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

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

March 2020

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)**
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
		PF10 (C)	AHETF	Mean	0.896
		PF50 (D)	AHETF	Mean	0.179
		Engineering control (water-soluble packaging)	AHETF	Mean	2.6
Mixing / Loading Granules	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	23.6
		Single layer, gloves	AHETF (MEA)	Mean	8.12
		Double layer, gloves (B)	AHETF (MEA)	Mean	5.80
		Engineering control (closed loading system)	PHED	"Best fit"	8.6
	Inhalation	No Respirator	AHETF	Mean	0.825
		PF10 (C)	AHETF	Mean	0.083
		PF50 (D)	AHETF	Mean	0.017
		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
		PF10 (C)	AHETF	Mean	0.022
		PF50 (D)	AHETF	Mean	0.0044
		Engineering control (closed loading system)	PHED	"Best fit"	0.083
Mixing / Loading Microencapsulates	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

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)**
Mixing / Loading Wettable Powders		Inhalation	No Respirator	AHETF	Mean	0.219
			PF10 (C)	AHETF	Mean	0.022
			PF50 (D)	AHETF	Mean	0.0044
			Engineering control (closed loading system)	PHED	"Best fit"	0.083
		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
		Inhalation	No Respirator	AHETF	Mean	2.75
			PF10 (C)	AHETF	Mean	0.275
			PF50 (D)	AHETF	Mean	0.055
			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	Mean	0.523
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	Mean	1041
			PF10 (C)	PHED	Mean	104.1
			PF50 (D)	PHED	Mean	20.82
	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
			PF10 (C)	MRID 44433302	Mean	327
			PF50 (D)	MRID 44433302	Mean	66
Applicator, Open Cab Airblast		Dermal	Single layer, no gloves (A)	AHETF	Mean	1770

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	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
		PF10 (C)	AHETF	Mean	0.471
		PF50 (D)	AHETF	Mean	0.094
		Engineering control (Enclosed Cab)	AHETF	Mean	0.068
Applicator, Open Cab Groundboom (tractor- and boat-mounted boom sprayers)	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
		PF10 (C)	AHETF	Mean	0.034
		PF50 (D)	AHETF	Mean	0.0068
		Engineering control (Enclosed Cab)	PHED	Mean	0.02
Applicator, Open Cab Solid Broadcast Spreader (tractor- and boat-drawn spreaders)	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	Mean	0.518
		PF10 (C)	PHED	Mean	0.0518
		PF50 (D)	PHED	Mean	0.01
		Engineering control (Enclosed Cab)	PHED	Mean	0.109
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

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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)**
Loader/Applicator, Brush/roller		Inhalation	No Respirator	PHED	Mean	380
			PF10 (C)	PHED	Mean	38
			PF50 (D)	PHED	Mean	7.6
		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	Mean	197
			PF10 (C)	PHED	Mean	19.7
			PF50 (D)	PHED	Mean	3.94
Loader/Applicator, Airless Sprayer		Dermal	Single layer, no gloves	PHED / MRID 43600102	Mean	42600
			Single layer, gloves (E)	PHED / MRID 43600102	Mean	11700
			Double layer, gloves (B, E)	PHED / MRID 43600102	Mean	10600
		Inhalation	No Respirator	PHED / MRID 43600102	Mean	560
			PF10 (C)	PHED / MRID 43600102	Mean	56
			PF10 (C)	PHED / MRID 43600102	Mean	11.2
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	Mean	0.202
			PF10 (C)	PHED	Mean	0.02
			PF50 (D)	PHED	Mean	0.004
	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	Mean	0.127
			PF10 (C)	PHED	Mean	0.0127
			PF50 (D)	PHED	Mean	0.0025
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

