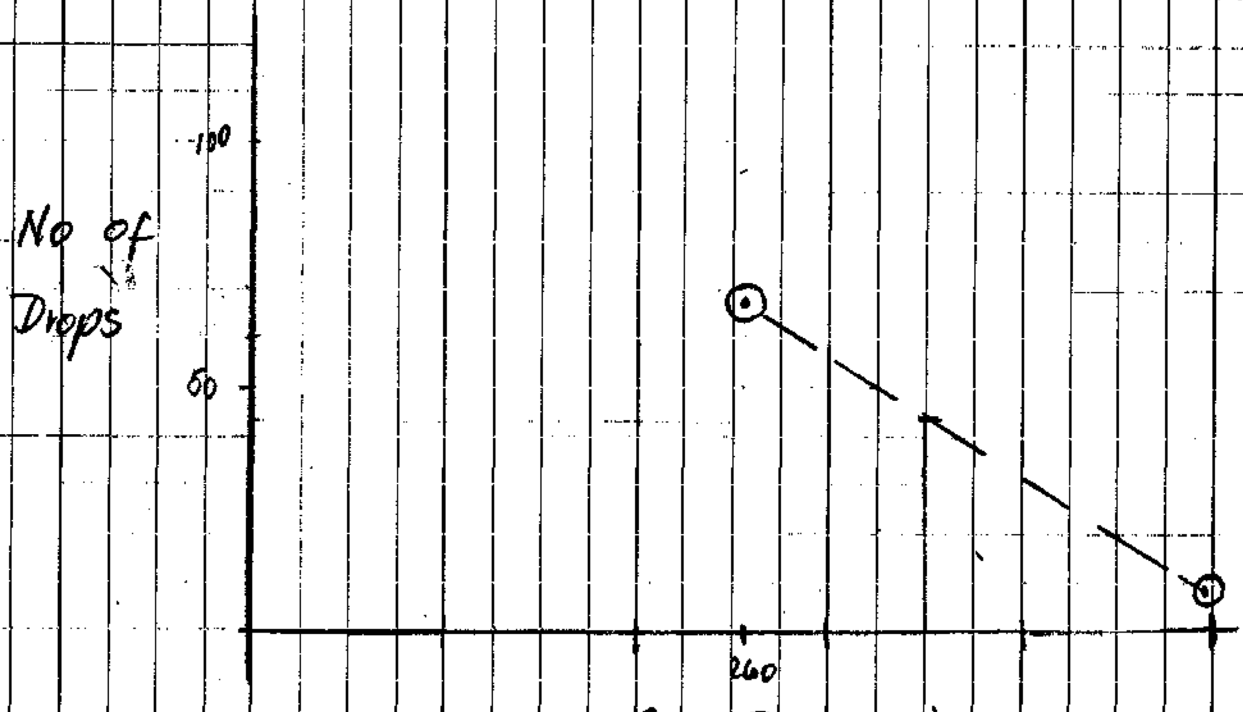
A large number of low volatile materials may be used as substitutes for water as insecticide carriers. Wright[5] suggested that when concerned with evaporation on a real hot, dry day, to add some propylene glycol or even ethylene glycol to the spray mixture. In the initial screening a number of criteria were used for selecting candidate carriers for inclusion in these studies:

1. relatively non-volatile
2. non-phytotoxic
3. compatible with insecticides
4. non-corrosive and non-damaging to aircraft components
5. non-flammable
6. relatively non-toxic
7. physical characteristics as close to water as possible or at least sprayable through systems in current use without major modifications
8. inexpensive (or their cost to be more than offset through reduction of insecticide required)
9. cleared for use on crops

Small plot studies on two month old cotton were conducted during 1978 on insecticidal formulations containing

(1)

Review Exec Summary
Send to A



No Drops	MDD	μl
67	260	0.617
9.1	499	.594

Mean = 0.61 μl

Mean diameter (spread) = 2,000 μ dia for drop dia of 350 μ

∴ Upon impact a drop of 350 μ dia containing 0.61 μl for a total of 42 drops

each drop: 2.0 mm diameter impact surface dia
Area covered would be

42 drops (Area)

$$Area = \frac{\pi}{4}(2)^2 = 3.14\,mm^2$$

3 gallons / Acre

8 X 3,785 ml

10,000 mls - 144,000

(2)

$$\frac{0.61\,\mu l}{42\,drops} = \frac{0.014\,\mu l}{drop}$$

each drop could cover $3.14\,mm^2$

$$\frac{0.014\,\mu l}{3.14\,mm^2} \quad 0.0046\,\frac{\mu l}{mm^2}$$

Assuming total affected skin surface is wetted, and total affected area is 25% of skin surface

