



**US Environmental Protection Agency
Office of Pesticide Programs**

**Occupational Pesticide Handler Unit
Exposure Surrogate Reference Table**

November 2016

**USEPA / Office of Pesticide Programs / Health Effects Division
Occupational Pesticide Handler Unit Exposure Surrogate Reference Table**

Exposure Scenario (Activity, Equipment, Formulation, Site, etc.)¹	Exposure Route	Personal Protective Equipment (PPE) Level²	Data Source^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)
Mixing / Loading Dry Flowable	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	227
		Single layer, gloves	AHETF (MEA)	Mean	51.6
		Double layer, gloves (B)	AHETF (MEA)	Mean	41.2
		Engineering control (water-soluble packaging)	AHETF (MEA)	Mean	12.5
	Inhalation	No Respirator	AHETF	Mean	8.96
		PF5 (C)	AHETF	Mean	1.79
		PF10 (D)	AHETF	Mean	0.896
Engineering control (water-soluble packaging)		AHETF	Mean	2.6	
Mixing / Loading Granules	Dermal	Single layer, no gloves	PHED	"Best fit"	8.4
		Single layer, gloves	PHED	"Best fit"	6.9
		Double layer, gloves	PHED	"Best fit"	3.4
		Engineering control (closed loading system)	PHED	"Best fit"	8.6
	Inhalation	No Respirator	PHED	"Best fit"	1.7
		PF5 (C)	PHED	"Best fit"	0.34
		PF10 (D)	PHED	"Best fit"	0.17
Engineering control (closed loading system)		PHED	"Best fit"	0.083	
Mixing / Loading Liquids	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	220
		Single layer, gloves	AHETF (MEA)	Mean	37.6
		Double layer, gloves (B)	AHETF (MEA)	Mean	29.1
		Engineering control (closed loading system)	PHED	"Best fit"	8.6
	Inhalation	No Respirator	AHETF	Mean	0.219
		PF5 (C)	AHETF	Mean	0.044
		PF10 (D)	AHETF	Mean	0.022
Engineering control (closed loading system)		PHED	"Best fit"	0.083	
Mixing / Loading Wettable Powders	Dermal	Single layer, no gloves (A)	AHETF	Mean	77.7
		Single layer, gloves	AHETF	Mean	57.5
		Double layer, gloves (B)	AHETF	Mean	32.8
		Engineering control (water-soluble packaging)	AHETF (MEA)	Mean	12.5

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Exposure Scenario (Activity, Equipment, Formulation, Site, etc.) ¹		Exposure Route	Personal Protective Equipment (PPE) Level ²	Data Source ^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)
		Inhalation	No Respirator	AHETF	Mean	2.75
			PF5 (C)	AHETF	Mean	0.55
			PF10 (D)	AHETF	Mean	0.275
			Engineering control (water-soluble packaging)	AHETF	Mean	2.6
Applicator, Aerial, Fixed-Wing	Liquids	Dermal	Engineering control (Enclosed cockpit)	AHETF (MEA)	Mean	2.08
		Inhalation	Engineering control (Enclosed cockpit)	AHETF (MEA)	Mean	0.0049
	Granules	Dermal	Engineering control (Enclosed cockpit)	PHED	"Best fit"	1.7
		Inhalation	Engineering control (Enclosed cockpit)	PHED	"Best fit"	1.3
Applicator, Aerosol Can	All sites (except animal treatments)	Dermal	Single layer, no gloves	PHED	"Best fit"	190000
			Single layer, gloves	PHED	"Best fit"	81000
			Double layer, gloves (B)	PHED	"Best fit"	64000
		Inhalation	No Respirator	PHED	"Best fit"	1300
			PF5 (C)	PHED	"Best fit"	260
			PF10 (D)	PHED	"Best fit"	130
	Animal (pet and livestock) treatments	Dermal	Single layer, no gloves	MRID 44433302	Mean	544000
			Single layer, gloves (E)	MRID 44433302	Mean	503000
			Double layer, gloves (B, E)	MRID 44433302	Mean	273000
		Inhalation	No Respirator	MRID 44433302	Mean	3270
			PF5 (C)	MRID 44433302	Mean	654
			PF10 (D)	MRID 44433302	Mean	327
Applicator, Open Cab Airblast	Dermal	Single layer, no gloves (A)	AHETF	Mean	1770	
		Single layer, gloves	AHETF	Mean	1590	
		Single layer, gloves, chemical-resistant hat	AHETF (MEA)	Mean	215	
		Double layer, gloves (B)	AHETF	Mean	1480	
		Double layer, gloves, chemical-resistant hat (B)	AHETF (MEA)	Mean	141	
		Engineering control (Enclosed Cab)	AHETF (MEA)	Mean	14.6	
		Inhalation	No Respirator	AHETF	Mean	4.71
	PF5 (C)		AHETF	Mean	0.942	

