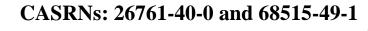
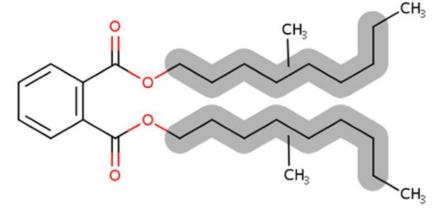


# Draft Environmental Release and Occupational Exposure Assessment for Diisodecyl Phthalate (DIDP)

# **Technical Support Document for the Draft Risk Evaluation**





(Representative Structure)

May 2024

IA	BLE OF CONTENTS	
SUN	AMARY	21
1	INTRODUCTION	
1.	1 Overview	
1.		
2	COMPONENTS OF AN OCCUPATIONAL EXPOSURE AND RELEASE ASSESS	MENT 28
2.	1 Approach and Methodology for Process Descriptions	
2.	2 Approach and Methodology for Estimating Number of Facilities	
2.	3 Environmental Releases Approach and Methodology	
	2.3.1 Identifying Release Sources	30
	2.3.2 Estimating Number of Release Days	30
	2.3.3 Estimating Releases from Models	
	2.3.4 Estimating Releases Using Literature Data	32
2.	4 Occupational Exposure Approach and Methodology	
	2.4.1 Identifying Worker Activities	
	2.4.2 Number of Workers and Occupational Non-users	
	2.4.3 Estimating Inhalation Exposures	
	2.4.3.1 Inhalation Monitoring Data	
	2.4.3.2 Inhalation Exposure Modeling	
	2.4.4 Estimating Dermal Exposures	
	2.4.4.1 Dermal Absorption Data	
	2.4.4.1.1 Dermal Absorption Data Interpretation	
	2.4.4.2 Dermal Absorption Modeling	
	2.4.4.3 Uncertainties in Dermal Absorption Estimation	
	2.4.5 Estimating Acute, Intermediate, and Chronic (Non-cancer) Exposures	
2.	5 Consideration of Engineering Controls and Personal Protective Equipment	
	2.5.1 Respiratory Protection	
	2.5.2 Glove Protection	
2.	6 Evidence Integration for Environmental Releases and Occupational Exposures	43
3	ENVIRONMENTAL RELEASE AND OCCUPATIONAL EXPOSURE ASSESSME BY OES	
3.		
5.	3.1.1 Process Description	
	3.1.2 Facility Estimates	
	3.1.3 Release Assessment	
	3.1.3.1 Environmental Release Points	
	<b>3 I 3 I Environmental Release Points</b>	// 6

3.1.4

3.2

3.2.1

3.1.4.1

3.1.4.2

3.1.4.3

3.1.4.4

3.1.4.5

Occupational Aggregate Exposure Results ...... 50

72	3.2.2 Fac	ility Estimates	51
73		ease Assessment	
74	3.2.3.1	Environmental Release Points	53
75		Environmental Release Assessment Results	
76		cupational Exposure Assessment	
77	3.2.4.1	Workers Activities	54
78	3.2.4.2	Number of Workers and Occupational Non-users	54
79		Occupational Inhalation Exposure Results	
80	3.2.4.4	Occupational Dermal Exposure Results	56
81		Occupational Aggregate Exposure Results	
82		pration into Adhesives and Sealants	
83	3.3.1 Pro	cess Description	57
84	3.3.2 Fac	eility Estimates	58
85		ease Assessment	
86		Environmental Release Points	
87	3.3.3.2	Environmental Release Assessment Results	59
88		cupational Exposure Assessment	
89	3.3.4.1	Workers Activities	60
90	3.3.4.2	Number of Workers and Occupational Non-users	60
91	3.3.4.3	Occupational Inhalation Exposure Results	60
92	3.3.4.4	Occupational Dermal Results	62
93	3.3.4.5	Occupational Aggregate Exposure Results	62
94	3.4 Incorpo	pration into Paints and Coatings	63
95	3.4.1 Pro	cess Description	63
96	3.4.2 Fac	ility Estimates	64
97	3.4.3 Rel	ease Assessment	65
98	3.4.3.1	Environmental Release Points	65
99	3.4.3.2	Environmental Release Assessment Results	65
100	3.4.4 Occ	cupational Exposure Assessment	65
101	3.4.4.1	Worker Activities	65
102	3.4.4.2	Number of Workers and Occupational Non-users	65
103		Occupational Inhalation Exposure Results	
104	3.4.4.4	Occupational Dermal Exposure Results	68
105	3.4.4.5	Occupational Aggregate Exposure Results	69
106	3.5 Incorpo	pration into Other Formulations, Mixtures, and Reaction Products Not Covered	
107	Elsewh	ere	69
108	3.5.1 Pro	cess Description	69
109	3.5.2 Fac	ility Estimates	70
110	3.5.3 Rel	ease Assessment	71
111		Environmental Release Points	
112	3.5.3.2	Environmental Release Assessment Results	71
113		cupational Exposure Assessment	
114	3.5.4.1	Worker Activities	71
115	3.5.4.2	Number of Workers and Occupational Non-users	
116		Occupational Inhalation Exposure Results	
117		Occupational Dermal Exposure Results	
118		Occupational Aggregate Exposure Results	
119		lastics Compounding	
120	3.6.1 Pro	cess Description	75

121	3.6.2 Fa	cility Estimates	
122	3.6.3 Re	elease Assessment	
123	3.6.3.1	Environmental Release Points	
124	3.6.3.2	Environmental Release Assessment Results	
125		ccupational Exposure Assessment	
126		Worker Activities	
127		Number of Workers and Occupational Non-users	
128		Occupational Inhalation Exposure Results	
129	3.6.4.4	Occupational Dermal Exposure Results	
130	3.6.4.5	Occupational Aggregate Exposure Results	
131	3.7 PVC H	Plastics Converting	
132		ocess Description	
133		cility Estimates	
134		elease Assessment	
135		Environmental Release Points	
136		Environmental Release Assessment Results	
137		ccupational Exposure Assessment	
138		Worker Activities	
139		Number of Workers and Occupational Non-users	
140		Occupational Inhalation Exposure Results	
141		Occupational Dermal Exposure Results	
142		Occupational Aggregate Exposure Results	
143		VC Material Compounding	
144		ocess Description	
145		cility Estimates	
146		elease Assessment	
147		Environmental Release Points	
148		Environmental Release Assessment Results	
149		ccupational Exposure Assessment	
150		Worker Activities	
151		Number of Workers and Occupational Non-users	
152		Occupational Inhalation Exposure Results	
153		Occupational Dermal Exposure Results	
154		Occupational Aggregate Exposure Results	
155		PVC Material Converting	
156		ocess Description	
157		cility Estimates	
158		elease Assessment	
159	3.9.3.1	Environmental Release Points	
160		Environmental Release Assessment Results	
161		ccupational Exposure Assessment	
162		Worker Activities	
163		Number of Workers and Occupational Non-users	
164		Occupational Inhalation Exposure Results	
165		Occupational Dermal Exposure Results	
166		Occupational Aggregate Exposure Results	
167		cation of Adhesives and Sealants	
168		ocess Description	
169	3.10.2 Fa	cility Estimates	

170	3.10.3 Release Assessment	
171	3.10.3.1 Environmental Release Points	
172	3.10.3.2 Environmental Release Assessment Results	103
173	3.10.4 Occupational Exposure Assessment	
174	3.10.4.1 Worker Activities	103
175	3.10.4.2 Number of Workers and Occupational Non-users	103
176	3.10.4.3 Occupational Inhalation Exposure Results	105
177	3.10.4.4 Occupational Dermal Exposure Results	106
178	3.10.4.5 Occupational Aggregate Exposure Results	107
179	3.11 Application of Paints and Coatings	108
180	3.11.1 Process Description	
181	3.11.2 Facility Estimates	109
182	3.11.3 Release Assessment	109
183	3.11.3.1 Environmental Release Points	109
184	3.11.3.2 Environmental Release Assessment Results	109
185	3.11.4 Occupational Exposure Assessment	110
186	3.11.4.1 Worker Activities	
187	3.11.4.2 Number of Workers and Occupational Non-users	
188	3.11.4.3 Occupational Inhalation Exposure Results	
189	3.11.4.4 Occupational Dermal Exposure Results	
190	3.11.4.5 Occupational Aggregate Exposure Results	
191	3.12 Use of Laboratory Chemicals	
192	3.12.1 Process Description	
193	3.12.2 Facility Estimates	
194	3.12.3 Release Assessment	
195	3.12.3.1 Environmental Release Points	
196	3.12.3.2 Environmental Release Assessment Results	
197	3.12.4 Occupational Exposure Assessment	
198	3.12.4.1 Worker Activities	
199	3.12.4.2 Number of Workers and Occupational Non-users	
200	3.12.4.3 Occupational Inhalation Exposure Results	
200	3.12.4.4 Occupational Dermal Exposure Results	
202	3.12.4.5 Occupational Aggregate Exposure Results	
202	3.13 Use of Lubricants and Functional Fluids	
203	3.13.1 Process Description	
205	3.13.2 Facility Estimates.	
205	3.13.3 Release Assessment	
200	3.13.3.1 Environmental Release Points	
207	3.13.3.2 Environmental Release Assessment Results	
200	3.13.4 Occupational Exposure Assessment	
209	3.13.4.1 Worker Activities	
210	3.13.4.2 Number of Workers and Occupational Non-users	
211	3.13.4.3 Occupational Inhalation Exposure Results	
212	3.13.4.4 Occupational Dermal Exposure Results	
213	3.13.4.5 Occupational Aggregate Exposure Results	
214	3.14 Use of Penetrants and Inspection Fluids	
215	3.14.1 Process Description	
210	3.14.2 Facility Estimates	
217	3.14.3 Release Assessment	
<i>4</i> 10	J. I T, J INDUASU ASSUSSIIUM	

219	3.14.3.1 Environmental Release Points	
220	3.14.3.2 Environmental Release Assessment Results	
221	3.14.4 Occupational Exposure Assessment	
222	3.14.4.1 Worker Activities	
223	3.14.4.2 Number of Workers and Occupational Non-users	
224	3.14.4.3 Occupational Inhalation Exposure Results	
225	3.14.4.4 Occupational Dermal Exposure Results	
226	3.14.4.5 Occupational Aggregate Exposure Results	
227	3.15 Fabrication and Final Use of Products or Articles	
228	3.15.1 Process Description	
229	3.15.2 Facility Estimates	
230	3.15.3 Release Assessment	
231	3.15.3.1 Environmental Release Points	
232	3.15.4 Occupational Exposure Assessment	
233	3.15.4.1 Worker Activities	
234	3.15.4.2 Number of Workers and Occupational Non-users	
235	3.15.4.3 Occupational Inhalation Exposure Results	
236	3.15.4.4 Occupational Dermal Exposure Results	
237	3.15.4.5 Occupational Aggregate Exposure Results	
238	3.16 Recycling	
239	3.16.1 Process Description	
240	3.16.2 Facility Estimates	
241	3.16.3 Release Assessment	
242	3.16.3.1 Environmental Release Points	
243	3.16.3.2 Environmental Release Assessment Results	
244	3.16.4 Occupational Exposure Assessment	
245	3.16.4.1 Worker Activities	
246	3.16.4.2 Number of Workers and Occupational Non-users	
247	3.16.4.3 Occupational Inhalation Exposure Results	
248	3.16.4.4 Occupational Dermal Exposure Results	
249	3.16.4.5 Occupational Aggregate Exposure Results	
250	3.17 Disposal	
251	3.17.1 Process Description	
252	3.17.2 Facility Estimates	
253	3.17.3 Release Assessment	
254	3.17.3.1 Environmental Release Points	
255	3.17.4 Occupational Exposure Assessment	
256	3.17.4.1 Worker Activities	
257	3.17.4.2 Number of Workers and Occupational Non-users	
258	3.17.4.3 Occupational Inhalation Exposure Results	
259	3.17.4.4 Occupational Dermal Exposure Results	
260	3.17.4.5 Occupational Aggregate Exposure Results	
261	3.18 Distribution in Commerce	
262	3.18.1 Process Description	
263	4 WEIGHT OF SCIENTIFIC EVIDENCE CONCLUSIONS	
264	4.1 Environmental Releases	
265	4.2 Occupational Exposures	
266	REFERENCES	

267	APPENDICI	ES	182
268 269	Appendix A	EXAMPLE OF ESTIMATING NUMBER OF WORKERS AND OCCUPATIONAL NON-USERS	182
270 271	Appendix B	EQUATIONS FOR CALCULATING ACUTE, INTERMEDIATE, AND CHRONIC (NON-CANCER) INHALATION AND DERMAL EXPOSURES	187
272 273 274 275 276 277 278 279 280 281 282 283	Expo B.2 Equat B.3 Calcu B.4 Acute B.4.1 E B.4.2 B B.4.2 B B.4.3 E B.4.3 In B.4.5 In B.4.6 W	tions for Calculating Acute, Intermediate, and Chronic (Non-cancer) Inhalation sure tions for Calculating Acute, Intermediate, and Chronic (Non-cancer) Dermal Expos lating Aggregate Exposure e, Intermediate, and Chronic (Non-cancer) Equation Inputs xposure Duration (ED) reathing Rate xposure Frequency (EF) termediate Exposure Frequency (EF <sub>int</sub> ) termediate Duration (ID) vorking Years (WY)	sures 188 188 189 189 189 189 190 190 190
284 285 286	Appendix C	SAMPLE CALCULATIONS FOR CALCULATING ACUTE, INTERMEDIATE, AND CHRONIC (NON-CANCER) OCCUPATIONAL EXPOSURES	193
287 288 289 290 291 292	C.1.1 E C.1.2 E C.2 Derm C.2.1 E	ation Exposures xample High-End AD, IADD, and ADD Calculations xample Central Tendency AD, IADD, and ADD Calculations al Exposures xample High-End AD, IADD, and ADD Calculations xample Central Tendency AD, IADD, and ADD Calculations	193 193 194 194
293	Appendix D	DERMAL EXPOSURE ASSESSMENT METHOD	196
294 295 296 297 298 299 300 301	D.2 Paran D.2.1 A D.2.1.1 D.2.1.2 D.2.2 St D.2.3 A	al Dose Equation neters of the Dermal Dose Equation bsorptive Flux Dermal Contact with Liquids or Formulations Containing DIDP 2 Dermal Contact with Solids or Articles Containing DIDP urface Area bsorption Time	196 197 197 197 198 198
302	Appendix E	MODEL APPROACHES AND PARAMETERS	200
303 304 305 306 307 308	E.2 Manu E.2.1 M E.2.2 M E.2.3 N	OPPT Standard Models facturing Model Approaches and Parameters Iodel Equations Iodel Input Parameters umber of Sites hroughput Parameters	204 205 207 212
309 310		umber of Containers Per Year perating Hours	
311	E.2.7 M	Ianufactured DIDP Concentration	213

312	E.2.8	Air Speed	
313		Diameters of Opening	
314		Saturation Factor	
315		Container Size	
316		Bulk Container Residue Loss Fraction	
317		Filtration Loss Fraction.	
318		Sampling Loss Fraction	
319		Operating Days	
320		Process Operations Emission Factor	
321		Equipment Cleaning Loss Fraction	
322		Container Fill Rates	
323		Mixing Factor	
324		port and Repackaging Model Approaches and Parameters	
325		Model Equations	
326	E.3.2	Model Input Parameters	
327	E.3.3	Number of Sites	221
328	E.3.4	Throughput Parameters	
329	E.3.5	Number of Containers per Year	
330	E.3.6	Operating Hours	223
331	E.3.7	Operating Days	
332	E.3.8	Manufactured DIDP Concentration	224
333	E.3.9	Air Speed	224
334	E.3.10	Saturation Factor	225
335	E.3.11	Container Size	225
336	E.3.12	Bulk Container Residue Loss Fraction	225
337	E.3.13	Sampling Loss Fraction	226
338	E.3.14	Diameters of Opening	226
339	E.3.15	Equipment Cleaning Loss Fraction	227
340		Container Fill Rates	
341		orporation into Adhesives and Sealants Model Approaches and Parameters	
342	E.4.1	Model Equations	227
343		Model Input Parameters	
344	E.4.3	Number of Sites	233
345	E.4.4	Throughput Parameters	
346	E.4.5	Number of Containers per Year	
347	E.4.6	Operating Hours	
348	E.4.7	Initial DIDP Concentration	
349		Final DIDP Concentration	
350		Air Speed	
351		Saturation Factor	
352		Container Size	
353		Drum Residue Loss Fraction	
354		Sampling Loss Fraction	
355		Diameters of Opening	
356		Hours per Batch for Equipment Cleaning	
357		Operating Days	
358		Batch Size	
359		Container Fill Rates	
360	E.4.19	Equipment Cleaning Loss Fraction	