$\frac{1000\,mm}{1000\,mm}$ $(1.9\,m^2)(.25) = 0.4750\,m^2$

$= 4.75 \times 10^5\,mm^2$

$$4.75 \times 10^5\,mm^2 \times 0.0046\,\frac{\mu l}{mm^2} = 2.185\,ml\ HO$$

$$2.2\,ml\ HO \times \frac{gal}{3785\,ml} \times \frac{4\#T}{gal} \times \frac{Kg}{2.2\#}$$

$= 0.0011\,Kg = 1.1\,g\,T$

47 ppm highest value

TCDD @ 94 mg TCDD/Kg T

$$1.1\,g\,T \times \frac{94\,\mu g}{g} = 103\,\mu g\ TCDD$$

Assuming 10% absorption

2,4,5-T = 110 mg

TCDD = 10.3 μg

3

Assuming a 70 Kg Man

2,4,5-T $\frac{110 \text{ mg}}{70 \text{ Kg}}$ = 1.57 mg/Kg

TCDD $\frac{10.3 \text{ µg}}{70 \text{ Kg}}$ = 147 ng/Kg

TCDD @ 4 mg TCDD/Kg

TCDD : 1.1 g x $\frac{4 \text{ µg}}{\text{g}}$ = 4.4 µg TCDD

10% absorpt. 0.44 µg TCDD

70 Kg man $\frac{0.44 \text{ µg}}{70}$ 6.3 ng/Kg

.0063 µg/k

EPA — no effect in Animals (0.03 µg/k)

MEAN FOR Orange
367 m μ

Hurtt & Darrow

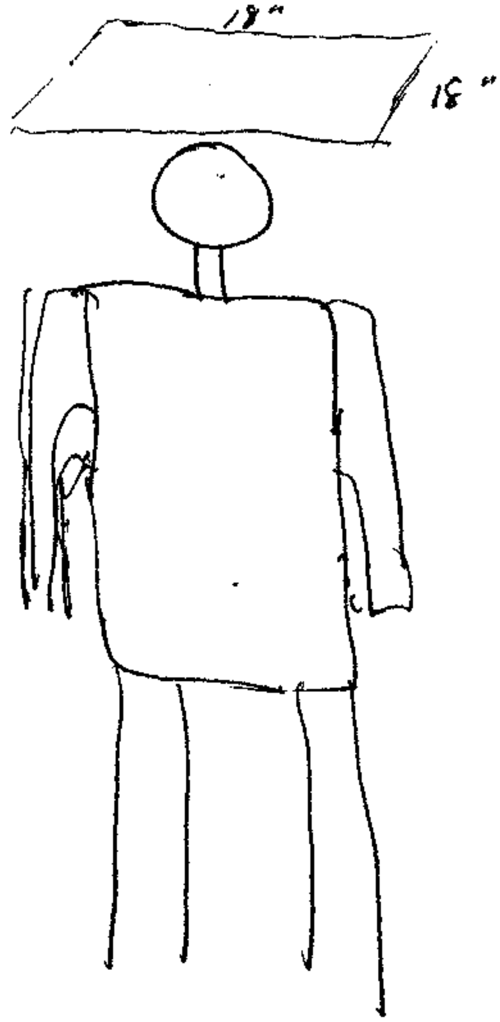
formulation

Conc.	Drop
Orange	mmD
125 μg.	→ 126
250 μg	260
500 μg.	498

$\frac{250}{260} = \frac{367}{x}$

$x = \frac{367(260)}{250}$

drops in² = 400μ - 500μ = 100 drops/in²



NA454-4

1.5 Sq METER

= 2325 in²

232500 drops

~~381~~ μ Orange = 367mm drop

88.582500 grams.

88 grams if incepted entire body

if 1.91 mg/kg x .088 kg = .17 mg TCDD

if 70 kg man = .17 mg / 70 kg = .0024 μg/kg.

Textbook of

MEDICAL PHYSIOLOGY

SECOND EDITION, Illustrated

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Professor and Chairman of the
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University of Mississippi School of Medicine

1961

W. B. SAUNDERS COMPANY

Philadelphia and London

is not the reason why the basal metabolic rates of different persons vary according to the surface area; instead, this relationship is only an empirical one.

Referring once again to Figure 660 it will be noted that the total number of Calories liberated by the patient per hour is divided by his total body surface area of 1.5 square meters. This means that his basal metabolic rate is 48.3 Calories per square meter per hour.