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		PF10 (D)	AHETF	Mean	0.471
		Engineering control (Enclosed Cab)	AHETF	Mean	0.068
Applicator, Open Cab Groundboom	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	78.6
		Single layer, gloves	AHETF (MEA)	Mean	16.1
		Double layer, gloves (B)	AHETF (MEA)	Mean	12.6
		Engineering control (Enclosed Cab)	PHED	"Best fit"	5.1
	Inhalation	No Respirator	AHETF	Mean	0.34
		PF5 (C)	AHETF	Mean	0.07
		PF10 (D)	AHETF	Mean	0.03
		Engineering control (Enclosed Cab)	PHED	"Best fit"	0.043
Applicator, Open Cab Solid Broadcast Spreader	Dermal	Single layer, no gloves	PHED	"Best fit"	9.9
		Single layer, gloves (E)	PHED	"Best fit"	7.2
		Double layer, gloves (B, E)	PHED	"Best fit"	4.2
		Engineering control (Enclosed Cab)	PHED	"Best fit"	2.0
	Inhalation	No Respirator	PHED	"Best fit"	1.2
		PF5 (C)	PHED	"Best fit"	0.24
		PF10 (D)	PHED	"Best fit"	0.12
		Engineering control (Enclosed Cab)	PHED	"Best fit"	0.22
Applicator, Granules by Hand	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	104000
		Single layer, gloves	PHED	"Best fit"	71000
		Double layer, gloves (B)	PHED	"Best fit"	40280
	Inhalation	No Respirator	PHED	"Best fit"	470
		PF5 (C)	PHED	"Best fit"	94
		PF10 (D)	PHED	"Best fit"	47
Applicator, Paintbrush/roller	Dermal	Single layer, no gloves	PHED	"Best fit"	180000
		Single layer, gloves (E)	PHED	"Best fit"	24000
		Double layer, gloves (B, E)	PHED	"Best fit"	22000
	Inhalation	No Respirator	PHED	"Best fit"	280
		PF5 (C)	PHED	"Best fit"	56
		PF10 (D)	PHED	"Best fit"	28
Applicator, Airless Sprayer	Dermal	Single layer, no gloves	PHED	Mean	42600

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Exposure Scenario (Activity, Equipment, Formulation, Site, etc.) ¹		Exposure Route	Personal Protective Equipment (PPE) Level ²	Data Source ^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)
			Single layer, gloves (E)	MRID 43600102	Mean	11700
				PHED		
				MRID 43600102		
			Double layer, gloves (B, E)	PHED	Mean	10600
				MRID 43600102		
				PHED		
		Inhalation	No Respirator	PHED	Mean	560
				MRID 43600102		
				PHED		
		PF5 (C)	PHED	Mean	112	
			MRID 43600102			
		PF10 (D)	PHED	Mean	56	
			MRID 43600102			
Flagger	Liquids	Dermal	Single layer, no gloves	PHED	"Best fit"	11
			Single layer, gloves	PHED	"Best fit"	12
			Double layer, gloves (B)	PHED	"Best fit"	10.6
		Inhalation	No Respirator	PHED	"Best fit"	0.35
			PF5 (C)	PHED	"Best fit"	0.07
			PF10 (D)	PHED	"Best fit"	0.04
	Granules	Dermal	Single layer, no gloves (F)	PHED	"Best fit"	2.75
			Single layer, gloves (E, F)	PHED	"Best fit"	2.73
			Double layer, gloves (E, G)	PHED	"Best fit"	1.59
		Inhalation	No Respirator	PHED	"Best fit"	0.15
			PF5 (C)	PHED	"Best fit"	0.03
			PF10 (D)	PHED	"Best fit"	0.02
Loader / Applicator, Belly Grinder		Dermal	Single layer, no gloves	PHED	"Best fit"	10000
			Single layer, gloves	PHED	"Best fit"	9300
			Double layer, gloves (B)	PHED	"Best fit"	5700
		Inhalation	No Respirator	PHED	"Best fit"	62
			PF5 (C)	PHED	"Best fit"	12.4
			PF10 (D)	PHED	"Best fit"	6.2
Loader / Applicator, "Push-type" Rotary Spreader		Dermal	Single layer, no gloves	ORETF	Mean	440
			Single layer, gloves	ORETF	Mean	240
			Double layer, gloves (B)	ORETF	Mean	130
		Inhalation	No Respirator	ORETF	Mean	10
			PF5 (C)	ORETF	Mean	2.0
			PF10 (D)	ORETF	Mean	1.0
		Dermal	Single layer, no gloves	PHED	"Best fit"	100000