361	E.4.20 Off-Spec Loss Fraction	240
362	E.5 Incorporation into Paints and Coatings Model Approaches and Parameters	
363	E.5.1 Model Equations	
364	E.5.2 Model Input Parameters	
365	E.5.3 Number of Sites	
366	E.5.4 Throughput Parameters	
367	E.5.5 Number of Containers per Year	
368	E.5.6 Operating Hours	
369	E.5.7 Initial DIDP Concentration	
370	E.5.8 Final DIDP Concentration	
371	E.5.9 Air Speed	
372	E.5.10 Saturation Factor	
373	E.5.11 Container Size	
374	E.5.12 Drum Residue Loss Fraction	
375	E.5.13 Sampling Loss Fraction	
376	E.5.14 Diameters of Opening.	
377	E.5.15 Overall Paint/Coating Production Rate	
378	E.5.16 Operating Days	
379	E.5.17 Batch Size	
380	E.5.18 Container Fill Rates	
381	E.5.19 Equipment Cleaning Loss Fraction	
382	E.5.20 Off-Spec Loss Fraction	
383	E.6 Incorporation into Other Formulations, Mixtures, and Reaction Products Not Covered	237
384	Elsewhere Model Approaches and Parameters	254
385	E.6.1 Import DIDP Concentration	
386	E.6.2 Final DIDP Concentration	
387	E.7 Non-PVC Plastics Materials Model Approaches and Parameters	
388	E.7 Non-1 ve Trasties Waternais Woder Approaches and Taranteters	
389	E.7.2 Model Input Parameters	
390	E.7.2 Woder input Faranceers E.7.3 Number of Sites	
391	E.7.4 Throughput Parameters	
392	E.7.4 Throughput Faranceers E.7.5 Mass Fraction of All Additives in Compounded Plastic Resin	
392 393	E.7.6 Annual Use Rate of All Plastic Additives During Converting	
393 394	E.7.0 Annual Ose Rate of An Flastic Additives During Converting	
39 <del>4</del> 395	E.7.7 Number of Containers per Tear E.7.8 Operating Hours	
395 396	E.7.9 Initial DIDP Concentration	
390 397	E.7.10 Final DIDP Concentration	
397 398		
398 399	E.7.11 Operating Days E.7.12 Saturation Factor	
400	E.7.12 Saturation Factor E.7.13 Container Size	
400	E.7.14 Container Residue Loss Fractions	
401	E.7.14 Container Residue Loss Fractions E.7.15 Dust Generation Loss Fraction, Dust Capture Efficiency, and Dust Control Efficiency.	
403	E.7.16 Fraction of DIDP Lost as Particulates During Converting Processes	
404	E.7.17 Container Fill Rates	
405	E.7.18 Equipment Cleaning Loss Fraction	
406	E.7.19 Cooling Water Loss Fraction	
407	E.7.20 Rubber Production Rate	
408	E.7.21 Fraction of DIDP Lost from Volatilization During Forming and Molding Processes	
409	E.7.22 Solid Container Loss Fraction	269

410	E.7.23 Trimming Loss Fraction	
411	E.8 PVC Plastics Model Approaches and Parameters	
412	E.8.1 Throughput Parameters	
413	E.8.2 Plastic DIDP Concentration	
414	E.8.3 Fraction of DIDP in Compounded Plastic Resin	
415	E.8.4 Dust Capture and Control Efficiency	
416	E.8.5 Annual Use Rate of All Plastic Additives During Compounding	
417	E.9 Application of Adhesives and Sealants Model Approaches and Parameters	
418	E.9.1 Model Equations	
419	E.9.2 Model Input Parameters	
420	E.9.3 Number of Sites	
421	E.9.4 Throughput Parameters	
422	E.9.5 Number of Containers per Year	
423	E.9.6 Operating Hours	
424	E.9.7 Adhesive/ Sealant DIDP Concentration	
425	E.9.8 Operating Days	
426	E.9.9 Air Speed	
427	E.9.10 Saturation Factor	
428	E.9.11 Container Size	
429	E.9.12 Small Container Residue Loss Fraction	
430	E.9.13 Fraction of DIDP Released as Trimming Waste	
431	E.9.14 Container Unloading Rates	
432	E.9.15 Diameters of Opening	
433	E.9.16 Equipment Cleaning Loss Fraction	
434	E.10 Application of Paints and Coatings Model Approaches and Parameters	
435	E.10.1 Model Equations	
436	E.10.2 Model Input Parameters	
437	E.10.3 Number of Sites	
438	E.10.4 Throughput Parameters	
439	E.10.5 Number of Containers per Year	
440	E.10.6 Operating Hours	
441	E.10.7 Paint/Coating DIDP Concentration	
442	E.10.8 Operating Days	
443	E.10.9 Air Speed	
444	E.10.10 Saturation Factor	
445	E.10.11 Container Size	
446	E.10.12 Small Container Loss Fraction	
447	E.10.13 Sampling Loss Fraction	
448	E.10.14 Diameters of Opening	
449	E.10.15 Transfer Efficiency Fraction	
450	E.10.16 Small Container Unloading Rate	
451	E.10.17 Equipment Cleaning Loss Fraction	
452	E.10.18 Capture Efficiency for Spray Booth	
453	E.10.19 Fraction of Solid Removed in Spray Mist	
454	E.11 Use of Laboratory Chemicals Model Approaches and Parameters	
455	E.11.1 Model Equations	
456	E.11.2 Model Input Parameters	
457	E.11.3 Throughput Parameters	
458	E.11.4 Number of Containers per Year	

459	E.11.5 Operating Hours	298
460	E.11.6 DIDP Concentration in Laboratory Chemicals	299
461	E.11.7 Operating Days	299
462	E.11.8 Air Speed	299
463	E.11.9 Saturation Factor	300
464	E.11.10 Container Size	300
465	E.11.11 Container Loss Fractions	300
466	E.11.12 Dust Generation Loss Fraction, Dust Capture Efficiency, and Dust Control	
467	Efficiency	301
468	E.11.13 Small Container Fill Rate	301
469	E.11.14 Diameters of Opening	301
470	E.11.15 Equipment Cleaning Loss Fraction	301
471	E.12 Use of Lubricants and Functional Fluids Model Approaches and Parameters	302
472	E.12.1 Model Equations	302
473	E.12.2 Model Input Parameters	304
474	E.12.3 Throughput Parameters	306
475	E.12.4 Mass Fraction of DIDP in Lubricant/Fluid and Product Density	307
476	E.12.5 Operating Days	307
477	E.12.6 Container Size	307
478	E.12.7 Loss Fractions	307
479	E.12.8 Percentage of Waste to Recycling	307
480	E.12.9 Percentage of Waste to Fuel Blending	307
481	E.13 Use of Penetrants and Inspection Fluids Release Model Approaches and Parameters	308
482	E.13.1 Model Equations	308
483	E.13.2 Model Input Parameters	310
484	E.13.3 Throughput Parameters	313
485	E.13.4 Number of Containers per Year	313
486	E.13.5 Operating Hours	314
487	E.13.6 Penetrant DIDP Concentration	314
488	E.13.7 Operating Days	314
489	E.13.8 Air Speed	314
490	E.13.9 Saturation Factor	315
491	E.13.10 Container Size	315
492	E.13.11 Container Loss Fractions	315
493	E.13.12 Equipment Cleaning Loss Fraction	316
494	E.13.13 Container Fill Rates	316
495	E.13.14 Diameters of Opening	316
496	E.13.15 Penetrant Used per Job	317
497	E.13.16 Jobs per Day	
498	E.13.17 Percentage of Aerosol Released to Fugitive Air and Uncertain Media	317
499	E.14 Spray Exposure Model Approach and Parameters	317
500	E.14.1 Model Design Equations	317
501	E.14.2 Model Parameters	317
502	E.14.2.1 Concentration of Mist	
503	E.14.2.2 DIDP Product Concentration	
504	E.14.2.3 Concentration of Nonvolatile Solids in the Spray Product	319
505	E.14.2.4 DIDP Concentration in Nonvolatile Components	
506	E.14.2.5 Exposure Duration	
507	E.15 Inhalation Exposure Modeling for Penetrants and Inspection Fluids	319

508	E.15.1 Model Design Equations	320
509	E.15.2 Model Parameters	324
510	E.15.2.1 Far-Field Volume	326
511	E.15.2.2 Air Exchange Rate	326
512	E.15.2.3 Near-Field Indoor Air Speed	326
513	E.15.2.4 Near-Field Volume	327
514	E.15.2.5 Application Time	327
515	E.15.2.6 Averaging Time	327
516	E.15.2.7 DIDP Product Concentration	327
517	E.15.2.8 Volume of Penetrant Used per Job	327
518	E.15.2.9 Number of Applications per Job	328
519	E.15.2.10 Amount of DIDP Used per Application	328
520	E.15.2.11 Number of Jobs per Work Shift	328
521	E.16 Inhalation Exposure to Respirable Particulates Model Approach and Parameters	328
522	Appendix F Products Containing DIDP	330

#### LIST OF TABLES

525	Table 1-1. Crosswalk of Conditions of Uses Listed in the Final Scope Document to Occupational	
526	Exposure Scenarios Assessed in the Risk Evaluation	4
527	Table 2-1. Data Evaluation of Sources Containing Occupational Exposure Monitoring Data	5
528	Table 2-2. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134 40	0
529	Table 2-3. Number and Percent of Sites and Employees Using Respirators within 12 Months Prior to	
530	Survey	2
531	Table 2-4. Glove Protection Factors for Different Dermal Protection Strategies	3
532	Table 3-1. Summary of Modeled Environmental Releases for Manufacture of DIDP 40	б
533	Table 3-2. Estimated Number of Workers Potentially Exposed to DIDP During the Manufacturing of	
534	DIDP	
535	Table 3-3. Summary of Estimated Worker Inhalation Exposures for Manufacture of DIDP 49	9
536	Table 3-4. Summary of Modeled Worker Inhalation Exposures for Manufacture of DIDP	C
537	Table 3-5. Summary of Estimated Worker Dermal Exposures for the Manufacturing of DIDP 50	C
538	Table 3-6. Summary of Estimated Worker Aggregate Exposures for Manufacture of DIDP	1
539	Table 3-7: Production Volume of DIDP CASRN 26761-40-0 Import and Repackaging Sites, 2020 CDR	
540		
541	Table 3-8. Summary of Modeled Environmental Releases for Import and Repackaging of DIDP 53	
542	Table 3-9. Estimated Number of Workers Potentially Exposed to DIDP during Import and Repackaging	
543		
544	Table 3-10. Summary of Estimated Worker Inhalation Exposures for Import and Repackaging of DIDP	
545		
546	Table 3-11. Summary of Estimated Worker Dermal Exposures for Import and Repackaging of DIDP . 57	
547	Table 3-12. Summary of Estimated Worker Aggregate Exposures for Import and Repackaging of DIDP	
548		7
549	Table 3-13. Summary of Modeled Environmental Releases for Incorporation into Adhesives and	
550	Sealants	9
551	Table 3-14. Estimated Number of Workers Potentially Exposed to DIDP during Incorporation into	
552	Adhesives and Sealants	0
553	Table 3-15. Summary of Estimated Worker Inhalation Exposures for Incorporation into Adhesives and	
554	Sealants6	1

555	Table 3-16.	Summary of Estimated Worker Dermal Exposures for Incorporation into Adhesives and
556 557	Table 3-17.	Sealants
558		Sealants
559	Table 3-18.	Summary of Modeled Environmental Releases for Incorporation into Paints and Coatings 65
560	Table 3-19.	Estimated Number of Workers Potentially Exposed to DIDP during Incorporation into
561	$T_{able} = 2.20$	Paints and Coatings
562	Table 5-20.	Summary of Estimated Worker Inhalation Exposures for Incorporation into Paints and
563	Table 2 01	Coatings
564 565	Table 5-21.	Summary of Estimated Worker Dermal Exposures for Incorporation into Paints and
565 566	Table 2 22	Coatings
566 567	Table 3-22.	Summary of Estimated Worker Aggregate Exposures for Incorporation into Paints and
567 569	Table 2.02	Coatings
568	Table 3-23.	Summary of Modeled Environmental Releases for Incorporation into Other Formulations,
569	T-1-1- 2-24	Mixtures, and Reaction Products
570	Table 3-24.	Estimated Number of Workers Potentially Exposed to DIDP during Incorporation into Other
571	T 11 2 25	Formulations, Mixtures, or Reaction Products not Covered Elsewhere
572	Table 3-25.	Summary of Estimated Worker Inhalation Exposures for Incorporation into Other
573	<b>T</b> 11 2 26	Formulations, Mixtures, and Reaction Products Not Covered Elsewhere
574	Table 3-26.	Summary of Estimated Worker Dermal Exposures for Incorporation into Other
575	<b>T</b> 11 0 07	Formulations, Mixtures, and Reaction Products Not Covered Elsewhere
576	Table 3-27.	Summary of Estimated Worker Aggregate Exposures for Incorporation into Other
577	<b>T</b> 11 2 20	Formulations, Mixtures, or Reaction Products Not Covered Elsewhere
578		DIDP Concentration for Different PVC Products
579		Summary of Modeled Environmental Releases for PVC Plastics Compounding
580 581	Table 3-30.	Estimated Number of Workers Potentially Exposed to DIDP during PVC Plastics Compounding
582	Table 3-31	Summary of Estimated Worker Inhalation Exposures for PVC Plastics Compounding 80
582		Summary of Estimated Worker Dermal Exposures for PVC Plastics Compounding
585 584		Summary of Estimated Worker Aggregate Exposures for PVC Plastics Compounding
585		Summary of Modeled Environmental Releases for PVC Plastics Converting
586		Estimated Number of Workers Potentially Exposed to DIDP during PVC Plastics
580 587	Table 5-55.	Converting
588	Table 3-36	Summary of Estimated Worker Inhalation Exposures for PVC Plastics Converting
589		Summary of Estimated Worker Dermal Exposures for PVC Plastics Converting
590		Summary of Estimated Worker Aggregate Exposures for PVC Plastics Converting
591		Summary of Modeled Environmental Releases for Non-PVC Material Compounding
592		Estimated Number of Workers Potentially Exposed to DIDP during Non-PVC Material
592 593	1 auto 5-40.	Compounding
594	Table 3-41	Summary of Estimated Worker Inhalation Exposures for Non-PVC Material Compounding
595	10010 5 111	94
596	Table 3-42	Summary of Estimated Worker Dermal Exposures for Non-PVC Material Compounding . 95
597		Summary of Estimated Worker Aggregate Exposures for Non-PVC Material Compounding
598	1000 5 15.	95
599	Table 3-44	Summary of Modeled Environmental Releases for Non-PVC Material Converting
600		Estimated Number of Workers Potentially Exposed to DIDP during Non-PVC Material
601	1	Converting
602	Table 3-46	Summary of Estimated Worker Inhalation Exposures for Non-PVC Material Converting 100
603		Summary of Estimated Worker Dermal Exposures for Non-PVC Material Converting 101
		· · · · · · · · · · · · · · · · · · ·

604		Summary of Estimated Worker Aggregate Exposures for Non-PVC Material Converting 101
605	Table 3-49.	Summary of Modeled Environmental Releases for Application of Adhesives and Sealants
606		
607	Table 3-50.	Estimated Number of Workers Potentially Exposed to DIDP during Application of
608		Adhesives and Sealants104
609	Table 3-51.	Summary of Estimated Worker Inhalation Exposures for Application of Adhesives and
610		Sealants 106
611	Table 3-52.	Summary of Estimated Worker Dermal Exposures for Application of Adhesives and
612		Sealants 107
613	Table 3-53.	Summary of Estimated Worker Aggregate Exposures for Application of Adhesives and
614		Sealants 107
615		Summary of Modeled Environmental Releases for Application of Paints and Coatings 109
616	Table 3-55.	Estimated Number of Workers Potentially Exposed to DIDP during Application of Paints
617		and Coatings 111
618	Table 3-56.	Summary of Estimated Worker Inhalation Exposures for Application of Paints and Coatings
619		
620	Table 3-57.	Summary of Estimated Worker Dermal Exposures for Application of Paints and Coatings
621		
622	Table 3-58.	Summary of Estimated Worker Aggregate Exposures for Application of Paints and Coatings
623		
624	Table 3-59.	CDR Reported Site Information for Use in Calculation of Laboratory Chemicals Production
625		Volume
626	Table 3-60.	Summary of Modeled Environmental Releases for Use of Laboratory Chemicals 116
627	Table 3-61.	Estimated Number of Workers Potentially Exposed to DIDP during Use of Laboratory
628		Chemicals117
629		Summary of Estimated Worker Inhalation Exposures for Use of Laboratory Chemicals 119
630	Table 3-63.	Summary of Estimated Worker Dermal Exposures for Use of Laboratory Chemicals 120
631	Table 3-64.	Summary of Estimated Worker Aggregate Exposures for Use of Laboratory Chemicals 121
632	Table 3-65.	Summary of Modeled Environmental Releases for Use of Lubricants and Functional Fluids
633		
634	Table 3-66.	Estimated Number of Workers Potentially Exposed to DIDP during Use of Lubricants and
635		Functional Fluids 124
636	Table 3-67.	Summary of Estimated Worker Inhalation Exposures for Use of Lubricants and Functional
637		Fluids125
638	Table 3-68.	Summary of Estimated Worker Dermal Exposures for Use of Lubricants and Functional
639		Fluids126
640	Table 3-69.	Summary of Estimated Worker Aggregate Exposures for Use of Lubricants and Functional
641		Fluids127
642	Table 3-70.	CDR Reported Site Information for Use in Calculation of Use of Penetrants and Inspection
643		Fluids Production Volume
644	Table 3-71.	Summary of Modeled Environmental Releases for Use of Penetrants and Inspection Fluids
645		
646	Table 3-72.	Estimated Number of Workers Potentially Exposed to DIDP during Use of Penetrants and
647		Inspection Fluids
648	Table 3-73.	Summary of Estimated Worker Inhalation Exposures for Use of Penetrants and Inspection
649		Fluids
650	Table 3-74.	Summary of Estimated Worker Dermal Exposures for Use of Penetrants and Inspection
651		Fluids