Method for calculating the total surface area. The surface area of the body varies approximately in proportion to weight $^{0.67}$. However, more accurate measurements of the body surface area have shown that it can be determined more accurately by a complicated formula based on weight and height of the subject as follows:

$$\text{Body surface area} = \text{Weight}^{0.425} \times \text{Height}^{0.725} \times 0.07184$$

Figure 661 presents a graph based on this formula. In the formula and in the figure, body surface area is expressed in *square meters,* weight in *kilograms,* and height in *centimeters.*

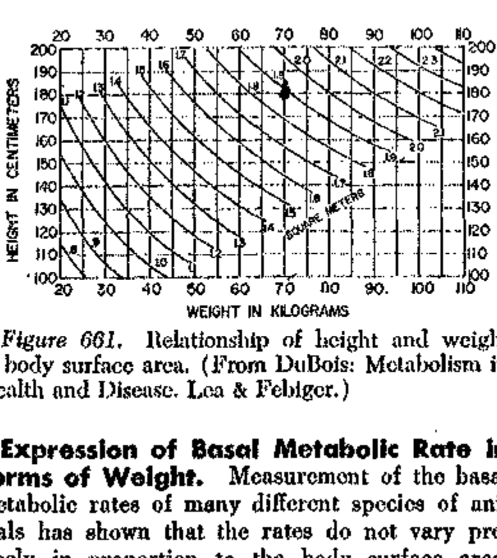

Figure 661. Relationship of height and weight to body surface area. (From DuBois: Metabolism in Health and Disease. Lea & Febiger.)

Expression of Basal Metabolic Rate in Terms of Weight. Measurement of the basal metabolic rates of many different species of animals has shown that the rates do not vary precisely in proportion to the body surface area. Instead, in animals ranging in size from the mouse to the horse, the basal metabolic rate has been found to be proportional to weight $^{0.734}$. Because surface area is approximately proportional to weight $^{0.67}$, it is obvious that correlating basal metabolic rates between animal species on the basis of surface areas would be in extreme error. This fact has considerable implication in human physiology and in clinical medicine, for some physiologists believe that even in comparing basal metabolic rates between human beings the factor weight $^{0.734}$ should be used instead of surface area. *If this is true, overweight subjects would have to have basal metabolic rates considerably above the mean as based on the surface area method in order to be normal, and very thin subjects would have to have basal metabolic rates considerably less than the mean as based on the surface area method in order to be normal.*

Expression of Basal Metabolic Rate in Percentage Above or Below Normal. In Fig. 659 it will be noted that the basal metabolic rate varies tremendously with age; also, males in general have a basal metabolic rate approximately 8 per cent greater per square meter than that of females. Therefore, to compare the basal metabolic rate of any one subject with the normal basal metabolic rate, it is necessary to refer to a chart such as that in Figure 659, which gives the normal basal metabolic rate per square meter at each age and for each sex. Once reference has been made to such a chart, the basal metabolic rate is ordinarily expressed as a percentage above or below normal. For example, in Figure 659 the normal basal metabolic rate for a 20-year-old male is shown to be 38.5 Calories per square meter per hour. Therefore, if the particular patient represented in the calculations of Figure 660 is a 20-year-old male, he liberates 9.8 Calories per square meter per hour above the normal mean value. It is then determined that this is 25.5 per cent above normal. Therefore, the basal metabolic rate is expressed as plus 25.5. Similarly, basal metabolic rates below normal are expressed as minus values.

Constancy of Basal Metabolic Rate in the Same Person. Basal metabolic rates have been measured in many subjects at repeated intervals for as long as 20 or more years. As long as a subject remains healthy, almost invariably his basal metabolic rate as expressed in percentage of normal does not vary more than 5 to 10 per cent.

Constancy of Basal Metabolic Rate from Person to Person. When the basal metabolic rate is measured in a wide variety of different persons and comparisons are made within single age, weight, and sex groups, 85 per cent of normal persons have been found to have basal metabolic rates within 10 per cent of the mean. Thus, it is obvious that measurements of metabolic rates performed under basal conditions offer an excellent means for comparing the rates of metabolism from one person to another.