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Mixer / Loader / Applicator, Manually-pressurized Handwand	Greenhouses, Wildlife management, Nurseries, Landscaping, Industrial/Commercial areas, Poultry/livestock houses, Animal treatments, Outdoor residential areas, Interior landscaping, Aquatic areas, Structural, Mushroom houses, Christmas Tree Farms		Single layer, gloves	PHED	"Best fit"	430	
			Double layer, gloves (B)	PHED	"Best fit"	365	
		Inhalation	No Respirator	PHED	"Best fit"	30	
			PF5 (C)	PHED	"Best fit"	6.0	
			PF10 (D)	PHED	"Best fit"	3.0	
	Food handling establishments, Warehouses, Residential Living Spaces, Childcare centers/schools	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	29000	
			Single layer, gloves	PHED	"Best fit"	8600	
			Double layer, gloves (B)	PHED	"Best fit"	6200	
		Inhalation	No Respirator	PHED	"Best fit"	1100	
			PF5 (C)	PHED	"Best fit"	220	
			PF10 (D)	PHED	"Best fit"	110	
Mixer / Loader / Applicator, Backpack Sprayer	Poultry/Livestock houses, Industrial/Commercial areas, Livestock treatments, Structural treatments	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	2510	
			Single layer, gloves	PHED	"Best fit"	2500	
			Double layer, gloves (B)	PHED	"Best fit"	1600	
		Inhalation	No Respirator	PHED	"Best fit"	30	
			PF5 (C)	PHED	"Best fit"	6.0	
			PF10 (D)	PHED	"Best fit"	3.0	
		Greenhouses	Dermal	Single layer, no gloves (A)	AHETF	Mean	13200
				Single layer, gloves	AHETF	Mean	11200
				Double layer, gloves (B)	AHETF	Mean	6230
	Inhalation		No Respirator	AHETF	Mean	140	
			PF5 (C)	AHETF	Mean	28	
			PF10 (D)	AHETF	Mean	14	
	Nurseries, Christmas Tree Farms, Wildlife management, Rights-of-way, Forestry, Landscaping (turf/plants/bushes/trees),	Dermal	Single layer, no gloves (A)	AHETF (MEA, fRA)	Mean	58400	
			Single layer, gloves	AHETF (MEA, fRA)	Mean	30500	
			Double layer, gloves (B)	AHETF (MEA, fRA)	Mean	16900	
		Inhalation	No Respirator	AHETF	Mean	69.1	
			PF5 (C)	AHETF	Mean	13.8	
			PF10 (D)	AHETF	Mean	6.9	
	Dermal	Single layer, no gloves (A)	MRID 44339801	Mean	8260		

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	Foundation/perimeter treatments, Aquatic areas ⁴			Single layer, gloves	MRID 44339801	Mean	8260		
				Double layer, gloves (B)	MRID 44339801	Mean	4120		
			Inhalation	No Respirator	MRID 44339801	Mean	2.58		
				PF5 (C)	MRID 44339801	Mean	0.516		
				PF10 (D)	MRID 44339801	Mean	0.258		
	Ground/Soil-directed (e.g., drench treatments, herbicides in orchards, vineyards, and tree farms) ⁵	Dermal	Single layer, no gloves (A)	MRID 44339801	Mean	8260			
			Single layer, gloves	MRID 44339801	Mean	8260			
			Double layer, gloves (B)	MRID 44339801	Mean	4120			
		Inhalation	No Respirator	MRID 44339801	Mean	2.58			
			PF5 (C)	MRID 44339801	Mean	0.516			
			PF10 (D)	MRID 44339801	Mean	0.258			
	Granule formulation applications	Dermal	Single layer, no gloves (A)	MRID 45167201	Mean	155			
			Single layer, gloves	MRID 45167201	Mean	144			
			Double layer, gloves (B)	MRID 45167201	Mean	72.6			
		Inhalation	No Respirator	MRID 45250702	Mean	23.8			
MRID 45167201									
PF5 (C)			MRID 45250702	Mean	4.76				
			MRID 45167201						
PF10 (D)			MRID 45250702	Mean	2.38				
			MRID 45167201						
Mixer / Loader / Applicator, Mechanically-pressurized Handgun Sprayer	Orchards, Vineyards, Specialty Agricultural Crops, Rights-of-way, Nurseries, Landscaping (non-turf), Industrial/Commercial areas, Aquatic areas, Wildlife management, Christmas Tree farms	General Broadcast/Foliar Applications	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	6050		
				Single layer, gloves	AHETF (MEA)	Mean	2050		
				Double layer, gloves (B)	AHETF (MEA)	Mean	1360		
			Inhalation	No Respirator	AHETF	Mean	8.68		
				PF5 (C)	AHETF	Mean	1.74		
				PF10 (D)	AHETF	Mean	0.87		
			Drench/Soil-directed Applications	All formulations, except wettable powders	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	6050
						Single layer, gloves	AHETF (MEA)	Mean	2050
						Double layer, gloves (B)	AHETF (MEA)	Mean	1360
	Inhalation	No Respirator		AHETF	Mean	8.68			
		PF5 (C)		AHETF	Mean	1.74			
		PF10 (D)		AHETF	Mean	0.87			
	Wettable Powders	Dermal	Single layer, no gloves (A)	MRID 45773201	Mean	4310			
			Single layer, gloves	MRID 45773201	Mean	4310			
			Double layer, gloves (B)	MRID 45773201	Mean	2160			
Inhalation		No Respirator	MRID 45773201	Mean	3931				