652	Table 2.75 Summers of Estimated Worker Aggregate Exposures for Use of Depatrents and Inspection
653	Table 3-75. Summary of Estimated Worker Aggregate Exposures for Use of Penetrants and Inspection         Fluids
654	Table 3-76. Release Activities for Fabrication/Use of Final Articles Containing DIDP
655	Table 3-77. Estimated Number of Workers Potentially Exposed to DIDP during the Fabrication and
656	Final Use of Products or Articles
657	Table 3-78. Summary of Estimated Worker Inhalation Exposures for Fabrication and Final Use of
658	Products or Articles
659	Table 3-79. Summary of Estimated Worker Dermal Exposures for Fabrication and Final Use of Products
660	or Articles
661	Table 3-80. Summary of Estimated Worker Aggregate Exposures for Fabrication and Final Use of
662	Products or Articles
663	Table 3-81. Summary of Modeled Environmental Releases for Recycling       142
664	Table 3-81. Summary of Wodeled Environmental Releases for Recycling
665	143
	Table 3-83. Summary of Estimated Worker Inhalation Exposures for Recycling
666	
667	Table 3-84. Summary of Estimated Worker Dermal Exposures for Recycling       145         Table 3-85. Summary of Estimated Worker Dermal Exposures for Recycling       145
668	Table 3-85. Summary of Estimated Worker Aggregate Exposures for Recycling
669	Table 3-86. Estimated Number of Workers Potentially Exposed to DIDP during Recycling and Disposal
670	
671	Table 3-87. Summary of Estimated Worker Inhalation Exposures for Disposal    152
672	Table 3-88. Summary of Estimated Worker Dermal Exposures for Disposal
673	Table 3-89. Summary of Estimated Worker Aggregate Exposures for Disposal    153
674	Table 4-1. Summary of Assumptions, Uncertainty, and Overall Confidence in Release Estimates by OES
675	
676	Table 4-2. Summary of Assumptions, Uncertainty, and Overall Confidence in Inhalation Exposure
677	Estimates by OES166
678	

# 679 **LIST OF FIGURES**

680	Figure 2-1. Average absorptive flux absorbed into and through skin as function of absorption time	38
681	Figure 3-1. Manufacturing Flow Diagram (ExxonMobil, 2022b)	45
682	Figure 3-2. Import and Repackaging Flow Diagram (U.S. EPA, 2022a)	51
683	Figure 3-3. Incorporation into Adhesives and Sealants Flow Diagram (OECD, 2009a)	58
684	Figure 3-4. Incorporation into Paints and Coatings Flow Diagram (U.S. EPA, 2014a)	64
685	Figure 3-5. Incorporation into Other Formulations, Mixtures, and Reaction Products Flow Diagram	
686	(U.S. EPA, 2014a)	70
687	Figure 3-6. PVC Plastics Compounding Flow Diagram (U.S. EPA, 2021e)	76
688	Figure 3-7. PVC Plastics Converting Flow Diagram (U.S. EPA, 2004a)	83
689	Figure 3-8. Non-PVC Material Compounding Flow Diagram	89
690	Figure 3-9. Consolidated Compounding and Converting Flow Diagram	90
691	Figure 3-10. Non-PVC Material Converting Flow Diagram (U.S. EPA, 2004a)	96
692	Figure 3-11. Application of Adhesives and Sealants Flow Diagram	. 102
693	Figure 3-12. Application of Paints and Coatings Flow Diagram	. 108
694	Figure 3-13. Use of Laboratory Chemicals Flow Diagram	. 114
695	Figure 3-14. Use of Lubricants and Functional Fluids Flow Diagram	. 122
696	Figure 3-15. Use of Penetrants and Inspection Fluids Flow Diagram Non-Aerosol Use	. 128
697	Figure 3-16. Use of Penetrants and Inspection Fluids Flow Diagram Aerosol Use	. 129
698	Figure 3-17. DIDP-Containing PVC Recycling Flow Diagram	. 141
699	Figure 3-18. Typical Waste Disposal Process	
700	Figure 3-19. Typical Industrial Incineration Process	. 148

# 701 LIST OF APPENDIX TABLES

702	Table_Apx A-1. SOCs With Worker and ONU Designation for All COUs Except Dry Cleaning 18	3
703	Table_Apx A-2. SOCs with Worker and ONU Designations for Dry Cleaning Facilities	4
704	Table_Apx A-3. Estimated Number of Potentially Exposed Workers and ONUs under NAICS 812320	
705		5
706	Table_Apx B-1. Parameter Values for Calculating Inhalation Exposure Estimates	9
707	Table_Apx B-2. Overview of Average Worker Tenure from U.S. Census SIPP (Age Group 50+) 19	1
708	Table_Apx B-3. Median Years of Tenure with Current Employer by Age Group	
709	Table_Apx D-1. Summary of Dermal Dose Equation Values	6
710	Table_Apx D-2. Exposure Control Efficiencies and Protection Factors for Different Dermal Protection	
711	Strategies from ECETOC TRA v3	9
712	Table_Apx E-1. Models and Variables Applied for Release Sources in the Manufacturing OES 20	
713	Table_Apx E-2. Summary of Parameter Values and Distributions Used in the Manufacturing Models 20	
714	Table_Apx E-3. Sites Reporting to CDR for Domestic Manufacture of DIDP	2
715	Table_Apx E-4. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating	
716	Environmental Releases from Sampling Waste	6
717	Table_Apx E-5. Models and Variables Applied for Release Sources in the Import and Repackaging OE	
718		
719	Table_Apx E-6. Summary of Parameter Values and Distributions Used in the Import and Repackaging	
720	Model	9
721	Table_Apx E-7. Sites Reporting to CDR for Domestic Manufacture of DIDP	
722	Table_Apx E-8. Sites with Known Production Volumes in CDR	
723	Table_Apx E-9. Sites with Known DIDP Concentrations in CDR	
724	Table_Apx E-10. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating	
725	Environmental Releases from Sampling Waste	6
726	Table_Apx E-11. Models and Variables Applied for Release Sources in the Incorporation into	
727	Adhesives and Sealants OES	8
728	Table_Apx E-12. Summary of Parameter Values and Distributions Used in the Incorporation into	
729	Adhesives and Sealants Model	0
730	Table_Apx E-13. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating	
731	Environmental Releases from Sampling Waste	8
732	Table_Apx E-14. Models and Variables Applied for Release Sources in the Incorporation into Paints	
733	and Coatings OES	2
734	Table_Apx E-15. Summary of Parameter Values and Distributions Used in the Incorporation into Paints	
735	and Coatings Model	
736	Table_Apx E-16. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating	-
737	Environmental Releases from Sampling Waste	2
738	Table_Apx E-17. Models and Variables Applied for Release Sources in the Non-PVC Plastics Materials	
739	OES	
740	Table_Apx E-18. Summary of Parameter Values and Distributions Used in the Non-PVC Plastics	Č
741	Materials Model	9
742	Table_Apx E-19. Models and Variables Applied for Release Sources in the Application of Adhesives	1
743	and Sealants OES	2
744	Table_Apx E-20. Summary of Parameter Values and Distributions Used in the Application of Adhesive	
745	and Sealants Model	
746	Table_Apx E-21. Models and Variables Applied for Release Sources in the Application of Paints and	r
747	Coatings OES	1
748	Table_Apx E-22. Summary of Parameter Values and Distributions Used in the Application of Paints and	
749	Coatings Model	
/	20 www.go 1.10 www	

750	Table_Apx E-23. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating
751	Environmental Releases from Sampling Waste
752	Table_Apx E-24. Models and Variables Applied for Release Sources in the Use of Laboratory
753	Chemicals OES
754	Table_Apx E-25. Summary of Parameter Values and Distributions Used in the Use of Laboratory
755	Chemicals Model
756	Table_Apx E-26. Models and Variables Applied for Release Sources in the Use of Lubricants and
757	Functional Fluids OES
758	Table_Apx E-27. Summary of Parameter Values and Distributions Used in the Use of Lubricants and
759	Functional Fluids Model 305
760	Table_Apx E-28. Models and Variables Applied for Release Sources in the Use of Penetrants and
761	Inspection Fluids OES 309
762	Table_Apx E-29. Summary of Parameter Values and Distributions Used in the Release Estimation of
763	Penetrants and Inspection Fluids
764	Table_Apx E-30. Summary of Parameter Values Used in the Spray Inhalation Model       318
765	Table_Apx E-31. Summary of Parameter Values Used in the Near-Field/Far-Field Inhalation Exposure
766	Modeling of Penetrants and Inspection Fluids
767	Table_Apx E-32. Summary of DIDP Exposure Estimates for OESs Using the Generic Model for
768	Exposure to PNOR
769	Table_Apx F-1. Products Containing DIDP
770	

# 771 ABBREVIATIONS AND ACRONYMS

AC	Acute Exposure Concentration
ACGIH	American Conference of Governmental Industrial Hygienists
AD	Acute Retained Dose
ADD	Average Daily Dose
ADCintermediate	Intermediate Average Daily Concentration
AIHA	American Industrial Hygiene Association
APDR	Acute Potential Dermal Dose Rate
APF	Assigned Protection Factor
AT <sub>acute</sub>	Acute Averaging Time
AT <sub>C</sub>	Averaging Time for Cancer Risk
ATI	Averaging Time for Intermediate Exposure
AWD	Annual Working Days
BLS	Bureau of Labor Statistics
BR	Breathing rate
BW	Body weight
C	Contaminant Concentration in Air
CDR	Chemical Data Reporting
CEB	Chemical Engineering Branch
CEHD	Chemical Exposure Health Database
CFR	Code of Federal Regulations
CPS	Current Population Survey
CPSC	Consumer Product Safety Commission
CT	Central tendency
DD	Dermal Daily Dose
DIDP	Diisodecyl phthalate
DMR	Discharge Monitoring Report
ECETOC TRA	European Centre for Ecotoxicology and Toxicology of Chemicals Targeted
Lelloe Imi	Risk Assessment
ED	Exposure duration
EF	Exposure frequency
EFint	Intermediate Exposure Frequency
ELG	Effluent Limitation Guidelines
EPA	United States Environmental Protection Agency
ESD	Emission Scenario Document
ESD ETIMEOFF	Months When Not Working (CPS data)
f	
G	Fractional number of working days per year a worker works Vapor Generation Rate
GS	Generic Scenario
h	
HAP	Exposure durations
	Hazardous Air Pollutant
HE	High-end
HVLP	High volume low pressure
IADC	Intermediate Average Daily Concentration
ID	Days for intermediate duration
J 1-	Absorptive flux
k LADC	Mixing factor
LADC	Lifetime Average Daily Concentrations
LADD	Lifetime Average Daily Dose

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LOD	Limit of detection
LT	Lifetime years for cancer risk
MW	Molecular weight of DIDP
NAICS	North American Industry Classification System
NEI	National Emissions Inventory
NESHAP	National Emissions Standards of Hazardous Air Pollutants
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute of Occupational Safety and Health
OARS	Occupational Alliance for Risk Science
OAKS	-
	Operating days
OECD	Organisation for Economic Co-Operation and Development
OEL	Occupational Exposure Limit
OES	Occupational Exposure Scenario
OIS	Occupational Safety and Health Information System
ONU	Occupational non-users
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
OVS	OSHA Versatile Sampler
Р	Pressure
PAPR	Power air-purifying respirator
PBZ	Personal breathing zone
PEL	Permissible Exposure Limit
PF	Protection factor
POTW	Publicly owned treatment works
PPE	•
	Personal protective equipment
PV	Production volume
Q	Facility throughput
R	Universal Gas Constant
RD	Release days
REL	Recommended Exposure Limits
pproduct	Product density
pdidp	DIDP density
RQ	Reportable Quantity
S	Surface area
SDS	Safety data sheet
SIC	Standard Industrial Classification
SIPP	Survey of Income and Program Participation
SpERC	Specific Emission Release Category
SAR	Supplied-air respirator
SCBA	Self-contained breathing apparatus
SRRP	Source Reduction Research Partnership
SUSB	Statistics of US Businesses
T	Temperature
T T <sub>AGE</sub>	Worker age in SIPP
TDS	Technical data sheets
TJBIND1	Employed Individual Works (SIPP Data)
TLV	Threshold limit value
TMAKMNYR	First Year Worked (SIPP Data)
TRI	Toxics Release Inventory

Toxic Substances Control Act
Time-weighted average
Molar volume of DIDP
DIDP vapor pressure
Workers
Workplace Environmental Exposure Level
Weight of scientific evidence
Wastewater treatment
Working years per Lifetime
Surface Area

772

# 773 SUMMARY

774 This technical document is in support of the TSCA Draft Risk Evaluation for Diisodecyl Phthalate 775 (DIDP) (U.S. EPA, 2024). DIDP is a common chemical name for the category of chemical substances 776 that includes the following substances: 1,2-benzenedicarboxylic acid, 1,2-diisodecyl ester (CASRN 777 26761-40-0) and 1,2-benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich (CASRN 778 68515-49-1). Both CASRNs contain mainly C10 dialkyl phthalate esters. DIDP is not a Toxics Release 779 Inventory (TRI)-reportable substance; however, it is on the Toxic Substances Control Act (TSCA) 780 Inventory and reported under the CDR rule. This document describes the use of reasonably available 781 information to estimate environmental releases of DIDP and to evaluate occupational exposure to 782 workers. See the draft risk evaluation for a complete list of all the technical support documents for 783 DIDP. 784

# 785 Focus of the Module on Environmental Release and Occupational Exposure Assessment

During scoping, EPA considered all known TSCA uses for DIDP. The 2016 Chemical Data Reporting (CDR) indicated 1-20 million pounds of CASRN 26761-40-0 and 100 to 250 million pounds of CASRN 68515-49-1 were manufactured or imported in the U.S. in 2015 (U.S. EPA, 2019a). The 2020 CDR report indicates a reduction of CASRN 26761-40-0 to less than 1,000,000 lb and an increase of the upper range of CASRN 68515-49-1 to 100 million to 1 billion lb. The largest use of DIDP is as a plasticizer in PVC. Secondary uses are as a plasticizer in adhesives, sealants, paints, coatings, rubbers, non-PVC plastics and other applications.

- 794 Exposures to workers, consumers, general populations, and ecological species may occur from 795 industrial, commercial, and consumer uses of DIDP and DIDP-containing articles and releases to air, 796 water, or land. Workers and occupational non-users (ONUs) may be exposed to DIDP during conditions 797 of use such as plastics compounding and converting, paint and coating formulation and application, and 798 the use of inspection fluid/penetrants. Exposure to the general population and ecological species may 799 occur from industrial and commercial releases related to the manufacture, import, processing, 800 distribution, and use of DIDP. The module provides the details of the assessment of the environmental 801 releases and occupational exposures from each condition of use of DIDP.
- 802

# 803 Approach for Environmental Releases and Occupational Exposures in this Risk Evaluation

EPA evaluated environmental releases of DIDP to air, water, and land from the conditions of use
 assessed in this risk evaluation. EPA used release data from literature sources where available and used
 modeling approaches where release data were not available.

807

808 EPA evaluated acute, intermediate, and chronic exposures to workers and occupational non-users in 809 association with DIDP conditions of use. EPA used inhalation monitoring data from literature sources 810 where available and exposure models where monitoring data were not available or were deemed 811 insufficient for capturing actual exposure within the condition of use. EPA also used *in vivo* rat 812 absorption data, along with modeling approaches, to estimate dermal exposures to workers.

812813

# 814 Results for Environmental Releases and Occupational Exposures in this Risk Evaluation

815 EPA evaluated environmental releases and occupational exposures for each Occupational Exposure

816 Scenario (OES). Each OES is developed based on a set of occupational activities and conditions such

that similar occupational exposures and environmental releases are expected from the use(s) covered

- 818 under the OES. For each OES, EPA provided occupational exposure and environmental release results,
- 819 which are expected to be representative of the entire population of workers and sites for the given OES
- 820 in the United States.
- 821

EPA evaluated environmental releases of DIDP to air, water, and/or land for fifteen out of the seventeen OES assessed in this risk evaluation. EPA did not quantitatively assess environmental releases for the other two OES due to the lack of readily available process-specific and DIDP-specific data. The OES with the highest expected release was Manufacturing, followed by Import/Repackaging, and then Non-PVC Compounding. Detailed release results for each OES to each media can be found in Section 3.

827

828 EPA also evaluated inhalation and dermal exposures to worker populations, including occupational non-829 users (ONUs) and females of reproductive age, for each OES. ONUs are those who may work in the 830 vicinity of chemical-related activities but do not handle the chemicals themselves, such as managers or 831 inspectors. Due to the low vapor pressure and low rate of dermal absorption of DIDP, the occupational 832 exposure assessment has shown that inhalation and dermal exposures to DIDP from most industrial and 833 commercial conditions of use (COUs) are also expected to be rather low, with exception of the COU for 834 the Industrial Use of Adhesives and Sealants. Because industrial adhesives and sealants containing DIDP may be applied through high-pressurized spray application, monitoring data show that it is 835 836 possible for such operations to lead to higher levels of inhalation exposure. Detailed exposure results for 837 each OES and exposure route can be found in Section 3.

838

# 839 Uncertainties of this Risk Evaluation

Uncertainties exist with the monitoring and modeling approaches used to assess DIDP environmental releases and occupational exposures. For example, the lack of DIDP facility production volume data and use of throughput estimates based on CDR reporting thresholds may not be representative of the actual production volume of DIDP used in the U.S. EPA also used generic EPA models and default input parameter values when site-specific data was not available. In addition, site-specific differences in use practices and engineering controls exist, but are largely unknown, this represents another source of variability that EPA could not quantify in the assessment.