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Hurtt Report

ORANGE

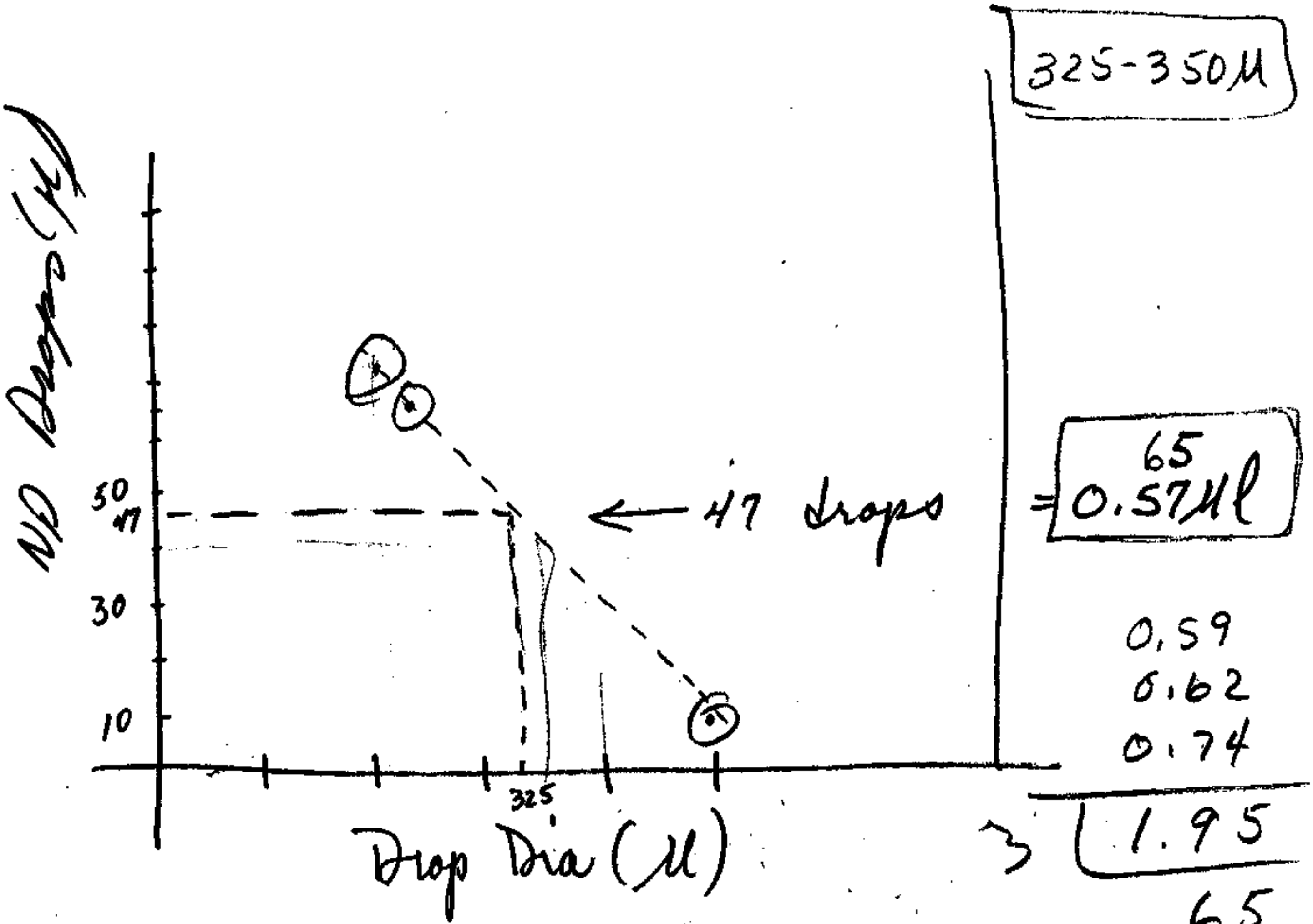
Drop diameter	No. of Drops	total µl	Leaf area contacted
260 µ	64	0.6	8.6 mm²
498 µ	9	0.6	5.7
127 µ	701	0.75	
260 µ	67	0.62	
499 µ	9	0.59	

	Average Flow Rate	Average Swath	Average Acres (1000 gal/swath)
Orange	227 GPM	259	364

Aerial appl : RPAR —

Dermal —	5×10^{-6}	ug/Kg	71%
Inhal —	2×10^{-6}	ug/Kg	29%

1 drop (325μ diameter) will cover 2000μ dia surface and will consist of 0.012 μl of HO



Therefore: area $= \frac{\pi D^2}{4} = \frac{\pi (2)^2 mm^2}{4}$

$= 3.14 mm^2$

18/15

The body surface area
affected is 31% of total area

$(\cancel{9.1}\,1.9\,m^2)(.31) = 0.59 m^2$

$= 5.9 \times 10^5 mm^2$

for each 3.14 mm² whave 0.012 µl
of HO

$\therefore \frac{5.9 \times 10^5 mm^2}{3.4 mm} \times 0.012 \mu l$

$= 2{,}082\ \mu l = 2.1\ ml$

Assuming 10% absortion
Total = 0.21 ml

$0.21\ ml\ HO \times \frac{gal}{3785\ ml} \times \frac{4\#}{gal} \times \frac{Kg}{2.2\#} \times$