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Greenhouses, Mushroom houses	Structural, Warehouses, Poultry/livestock houses, Livestock treatments		Dermal	PF5 (C)	MRID 45773201	Mean	786
				PF10 (D)	MRID 45773201	Mean	393
			Dermal	Single layer, no gloves	PHED	"Best fit"	1800
				Single layer, gloves	PHED	"Best fit"	640
				Double layer, gloves (B)	PHED	"Best fit"	365
			Inhalation	No Respirator	PHED	"Best fit"	79
	PF5 (C)	PHED		"Best fit"	15.8		
	PF10 (D)	PHED		"Best fit"	7.9		
	General Broadcast/Foliar Applications	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	3500	
			Single layer, gloves	PHED	"Best fit"	2500	
			Double layer, gloves (B)	PHED	"Best fit"	1600	
		Inhalation	No Respirator	PHED	"Best fit"	120	
			PF5 (C)	PHED	"Best fit"	24	
			PF10 (D)	PHED	"Best fit"	12	
		All formulations, except wettable powders	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	3500
				Single layer, gloves	PHED	"Best fit"	2500
				Double layer, gloves (B)	PHED	"Best fit"	1600
			Inhalation	No Respirator	PHED	"Best fit"	120
				PF5 (C)	PHED	"Best fit"	24
				PF10 (D)	PHED	"Best fit"	12
	Drench/Soil-directed Applications	Dermal	Single layer, no gloves (A)	MRID 45773201	Mean	4310	
			Single layer, gloves	MRID 45773201	Mean	4310	
			Double layer, gloves (B)	MRID 45773201	Mean	2160	
		Inhalation	No Respirator	MRID 45773201	Mean	3931	
			PF5 (C)	MRID 45773201	Mean	786	
			PF10 (D)	MRID 45773201	Mean	393	
	Turf (lawns, fields, golf courses)	Liquids	Dermal	Single layer, no gloves (A)	ORETF	Mean	1140
				Single layer, gloves	ORETF	Mean	880
Double layer, gloves (B)				ORETF	Mean	450	
Inhalation			No Respirator	ORETF	Mean	1.9	
			PF5 (C)	ORETF	Mean	0.38	
			PF10 (D)	ORETF	Mean	0.19	
Water-dispersible Granules		Dermal	Single layer, no gloves (A)	ORETF	Mean	1960	
			Single layer, gloves	ORETF	Mean	1400	
			Double layer, gloves (B)	ORETF	Mean	740	
Inhalation		No Respirator	ORETF	Mean	42		

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		Wettable Powders	Dermal	PF5 (C)	ORETF	Mean	8.40
				PF10 (D)	ORETF	Mean	4.20
			Inhalation	Single layer, no gloves (A)	ORETF	Mean	1650
				Single layer, gloves	ORETF	Mean	1210
				Double layer, gloves (B)	ORETF	Mean	630
				No Respirator	ORETF	Mean	250
		Water-soluble Packets	Dermal	PF5 (C)	ORETF	Mean	50
				PF10 (D)	ORETF	Mean	25
				Single layer, no gloves (A)	ORETF	Mean	1350
			Inhalation	Single layer, gloves	ORETF	Mean	855
		Double layer, gloves (B)		ORETF	Mean	458	
		No Respirator		ORETF	Mean	18	
		Mixer / Loader / Applicator, Fogging Equipment (handheld, portable, stationary)	Inhalation	PF5 (C)	ORETF	Mean	0.38
				PF10 (D)	ORETF	Mean	0.19
No data available							
No Respirator	MRID 49602401			Mean	8916		
Mixer / Loader / Applicator, Fogging Equipment (handheld, portable, stationary)	Inhalation	PF5 (C)	MRID 49602401	Mean	1783		
		PF10 (D)	MRID 49602401	Mean	892		
		Applicator not present, exposure assumed negligible.					
Applicator, Stationary Fogger (with re-entry restriction)		Applicator not present, exposure assumed negligible.					
Applicator, Truck-mounted Fogger	Dermal	Single layer, no gloves (A)	AHETF	Mean	1770		
		Single layer, gloves	AHETF	Mean	1590		
		Single layer, gloves, chemical-resistant hat	AHETF (MEA)	Mean	215		
		Double layer, gloves (B)	AHETF	Mean	1480		
		Double layer, gloves, chemical-resistant hat (B)	AHETF (MEA)	Mean	141		
		Engineering control (Enclosed Cab)	AHETF (MEA)	Mean	14.6		
	Inhalation	No Respirator	AHETF	Mean	4.71		
		PF5 (C)	AHETF	Mean	0.942		
		PF10 (D)	AHETF	Mean	0.471		
		Engineering control (Enclosed Cab)	AHETF	Mean	0.068		
Applicator, Termiticide Injection	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	1300		
		Single layer, gloves	PHED	"Best fit"	360		
		Double layer, gloves (B)	PHED	"Best fit"	250		