847

# 848 Environmental and Exposure Pathways Considered in this Risk Evaluation

EPA assessed environmental releases to air, water, and land to estimate exposures to the general population and ecological species for DIDP conditions of use. The environmental release estimates developed by EPA are used to estimate the presence of DIDP in the environment and biota and evaluate the environmental hazards. The release estimates were used to model exposure to the general population and ecological species where environmental monitoring data were not available.

854

EPA assessed risks for acute, intermediate, and chronic exposure scenarios in workers (those directly
handling DIDP) and occupational non-users (workers not directly involved with the use of DIDP) for
DIDP conditions of use. EPA assumed that workers and occupational non-users would be individuals of

both sexes (age 16 years and older, including pregnant workers) based upon occupational work permits,

although exposures to younger workers in occupational settings cannot be ruled out. An objective of the

860 monitored and modeled inhalation data was to provide separate exposure level estimates for workers and

861 occupational non-users. Dermal exposures were considered for all workers, but only considered for

862 occupational non-users with potential exposure to dust or mist deposited on surfaces.

# 863 1 INTRODUCTION

# 864 **1.1 Overview**

On May 24, 2019, EPA received a request from ExxonMobil Chemical Company, through the American 865 866 Chemical Council's (ACC) High Phthalates Panel (HPP), to conduct a risk evaluation for Diisodecyl Phthalate (CASRNs 26761-40-0 and 68515-49-1) (EPA-HQ-OPPT-2018-0435) under the Frank R. 867 Lautenberg Chemical Safety for the 21st Century Act, the legislation that amended TSCA on June 22, 868 2016. In December 2019, EPA notified the requesters that the Agency had granted their manufacturer 869 requested risk evaluation for DIDP. Pursuant to 40 CFR 702.37(e)(6)(iv), the requesters had 30 days 870 871 following the receipt of this notification to withdraw their request. In January of 2020, upon the 872 expiration of this 30-day period, EPA initiated the risk evaluation for DIDP. 873

- DIDP is a common chemical name for the category of chemical substances that includes the following
  substances: 1,2-benzenedicarboxylic acid, 1,2-diisodecyl ester (CASRN 26761-40-0) and 1,2benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich (CASRN 68515-49-1). Both
  CASRNs contain mainly C10 dialkyl phthalate esters. DIDP is a low volatility liquid that is used
  primarily as a plasticizer in PVC, though it is also used in adhesives, sealants, paints, coatings, rubbers,
- non-PVC plastics and other applications. All uses are subject to federal and state regulations and
- reporting requirements. DIDP is not a Toxics Release Inventory (TRI)-reportable substance; however, it
- is on the Toxic Substances Control Act (TSCA) Inventory and reported under the CDR rule.

# 1.2 Scope

883 EPA assessed environmental releases and occupational exposures for conditions of use as described in 884 Table 2-2 of the Final Scope of the Risk Evaluation for Diisodecyl Phthalate (DIDP) CASRN 26761-40-0 and 68515-49-1 (U.S. EPA, 2021b). To estimate environmental releases and occupational exposures, 885 886 EPA first developed Occupational Exposure Scenarios (OES) related to the conditions of use of DIDP. 887 An OES is based on a set of facts, assumptions, and inferences that describe how releases and exposures take place within an occupational condition of use. How releases/exposures take place may be similar 888 889 across multiple condition of uses, or there may be several ways in which releases/exposures takes place 890 for a given condition of use. Table 1-1 shows mapping between the conditions of use in Table 2-2 of the 891 Scope Document to the OES assessed in this report.

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In general, EPA mapped OESs to condition of uses using professional judgment based on available data and information. Several of the condition of use categories and subcategories were grouped and assessed together in a single OES due to similarities in the processes or lack of data to differentiate between them. This grouping minimized repetitive assessments. In other cases, conditions of use subcategories were further delineated into multiple OESs based on expected differences in process equipment and associated releases/exposure potentials between facilities. EPA assessed environmental releases and occupational exposures for the following DIDP OESs:

- 900 1. Manufacturing
- 901 2. Import and Repackaging
- 9023. Incorporation into Adhesives and Sealants
- 903 4. Incorporation into Paints and Coatings
- 5. Incorporation into Other Formulations, Mixtures, and Reaction Products Not Covered Elsewhere
- 905 6. PVC Plastics Compounding
- 906 7. PVC Plastics Converting
- 907 8. Non-PVC Material Compounding
- 908 9. Non-PVC Material Converting

- 909 10. Application of Adhesives and Sealants
- 910 11. Application of Paints and Coatings
- 911 12. Use of Laboratory Chemicals
- 912 13. Use of Lubricants and Functional Fluids
- 913 14. Use of Penetrants and Inspection Fluids
- 914 15. Fabrication and Final Use of Products or Articles
- 915 16. Recycling
- 916 17. Disposal
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# Table 1-1. Crosswalk of Conditions of Uses Listed in the Final Scope Document to Occupational Exposure Scenarios Assessed in the Risk Evaluation

Life Cycle Stage	Category	Subcategory	OES
	Domestic manufacturing	Domestic manufacturing	Manufacturing
Manufacturing	Importing	Importing	Import and repackaging
	Repackaging	Repackaging	Import and repackaging
		Adhesives and sealants manufacturing	Incorporation into adhesives and sealants
	Incorporation into formulation, mixture, or reaction product	Laboratory chemicals manufacturing	Incorporation into other formulations, mixtures, or reaction products
		Petroleum lubricating oil manufacturing; Lubricants and lubricant additives manufacturing	Incorporation into other formulations, mixtures, or reaction products
		Surface modifier in paint and coating manufacturing	Incorporation into paints and coatings
Processing		Plastic material and resin manufacturing	PVC plastics compounding; non-PVC material compounding
		Plasticizers (paint and coating manufacturing; colorants (including pigments); rubber manufacturing)	Incorporation into paints and coatings; non-PVC material compounding
		Processing aids, specific to petroleum production (oil and gas drilling, extraction, and support activities)	Incorporation into other formulations, mixtures, or reaction products
		Other (part of the formulation for manufacturing synthetic leather)	PVC plastics compounding; non-PVC material compounding

Life Cycle Stage	Category	Subcategory	OES
	Incorporation into articles	Abrasives manufacturing Plasticizers (asphalt paving, roofing, and coating materials manufacturing; construction; automotive products manufacturing, other than fluids; electrical equipment, appliance, and component manufacturing; fabric, textile, and leather products manufacturing; floor coverings manufacturing; furniture and related product manufacturing; plastics product manufacturing; textiles, apparel, and leather manufacturing; transportation equipment manufacturing; photographic supplies manufacturing)	Application of adhesives and sealants PVC plastics converting; non-PVC material converting
	Recycling	Recycling	Recycling
Disposal	Disposal	Disposal	Disposal
Distribution in commerce	Distribution in commerce	Distribution in commerce	Distribution in commerce
	Abrasives	Abrasives (surface conditioning and finishing discs; semi- finished and finished goods)	Fabrication or use of final products or articles
	Adhesive and sealants	Adhesives and sealants	Application of adhesives and sealants
Industrial uses	Functional fluids (closed systems)	Functional fluids (closed systems) (SCBA compressor oil)	Use of lubricants and functional fluids
	Lubricant and lubricant additives	Lubricants and lubricant additives	Use of lubricants and functional fluids

Life Cycle Stage	Category	Subcategory	OES
	Solvents (for cleaning or degreasing)	Solvents (for cleaning or degreasing)	Use of lubricants and functional fluids
	Automotive, fuel, agriculture, outdoor use products	Automotive products, other than fluids	Fabrication or use of final products or articles
		Lubricants	Use of lubricants and functional fluids
		Adhesives and sealants (including plasticizers in adhesives and sealants)	Application of adhesives and sealants
	Construction,	Building/construction materials (wire or wiring systems; joint treatment, fire-proof insulation	Fabrication or use of final products or articles
	paint, electrical, and metal products	Electrical and electronic products	Fabrication or use of final products or articles
		Paints and coatings (including surfactants in paints and coatings)	Application of paints and coatings
		Lacquers, stains, varnishes, and floor finishes (as plasticizer)	Application of paints and coatings; Application of adhesives and sealants
Commercial uses	Furnishing, cleaning,	Furniture and furnishings	Fabrication or use of final products or articles
		Construction and building materials covering large surface areas including stone, plaster, cement, glass, and ceramic articles; fabrics, textiles, and apparel (as plasticizer) (Floor coverings (vinyl tiles, PVC- backed carpeting, scraper mats))	Fabrication or use of final products or articles
	treatment/care products	Ink, toner, and colorant products	Application of paints and coatings
		PVC film and sheet	Fabrication or use of final products or articles
		Plastic and rubber products (textiles, apparel, and leather; vinyl tape; flexible tubes; profiles; hoses)	Fabrication or use of final products or articles
	Other uses	Laboratory chemicals	Use of laboratory chemicals

Life Cycle Stage	Category	Subcategory	OES
		Inspection fluid/penetrant	Use of penetrants and inspection fluids

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921 EPA's assessment of releases includes quantifying annual and daily releases of DIDP to air, water, and 922 land. Releases to air include both fugitive and stack air emissions and emissions resulting from on-site 923 waste treatment equipment, such as incinerators. For purposes of this report, releases to water include 924 both direct discharges to surface water and indirect discharges to publicly owned treatment works 925 (POTW) or non-POTW wastewater treatment (WWT). For purposes of this risk evaluation EPA did not 926 evaluate discharges to POTW and non-POTW WWT using the same methodology as discharges to 927 surface water. EPA considers removal efficiencies of POTWs and WWT plants as well as environmental 928 fate and transport properties when evaluating risks from indirect discharges. Releases to land include 929 any disposal of liquid or solid wastes containing DIDP into landfills, land treatment, surface 930 impoundments, or other land applications. The purpose of this module is to quantify releases; therefore, 931 this report does not discuss downstream environmental fate and transport factors used to estimate 932 exposures to the general population and ecological species. The Draft Risk Evaluation for Diisodecyl 933 *Phthalate (DIDP)* (U.S. EPA, 2024) describes how these factors were considered when determining

934 risk.

935936 For workplace exposures, EPA considered exposures to both workers who directly handle DIDP and

occupational non-users (ONUs) who do not directly handle DIDP, but may be exposed to dust, vapors or

mists that enter their breathing zone while working in locations near where DIDP handling occurs. EPA

evaluated inhalation and dermal exposures to both workers and ONUs.

# 940 2 COMPONENTS OF AN OCCUPATIONAL EXPOSURE AND 941 RELEASE ASSESSMENT

EPA describes the assessed conditions of use (COUs) for DIDP in the Section 1.1.2 of the *Draft Risk Evaluation for Diisodecyl Phthalate (DIDP)* (U.S. EPA, 2024); however, some COUs differ in terms of
 specific DIDP processes and associated exposure/release scenarios. Therefore, Table 1-1 provides a
 crosswalk that maps the DIDP COUs to the more specific OESs. The environmental release and
 occupational exposure assessments of each OES comprised the following components:

- Process Description: A description of the OES, including the function of the chemical in the
   scenario; physical forms and weight fractions of the chemical throughout the process; the total
   production volume associated with the OES; per site throughputs/use rates of the chemical;
   operating schedules; and process equipment used during the OES.
- **Facility Estimates:** An estimate of the number of sites that use DIDP for the given OES.
- 952 Environmental Release Assessment

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- **Environmental Release Sources:** A description of the potential sources of environmental releases in the process and their expected media of release for the OES.
- 955 o Environmental Release Assessment Results: Estimates of DIDP released into each
   956 environmental media (*i.e.*, surface water, POTW, non POTW-WWT, fugitive air, stack
   957 air, and each type of land disposal) for the given OES.
- 958 Occupational Exposure Assessment
  - **Worker Activities:** A description of the worker activities, including an assessment of potential worker and ONU exposure points.
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   962
   Number of Workers and Occupational Non-users: An estimate of the number of workers and ONUs potentially exposed to the chemical for the given OES.
- 963 Occupational Inhalation Exposure Results: Central tendency and high-end estimates of inhalation exposures to workers and ONUs.
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   966
   Occupational Dermal Exposure Results: Central tendency and high-end estimates of dermal exposures to workers

# 967 **2.1 Approach and Methodology for Process Descriptions**

EPA performed a literature search to find descriptions of processes involved in each OES. Where data
 were available to do so, EPA included the following information in each process description:

- Total production volume associated with the OES;
- Name and location of sites where the OES occurs;
- Facility operating schedules (*e.g.*, year-round, 5 days/week, batch process, continuous process, multiple shifts);
- Key process steps;
- Physical form and weight fraction of the chemical throughout the process;
- Information on receiving and shipping containers; and
- Ultimate destination of chemical leaving the facility.

978 Where DIDP-specific process descriptions were unclear or not available, EPA referenced generic

process descriptions from literature, including relevant Emission Scenario Documents (ESD) or Generic

980 Scenarios (GS). Sections 3.1 through 3.18 to provide process descriptions for each OES.

# 981 **2.2** Approach and Methodology for Estimating Number of Facilities

To estimate the number of facilities within each OES, EPA used a combination of bottom-up analyses of
 EPA reporting programs and top-down analyses of U.S. economic data and industry-specific data.
 Generally, EPA used the following steps to dayalon facility actimates:

- Generally, EPA used the following steps to develop facility estimates:
- Identify or "map" each facility that reported DIDP in the 2016 and 2020 CDR to an OES (U.S. EPA, 2019a); (U.S. EPA, 2020b). Mapping consists of using facility reported industry sectors (typically reported as either North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) codes), chemical activity, and processing and use information to assign the most likely OES to each facility.
- Based on the reporting thresholds and requirements of each data set, evaluate whether the data in the reporting programs is expected to cover most or all the facilities within the OES. If so, EPA assessed the total number of facilities in the OES as equal to the count of facilities mapped to the OES from each data set. If not, EPA proceeded to Step 3.
- Supplement the available reporting data with U.S. economic and market data using the following steps:
  - a. Identify the NAICS codes for the industry sectors associated with the OES.
  - b. Estimate total number of facilities using the U.S. Census' Statistics of US Businesses (SUSB) data on total sites by 6-digit NAICS code.
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  1000
  c. Use market penetration data to estimate the percentage of sites likely to be using DIDP instead of other chemicals.
- 1001d.Combine the data generated in Steps 3.a. through 3.c. to produce an estimate of the1002number of facilities using DIDP in each 6-digit NAICS code and sum across all1003applicable NAICS codes to arrive at an estimate of the total number of facilities within1004the OES. Typically, EPA assumed this estimate encompassed the facilities identified in1005Step 1; therefore, EPA assessed the total number of facilities for the OES as the total1006generated from this analysis.
- 4. If market penetration data required for Step 3.c. are not available, use generic industry data from GSs, ESDs, and other literature sources on typical throughputs/use rates, operating schedules, and the DIDP production volume used within the OES to estimate the number of facilities. In cases where EPA identified a range of operating data in the literature for an OES, EPA used stochastic modeling to provide a range of estimates for the number of facilities within the OES.
  EPA describes the approaches, equations, and input parameters used in stochastic modeling in the relevant OES sections throughout this report.