$1 \times 10^{-1} g$ $= 1.0\cancel{0} \times 10^{-4}$ Kg 2,4,5-T absorbed

.1 g
100 mg — 101 ~~#~~ mg 2,4,5-T

$$\frac{101\ mg}{70\ Kg} = 1.43\ mg/Kg\ 245T$$

$$\frac{1.43\ mg\ 2,4,5\text{-}T}{Kg\ man} \times \frac{x\ ng}{mg}$$ ug/g

TCDD	TCDD ng/Kg·man absorbed
2	2.86
15	21.3
30	42.6

90

$10^6 \mu = 1$ m

$10^3 \mu = 1$ cm

$1 \mu =$

100 cm = 1 m

1000 mm = 1 m

~~10000 dm~~ = 1 m

1,000,000 um = 1 m

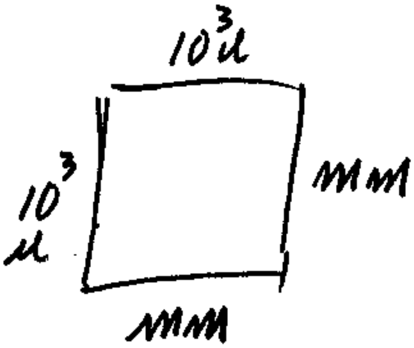
$$S.F. = \frac{\text{Drop dia}}{\text{Card Spot dia}}$$

$$\frac{\text{Card spot dia}}{\text{~~drop~~}} = \frac{\text{drop dia}}{S.F.} \times \#\text{drops}$$