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	Inhalation	No Respirator	PHED	"Best fit"	2.2		
		PF5 (C)	PHED	"Best fit"	0.44		
		PF10 (D)	PHED	"Best fit"	0.22		
Pour in/on	Liquids	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	220	
			Single layer, gloves	AHETF (MEA)	Mean	37.6	
			Double layer, gloves (B)	AHETF (MEA)	Mean	29.1	
			Engineering control (closed loading system)	PHED	"Best fit"	8.6	
			Inhalation	No Respirator	AHETF	Mean	0.219
				PF5 (C)	AHETF	Mean	0.044
				PF10 (D)	AHETF	Mean	0.022
	Engineering control (closed loading system)	PHED		"Best fit"	0.083		
	Granules	Dermal	Single layer, no gloves	PHED	"Best fit"	8.4	
			Single layer, gloves	PHED	"Best fit"	6.9	
			Double layer, gloves	PHED	"Best fit"	3.4	
			Engineering control (closed loading system)	PHED	"Best fit"	8.6	
		Inhalation	No Respirator	PHED	"Best fit"	1.7	
			PF5 (C)	PHED	"Best fit"	0.34	
			PF10 (D)	PHED	"Best fit"	0.17	
	Engineering control (closed loading system)	PHED	"Best fit"	0.083			
	Dusts	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	227	
			Single layer, gloves	AHETF (MEA)	Mean	51.6	
			Double layer, gloves (B)	AHETF (MEA)	Mean	41.2	
			Engineering control (water-soluble packaging)	AHETF (MEA)	Mean	12.5	
Inhalation		No Respirator	AHETF	Mean	8.96		
		PF5 (C)	AHETF	Mean	1.79		
		PF10 (D)	AHETF	Mean	0.896		
		Engineering control (water-soluble packaging)	AHETF	Mean	2.6		
Animal (pet and livestock) Treatments	Back rubber	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	220	
			Single layer, gloves	AHETF (MEA)	Mean	37.6	
			Double layer, gloves (B)	AHETF (MEA)	Mean	29.1	

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	Collar	Inhalation	No Respirator	AHETF	Mean	0.219	
			PF5 (C)	AHETF	Mean	0.044	
			PF10 (D)	AHETF	Mean	0.022	
		Dermal	Single layer, no gloves (A)	MRID 44433303	Mean	112000	
			Single layer, gloves	MRID 44433303	Mean	67800	
			Double layer, gloves (B)	MRID 44433303	Mean	42000	
			Inhalation	No Respirator	Applicator inhalation exposure expected to be negligible.		
				PF5 (C)			
				PF10 (D)			
	Dip	Dermal	Single layer, no gloves (F)	MRID 45528801	Mean	54300	
			Single layer, gloves (F, E)	MRID 45528801	Mean	53400	
			Double layer, gloves (G, E)	MRID 45528801	Mean	25600	
		Inhalation	No Respirator	MRID 45528801	Mean	26.6	
			PF5 (C)	MRID 45528801	Mean	5.33	
			PF10 (D)	MRID 45528801	Mean	2.66	
	Dust bag	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	227	
			Single layer, gloves	AHETF (MEA)	Mean	51.6	
			Double layer, gloves (B)	AHETF (MEA)	Mean	41.2	
		Inhalation	No Respirator	AHETF	Mean	8.96	
			PF5 (C)	AHETF	Mean	1.79	
			PF10 (D)	AHETF	Mean	0.90	
	Ear tag		Applicator exposure expected to be negligible; chemical-resistant gloves recommended.				
	Feed-through	Liquids	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	220
				Single layer, gloves	AHETF (MEA)	Mean	37.6
				Double layer, gloves (B)	AHETF (MEA)	Mean	29.1
			Inhalation	No Respirator	AHETF	Mean	0.219
				PF5 (C)	AHETF	Mean	0.044
PF10 (D)				AHETF	Mean	0.022	
Dust		Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	227	
			Single layer, gloves	AHETF (MEA)	Mean	51.6	
			Double layer, gloves (B)	AHETF (MEA)	Mean	41.2	
		Inhalation	No Respirator	AHETF	Mean	8.96	
			PF5 (C)	AHETF	Mean	1.79	
			PF10 (D)	AHETF	Mean	0.90	
Granules		Dermal	Single layer, no gloves	PHED	"Best fit"	8.4	
			Single layer, gloves	PHED	"Best fit"	6.9	