# 1014 **2.3 Environmental Releases Approach and Methodology**

1015 EPA assessed releases to the environment using data obtained through direct measurement via 1016 monitoring, calculations based on empirical data, and/or assumptions and models. For each OES, EPA 1017 attempted to provide annual releases, high-end and central tendency daily releases, and the number of 1018 release days per year for each media of release (*i.e.*, air, water, and lend)

- 1018 release days per year for each media of release (*i.e.*, air, water, and land).
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1020 EPA used the following hierarchy in selecting data and approaches for assessing environmental releases:

- 1021 1. Monitoring and measured data: 1022 a. Releases calculated from site- and media-specific concentration and flow rate data. 1023 b. Releases calculated from mass balances or emission factor methods using site-specific 1024 measurements. 1025 2. Modeling approaches: 1026 a. Surrogate release data 1027 b. Fundamental modeling approaches 1028 c. Statistical regression modeling approaches 1029 3. Release limits: 1030 a. Company-specific limits 1031 b. Regulatory limits (e.g., National Emission Standards for Hazardous Air Pollutants 1032 [NESHAPs] or effluent limitations/requirements). 1033 EPA described the final release results as either a point estimate (*i.e.*, a single descriptor or statistic, such 1034 as central tendency or high-end) or a full distribution. EPA considered three general approaches for estimating the final release result: 1035 Deterministic calculations: EPA used a combinations of point estimates of each input parameter 1036
- 1037(e.g., high-end and low-end values) to estimate central tendency and high-end release result.1038EPA documented the method and rationale for selecting parametric combinations representative1039of central tendency and high-end releases in the relevant OES subsections in Section 3.
- Probabilistic (stochastic) calculations: EPA ran Monte Carlo simulations using the statistical distribution for each input parameter to calculate a full distribution of the final release results.
   EPA selected the 50<sup>th</sup> and 95<sup>th</sup> percentiles of the resulting distribution to represent central tendency and high-end releases, respectively.
- Combination of deterministic and probabilistic calculations: EPA had statistical distributions for some parameters and point estimates for the remaining parameters. For example, EPA used Monte Carlo modeling to estimate annual throughputs and emission factors, but only had point estimates of release frequency and production volume. In this case, EPA documented the approach and rationale for combining point estimates with statistical distributions to estimate central tendency and high-end results in the relevant OES subsections in Sections 3.1 through 3.18.
- 1051 2.3.1 Identifying Release Sources
- EPA performed a literature search to identify process operations that could potentially result in releases of DIDP to air, water, or land from each OES. For each OES, EPA identified the release sources and the associated media of release. Where DIDP-specific release sources were unclear or unavailable, EPA referenced relevant ESDs or GSs. Sections 3.1 through 3.18 describe the release sources for each OES.
- 1056 2.3.2 Estimating Number of Release Days
- 1057 Unless EPA identified conflicting information, EPA assumed that the number of release days per year1058 for a given release source equals the number of operating days at the facility. To estimate the number of
- 1059 operating days, EPA used the following hierarchy:

- 4. Facility-specific data: EPA used facility-specific operating days per year data, if available. 1060 1061 Otherwise, EPA used data for other facilities within the same OES, if possible. EPA estimated 1062 the operating days per year using one of the following approaches:
- 1063 a. If other facilities have known or estimated average daily use rates, EPA calculated the days per year as: Days/year = Estimated Annual Use Rate for the facility (kg/year) / average daily use rate from facilities with available data (kg/day).
- 1066 b. If facilities with days per year data do not have known or estimated average daily use 1067 rates, EPA used the average number of days per year from the facilities with available 1068 data.
  - 5. Industry-specific data: EPA used industry-specific data from GSs, ESDs, trade publications, or other relevant literature.
- 1071 6. Manufacture of large-production volume (PV) commodity chemicals: For the 1072 manufacture of the large-PV commodity chemicals, EPA used a value of 350 days per year. This assumes the plant runs seven days per week and 50 weeks per year (with two weeks 1073 down for turnaround) and always produces the chemical. 1074
- 1075 7. Manufacture of lower-PV specialty chemicals: For the manufacture of lower-PV specialty chemicals, it is unlikely that the plant continuously manufactures the chemical throughout the 1076 year. Therefore, EPA used a value of 250 days per year. This assumes the plant manufactures 1077 1078 the chemical five days per week and 50 weeks per year (with two weeks down for 1079 turnaround).
- 1080 8. Other Chemical Plant OES (e.g., processing into formulation and repackaging): For 1081 these OES, EPA assumed that facility does not always use the chemical of interest, even if the facility operates 24/7. Therefore, EPA used a value of 300 days/year, based on the assumption 1082 that the facility operates 6 days/week and 50 weeks/year (with 2 weeks for turnaround). 1083 1084 However, in instances where the OES uses a low volume of the chemical of interest, EPA 1085 used 250 days per year as a lower estimate based on the assumption that the facility operates 5 days/week and 50 weeks/year (with 2 weeks for turnaround). 1086
- 1087 9. **POTWs:** Although EPA expects POTWs to operate continuously 365 days per year, the discharge frequency of the chemical of interest from a POTW will depend on the discharge 1088 patterns of the chemical from upstream facilities discharging to the POTW. However, there 1089 can be multiple upstream facilities (possibly with different OES) discharging to the same 1090 POTW and information on when the discharges from each facility occur (e.g., on the same 1091 day or separate days) is typically unavailable. Since EPA could not determine the exact 1092 1093 number of days per year that the POTW discharges the chemical of interest, EPA used a value 1094 of 365 days per year.
- 1095 10. All Other OES: Regardless of the facility operating schedule, other OES are unlikely to use 1096 the chemical of interest every day. Therefore, EPA used a value of 250 days per year for these 1097 OES.
- 1098 2.3.3 Estimating Releases from Models

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1099 EPA utilized models to estimate environmental releases for OES without TRI, DMR, or NEI data. These 1100 models apply deterministic calculations, stochastic calculations, or a combination of both to estimate 1101 releases. EPA used the following these steps to estimate releases:

- 1102 1. Identify release sources and associated release media for each relevant process.
- 1103 2. Identify or develop model equations for estimating releases from each source.

- 1104 3. Identify model input parameter values from relevant literature sources.
- 110511064. If a range of input values is available for an input parameter, determine the associated distribution of input values.
- 110711085. Calculate annual and daily release volumes for each release source using input values and model equations.
- 11096. Aggregate release volumes by release media and report total releases to each media from each<br/>facility.

1111 For release models that utilized stochastic calculations, EPA performed a Monte Carlo simulation using

- 1112 the Palisade @Risk software with 100,000 iterations and the Latin Hypercube sampling method.
- 1113 4.2Appendix E provide detailed descriptions of the model approaches that EPA used for each OES as
- 1114 well as model equations, input parameter values, and associated distributions.

# 2.3.4 Estimating Releases Using Literature Data

1116 Where available, EPA used data from literature sources to estimate releases. Literature data may include 1117 directly measured release data or other information related to release modeling. Therefore, EPA's

approach to literature data differed depending on the type of available literature data. For example, if

- 1119 facility-specific release data is available, EPA may use that data to estimate releases for that facility. If
- 1120 facility-specific data is available for a subset of the facilities within an OES, EPA may build a
- distribution from these data and estimate releases from facilities within the OES using central tendency and high-end values from this distribution. If facility-specific data is unavailable, but industry- or
- 1122 and figh-end values from this distribution. If facinity-specific data is unavailable, but industry- or 1123 chemical-specific emission factors are available, EPA may use these emission factors to calculate
- releases for an OES or incorporate the emission factors into release models to develop a distribution of
- 1125 potential releases for the OES. Sections 3.1 through 3.18 provides a detailed description of how EPA
- 1126 incorporated literature data into the release estimates for each OES.

# 1127 **2.4 Occupational Exposure Approach and Methodology**

For workplace exposures, EPA considered exposures to both workers who directly handle DIDP and ONUs who do not directly handle DIDP but may be exposed to vapors, particulates, or mists that enter their breathing zone while working in locations near DIDP handling. EPA evaluated inhalation and dermal exposures to both workers and ONUs.

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1133 EPA provided occupational exposure results representative of central tendency and high-end exposure 1134 conditions. The central tendency is expected to represent occupational exposures in the center of the

- distribution for a given COU. For risk evaluation, EPA used the 50<sup>th</sup> percentile (median), mean
- 1136 (arithmetic or geometric), mode, or midpoint values of a distribution as representative of the central
- 1137 tendency scenario. EPA preferred to provide the 50<sup>th</sup> percentile of the distribution. However, if the full
- distribution is unknown, EPA may assume that the mean, mode, or midpoint of the distribution
- 1139 represents the central tendency depending on the statistics available for the distribution.
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- 1141 The high-end exposure is expected to be representative of occupational exposures that occur at
- 1142 probabilities above the 90<sup>th</sup> percentile, but below the highest exposure for any individual (U.S. EPA,
- 1143 <u>1992a</u>). For risk evaluation, EPA provided high-end results at the 95<sup>th</sup> percentile. If the 95<sup>th</sup> percentile is
- not reasonably available, EPA used a different percentile greater than or equal to the 90<sup>th</sup> percentile but
- 1145 less than or equal to the 99.9<sup>th</sup> percentile, depending on the statistics available for the distribution. If the
- full distribution is not known and the preferred statistics are not reasonably available, EPA estimated a
- 1147 maximum or bounding estimate in lieu of the high-end.
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- 1149 For occupational exposures, EPA used measured or estimated air concentrations to calculate exposure
- 1150 concentration metrics required for risk assessment, such as average daily concentration (ADC). These
- 1151 calculations require additional parameter inputs, such as years of exposure, exposure duration and
- 1152 exposure frequency. EPA estimated exposure concentrations from monitoring data, modeling, or
- 1153 occupational exposure limits.
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- For the final exposure result metrics, each of the input parameters (*e.g.*, air concentrations, working years, exposure frequency) may be a point estimate (*i.e.*, a single descriptor or statistic, such as central tendency or high-end) or a full distribution. EPA considered three general approaches for estimating the final exposure result metrics:
- Deterministic calculations: EPA used combinations of point estimates of each parameter to estimate a central tendency and high-end for each final exposure metric result.
- Probabilistic (stochastic) calculations: EPA used Monte Carlo simulations using the full distribution of each parameter to calculate a full distribution of the final exposure metric results and selecting the 50<sup>th</sup> and 95<sup>th</sup> percentiles of this resulting distribution as the central tendency and high-end, respectively.
- Combination of deterministic and probabilistic calculations: EPA had full distributions for some parameters but point estimates of the remaining parameters. For example, EPA used Monte Carlo modeling to estimate exposure concentrations, but only had point estimates of exposure duration and frequency.
- Appendix B discusses the equations and input parameter values that EPA used to estimate each exposure metric.
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- For each OES, EPA attempted to provide high-end and central tendency, full-shift time-weighted average (TWA) (typically as an 8-hr TWA) inhalation exposure concentrations as well as high-end and
- 1174 average (1 wA) (typically as an 8-in 1 wA) initiation exposure concentrations as well as high-end and 1175 central tendency acute potential dermal dose rates (APDR). EPA applied the following hierarchy in
- 1176 selecting data and approaches for assessing occupational exposures:

# 1177 Monitoring data:

- a. Personal and directly applicable to the OES
- b. Area and directly applicable to the OES
- 1180 c. Personal and potentially applicable or similar to the OES
- d. Area and potentially applicable or similar to the OES
- 1182 7. Modeling approaches:
- 1183 a. Surrogate monitoring data
- b. Fundamental modeling approaches
- 1185 c. Statistical regression modeling approaches
- 1186 8. Occupational exposure limits:
- 1187a. Company-specific occupational exposure limits (OELs) (for site-specific exposure1188assessments, e.g., there is only one manufacturer who provides their internal OEL to1189EPA, but the manufacturer does not provide monitoring data)
- 1190b. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits1191(PEL)

1192c. Voluntary limits (*i.e.*, American Conference of Governmental Industrial Hygienists1193[ACGIH] Threshold Limit Values [TLV], National Institute for Occupational Safety and1194Health [NIOSH] Recommended Exposure Limits [REL], Occupational Alliance for Risk1195Science (OARS) workplace environmental exposure level (WEEL) [formerly by AIHA])

EPA used the estimated high-end and central tendency, full-shift TWA inhalation exposure concentrations and APDR to calculate the exposure metrics required for risk evaluation. Exposure metrics for inhalation exposures include acute concentrations (AC), intermediate average daily concentrations (IADC), and average daily concentrations (ADC). Exposure metrics for dermal exposures include acute dose (AD), intermediate average daily dose (IADD), and average daily dose

- 1201 (ADD). Appendix B describes the approach that EPA used to estimating each exposure metric.
- 1202 **2.4.1 Identifying Worker Activities**

EPA performed a literature search and reviewed data from systematic review to identify worker
activities that could potentially result in occupational exposures. Where worker activities were unclear
or not available, EPA referenced relevant ESDs or GSs. Section 3 provides worker activities for each
OES.

# 1207 2.4.2 Number of Workers and Occupational Non-users 1208 Where available, EPA used CDR data to provide a basis to estimate the number of workers and ONUs. 1209 EPA supplemented the available CDR data with U.S. economic data using the following method:

- 1210 1. Identify the NAICS codes for the industry sectors associated with these uses.
- Estimate total employment by industry/occupation combination using the Bureau of Labor
   Statistics' Occupational Employment Statistics data (BLS Data).
- 12133. Refine the Occupational Employment Statistics estimates where they are not sufficiently<br/>granular by using the U.S. Census' SUSB data on total employment by 6-digit NAICS.
- 4. Use market penetration data to estimate the percentage of employees likely to be using DIDP
  instead of other chemicals.
- 5. Where market penetration data are not available, use the estimated workers/ONUs per site in the 6-digit NAICS code and multiply by the number of sites estimated from CDR, TRI, DMR and/or NEI. In DMR data, sites report SIC codes rather than NAICS codes; therefore, EPA mapped each reported SIC code to a NAICS code for use in this analysis.
- 12216. Combine the data generated in Steps 1 through 5 to produce an estimate of the number of1222employees using DIDP in each industry/occupation combination and sum these to arrive at a1223total estimate of the number of employees with exposure within the OES.
- 1224 **2.4.3 Estimating Inhalation Exposures**

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2.4.3.1 Inhalation Monitoring Data

To assess inhalation exposure, EPA reviewed workplace inhalation monitoring data collected by government agencies such as OSHA and NIOSH, monitoring data found in published literature (*i.e.*, personal exposure monitoring data and area monitoring data), and monitoring data submitted via public comments. Studies were evaluated using the evaluation strategies laid out in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2021a).

Exposures are calculated from the monitoring data sets provided in the sources depending on the size of the data set. For data sets with six or more data points, EPA estimated central tendency and high-end

exposures using the 50<sup>th</sup> and 95<sup>th</sup> percentile values from the observed data set, respectively. For data sets

- 1235 with three to five data points, EPA estimated the central tendency and high-end exposures using the 1236 median and maximum values, respectively. For data sets with two data points, EPA presented the
- 1237 midpoint and the maximum value, Finally, EPA presented data sets with two data points, EFA presented the
- 1238 data sets including exposure data that were reported as below the limit of detection (LOD), EPA
- estimated the exposure concentrations for these data following guidance in EPA's *Guidelines for*
- 1240 Statistical Analysis of Occupational Exposure Data (U.S. EPA, 1994). EPA combined the exposure data
- from all studies applicable to a given occupational exposure scenario into a single data set.
- 1242

For exposure assessment, personal breathing zone (PBZ) monitoring data and applicable area monitoring data were used to determine the TWA exposure concentration. Table 2-1 presents the data quality rating of monitoring data that EPA used to assess occupational exposures. EPA evaluated monitoring data using the evaluation strategies laid out in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2021a).

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Source Reference	Data Type	Data Quality Rating	Occupational Exposure Scenario(s)
(ExxonMobil, 2022a)	PBZ Monitoring	Medium	Manufacturing
( <u>Porras et al., 2020</u> );	Area Monitoring	Medium	PVC Plastics Converting
( <u>Irwin, 2022</u> )	PBZ Monitoring	Medium	PVC Plastics Converting

# 1249 **Table 2-1. Data Evaluation of Sources Containing Occupational Exposure Monitoring Data**

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# 2.4.3.2 Inhalation Exposure Modeling

Where inhalation exposures are expected for an OES, but monitoring data were either unavailable or EPA determined that the monitoring data did not sufficiently capture the exposures for an OES, EPA attempted to utilize models to estimate inhalation exposures. These models apply deterministic calculations, stochastic calculations, or a combination of both deterministic and stochastic calculations to estimate inhalation exposures. EPA used the following steps to estimate exposures for each OES:

- 1256 1. Identify worker activities and potential sources of exposures from each process.
- 1257 2. Identify or develop model equations for estimating exposures from each source.
- Identify model input parameter values from relevant literature sources, including activity durations associated with sources of exposures.
- 12604. If a range of input values is available for an input parameter, determine the associated distribution of input values.
- 1262 5. Calculate exposure concentrations associated with each activity.
- 6. Calculate full-shift TWAs based on the exposure concentration and activity duration associated with each exposure source.
- 1265 7. Calculate exposure metrics (AC, IADC, ADC) from full-shift TWAs.

For exposure models that utilize stochastic calculations, EPA performed a Monte Carlo simulation using the Palisade @Risk software with 100,000 iterations and the Latin Hypercube sampling method.

1268 Appendix E provides detailed descriptions of the model approaches used for each OES, model 1269 equations, and input parameter values and associated distributions.

# 2.4.4 Estimating Dermal Exposures

1271 This section summarizes the available dermal absorption data related to DIDP (Section 2.4.4.1), the 1272 interpretation of the dermal absorption data (Section 2.4.4.1.1), dermal absorption modeling efforts 1273 (Section 2.4.4.2), and uncertainties associated with dermal absorption estimation (Section 2.4.4.3). 1274 Dermal data were sufficient to characterize occupational dermal exposures to liquids or formulations 1275 containing DIDP (Section 2.4.4.1); however, dermal data were not sufficient to estimate dermal 1276 exposures to solids or articles containing DIDP. Therefore, modeling efforts described in Section 2.4.4.2 1277 were utilized to estimate dermal exposures to solids or articles containing DIDP. Dermal exposures to 1278 vapors are not expected to be significant due to the extremely low volatility of DIDP, and therefore, are 1279 not included in the dermal exposure assessment of DIDP. The flux-based dermal exposure approach 1280 used for estimating occupational dermal exposures to DIDP is further explained in Appendix D.

# 1281 2.4.4.1 Dermal Absorption Data

Dermal absorption data related to DIDP are limited. Specifically, EPA identified only one study directly 1282 1283 related to the dermal absorption of DIDP (Elsisi et al., 1989), which was an in vivo absorption study 1284 using male F344 rats. For each *in vivo* dermal absorption experiment, neat DIDP was applied to a freshly shaven area of 1.3 cm<sup>2</sup> in doses ranging from  $5 - 8 \text{ mg/cm}^2$  and the site of application was 1285 1286 covered with a perforated cap. Urine and feces were collected and analyzed every 24 hours for a 1287 duration of 7 days, and at the end of the seventh day, each rat was killed and all remaining contents 1288 (tissues, organs, etc.) were analyzed. Results of the study showed the average percent absorption of 1289 DIDP (both into and through the skin) over the 7-day period was 1.5% and the average material 1290 recovery was 82%. However, OECD 156 (2022) guidelines suggest that material recovery from dermal 1291 absorption testing of non-volatile compounds should be 90 - 110%. Because the material recovery of 1292 DIDP fell outside the recommended recovery range, OECD 156 (2022) guidelines suggest the following 1293 normalization of the percent absorption.