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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)
Loader / Applicator, "Push-type" Rotary Spreader		Inhalation	No Respirator	PHED	Mean	80.6
			PF10 (C)	PHED	Mean	8.06
			PF50 (D)	PHED	Mean	1.61
		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
			PF10 (C)	ORETF	Mean	1.0
			PF50 (D)	ORETF	Mean	0.2
Mixer / Loader / Applicator, Manually-pressurized Handwand	Greenhouses, Wildlife management, Nurseries, Landscaping (turf, trees/bushes/shrubs, plants/flowers), Industrial/Commercial areas, Barn/Feedlot, Poultry house/bird treatment, Animal treatments, Interior landscaping, Aquatic areas, Exterior building components, Mushroom houses, Christmas Tree Farms, Mounds/nests	Dermal	Single layer, no gloves	PHED	"Best fit"	100000
			Single layer, gloves	PHED	"Best fit"	430
			Double layer, gloves (B)	PHED	"Best fit"	365
		Inhalation	No Respirator	PHED	Mean	23.6
			PF10 (C)	PHED	Mean	2.36
			PF50 (D)	PHED	Mean	0.472
	Food handling establishments, Warehouses, Structural treatments, 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	Mean	1044
			PF10 (C)	PHED	Mean	104
			PF50 (D)	PHED	Mean	21
Mixer / Loader / Applicator, Backpack Sprayer	General Broadcast/Foliar Applications	Poultry house/bird treatments, Barn/Feedlot, Industrial/Commercial areas, Animal/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	Mean	27.6
			PF10 (C)	PHED	Mean	2.76
			PF50 (D)	PHED	Mean	0.552
		Greenhouses	Dermal	Single layer, no gloves (A)	AHETF	Mean	13200
				Single layer, gloves	AHETF	Mean	11200

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)
				Double layer, gloves (B)	AHETF	Mean	6230
			Inhalation	No Respirator	AHETF	Mean	140
				PF10 (C)	AHETF	Mean	14
				PF50 (D)	AHETF	Mean	2.8
		Nurseries, Christmas Tree Farms, Wildlife management, Rights-of-way, Forestry, Conifer Plantations, Landscaping (turf/plants/bushes/trees)	Dermal	Single layer, no gloves (A)	AHETF (MEA, *f*RA)	Mean	58400
				Single layer, gloves	AHETF (MEA, *f*RA)	Mean	30500
				Double layer, gloves (B)	AHETF (MEA, *f*RA)	Mean	16900
			Inhalation	No Respirator	AHETF	Mean	69.1
				PF10 (C)	AHETF	Mean	6.91
				PF50 (D)	AHETF	Mean	1.38
		Foundation/perimeter treatments, Aquatic areas[4]	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
				PF10 (C)	MRID 44339801	Mean	0.258
				PF50 (D)	MRID 44339801	Mean	0.052
	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
				PF10 (C)	MRID 44339801	Mean	0.258
				PF50 (D)	MRID 44339801	Mean	0.052
	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 MRID 45167201	Mean	23.8
				PF10 (C)	MRID 45250702 MRID 45167201	Mean	2.38
				PF50 (D)	MRID 45250702 MRID 45167201	Mean	0.476
Mixer / Loader / Applicator, Mechanically-pressurized Handgun Sprayer	Orchards, Vineyards, Specialty Agricultural Crops, Rights-of-way, Landscaping (non-turf), Industrial/Commercial areas, Aquatic areas, Wildlife management, Christmas Tree farms		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
				PF10 (C)	AHETF	Mean	0.868