**USEPA / Office of Pesticide Programs / Health Effects Division
Occupational Pesticide Handler Unit Exposure Surrogate Reference Table**

Exposure Scenario (Activity, Equipment, Formulation, Site, etc.) ¹		Exposure Route	Personal Protective Equipment (PPE) Level ²	Data Source ^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)
Shampoo	Inhalation	Double layer, gloves	PHED	"Best fit"	3.4	
		No Respirator	PHED	"Best fit"	1.7	
		PF5 (C)	PHED	"Best fit"	0.34	
		PF10 (D)	PHED	"Best fit"	0.17	
	Dermal	Single layer, no gloves (F)	MRID 44658401	Mean	2098000	
		Single layer, gloves (E, F)	MRID 44658401	Mean	2052000	
		Double layer, gloves (E, B)	MRID 44658401	Mean	1029000	
		Inhalation	No Respirator	MRID 44658401	Mean	292
			PF5 (C)	MRID 44658401	Mean	58.4
			PF10 (D)	MRID 44658401	Mean	29.2
	Sponge	Dermal	Single layer, no gloves (F)	MRID 45528801	Mean	844000
			Single layer, gloves (F, E)	MRID 45528801	Mean	767000
			Double layer, gloves (G, E)	MRID 45528801	Mean	386000
		Inhalation	No Respirator	MRID 45528801	Mean	208
			PF5 (C)	MRID 45528801	Mean	41.6
			PF10 (D)	MRID 45528801	Mean	20.8
	Spot-on	Dermal	Single layer, no gloves (A)	MRID 44433303	Mean	112000
			Single layer, gloves	MRID 44433303	Mean	67800
Double layer, gloves (B)			MRID 44433303	Mean	42000	
Inhalation		No Respirator	Applicator inhalation exposure expected to be negligible.			
		PF5 (C)				
		PF10 (D)				
Loader / applicator, Bulb duster	Dermal	Single layer, no gloves	ORETF	Mean	166000	
		Single layer, gloves (E)	ORETF	Mean	24700	
		Double layer, gloves (E, B)	ORETF	Mean	20600	
	Inhalation	No Respirator	ORETF	Mean	1690	
		PF5 (C)	ORETF	Mean	338	
		PF10 (D)	ORETF	Mean	169	
Applicator, Wipe/Towelette	Dermal	Single layer, no gloves	AEATFII	Mean	2380000	
		Single layer, gloves (E)	AEATFII	Mean	238000	
		Double layer, gloves (E, B)	AEATFII	Mean	238000	
	Inhalation	No Respirator	AEATFII	Mean	480	
		PF5 (C)	AEATFII	Mean	96	
		PF10 (D)	AEATFII	Mean	48	
Loader / applicator, Cup	Dermal	Single layer, no gloves	MRID 45333401	Mean	112	
		Single layer, gloves (E)	MRID 45333401	Mean	11.2	

**USEPA / Office of Pesticide Programs / Health Effects Division
Occupational Pesticide Handler Unit Exposure Surrogate Reference Table**

Exposure Scenario (Activity, Equipment, Formulation, Site, etc.) ¹	Exposure Route	Personal Protective Equipment (PPE) Level ²	Data Source ^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)					
	Inhalation	Double layer, gloves (E)	MRID 45333401	Mean	11.2					
		No Respirator	MRID 45333401	Mean	12.5					
		PF5 (C)	MRID 45333401	Mean	2.51					
		PF10 (D)	MRID 45333401	Mean	1.25					
Loader / applicator, Spoon	Dermal	Single layer, no gloves (A, F)	MRID 45250702	Mean	4170					
		Single layer, gloves (F)	MRID 45250702	Mean	3030					
		Double layer, gloves (A, G)	MRID 45250702	Mean	1580					
	Inhalation	No Respirator	MRID 45250702	Mean	121					
		PF5 (C)	MRID 45250702	Mean	24.3					
		PF10 (D)	MRID 45250702	Mean	12.1					
Single-use Injection (gels/pastes)	Applicator exposure expected to be negligible.									
Loader / applicator, Plunger duster	Dermal	Single layer, no gloves	ORETF	Mean	166000					
		Single layer, gloves (E)	ORETF	Mean	24700					
		Double layer, gloves (E, B)	ORETF	Mean	20600					
	Inhalation	No Respirator	ORETF	Mean	1690					
		PF5 (C)	ORETF	Mean	338					
		PF10 (D)	ORETF	Mean	169					
Applicator, Total-release Fogger	Applicator exposure expected to be negligible.									
Applicator, Tree Injection	Applicator exposure expected to be negligible.									
Applicator, Trigger-spray Bottle	Dermal	Single layer, no gloves (A)	ORETF	Mean	3660					
		Single layer, gloves	ORETF	Mean	1800					
		Double layer, gloves (B)	ORETF	Mean	1110					
	Inhalation	No Respirator	ORETF	MRID 41054701 MRID 44739301	Mean	61.2				
			PF5 (C)				ORETF	MRID 41054701 MRID 44739301	Mean	12.2
			PF10 (D)				ORETF			
		Dermal	Single layer, no gloves (F)	MRID 44433302	Mean	544000				
			Single layer, gloves (F, E)	MRID 44433302	Mean	503000				
			Double layer, gloves (G, E)	MRID 44433302	Mean	273000				
	Inhalation	No Respirator	MRID 44433302	Mean	3300					
		PF5 (C)	MRID 44433302	Mean	654					