1294 1295

1296

1270

Normalized Percent Absorption of DIDP =  $(100/82) \times (1.5\%) = 1.8\%$ 

OECD 156 (2022) states that this approach of normalizing percent absorption assumes that losses
 occurred in all matrices equally, which is reasonable considering the duration of the experiment and the
 fact that the cap was perforated.

1300

1301 Though there are no direct points of comparison for absorption of neat DIDP, there was an analogous *in* 1302 vivo dermal absorption study conducted for neat DINP (Midwest Research Institute, 1983). For each in 1303 vivo dermal absorption experiment, neat DINP was applied to a freshly shaven area of 3 cm x 4 cm at a 1304 dose of 8 mg/cm<sup>2</sup> and the site of application was covered with a Styrofoam cup lined with aluminum foil. After 7 days of monitoring, the average percent absorption of DINP (both through and into the skin) 1305 1306 was 3.06% and the average material recovery was 96.55%. Because it is expected that DINP is slightly 1307 more absorptive than DIDP due to the slightly shorter alkyl chain length of DINP compared to DIDP, 1308 the results of the study from the Midwest Research Institute (1983) provide additional credence to the 1309 results of DIDP absorption from Elsisi (1989).

# 1310 2.4.4.1.1 Dermal Absorption Data Interpretation

1311 With respect to interpretation of the DIDP dermal absorption data reported in Elsisi (<u>1989</u>), it is

important to consider the relationship between the applied dermal load and the rate of dermal absorption.
Specifically, the work of Kissel (2011) suggests the dimensionless term N<sub>derm</sub> to assist with

- 1314 interpretation of dermal absorption data. The term N<sub>derm</sub> represents the ratio of the experimental load
- 1315 (*i.e.*, application dose) to the steady-state absorptive flux for a given experimental duration as shown in 1316 the following equation.

## 1317 Equation 2-1. Relationship Between Applied Dermal Load and Rate of Dermal Absorption experimental load (<u>mass</u>)

1318 
$$N_{derm} = \frac{(mass)^2}{steady - state flux (\frac{mass}{area * time}) \times experimental duration (time)}$$

1319

1320 Kissel (2011) indicates that high values of  $N_{derm}$  (>> 1) suggest that supply of the material is in surplus 1321 and that the dermal absorption is considered "flux-limited," whereas lower values of  $N_{derm}$  indicate that 1322 absorption is limited by the experimental load and would be considered "delivery-limited." Furthermore, 1323 Kissel (2011) indicates that values of percent absorption for flux-limited scenarios are highly dependent 1324 on the dermal load and should not be assumed transferable to conditions outside of the experimental 1325 conditions. Rather, the steady-state absorptive flux should be utilized for estimating dermal absorption 1326 of flux-limited scenarios.

Using an estimate of 1.8% absorption of  $5 - 8 \text{ mg/cm}^2$  of DIDP over a 7-day period, a range of potential steady-state fluxes of neat DIDP is calculated as  $5.36 \times 10^{-4}$  to  $8.57 \times 10^{-4}$  mg/cm<sup>2</sup>/hr. The application of N<sub>derm</sub> to the DIDP dermal absorption data reported in Elsisi (1989) is shown below.

1331

1332

1327

$$N_{derm} = \frac{8 \, mg/cm^2}{8.57 \, \mathrm{E} - 04 \frac{mg}{cm^2 \cdot hr} \times 7 \, days \times 24 \frac{hr}{day}} = 56$$

1333

1334 Because  $N_{derm} >> 1$  for the experimental conditions of Elsisi (1989), it is shown that the absorption of DIDP is considered flux-limited even at finite doses (*i.e.*, less than 10  $\mu$ L/cm<sup>2</sup> (OECD, 2004c)) and that 1335 1336 percent absorption should not be considered transferrable across exposure conditions. The range of 1337 estimated steady-state fluxes of DIDP presented in this section, based on the results of Elsisi (1989), is 1338 representative of exposures to liquid materials or formulations only. Dermal exposures to liquids 1339 containing DIDP are characterized in Appendix D. Regarding dermal exposures to solids containing 1340 DIDP, there were no available data and dermal exposures to solids are modeled as described in Section 1341 2.4.4.2.

1342

## 2.4.4.2 Dermal Absorption Modeling

1343 It is expected that dermal exposure to solid matrices would result in far less absorption, but there are no 1344 studies that report dermal absorption of DIDP from a solid matrix. For cases of dermal absorption of 1345 DIDP from a solid matrix, EPA assumes that DIDP will first migrate from the solid matrix to a thin 1346 layer of moisture on the skin surface. Therefore, absorption of DIDP from solid matrices is considered 1347 limited by aqueous solubility and is estimated using an aqueous absorption model as described below.

- 1348
- 1349 The first step in determining the dermal absorption through aqueous media is to estimate the steady-state 1250  $K_{1}$  ( $K_{2}$ )  $K_{2}$  ( $K_{2}$ ) ( $K_{2}$  ( $K_{2}$ )  $K_{2}$  ( $K_{2}$ ) ( $K_{2}$ )  $K_{2}$  ( $K_{2}$ ) ( $K_{2}$ )  $K_{2}$  ( $K_{2}$ ) ( $K_{2}$ )
- permeability coefficient,  $K_p$  (cm/hr). EPA utilized the Consumer Exposure Model (CEM) (U.S. EPA, 2023a) to estimate the steady-state aqueous permeability coefficient of DIDP. Next, EPA relied on
- 1351 <u>2023a</u>) to estimate the steady-state aqueous permeability coefficient of DIDP. Next, EPA relied on 1352 Equation 3.2 from the *Risk Assessment Guidance for Superfund (RAGS)*, *Volume I: Human Health*
- Equation 3.2 from the *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, (Part E: Supplemental Guidance for Dermal Risk Assessment)* (U.S. EPA, 2004b)
- 1355 Evaluation Manual, (Part E: Supplemental Guldance for Dermal Risk Assessment) (0.5. EPA, 2004b) 1354 which characterizes dermal uptake (through and into skin) for aqueous organic compounds. Specifically,
- 1355 Equation 3.2 from U.S. EPA (2004b) was used to estimate the dermally absorbed dose (DA<sub>event</sub>,
- $1356 \text{ mg/cm}^2$ ) for an absorption event occurring some duration ( $t_{abs}$ , hours) as shown below.

#### **Equation 2-2. Dermal Absorption Dose During Absorption Event** 1357

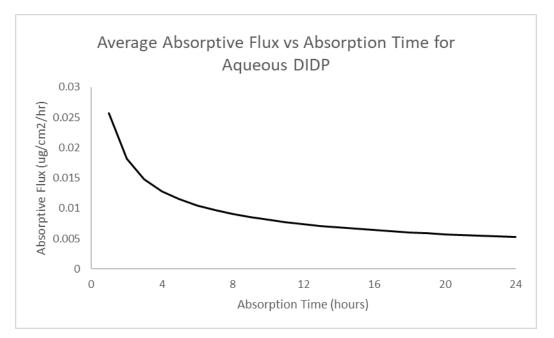
$$DA_{event} = 2 \times FA \times K_p \times S_W \times \sqrt{\frac{6 \times t_{lag} \times t_{abs}}{\pi}}$$

1359 Where:

1358

1360	DAevent	=	Dermally absorbed dose during absorption event $t_{abs}$ (mg/cm <sup>2</sup> )
1361	FA	=	Effect of stratum corneum on quantity absorbed = $0.68$ [see Exhibit A-5 of U.S. EPA
1362			(2004b)]
1363	K <sub>p</sub>	=	Permeability coefficient = $0.0071$ cm/hr (calculated using CEM ( <u>U.S. EPA, 2023a</u> ))
1364	$\mathbf{S}_{\mathbf{w}}$	=	Water solubility = $0.33 \text{ mg/L}$ [Mean value determined from the following studies: (NLM,
1365			2020; EC/HC, 2017; ECJRC, 2003a; NTP-CERHR, 2003; Letinski et al., 2002; Howard
1366			et al., 1985; SRC, 1983)]
1367	t <sub>lag</sub>	=	$\overline{0.105*10^{0.0056MW}} = 0.105*10^{0.0056*446.68} = 33.3$ hours [calculated from A.4 of U.S. EPA
1368	-		( <u>2004b</u> )]
1369	t <sub>abs</sub>	=	Duration of absorption event (hours)
1370			
1371	By dividir	ng tl	the dermally absorbed dose (DA <sub>event</sub> ) by the duration of absorption (t <sub>abs</sub> ), the resulting
1372	•	<u> </u>	elds the average absorptive flux. Figure 2-1 illustrates the relationship between the average
1373	-	•	x and the absorption time.

1374



1375

1376 Figure 2-1. Average Absorptive Flux Absorbed into and through Skin as Function of Absorption Time 1377

1378

1379 Figure 2-1 shows that the average absorptive flux for aqueous DIDP is expected to vary between 0.005 and  $0.025 \,\mu \text{g/cm}^2/\text{hr}$  for durations between 1-hour and 1-day, and the average absorptive flux for an 8-hr 1380 1381 exposure is 0.00899  $\mu$ g/cm<sup>2</sup>/hr. The estimation of average flux of aqueous material through and into the skin is dependent on the duration of absorption and must be determined based on the scenario under 1382

assessment. The range of estimated steady-state fluxes of DIDP presented in this section, based on 1383

- modeling from (U.S. EPA, 2004b), is considered representative of dermal exposures to solid materials or 1384
- 1385 articles containing DIDP. Dermal exposures to solids containing DIDP are characterized in Appendix D.

#### 1386 2.4.4.3 Uncertainties in Dermal Absorption Estimation

As noted above in Section 2.4.4.1, EPA identified only one set of experimental data related to the 1387 1388 dermal absorption of neat DIDP (Elsisi et al., 1989). This dermal absorption study was conducted in vivo using male F344 rats. There have been additional studies conducted to determine the difference in 1389 1390 dermal absorption between rat skin and human skin. Specifically, Scott (1987) examined the difference 1391 in dermal absorption between rat skin and human skin for four different phthalates (i.e., DMP, DEP, 1392 DBP, and DEHP) using *in vitro* dermal absorption testing. Results from the *in vitro* dermal absorption 1393 experiments showed that rat skin was more permeable than human skin for all four phthalates examined. 1394 For example, rat skin was up to 30 times more permeable than human skin for DEP, and rat skin was up 1395 to 4 times more permeable than human skin for DEHP. Though there is uncertainty regarding the 1396 magnitude of difference between dermal absorption through rat skin vs. human skin for DIDP, EPA is 1397 confident that the *in vivo* dermal absorption data using male F344 rats (Elsisi et al., 1989) provides an 1398 upper bound of dermal absorption of DIDP based on the findings of Scott (1987). 1399

1400 Another source of uncertainty regarding the dermal absorption of DIDP from products or formulations

1401 stems from the varying concentrations and co-formulants that exist in products or formulations

- 1402 containing DIDP. For purposes of this risk evaluation, EPA assumes that the absorptive flux of neat
- 1403 DIDP measured from *in vivo* rat experiments serves as an upper bound of potential absorptive flux of
- 1404 chemical into and through the skin for dermal contact with all liquid products or formulations, and that
- 1405 the modeled absorptive flux of aqueous DIDP serves as an upper bound of potential absorptive flux of

1406 chemical into and through the skin for dermal contact with all solid products. However, dermal contact 1407 with products or formulations that have lower concentrations of DIDP may exhibit lower rates of flux

1408 since there is less material available for absorption. Conversely, co-formulants or materials within the

1409 products or formulations may lead to enhanced dermal absorption, even at lower concentrations.

1410 Therefore, it is uncertain whether the products or formulations containing DIDP would result in

1411 decreased or increased dermal absorption. Based on the available dermal absorption data for DIDP, EPA 1412 has made assumptions that result in exposure assessments that are the most human health protective in 1413 nature.

1414 Lastly, EPA notes that there is uncertainty with respect to the modeling of dermal absorption of DIDP 1415 from solid matrices or articles. Because there were no available data related to the dermal absorption of

- 1416 DIDP from solid matrices or articles, EPA has assumed that dermal absorption of DIDP from solid
- 1417 objects would be limited by aqueous solubility of DIDP. Therefore, to determine the maximum steady-
- state aqueous flux of DIDP, EPA utilized the Consumer Exposure Model (CEM) (U.S. EPA, 2023a) to 1418

1419 first estimate the steady-state aqueous permeability coefficient of DIDP. The estimation of the steady-1420

state aqueous permeability coefficient within CEM (U.S. EPA, 2023a) is based on quantitative structure-1421 activity relationship (OSAR) model presented by ten Berge (2009), which considers chemicals with

1422  $log(K_{ow})$  ranging from -3.70 to 5.49 and molecular weights ranging from 18 to 584.6. The molecular

- weight of DIDP falls within the range suggested by ten Berge (2009), but the  $log(K_{ow})$  of DIDP exceeds 1423
- 1424 the range suggested by ten Berge (2009). Therefore, there is uncertainty regarding the accuracy of the QSAR model used to predict the steady-state aqueous permeability coefficient for DIDP.
- 1425
- 1426

## 2.4.5 Estimating Acute, Intermediate, and Chronic (Non-cancer) Exposures

1427 For each condition of use, the estimated exposures were used to calculate acute, intermediate, and 1428 chronic (non-cancer) inhalation exposures and dermal doses. These calculations require additional 1429 parameter inputs, such as years of exposure, exposure duration and exposure frequency.

1430

1431 For the final exposure result metrics, each of the input parameters (*e.g.*, air concentrations, dermal doses, 1432 working years, exposure frequency) may be a point estimate (*i.e.*, a single descriptor or statistic, such as

1433 central tendency or high-end) or a full distribution. As described in Section 2.4, EPA considered three

1434 general approaches for estimating the final exposure result metrics: deterministic calculations,

1435 probabilistic (stochastic) calculations, and a combination of deterministic and probabilistic calculations.

1436 Equations for these exposures can be found in Appendix B.

# 1437 2.5 Consideration of Engineering Controls and Personal Protective 1438 Equipment

1439 OSHA and NIOSH recommend employers utilize the hierarchy of controls to address hazardous 1440 exposures in the workplace. The hierarchy of controls strategy outlines, in descending order of priority, 1441 the use of elimination, substitution, engineering controls, administrative controls, and lastly personal 1442 protective equipment (PPE). The hierarchy of controls prioritizes the most effective measures, which 1443 eliminate or substitute the harmful chemical (e.g., use a different process, substitute with a less 1444 hazardous material), thereby preventing or reducing exposure potential. Following elimination and 1445 substitution, the hierarchy recommends engineering controls to isolate employees from the hazard, 1446 followed by administrative controls or changes in work practices to reduce exposure potential (e.g., 1447 source enclosure, local exhaust ventilation systems). Administrative controls are policies and procedures 1448 instituted and overseen by the employer to protect worker exposures. OSHA and NIOSH recommend 1449 the use of PPE (e.g., respirators, gloves) as the last means of control, when the other control measures 1450 cannot reduce workplace exposure to an acceptable level.

## 2.5.1 Respiratory Protection

OSHA's Respiratory Protection Standard (29 CFR 1910.134) requires employers in certain industries to 1452 1453 address workplace hazards by implementing engineering control measures and, if these are not feasible, 1454 providing respirators that are applicable and suitable for the purpose intended. Respirator selection provisions are provided in section 1910.134(d) and require that appropriate respirators be selected based 1455 on the respiratory hazard(s) to which the worker will be exposed and workplace and user factors that 1456 1457 affect respirator performance and reliability. Assigned protection factors (APFs) are provided in Table 1 1458 under section 1910.134(d)(3)(i)(A) (see below in Table 2-2) and refer to the level of respiratory 1459 protection that a respirator or class of respirators is expected to provide to employees when the employer 1460 implements a continuing, effective respiratory protection program according to the requirements of 1461 OSHA's Respiratory Protection Standard.

1462

1451

1463 If respirators are necessary in atmospheres that are not immediately dangerous to life or health, workers 1464 must use NIOSH-certified air-purifying respirators or NIOSH-approved supplied-air respirators with the 1465 appropriate APF. Respirators that meet these criteria include air-purifying respirators with organic vapor 1466 cartridges. Respirators must meet or exceed the required level of protection listed in Table 2-2. Based on 1467 the APF, inhalation exposures may be reduced by a factor of 5 to 10,000 if respirators are properly worn 1468 and fitted.

1469

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/ Hood	Loose- Fitting Facepiece
1. Air-Purifying Respirator	5	10	50		
2. Power Air-Purifying Respirator (PAPR)		50	1,000	25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
Demand mode		10	50		
Continuous flow mode		50	1,000	25/1,000	25

## 1470 Table 2-2. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/ Hood	Loose- Fitting Facepiece
Pressure-demand or other positive- pressure mode		50	1,000		
4. Self-Contained Breathing Apparatus (SCB)	A)				
Demand mode		10	50	50	
• Pressure-demand or other positive- pressure mode ( <i>e.g.</i> , open/closed circuit)			10,000	10,000	
Source: 29 CFR 1910.134(d)(3)(i)(A)	-				

1471

NIOSH and BLS conducted a voluntary survey of U.S. employers regarding the use of respiratory
protective devices between August 2001 and January 2002 (<u>NIOSH, 2003</u>). NIOSH and BLS sent the
survey to a sample of 40,002 sites designed to represent all private sector sites. The survey had a 75.5
percent response rate (<u>NIOSH, 2003</u>). A voluntary survey may not be representative of all private
industry respirator use patterns as some sites with low or no respirator use may choose to not respond to

industry respirator use patterns as some sites with low or no respirator use may choose to not respond tothe survey. Therefore, results of the survey may potentially be biased towards higher respirator use.