$$= \frac{495 \mu}{1.79}$$

$$\text{Area} = \frac{\pi D^2}{4}$$

6.006 X 9 Drops



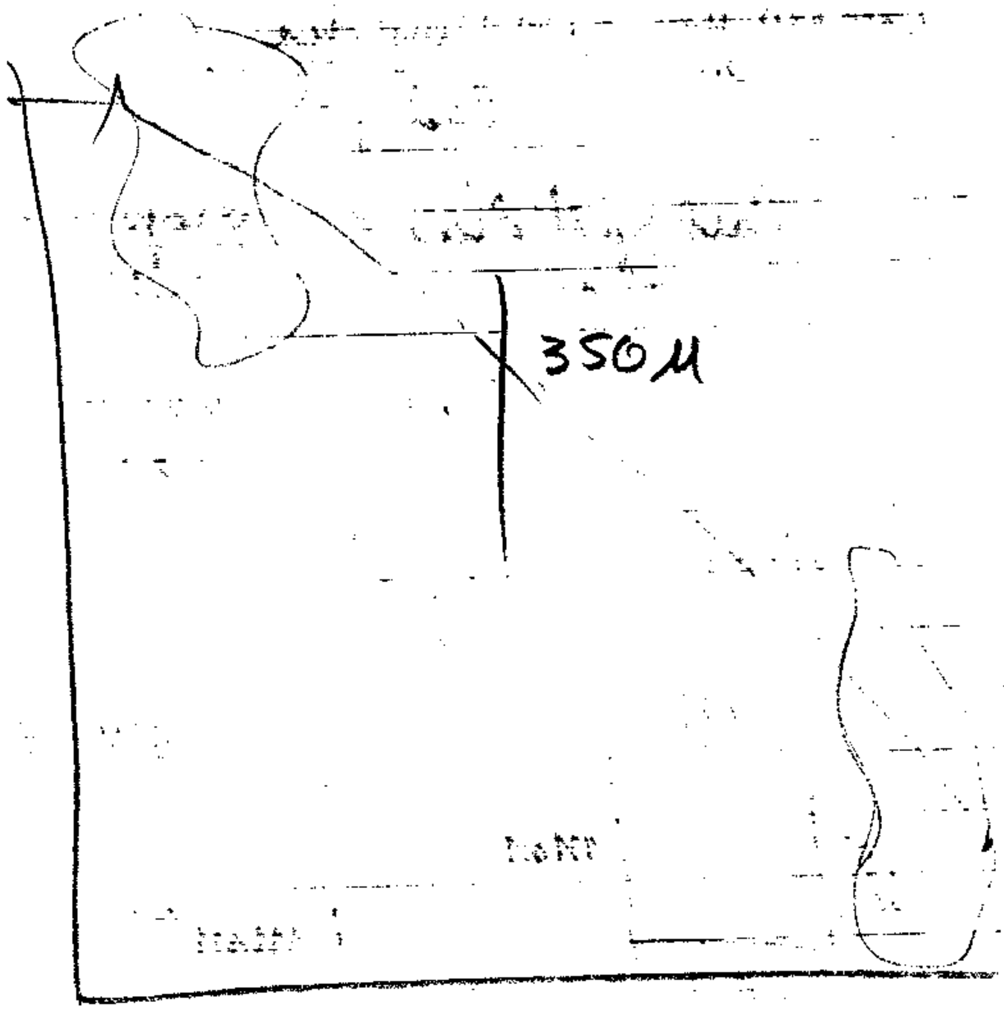
540,551 um^2

$1\ mm^2 = 10^6\ um^2$

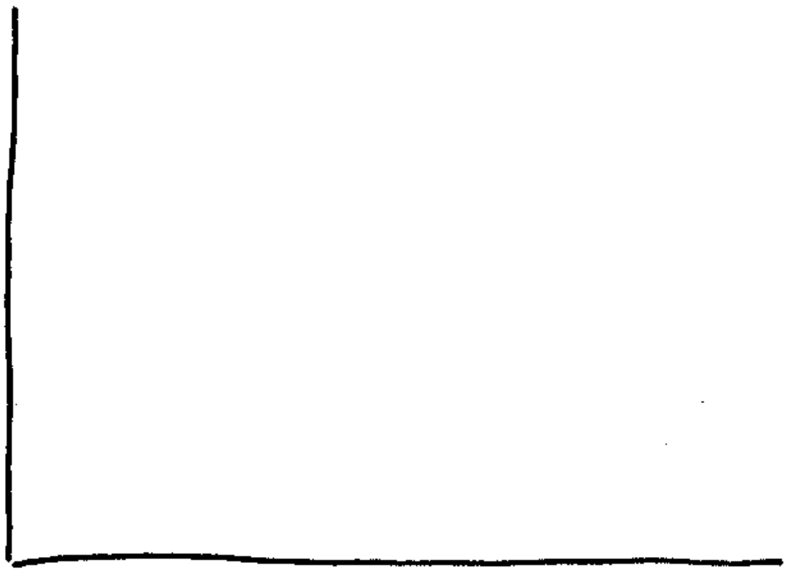
$5.4 \times 10^5\ um^2$

1,750 µ - 2,100 µ

Say 2,000 µ for each droplet of size 325 µ


350μ

0.57 µl	125 µ	564 drops
0.57 µl	250 µ	70 drops
"	500 µ	8.7 "



With 47 drops

$$= \frac{47 \text{ drops}}{0.57 \text{ ml}}\left(\frac{\pi}{4}\right)\left(2000\,\mu\right)^2$$

$$\left(2 \times 10^{-3} \text{ m}\right)^2$$

$$\frac{47}{.57}\left(\frac{\pi}{4}\right)\left(= 2 \text{ mm}\right)^2$$

$$= 259 \frac{\text{mm}^2}{\text{ml}}$$

$$\left(\frac{1 \text{ ml}}{259 \text{ mm}^2}\right)\left(\frac{1.9 \times 10^6 \text{ mm}^2}{\text{man}}\right)$$

7,336 ml

$$= \frac{7.4 \text{ ml}}{\text{man}}$$ made 100% conc

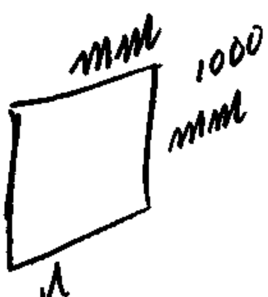
$$\left(\frac{7.4 \text{ ml}}{\text{man}}\right)\left(\frac{\text{gal}}{3785 \text{ ml}}\right)\left(\frac{4 \# \text{ 2,4,5-T ae}}{\text{gal}}\right)\left(\frac{\text{Kg}}{2.2 \#}\right)$$

$$= 0.004 \frac{\text{Kg}}{\text{man}} = 4 \text{ g 2,4,5-T}$$

Drop Dia (μ)	No Drops	Total μl	Area Contacted
120	618	.572	16.68
126	584	.583	18.09
243	70.8	0.534	9.10
260	64.1	.590	8.59
495	9.0	.572	5.11

$$\text{Spread factor} = \frac{\text{Drop dia } \mu}{\text{Card spot dia } \mu}$$

$$\text{Card spot} = \frac{495}{1.790} = 276\ \mu$$



$$\text{Area} = \frac{\pi D^2}{4}$$

5.4055 mm^2

PERSONNEL

COMPARISON OF RANCH HAND, AND GROUND TROOP EXPOSURE TO AGENT ORANGE

RANCH HAND

Console Operator:

VAPOR: PACER HO data (Air Force Technical Report 78-92, 1978) - within Dedrum Facility at Naval Construction Battalion Center, Gulfport MS, 90-95° F.