**USEPA / Office of Pesticide Programs / Health Effects Division
Occupational Pesticide Handler Unit Exposure Surrogate Reference Table**

Exposure Scenario (Activity, Equipment, Formulation, Site, etc.) ¹		Exposure Route	Personal Protective Equipment (PPE) Level ²	Data Source ^{3,4,5}	Statistic	Unit Exposure (µg/lb ai)
			PF10 (D)	MRID 44433302	Mean	327
Applicator, Shaker can	Granules	Dermal	Single layer, no gloves	MRID 45333401	Mean	112
			Single layer, gloves (E)	MRID 45333401	Mean	11.2
			Double layer, gloves (E)	MRID 45333401	Mean	11.2
		Inhalation	No Respirator	MRID 45333401	Mean	12.5
			PF5 (C)	MRID 45333401	Mean	2.51
			PF10 (D)	MRID 45333401	Mean	1.25
	Dusts	Dermal	Single layer, no gloves	MRID 44439901	Mean	4042000
				MRID 45519601		
			Single layer, gloves	MRID 44439901	Mean	110000
				MRID 45519601		
		Double layer, gloves (B)	MRID 44439901	Mean	72600	
			MRID 45519601			
		Inhalation	No Respirator	MRID 44439901	Mean	17500
				MRID 45519601		
PF5 (C)	MRID 44439901		Mean	3500		
	MRID 45519601					
PF10 (D)	MRID 44439901	Mean	1750			
	MRID 45519601					
Trap/bait station	Re-fillable	Dermal	Single layer, no gloves (A)	PHED	"Best fit"	104000
			Single layer, gloves	PHED	"Best fit"	71000
			Double layer, gloves (B)	PHED	"Best fit"	40280
		Inhalation	No Respirator	PHED	"Best fit"	470
			PF5 (C)	PHED	"Best fit"	94
			PF10 (D)	PHED	"Best fit"	47
	Single-use	Applicator exposure expected to be negligible.				

¹ If the description of the scenario is silent on specific equipment, sites, formulations, etc., the data is applicable to all potential applications for that scenario.

² Single layer = long-sleeve shirt, long pants, shoes plus socks. Double layer = "coveralls" in addition to single layer.

Exposure monitoring data representing all levels of PPE for all scenarios is unavailable. In order to represent different PPE levels, exposure values are calculated using assumptions for the protection afforded by additional layers of clothing, chemical-resistant gloves, or respirators. Exposure assessors should be mindful of the uncertainties that this convention introduces into the overall calculations. In all cases, estimates based on direct measurements representing the PPE-level specified are the most reliable. If a scenario uses PPE calculation assumptions, they are identified in the table with one or more of the following notations:

- (A) "No glove" hand exposure back-calculated from available "gloved hand" exposure data by multiplying by 10 (i.e., chemical-resistant gloves are assumed to reduce hand exposure by 90%).
- (B) "Double layer" body exposure calculated from available "single layer" body exposure data by dividing by 2 (i.e., an additional layer of clothing is assumed to reduce body exposure by 50%).
- (C) "PF5" respirator exposure calculated from available "no respirator" exposure data by dividing by 5 (i.e., a PF5 respirator is assumed to reduce inhalation exposure by 80%).
- (D) "PF10" respirator exposure calculated from available "no respirator" exposure data by dividing by 10 (i.e., a PF10 respirator is assumed to reduce inhalation exposure by 90%).
- (E) "Gloved" hand exposure calculated from available "no glove" hand exposure data by dividing by 10 (i.e., chemical-resistant gloves are assumed to reduce hand exposure by 90%).