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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)
			PF50 (D)	AHETF	Mean	0.174
Structural treatments, Warehouses, Poultry house/bird treatments, Barn/Feedlot, Animal/Livestock treatments		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	Mean	45.5
			PF10 (C)	PHED	Mean	4.55
			PF50 (D)	PHED	Mean	0.91
Greenhouses, Nurseries, Mushroom houses		Dermal	Single layer, no gloves (A)	AHETF (*f*RA)	Mean	5950
			Single layer, gloves	AHETF (*f*RA)	Mean	3610
			Double layer, gloves (B)	AHETF (*f*RA)	Mean	2990
		Inhalation	No Respirator	AHETF	Mean	448
			PF10 (C)	AHETF	Mean	44.8
			PF50 (D)	AHETF	Mean	8.96
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
			PF10 (C)	ORETF	Mean	0.19
			PF50 (D)	ORETF	Mean	0.038
	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
			PF10 (C)	ORETF	Mean	4.2
			PF50 (D)	ORETF	Mean	0.84
	Wettable Powders	Dermal	Single layer, no gloves (A)	ORETF	Mean	1650
			Single layer, gloves	ORETF	Mean	1210
			Double layer, gloves (B)	ORETF	Mean	630
		Inhalation	No Respirator	ORETF	Mean	250
			PF10 (C)	ORETF	Mean	25
			PF50 (D)	ORETF	Mean	5
	Water-soluble Packets	Dermal	Single layer, no gloves (A)	ORETF	Mean	1350
			Single layer, gloves	ORETF	Mean	855
			Double layer, gloves (B)	ORETF	Mean	458
		Inhalation	No Respirator	ORETF	Mean	18
			PF10 (C)	ORETF	Mean	1.8

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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)
				PF50 (D)	ORETF	Mean	0.36
Mixer / Loader / Applicator, Handheld/Portable Fogger/Mister			Dermal	No data available			
			Inhalation	No Respirator	MRID 49602401	Mean	8916
				PF10 (C)	MRID 49602401	Mean	892
				PF50 (D)	MRID 49602401	Mean	178
Mixer / Loader / Applicator, Stationary/Automatic Fogger/Mister (without re-entry restriction)			Dermal	No data available			
			Inhalation	No Respirator	MRID 49602401	Mean	8916
				PF10 (C)	MRID 49602401	Mean	892
				PF50 (D)	MRID 49602401	Mean	178
Applicator, Stationary/Automatic Fogger/Mister (with re-entry restriction)			Applicator not present, exposure assumed negligible.				
Applicator, Truck-mounted Fogger/Mister			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
				PF10 (C)	AHETF	Mean	0.471
				PF50 (D)	AHETF	Mean	0.094
				Engineering control (Enclosed Cab)	AHETF	Mean	0.068
Mixer/Loader/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
			Inhalation	No Respirator	PHED	Mean	2.79
				PF10 (C)	PHED	Mean	0.279
				PF50 (D)	PHED	Mean	0.056
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
			Inhalation	No Respirator	AHETF	Mean	0.219
				PF10 (C)	AHETF	Mean	0.022

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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)**
			PF50 (D)	AHETF	Mean	0.0044
	Granules	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	23.6
			Single layer, gloves	AHETF (MEA)	Mean	8.12
			Double layer, gloves (B)	AHETF (MEA)	Mean	5.80
		Inhalation	No Respirator	AHETF	Mean	0.825
			PF10 (C)	AHETF	Mean	0.083
			PF50 (D)	AHETF	Mean	0.017
	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
			PF10 (C)	AHETF	Mean	0.896
			PF50 (D)	AHETF	Mean	0.179
			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
		Inhalation	No Respirator	AHETF	Mean	0.219
			PF10 (C)	AHETF	Mean	0.022
			PF50 (D)	AHETF	Mean	0.0044
	Collar	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.		
			PF10 (C)			
			PF50 (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
			PF10 (C)	MRID 45528801	Mean	2.66
			PF50 (D)	MRID 45528801	Mean	0.532
	Dust bag	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	227