1478

NIOSH and BLS estimated that about 619,400 sites used respirators for voluntary or required purposes
(including emergency and non-emergency uses). About 281,800 sites (45 percent) used respirators for
required purposes in the 12 months prior to the survey. NIOSH and BLS estimated that the 281,800 sites
that used respirators for required purposes constituted approximately 4.5 percent of all private industry
sites in the United States at that time (NIOSH, 2003).

1484 The survey found that the sites that required respirator use had the following respirator program 1485 characteristics (NIOSH, 2003):

- 59 percent provided training to workers on respirator use;
- 34 percent had a written respiratory protection program;
- 47 percent performed an assessment of the employees' medical fitness to wear respirators; and
- 24 percent included air sampling to determine respirator selection.

1490 The survey report does not provide statistics for respirator fit testing or identify if fit testing was1491 included in one of the other program characteristics.

1492

1493 Of the sites that used respirators for a required purpose within the 12 months prior to the survey, NIOSH 1494 and BLS found (<u>NIOSH, 2003</u>):

- Non-powered air purifying respirators are most common, 94 percent overall and varying from 89 to 100 percent across industry sectors;
- Powered air-purifying respirators represent a minority of respirator use, 15 percent overall and varying from 7 to 22 percent across industry sectors; and
- Supplied air respirators represent a minority of respirator use, 17 percent overall and varying from 4 to 37 percent across industry sectors.

1501 Of the sites that used non-powered air-purifying respirators for a required purpose within the 12 months 1502 prior to the survey, NIOSH and BLS found (<u>NIOSH, 2003</u>) that:

A majority use dust masks, 76 percent overall and varying from 56 to 88 percent across industry sectors;

- Varying fractions use half-mask respirators, 52 percent overall and varying from 26 to 66 percent across industry sectors; and
- Varying fractions use full-facepiece respirators, 23 percent overall and varying from 4 to 33 percent across industry sectors.

1509 Table 2-3 summarizes the number and percent of all private industry sites and employees that used

respirators for a required purpose within the 12 months prior to the survey and includes a breakdown by industry sector (NIOSH, 2003).

1512

# Table 2-3. Number and Percent of Sites and Employees Using Respirators within 12 Months Prior to Survey

Ĩ		Sites	Employees		
Industry	Number	Percent of All Sites	Number	Percent of All Employees	
Total Private Industry	281,776	4.5	3,303,414	3.1	
Agriculture, forestry, and fishing	13,186	9.4	101,778	5.8	
Mining	3,493	11.7	53,984	9.9	
Construction	64,172	9.6	590,987	8.9	
Manufacturing	48,556	12.8	882,475	4.8	
Transportation and public utilities	10,351	3.7	189,867	2.8	
Wholesale Trade	31,238	5.2	182,922	2.6	
Retail Trade	16,948	1.3	118,200	0.5	
Finance, Insurance, and Real Estate	4,202	0.7	22,911	0.3	
Services	89,629	4.0	1,160,289	3.2	

## 1515 **2.5.2 Glove Protection**

Data on the frequency of effective glove use (*i.e.*, the proper use of effective gloves) in industrial settings is very limited. An initial literature review suggests that there is unlikely to be sufficient data to justify a specific probability distribution for effective glove use for DIDP or a given industry. Instead, EPA explored the impact of effective glove use by considering different percentages of effectiveness (*e.g.*, 25 percent vs. 50 percent effectiveness).

1521

EPA also made assumptions about glove use and associated protection factors. When workers wear gloves, they may be exposed to DIDP-based products that penetrate the gloves. This may occur though seepage at the cuff from improper donning of the gloves. When workers do not wear gloves, they are exposed through direct dermal contact with DIDP-based products.

1526

1527 Gloves only offer barrier protection until the chemical breaks through the glove material. Using a

1528 conceptual model, Cherrie (2004) proposed a glove workplace protection factor, defined as the ratio of

1529 estimated uptake through the hands without gloves to the estimated uptake though the hands while

1530 wearing gloves. This protection factor is driven by flux, and thus the protection factor varies with time.

1531 The ECETOC TRA model represents the glove protection factor as a fixed, assigned value equal to 5,

1532 10, or 20 (Marquart et al., 2017). Like the APR for respiratory protection, the inverse of the protection

1533 factor is the fraction of the chemical that penetrates the glove. Table 2-4 presents dermal doses without

- 1534 glove use, with the potential impacts of these protection factors presented as what-if scenarios in the
- 1535 dermal exposure summary.
- 1536

## 1537 **Table 2-4. Glove Protection Factors for Different Dermal Protection Strategies**

Dermal Protection Characteristics	Setting	Protection Factor, PF
a. No gloves used, or any glove/gauntlet without permeation data and without employee training	Industrial	1
b. Gloves with available permeation data indicating that the material of construction offers good protection for the substance	and Commercial	5
c. Chemically resistant gloves ( <i>i.e.</i> , as <i>b</i> above) with "basic" employee training	Uses	10
d. Chemically resistant gloves in combination with specific activity training ( <i>e.g.</i> , procedure for glove removal and disposal) for tasks where dermal exposure can be expected to occur	Industrial Uses Only	20
Source: (Marquart et al., 2017)		

## 1538 2.6 Evidence Integration for Environmental Releases and Occupational 1539 Exposures

Evidence integration for the environmental release and occupational exposure assessment includes analysis, synthesis, and integration of information and data to produce estimates of environmental releases and occupational exposures. During evidence integration, EPA considered the likely location, duration, intensity, frequency, and quantity of releases and exposures while also considering factors that increase or decrease the strength of evidence when analyzing and integrating the data. Key factors that EPA considered when integrating evidence include:

- Data Quality: EPA only integrated data or information rated as *high, medium, or low* obtained during the data evaluation phase. EPA did not use data and information rated as *uninformative* in exposure evidence integration. In general, EPA gave preference to higher rankings over lower rankings; however, EPA may use lower ranked data over higher ranked data after carefully examining and comparing specific aspects of the data. For example, EPA may use a lower ranked data set that precisely matches the OES of interest over a higher ranked study that does not match the OES of interest as closely.
- Data Hierarchy: EPA used both measured and modeled data to obtain accurate and representative estimates (*e.g.*, central-tendency, high-end) of the environmental releases and occupational exposures resulting directly from a specific source, medium, or product. If available, measured release and exposure data are given preference over modeled data, with the highest preference given to data that are both chemical-specific and directly representative of the OES/exposure source.
- EPA considered both data quality and data hierarchy when determining evidence integration strategies. For example, EPA may use high quality modeled data that is directly applicable to a given OES over low quality measurement data that is not specific to the OES. The final integration of the environmental release and occupational exposure evidence combined decisions regarding the strength of the available information, including information on plausibility and coherence across each evidence stream.
- 1564
- 1565 EPA evaluated environmental releases based on reported release data and evaluated occupational
- exposures based on monitoring data and worker activity information from standard engineering sources
- and systematic review. EPA estimated OES-specific assessment approaches where supporting data

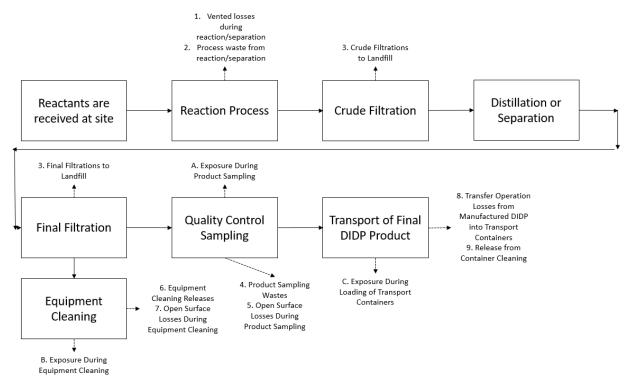
- 1568 existed and documented uncertainties where supporting data were only applicable for broader
- 1569 assessment approaches.

# 1570 3 ENVIRONMENTAL RELEASE AND OCCUPATIONAL 1571 EXPOSURE ASSESSMENTS BY OES

## 1572 **3.1 Manufacturing**

## 1573 **3.1.1 Process Description**

At a typical manufacturing site, DIDP is formed through the reaction of phthalic anhydride and isodecyl 1574 1575 alcohol using an acid catalyst. The alkyl esters of DIDP are a mixture of branched hydrocarbon isomers in the C9 through C11 ranges, comprised primarily of C10 isomers of decyl esters (U.S. EPA, 2021b). 1576 1577 Typical manufacturing operations consist of reaction, followed by crude filtration, where the product is 1578 distilled or separated, and final filtration. Manufacturing operations may also include quality control 1579 sampling of the DIDP product. Additionally, manufacturing operations include equipment cleaning/reconditioning and product transport to other areas of the manufacturing facility or offsite 1580 1581 shipment for downstream processing or use. No changes to chemical composition occur during transportation (ExxonMobil, 2022a). Figure 3-1 provides an illustration of the manufacturing process. 1582 1583



## 1584

## 1585 Figure 3-1. Manufacturing Flow Diagram (ExxonMobil, 2022b)

1586

3.1.2 Facility Estimates

1587 In the 2020 CDR, three sites reported domestic manufacturing of DIDP CASRN 68515-49-1. A fourth 1588 site, Teknor Apex in Brownsville, TN, did not report any activity specific to DIDP but did report their 1589 overall site activity for their NAICS code as "manufacture"; therefore, EPA assessed this site as a domestic manufacturer of DIDP. Troy Chemical in Phoenix, AZ reported a production volume of 20,507 1590 kg for the 2020 CDR reporting years of 2016-2019. The remaining three sites reported their production 1591 1592 volumes as CBI (U.S. EPA, 2020a). No sites reported domestic manufacturing of DIDP under CASRN 1593 26761-40-0. EPA did not identify other data on current manufacturing sites or volumes from systematic 1594 review.

- 1595 EPA evaluated the production volume for sites that claimed this information as CBI by subtracting
- 1596 known production volumes from other manufacturing and import sites from the total DIDP production
- volume reported to the 2020 CDR. EPA considered production volumes for both import and
- 1598 manufacturing sites because the annual DIDP production volumes in the CDR include both domestic 1599 manufacture and importation.<sup>1</sup> The 2020 CDR reported a range of national production volume for DIDP,
- 1600 therefore EPA provided the manufacturing production volume as a range. EPA split the remaining
- 1601 production volume range evenly across all sites that reported this information as CBI. The calculated
- 1602 production volume range eventy across an sites that reported this information as CDI. The calculated
- 1603 7,556,455 to 75,595,310 kg per average site per year. No production volume was calculated for CASRN
- 1604 26761-40-0 because no sites reporting any manufacture activity for this CASRN.
- 1605
- 1606 EPA did not identify information from systematic review for general site throughputs; site throughput
- 1607 information was estimated through Monte Carlo Modeling, with a 50<sup>th</sup> to 95<sup>th</sup> percentile range of
- 1608 230,977-401,073 kg/site-day. A published report from ExxonMobil indicated a continuous half year
- 1609 operation dedicated to the manufacture of DIDP. Therefore, EPA assessed 180 days per year of
- 1610 continuous DIDP manufacturing operations (<u>ExxonMobil, 2022b</u>). The ExxonMobil report also
- 1611 indicated that DIDP is transported via marine vessels, rail cars, and trucks to/from the ExxonMobil
- 1612 facility. Based on CDR and systematic review information, DIDP is manufactured in liquid form at a 1613 concentration of 90–100% (ExxonMobil, 2022b; U.S. EPA, 2020a; NICNAS, 2015; ECJRC, 2003a).
- $1015 \quad \text{concentration of } 90-100\% \text{ (Exxontytoon, 20220; U.S. EPA, 2020a; NICNAS, 2015; ECJRC, 2003a)}$
- 1614**3.1.3 Release Assessment**
- 1615

## 3.1.3.1 Environmental Release Points

1616 ExxonMobil provided EPA with a walkthrough presentation of their Baton Rouge manufacturing facility 1617 and identified non-air releases but did not quantify releases to protect their CBI claim on production 1618 volume. Each release point and suspected fugitive air release points were assigned a default EPA model 1619 to quantify potential releases. EPA expects stack air releases from vented losses to air during process 1620 operations, and fugitive air releases from sampling, equipment cleaning, and container loading. EPA 1621 expects releases to onsite wastewater treatment, incineration, or landfill from equipment cleaning, 1622 process wastes, and sampling wastes. EPA expects landfill release from crude and final filtration steps, and onsite wastewater release from container cleaning. Fugitive emissions may occur at loading racks 1623 1624 and container filling from equipment leaks and displaced vapor as containers are filled.

- 1625
- 3.1.3.2 Environmental Release Assessment Results
- 1626 **Table 3-1. Summary of Modeled Environmental Releases for Manufacture of DIDP**

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive Air	4.60E-05	1.53E-04	180		2.56E-07	8.52E-07
45,211 lb production	Stack Air	2.05E01				1.14E-01	
volume	Wastewater to Onsite Treatment or	2.62	4.73			1.05E-01	1.89E-01

<sup>&</sup>lt;sup>1</sup> For specific values of the known site production volumes belonging to the Import OES, see the Import process description (Section 3.2).

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Discharge to POTW						
	Onsite Wastewater, Incineration, or Landfill	7.84E01	1.03E02			2.70	2.84
	Landfill	1.25E02	2.16E02			1.30	2.25
	Fugitive Air	7.64E-04	1.31E-03	180		4.24E-06	7.47E-06
	Stack Air	4.16E04	7.22E04			2.31E02	4.01E02
16,659,131- 166,659,131 lb. production volume	Wastewater to Onsite Treatment or Discharge to POTW	4.85E03	1.27E04			1.93E02	5.06E02
	Onsite Wastewater, Incineration, or Landfill	1.61E04	3.20E04			4.69E03	8.14E03
	Landfill	8.34E04				8.69E02	

### 1627

### 3.1.4 Occupational Exposure Assessment

1628

## 3.1.4.1 Workers Activities

During manufacturing, worker exposures to DIDP occur during product sampling. Additionally, worker exposures may occur via inhalation of vapors or dermal contact with liquids during equipment cleaning, container cleaning, and packaging and loading of DIDP into transport containers for shipment. Workers that manufacture DIDP at ExxonMobil sites wear standard PPE during filtration; however, EPA did not identify additional information on the extent to which engineering controls and required PPE are used at any other manufacturing sites or throughout the remainder of the process at ExxonMobil sites (ExxonMobil, 2022b).

1636

ONUs include employees (*e.g.*, supervisors, managers) that work at the manufacturing facility, but do
not directly handle DIDP. Generally, EPA expects ONUs to have lower inhalation and dermal exposures
than workers who handle the chemicals directly. For the worker activities within the Manufacturing
OES, it is expected that workers are exposed through inhalation of vapors and dermal contact with

1641 concentrated liquids. However, ONUs are not expected to encounter dermal contact with liquids

1642 containing DINP; therefore, only inhalation exposures were estimated for ONUs under the

1643 Manufacturing OES.

## 3.1.4.2 Numbers of Workers and Occupational Non-users

- 1645 EPA used data from the BLS and the U.S. Census' SUSB (<u>U.S. BLS, 2016</u>);(<u>U.S. Census Bureau, 2015</u>) 1646 to estimate the number of workers and ONUs that are potentially exposed to DIDP during the
- 1647 manufacturing of DIDP. This approach involved the identification of relevant Standard Occupational
- 1648 Classification (SOC) codes within the BLS data for select NAICS codes. Section 2.4.2 provides
- additional details on the methodology that EPA used to estimate the number of workers and ONUs per
- 1650 site. EPA assigned the NAICS codes 325110, 325199, and 325998 for this OES, based on the "Emission
- 1651 Scenario Document on the Chemical Industry" and CDR reported NAICS codes for DIDP
- 1652 manufacturers (U.S. EPA, 2020a; OECD, 2011c). Table 3-2 summarizes the per site estimates for this
- 1653 OES. As discussed in Section 3.1.2, EPA did not identify site-specific data for the number of facilities in
- 1654 the United States that manufacture DIDP.
- 1655

1644

# Table 3-2. Estimated Number of Workers Potentially Exposed to DIDP During the Manufacturing of DIDP

NAICS Code	Number of Sites	Exposed Workers per Site <sup>a</sup>	Total Number of Exposed Workers	Exposed ONUs per Site <sup>a</sup>	Total Number of Exposed ONUs
325510 – Petrochemical Manufacturing	1	64	64	30	30
325199 – All Other Basic Organic Chemical Manufacturing	2	39	77	18	36
325998 – All Other Miscellaneous Chemical Product and Preparation Manufacturing	1	14	14	5	5
Total/Average	4	39	155	18	71

<sup>*a*</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer.

## 1658

## 3.1.4.3 Occupational Inhalation Exposure Results

1659 EPA identified inhalation monitoring data for the manufacture of DIDP during systematic review of literature sources. EPA used monitoring data provided in an exposure study conducted by ExxonMobil 1660 at their DIDP manufacturing site to estimate inhalation exposure for this OES (ExxonMobil, 2022a). 1661 1662 ExxonMobil collected PBZ samples via an American Industrial Hygiene Association (AIHA) validated method involving polytetrafluoroethylene (PTFE) Teflon filters, extraction with acetonitrile, and high-1663 1664 performance liquid chromatography (HPLC) analysis with UV detection. The study took PBZ samples from plasticizer assistant operators, laboratory technicians, maintenance operators (ExxonMobil, 2022a). 1665 EPA used the samples taken during filter change-out from maintenance operators to represent this OES, 1666 as this activity was determined to best represent the activities that occur during manufacturing. The 1667 study included two PBZ data points for DIDP. Both data points were below the limit of detection 1668 (LOD). Therefore, EPA could not create a full distribution of monitoring results to use in estimating 1669 central tendency and high-end exposures. To estimate high-end exposures to workers, EPA use the LOD 1670 1671 reported in the study. To estimate central tendency worker exposure, EPA used half of the LOD.