**USEPA / Office of Pesticide Programs / Health Effects Division
Occupational Pesticide Handler Unit Exposure Surrogate Reference Table**

Exposure Scenario (Activity, Equipment, Formulation, Site, etc.)¹	Exposure Route	Personal Protective Equipment (PPE) Level²	Data Source^{3,4,5}	Statistic	Unit Exposure ($\mu\text{g}/\text{lb ai}$)
<p>(F) "Single layer" body exposure calculated from available "total deposition" body exposure data by dividing by 2 (i.e., an additional layer of clothing is assumed to reduce body exposure by 50%).</p> <p>(G) "Double layer" body exposure calculated from available "total deposition" body exposure data by dividing by 4 (i.e., two layers of clothing are assumed to reduce body exposure by 75%).</p> <p>If a scenario does not have one of these notations, the data underlying the recommended values is a direct match for the indicated level of PPE.</p> <p>³ PHED = Pesticide Handler Exposure Database; AHETF = Agricultural Handler Exposure Task Force; ORETF = Outdoor Residential Exposure Task Force; MRID = Master Record Identification (#).</p> <p>⁴ Where applicable, the notation "MEA" is added to signify that the default values reflect an (upward) adjustment by the U.S. EPA for potential inefficiency of the hand wash and face/neck wipe exposure monitoring methods. MEA = Method Efficiency Adjustment.</p> <p>⁵ Where applicable, the notation "fRA" is added to signify that the default value reflects an (upward) adjustment by the U.S. EPA to reflect that the underlying data did not meet benchmark accuracy objectives. fRA = fold Relative Accuracy.</p> <p>⁶ Due to the effect that the back-calculation from "gloved hands" to represent "non-gloved hands" has on distributional variability and parametric estimates, no adjustment was made to hand measurements to represent unit exposures for "single layer, no gloves". That is, the unit exposure for "single layer, gloves" is also assigned to "single layer, no gloves".</p>					

Attachment 1
Documentation of Revisions

Date	Documentation of Revisions
Apr2011	<ul style="list-style-type: none"> • Original version, modeled based on “PHED Surrogate Guide” • Reflects move from data from PHED to AHETF for following scenarios <ul style="list-style-type: none"> ○ Open Cab Groundboom ○ Open Mix/Load Liquids ○ Open Mix/Load Dry Flowable • Published EPA webpage on occupational pesticide handler exposure, including link to reference table
May2011	<ul style="list-style-type: none"> • Replaced PHED values for “Closed Cab Airblast” with those from AHETF
Jun2011	<ul style="list-style-type: none"> • Replaced PHED values for “Open Cab Airblast” with those from AHETF • Corrected unit exposure for “Mixer / Loader / Applicator, Low-pressure Handwand, Wettable Powder, Double layer, gloves” from 620 µg/lb ai to 6200 µg/lb ai
Sep2011	<ul style="list-style-type: none"> • Reflects overhaul of exposure scenario assignment of available surrogate data <ul style="list-style-type: none"> ○ New scenarios added (e.g., pet/animal treatments) ○ Scenario subsets added (e.g., power handgun site subsets) ○ Available individual proprietary studies assigned • Footnotes edited • Orientation changed to landscape to accommodate scenario additions
Mar2012	<ul style="list-style-type: none"> • Corrected “Dip” and “Sponge” inhalation unit exposures to reflect use of ½ LOD without correction for field fortification per standard policy • Corrected “Mixing / Loading Liquids” inhalation unit exposures to 2 significant figures • Removed PPE footnote notation “(H)” since that does not apply to any scenario • Corrected PPE notations for “Spoon” scenario to reflect exposure monitoring of “total deposition with chemical-resistant gloves” • For “Mechanically-pressurized Handgun Sprayer”, added “Specialty Agricultural Crops” to a sub-set category • Added “Documentation of Revisions” as an attachment
Mar2013	<ul style="list-style-type: none"> • Aerial Applicator scenario: PHED replaced with data from the AHETF • Re-assigned MRID45773201 to drench/soil-directed applications of wettable powders only • Footnote (G) typographical correction: “100%” corrected to “75%” (unit exposures are unchanged)
Sept2015	<ul style="list-style-type: none"> • Additional livestock treatment scenarios incorporated (backpack and mechanically-pressurized handgun) • Wildlife management incorporated into mechanically-pressurized handgun scenario • Mushroom houses incorporated into mechanically-pressurized handgun scenario and manually-pressurized handwand scenario • Granule formulations added to “animal, feed-through” scenario • Characterized Animal treatments as “Pet” or “Livestock” • Incorporated new data from AHETF for backpack applicator and mechanically-pressurized handgun applicators in rights-of-ways and other similar use patterns. • Added tree injection applicator scenario.
Nov2016	<ul style="list-style-type: none"> • Incorporated new data from AHETF for mixing/loading wettable powders and mixing/loading water-soluble packets • Added clarifying footnotes to the “Data Source” • Added scenario for “Mixer/Loader/Applicator, Fogging Equipment (handheld, portable, stationary)” • Added scenario for “Applicator, Truck-mounted Fogger” • Added scenario for “Applicator, Stationary Fogger (with re-entry restriction)” • Added scenario for “Applicator, Wipe/Towelette”

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| | <ul style="list-style-type: none">• Revised table formatting for “Applicator, Pour in/on” scenario |
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