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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	AHETF (MEA)	Mean	51.6
				Double layer, gloves (B)	AHETF (MEA)	Mean	41.2
			Inhalation	No Respirator	AHETF	Mean	8.96
				PF10 (C)	AHETF	Mean	0.896
				PF50 (D)	AHETF	Mean	0.179
	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
				PF10 (C)	AHETF	Mean	0.022
				PF50 (D)	AHETF	Mean	0.0044
		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
				PF10 (C)	AHETF	Mean	0.896
				PF50 (D)	AHETF	Mean	0.179
		Granules	Dermal	Single layer, no gloves (A)	AHETF (MEA)	Mean	23.6
				Single layer, gloves	AHETF (MEA)	Mean	8.12
				Double layer, gloves (B)	AHETF (MEA)	Mean	5.80
			Inhalation	No Respirator	AHETF	Mean	0.825
				PF10 (C)	AHETF	Mean	0.083
				PF50 (D)	AHETF	Mean	0.017
	Shampoo		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
				PF10 (C)	MRID 44658401	Mean	29.2
				PF50 (D)	MRID 44658401	Mean	5.84
	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
				PF10 (C)	MRID 45528801	Mean	20.8
				PF50 (D)	MRID 45528801	Mean	4.16

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)**
	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.		
			PF10 (C)			
			PF50 (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
			PF10 (C)	ORETF	Mean	169
			PF50 (D)	ORETF	Mean	33.8
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
			PF10 (C)	AEATFII	Mean	48
			PF50 (D)	AEATFII	Mean	9.6
Loader / applicator, Cup		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
			PF10 (C)	MRID 45333401	Mean	1.25
			PF50 (D)	MRID 45333401	Mean	0.25
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
			PF10 (C)	MRID 45250702	Mean	12.1
			PF50 (D)	MRID 45250702	Mean	2.42
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
			PF10 (C)	ORETF	Mean	169

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)
			PF50 (D)	ORETF	Mean	33.8
Applicator, Total-release Fogger		Applicator exposure expected to be negligible.				
Applicator, Tree Injection		Applicator exposure expected to be negligible.				
Applicator, Trigger-spray Bottle	All application sites, except animals	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
			PF10 (C)	ORETF / MRID 41054701 / MRID 44739301	Mean	6.12
			PF50 (D)	ORETF / MRID 41054701 / MRID 44739301	Mean	1.22
	Animal treatments	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
			PF10 (C)	MRID 44433302	Mean	330
			PF50 (D)	MRID 44433302	Mean	66
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
			PF10 (C)	MRID 45333401	Mean	1.25
			PF50 (D)	MRID 45333401	Mean	0.25
	Dusts	Dermal	Single layer, no gloves	MRID 44439901 / MRID 45519601	Mean	4042000
			Single layer, gloves	MRID 44439901 / MRID 45519601	Mean	110000
			Double layer, gloves (B)	MRID 44439901 / MRID 45519601	Mean	72600
		Inhalation	No Respirator	MRID 44439901 / MRID 45519601	Mean	17500
			PF10 (C)	MRID 44439901	Mean	1750

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)**
				MRID 45519601		
			PF50 (D)	MRID 44439901	Mean	350
				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	Mean	380
			PF10 (C)	PHED	Mean	38
			PF50 (D)	PHED	Mean	7.6
	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 are 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 are 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) "PF10" respirator exposure calculated from available "no respirator" exposure data by dividing by 10 (i.e., a PF50 respirator is assumed to reduce inhalation exposure by 90%).
(D) "PF50" respirator exposure calculated from available "no respirator" exposure data by dividing by 50 (i.e., a PF50 respirator is assumed to reduce inhalation exposure by 98%).
(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%).
(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%).
(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%).

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.

[3] PHED = Pesticide Handler Exposure Database; AHETF = Agricultural Handler Exposure Task Force; ORETF = Outdoor Residential Exposure Task Force; MRID = Master Record Identification (#).

[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.

[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.

[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".