- Air Concentration

$$2,4\text{-}D = 135\ \mu g/m^3$$

$$2,4,5\text{-}T = 80\ \mu g/m^3$$

- Respiration rate for average man at work

$\frac{30 \text{ resp}}{\text{min}} \times$

D. Laskowski

Water/Air Ratio:

$$\text{Water/Air} = \frac{(\text{Water Sol.})(8.206)(0.76)(273.15 + T^\circ C)}{(\text{Vapor Press.})(\text{Mol. wt.})(10^2)}$$

$$\text{Water/Air} = \text{ppm} / \mu g/cc$$

Water sol. = ppm

Vapor Press. = mm Hg^0

LTR TO DOD — w/o AOWG

800 names from Army Units
200 names from Marine Units

Criteria — 4400 Names
a Nr conscious effort to exclude ~~none~~ the Service formed.
- Exclude Officers
- Exclude Multiply Tours
- Exclude KIA

- Engineer battalions — Construction
- Air Cavalry — Mobile — Infantry
-

Division 18,000

MARINES

Infantry Brigades
3 Man.
(Delete Chandler Company)

80%
20%

Signal Brigade
Medical Brigade

Engineer Command

Universe of Vietnam Veterans

- Infantry — MOS

Platoon — 34 + 1 officer
↓
4 Squads

Participant — Date Individual Rotates out of Vietnam.

Entry on death

Selection of Subjects for the pilot phase.
Reference Abstracts

Population of interest description

↓

all ~~soldiers~~ in qualified Battalion

NOT Survey of the Population

e.g. — two groups of high exposure –
RANCH HAND
Chemical Corps

Criteria for inclusion & Exclusion

- Cover majority of persons & homogeneity
  - Draftees with one tour of duty in Vietnam.

→ One yr tour in Vietnam

- Exclude Officers
  - Statistical problem – need to over-sample
  - stratification Required
  - Epi-study – compare health outcomes between two major groups.

= Exclude Multiple tours.
Officers may have more confounders
n = enlisted groups

• Must be in unit for 10 months
• Must track more carefully the unexposed personnel.

• Wounded in Action
& Bares excess risk.

• Characterization of Population

Mortality

Group Matching
& SEX (Similar)
* Age
— Racial
— WIA
— Education
Regional Split
— MOS
Officer vs enlisted

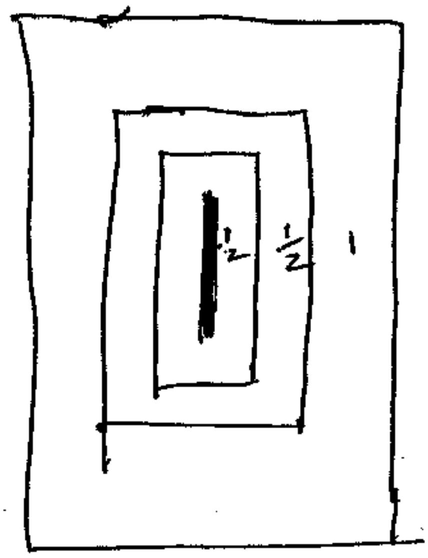
Rural/Urban

Army vs Marine.

Branch of Service

Exposure Subcommittee

- Carl Keller - Mailing list for VA Health Effects Comm



~~[illegible]~~
0 - 23 Hz
24 - 47
48 - 72

✓ Manuscript for Salzburg
✓ Ltr to Ayres
✓ Book for Reggiani

Ltr to AAOTF ✓
Australian Response ✓
Ltr on Dr Hood → Justification
✓ Slides for Salzburg
✓ Itineraries
✓ Jeff Ryan
✓ Ray Carroll "
✓ Ltr to Ed Gangstead

SALZBURG -

Denniti - Twin Study

- Ltr. to DOD   copy to: Houk
  - Start Cohort Selection   HHS.
  - — [Kelley / Hobbs]   ~~Attorney~~
  PETE Flynn.

Ltr on 1,000 ?

Subjects of our Pilot phase will not be used to Vietnam

Phase I   Recruitment

- Establish Oversight

Ltr. Seppe

~~Other~~ ~~Advisory~~ Committee

Epidemics

Model: Chemical, Target, Time after application, and distance from application site.