Attachment 1
Documentation of Revisions

Date	Documentation of Revisions

Apr2011	• Original version, modeled based on "PHED Surrogate Guide"
	• Reflects move from data from PHED to AHETF for following scenarios
	   o Open Cab Groundboom
	   o Open Mix/Load Liquids
	   o Open Mix/Load Dry Flowable
	• Published EPA webpage on occupational pesticide handler exposure, including link to reference table

May2011	• Replaced PHED values for "Closed Cab Airblast" with those from AHETF
Jun2011	• 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	• Reflects overhaul of exposure scenario assignment of available surrogate data
	   o New scenarios added (e.g., pet/animal treatments)
	   o Scenario subsets added (e.g., power handgun site subsets)
	   o Available individual proprietary studies assigned
	• Footnotes edited
	• Orientation changed to landscape to accommodate scenario additions

Mar2012	• 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	• 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	• 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	• 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"

	• Revised table formatting for "Applicator, Pour in/on" scenario
Jun2018	• Replaced data for Open Pour Loading Granules with new AHETF data. Scenarios effected: Loading Granules as well as Feed-through and Pour in/on • PF5 respirators revised to PF10, bringing EPA up to date with long-standing assumptions and practice by the Occupational Safety and Health Administration (OSHA) and the National Institutes for the Occupational Safety and Health (NIOSH). • PF50 respirators added as a potential PPE option. • Separated and edited the "Mixer/Loader/Applicator, Fogging Equipment (handheld, portable, stationary)" into "Mixer/Loader/Applicator, Handheld/Portable Fogger/Mister" and "Mixer/Loader/Applicator, Automatic/Stationary Fogger/Mister (without re-entry restriction)" • Edited scenario for "Applicator, Truck-mounted Fogger" to "Applicator, Truck-mounted Fogger/Mister" • Edited scenario for "Applicator, Stationary Fogger (with re-entry restriction)" to "Applicator, Stationary/Automatic Fogger/Mister (with re-entry restriction)" • For manually pressurized handwand, clarified Structural treatments by adding a scenario for Exterior building components and moving Structural treatments to a different surrogate dataset • Added scenarios for Microencapsulate formulations with liquid AHETF data as the surrogate dataset • Removed inapplicable engineering control scenarios from Pour in/on scenarios • Edited "Paintbrush/roller" to "Brush/roller" • Corrected inhalation unit exposures for Handgun/Turf/Water-soluble Packets. Previously mistakenly showed values for liquid formulations (i.e., copy/paste error). EPA calculations, however, used correct unit exposures.

March2020	• Added data from new AHETF study AHE1023 (Handgun Applications in Greenhouses/Nurseries), replacing PHED Scenario 35 previously used for greenhouse and mushroom house and replaces AHE1013 previously used for nursery scenarios
	• Removed MRID 45773201 as a surrogate data source [decision made during review of AHE1023 - Handgun Applications in Greenhouses/Nurseries; consideration of influence of formulation (WPs vs DFs) and study deficiencies (pre-measured bags)]
	• Updated select PHED scenarios to refine breathing rate assumption and use of arithmetic mean unit exposure:
	   ○ Applicator/aerial/granules (PHED Scenario 8);
	   ○ Aerosol can, non-animals (PHED Scenario 10);
	   ○ Applicator, Solid Broadcast Spreader, Open and Closed Cab (PHED Scenario 15 and 16);
	   ○ Applicator, Brush/Roller (PHED Scenario 22);
	   ○ Flagger, Liquids (PHED Scenario 25);
	   ○ Flagger, Granules (PHED Scenario 26);
	   ○ Loader/Applicator, Belly Grinder (PHED Scenario 30);
	   ○ Manually-pressurized Handwand (PHED Scenario 32);
	   ○ Manually-pressurized Handwand (PHED Scenario 33);
	   ○ Backpack Sprayer (PHED Scenario 34);
	   ○ Mech Pressurized Handgun (PHED Scenario 19);
	   ○ Applicator, Termiticide Injection (PHED Scenario 37);
	   ○ Applicator, Granules by Hand Dispersal (PHED Scenario 17);
	   ○ Applicator, Groundboom Enclosed Cab (PHED Scenario 14)
	• Added exposure scenarios for applications to "conifer plantations"

	• Revised "Exposure Scenario" labels to match Occupational Handler Exposure Calculator (link)