Factors that influenced exposure to herbicides

- Herbicide Formulation
  - Chemical / Physical Characteristics
  - Solubility
  - Vapor Pressure
- Dissemination of Herbicides
  - Application parameters
  - Target vegetation
- Route of Exposure
  - Dermal
  - Inhalation
  - Ingestion
- Environmental Fate
  - in air
  - on vegetation
  - in soil
  - in water

Dissemination Systems

1. RANCH HAND A/A 45Y-1 Internal Defoliant Dispenser
2. UH-1 B/D Helicopter Spray System (AGRINAUTICS)
3. Buffalo Turbine
4. Power-Driven Decontamination Apparatus (PDDA)
5. Back-Pack Sprayers (2 & 5 Gallon)
6. "Jerry-rigged" or Field Expedient Devices

ASSIGNMENT OF WEIGHTS

		Score WT
o Toxicity of Herbicide		
Orange	600mg/kg	5
White	2600 mg/kg	2
Blue	3100 mg/kg	1

o Location of Mission

Defoliation		
Jungle (heavy Canopy)	10% penetration	1
Mangrove (light Canopy)	30% "	3
Crop/Abort	100% "	10
Perimeter	70% "	7

TIME / DISTANCE MATRIX

TIME	DISTANCE (km)
DAYS	

[aug 30th 1030] EPA

Sept 28, 29 . RTP
RH advisory comm.

SUBCOMMITTEE

Resolve
- 3rd Cohort Issue - Study design
- Individual criteria to determine eligibility for study
- Time & distance parameters
- Weighting scheme for exposure index

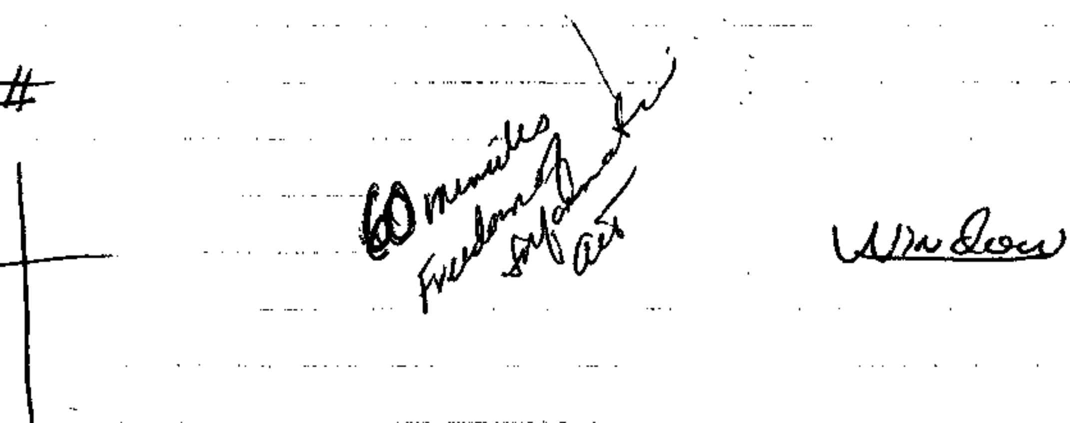
- Rifleman

→ dose response vs threshold
→

- #

Review

Building



Time
- Prepare a map
- Define area & Select area for search
- Obtain appropriate station list (1/4 yr report of whe
- battalion
- Determine availability of records
- record unit daily coordinates (activity)
- Develop "In-service" HERBS TAPE
-

- Index of weighting

Km drop

days	<0.5	1	1.5	2
1	8	2	1	1
2	4	1		
3	2	—	—	
4	1	—	—	

	<0.5	1	1.5	2.0
Days	70	15	10	5
1		8	5	3
2	35			
3	18	4	3	1

Weighted System

Fate of TCDD
- Location of Mission
  - Jungle
  - Mangrove
  - Crop
  - Other

Type of Mission Involved
- RANCH HAND
- Perimeter
- Abort

Time after Exposure
- Days
  - within 1
  - " 2
  - " 3

Distance from Exposure Type (Application Site)
- Within 0.5 km
- " 1.0 "
- " 1.5 "
- " 2.0 "

Exposure Cohort See Stevenson

Combat Orange $\bar{C}$ $\bar{O}$
Non Combat Orange C $\bar{O}$
Non Combat Non Orange C O

EXPOSURE 1. Threshold vs Gradient } Model of Dioxin
2. Index
Calculation (Background/Assumption)
Validation (Social/Political)

20 Hits of Orange

1-4 Hits Low
8-12 Intermediate
16-20 High

44 Abods / Orange date Location

Weighting Scheme Perimeter day and distance
Describe "Non-Hit"
Distance vs Time