1672 Table 3-3 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker

1673 exposures to DIDP during the manufacture of DIDP. The central tendency and high-end exposures use

- 1674 180 days per year as the exposure frequency based on industry-provided information on operating days
- 1675 (ExxonMobil, 2022b). Specifically, ExxonMobil indicated that DIDP is manufactured in continuous,
- 1676 half-year campaigns. However, it is uncertain whether this captures actual worker schedules and
- 1677 exposures at that and other manufacturing sites.
- 1678

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	9.0E-03
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	6.6E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.2E-03	4.4E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	5.0E-03	9.9E-03
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.6E-03	7.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.5E-03	4.9E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	3.6E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	4.5E-03
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	3.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.2E-03	2.2E-03

## 1679 **Table 3-3. Summary of Estimated Worker Inhalation Exposures for Manufacture of DIDP**

1680

1681 EPA compared the exposures in Table 3-3 to a Monte Carlo simulation for the OES. In this simulation, 1682 EPA applied the EPA Mass Balance Inhalation Model to all release points with inhalation exposure 1683 potential (e.g., those with fugitive air releases) and estimated an 8-hour TWA assuming no exposure 1684 occurred outside of the manufacturing activities. The EPA/OPPT Mass Balance Inhalation Model 1685 estimates a worker inhalation exposure to an estimated concentration of chemical vapors within the 1686 worker's breathing zone using a one box model. The model estimates the amount of chemical inhaled by 1687 a worker during an activity in which the chemical has volatilized and the airborne concentration of the 1688 chemical vapor is estimated as a function of the source vapor generation rate or the saturation level of 1689 the chemical in air. Within the simulation, workers were expected to be exposed to DIDP during product 1690 sampling, equipment cleaning, and loading of DIDP into transport containers.

1691

1692 EPA used a Monte Carlo simulation to capture variability in the following model input parameters:

1693 production rate, DIDP concentration, air speed, diameter of openings, saturation factor, container size,

- 1694 loss fractions, mixing factor, and ventilation rate. EPA used the outputs from a Monte Carlo simulation
- 1695 with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release
- amounts and exposure concentrations for this OES.

1697

1698 For the modeled scenario using average production volumes across all the CDR sites that reported CBI

1699 PVs, the results of this analysis were within two orders of magnitude of the high-end and central 1700

tendency inhalation exposure estimates developed from ExxonMobil's study. For the modeled scenario

1701 using the one reported PV, the exposure concentrations were much lower, due to the PV being 3-4 1702 orders of magnitude lower. The comparable simulation results justify the use of the ExxonMobil

monitoring data for this OES. Table 3-4 presents the central tendency and high-end (50<sup>th</sup> and 95<sup>th</sup> 1703

1704 percentile) 8-hr TWA exposure concentrations for each simulation.

1705

#### 1706 Table 3-4. Summary of Modeled Worker Inhalation Exposures for Manufacture of DIDP

Modeled Scenario	Central Tendency 8h-TWA (mg/m3)	High-End 8h-TWA (mg/m3)
Production Volume 1: Troy Chemical Corp.	9.5E-06	5.0E-05
Average PV Across all Sites with CBI PVs	1.2E-04	4.5E-04

1707

## **3.1.4.4** Occupational Dermal Exposure Results

1708 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 1709 various "Exposure Concentration Types" from Table 3-5 are explained in Appendix B. Because dermal 1710 exposures to workers may occur in the neat liquid form during manufacturing of DIDP, EPA assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see Appendix D.2.1.1 1711 for details). Table 3-5 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the 1712 1713 Intermediate Average Daily Dose (IADD), and the Average Daily Dose (ADD) for both average adult workers and female workers of reproductive age. Because there are no dust or mist expected to be 1714 1715 deposited on surfaces from this OES, dermal exposures to ONUs from contact with surfaces were not 1716 assessed. Dermal exposure parameters are described in Appendix D.

1717

#### 1718 Table 3-5. Summary of Estimated Worker Dermal Exposures for the Manufacturing of DIDP

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult Worker	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.3E-02	4.5E-02
Female of Reproductive Age	Dose Rate (APDR, mg/day)	3.1	6.1
	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.1E-02	4.2E-02

#### 1719 3.1.4.5 Occupational Aggregate Exposure Results

1720 Inhalation and dermal exposure estimates were aggregated based on the approach described in Appendix 1721 B.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-6.

1722

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	5.0E-02	0.10
	Intermediate (IADD, mg/kg-day)	3.7E-02	7.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.5E-02	5.0E-02
Female of Reproductive	Acute (AD, mg/kg-day)	4.7E-02	9.4E-02
Age	Intermediate (IADD, mg/kg-day)	3.5E-02	6.9E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.3E-02	4.6E-02
ONU	Acute (AD, mg/kg-day)	4.5E-03	4.5E-03
	Intermediate (IADD, mg/kg-day)	3.3E-03	3.3E-03
	Chronic, Non-cancer (ADD, mg/kg-day)	2.2E-03	2.2E-03

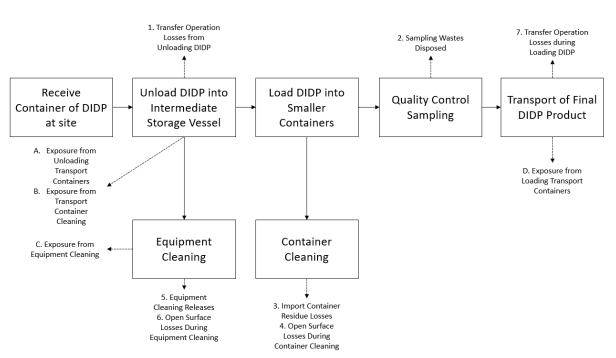
## 1723 Table 3-6. Summary of Estimated Worker Aggregate Exposures for Manufacture of DIDP

## 1724 **3.2 Import and Repackaging**

## 1725 **3.2.1 Process Description**

At a typical import and repackaging site, DIDP arrives via water, air, land, or intermodal shipment on oceangoing chemical tankers, rail cars, tank trucks, or intermodal tank containers (U.S. EPA, 2021b). Sites unload the import containers and transfer DIDP into smaller containers (drums or rail cars) for downstream processing, use within the facility, or offsite use. Operations may include quality control sampling of DIDP product and equipment cleaning. No changes to chemical composition occur during transportation (U.S. EPA, 2022a). Figure 3-2 provides an illustration of the import and repackaging process.

1733



1734



## 1736**3.2.2 Facility Estimates**

In the 2020 CDR, eight sites reported import and repackaging of DIDP CASRN 26761-40-0. Five out of
the eight sites that reported import activity provided a non-CBI production volume for the reporting
years of 2016-2019, with the other three sites reporting their production volumes as CBI (U.S. EPA,

1740 <u>2020a</u>). Table 3-7 provides the location and reported production volume for DIDP CASRN 26761-40-0
 1741 import sites.

## 1742 1743

# Table 3-7: Production Volume of DIDP CASRN 26761-40-0 Import andRepackaging Sites, 2020 CDR

DIDP Import Site, Site Location	2019 Reported Production Volume of DIDP CASRN 26761-40-0 (kg/year)
LG Hausys America, Adairsville, GA	11,895
Harwick Standard Distribution, Akron, OH	19,447
Tremco Inc., Beachwood, OH	362,965
Akrochem Corp., Stow, OH	6,616
Chemspec LTD., Uniontown, OH	23,801
3M Company, St. Paul, MN	CBI
LG Chemical America, Atlanta, GA	CBI
ICC Chemical Corporation, New York, NY	СВІ

1744

In the 2020 CDR, three sites reported the import of DIDP CASRN 68515-49-1, with all three sites
reporting their DIDP production volume as CBI (U.S. EPA, 2020a). EPA did not identify other
information on current DIDP import sites or volumes from systematic review.

1748

1749 EPA evaluated the production volume for sites that claimed this information as CBI by subtracting 1750 known production volumes of other manufacturing and import sites from the total DIDP production volume reported to the 2020 CDR. The 2020 CDR reported a range of national production volume for 1751 1752 DIDP for CASRN 68515-49-1 and a maximum production volume value for DIDP CASRN 26761-40-0; 1753 therefore, EPA provided the import production volume as a range. EPA considered production volumes for both import and manufacturing sites because the annual DIDP production volumes in the CDR 1754 include both domestic manufacture and importation.<sup>2</sup> EPA split the remaining production volume range 1755 1756 evenly across all sites that reported this information as CBI. For CASRN 26761-40-0, the calculated production volume for sites that reported this information as CBI was 9,623 kg/site-year. For CASRN 1757 1758 68515-49-1, the calculated production volume for sites that reported this information as CBI ranged 1759 from 7,556,455 to 75,595,310 kg/site-year.

1760

EPA did not identify information from systematic review for import site operating days; therefore, EPA 1761 1762 assessed the total number of operating days for DIDP import as 174-260 days per year based on the 1763 length of worker shifts described in the 2022 GS on Chemical Repackaging (U.S. EPA, 2022a). Import 1764 and repackaging facilities operate 24 hours/day, 7 days/week (i.e., multiple shifts). However, EPA 1765 capped the total number of operating days, so as not to exceed estimated site throughputs. Based on 1766 CDR reports, DIDP is imported in liquid, pellets or large crystals, dry powder, or other solid forms with concentrations ranging from 1-100% DIDP (U.S. EPA, 2020a). EPA did not identify chemical- or site-1767 specific information on site throughputs; site throughput information was estimated through Monte 1768 Carlo Modeling, with a 50<sup>th</sup> to 95<sup>th</sup> percentile range of 46-55 kg/site-day. 1769

 $<sup>^{2}</sup>$  For CDR-reported production volumes for the Manufacturing OES, see the Manufacturing Process Description (section 3.1).

#### 1770 3.2.3 **Release Assessment**

#### 1771 3.2.3.1 Environmental Release Points

1772 EPA assigned release points based on the 2022 GS on Chemical Repackaging (U.S. EPA, 2022a) and

used default models to quantify releases from each identified release point. Release points include 1773 fugitive air releases from loading and unloading, container cleaning, and equipment cleaning as well as 1774

1775 releases to onsite wastewater treatment, discharges to POTW, and waste disposal from sampling,

1776 container residue, and equipment cleaning.

#### 1777 3.2.3.2 Environmental Release Assessment Results

1778

## 1779

## Table 3-8. Summary of Modeled Environmental Releases for Import and Repackaging of DIDP

Modeled	Environmental Media	Annual (kg/sit	Release	Number of Release Days		Daily Release (kg/site-day)	
Scenario		Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
26,223 lbs	Fugitive Air	2.98E-07	4.18E-07			4.71E-08	6.13E-08
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	6.84E01	2.36E02	208	260	1.57	1.81
42,873 lb	Fugitive Air	7.72E-07	9.99E-07			1.00E-07	1.05E-07
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	9.80E01	1.25E02	208	260	2.31	2.86
800,201 lb	Fugitive Air	1.19E-06	2.73E-06			2.17E-08	4.08E-08
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	1.56E03	2.00E03	208	260	4.17E01	5.16E01
14,585 lb	Fugitive Air	2.49E-07	3.35E-07			4.69E-08	6.10E-08
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	1.06E02	1.38E02	208	260	1.09	1.50
52,472 lb	Fugitive Air	8.57E-07	1.13E-06			1.01E-07	1.06E-07
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	1.20E02	1.54E02	208	260	2.82	3.51
21,215 lb	Fugitive Air	4.34E-07	6.30E-07			7.38E-08	1.01E-07
production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	1.18E02	1.99E02	208	260	1.39	1.83
16,659,131-	Fugitive Air	5.06E-04	1.41E-03			2.45E-06	6.99E-06
166,659,131 lb production volume	Wastewater to Onsite Treatment, Discharge to POTW, or Landfill	6.44E04	1.36E05	208	260	4.12E03	7.98E03

### 1780 **3.2.4 Occupational Exposure Assessment**

### **3.2.4.1 Workers Activities**

During import and repackaging, worker exposures to DIDP occur when transferring DIDP from the
import vessels (*e.g.*, chemical tankers, rail cars, intermodal tank containers) into smaller containers.
Worker exposures also occur via inhalation of vapors or dermal contact with liquids when cleaning
import vessels, loading and unloading DIDP, sampling, and cleaning equipment. EPA did not find any
information on the extent to which engineering controls and worker PPE are used at facilities that
repackage DIDP from import vessels into smaller containers.

1788

ONUs include employees (*e.g.*, supervisors, managers) that work at the import site where repackaging
occurs but do not directly handle DIDP. Therefore, EPA expects the ONUs to have lower inhalation
exposures and *di minimis* dermal exposures.

1792 **3.2.4.2** Number of Workers and Occupational Non-users

1793 EPA used data from the BLS and the U.S. Census' SUSB specific (U.S. BLS, 2016; U.S. Census 1794 **Bureau**, 2015) to estimate the number of workers and ONUs that are potentially exposed to DIDP 1795 during DIDP import and repackaging. This approach involved the identification of relevant SOC codes 1796 within the BLS data for select NAICS codes. Section 2.4.2 provides additional details on the 1797 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the 1798 NAICS codes 322220, 325211, 325510, 325520, 326113, 424690, and 444120 for this OES, based on 1799 the *Chemical Repackaging Generic Scenario* and CDR reported NAICS codes for DIDP importers (U.S. 1800 EPA, 2022a, 2020a). Table 3-9 summarizes the per site estimates for this OES. As discussed in Section 1801 3.2.2, EPA did not identify site-specific data for the number of facilities in the United States that import 1802 and repackage DIDP.

1803

# Table 3-9. Estimated Number of Workers Potentially Exposed to DIDP during Import and Repackaging

	Number	Exposed Workers	Total Number of Exposed	Exposed Occupational Non-users per	Total Number of Exposed
NAICS Code 322220 – Paper Bag and	of Sites <sup>a</sup>	per Site <sup>b</sup>	Workers	Site <sup>b</sup>	ONUs
Coated and Treated Paper Manufacturing	2	35	70	5	9
325211 – Plastic Material and Resin Manufacturing	1	27	27	12	12
325510 – Paint and Coating Manufacturing	2	14	29	5	11
325520 – Adhesive Manufacturing	1	18	18	7	7
326113 – Unlaminated Plastics Film and Sheet (except Packaging)					
Manufacturing	0	22	0	6	0

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers	Exposed Occupational Non-users per Site <sup>b</sup>	Total Number of Exposed ONUs
424690 – Other Chemical and Allied Products Merchant Wholesalers	5	1	6	0.4	2
444120 – Paint and Wallpaper Stores	0	0.16	0	0.02	0
Total/Average	11	17	151	5	41

<sup>*a*</sup> Number of sites for MFG and Import are based on reported NAICS code for each site. Some NAICS codes had 0 sites reporting under them in CDR, but they are none-the-less included here because the reporting thresholds for CDR do not provide for a 100% capture of the industry.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

## 1806 **3.2.4.3 Occupational Inhalation Exposure Results**

EPA did not identify inhalation monitoring data for import and repackaging from systematic review of
 literature sources. However, EPA estimated inhalation exposures for this OES using monitoring data for
 DIDP exposures during manufacturing (ExxonMobil, 2022a). EPA expects that inhalation exposures
 during manufacturing are greater than inhalation exposures during import and repackaging.

1811 EPA used surrogate monitoring data from an exposure study conducted by ExxonMobil at their DIDP

1812 manufacturing site to estimate inhalation exposure for this OES. ExxonMobil collected PBZ samples via

1813 an AIHA validated method involving PTFE Teflon filters, extraction with acetonitrile, and HPLC

1814 analysis with UV detection. ExxonMobil took PBZ samples from plasticizer assistant operators,

1815 laboratory technicians, maintenance operators (<u>ExxonMobil, 2022b</u>). EPA used the samples taken

during filter change-out from maintenance operators to represent this OES, as this activity was
 determined to best represent the activities that occur during manufacturing. The study included two PBZ

1818 data points for DIDP. Both data points were below the LOD. Therefore, EPA could not create a full

1819 distribution of monitoring results to use in estimating central tendency and high-end exposures. To

estimate high-end exposures to use in containing central tendency and high-end exposures. 10
 estimate high-end exposures to workers, EPA use the LOD reported in the study. To estimate central
 tendency worker exposure, EPA used half of the LOD.

1822

Table 3-10 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
exposures to DIDP during the import and repackaging of DIDP. The high-end exposures are based on
250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release
assessment exceeded 250 days per year, which is the expected maximum for working days. The central

tendency exposures use 208 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of

1828 operating days from the release assessment.

1829

# Table 3-10. Summary of Estimated Worker Inhalation Exposures for Import and Repackaging of DIDP

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	9.0E-03
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	6.6E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-03	6.2E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
Female of Reproductive	Acute Dose (AD) (mg/kg/day)	5.0E-03	9.9E-03
Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.6E-03	7.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.8E-03	6.8E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	3.6E-02
ONU	Acute Dose (AD) (mg/kg/day)	4.5E-03	4.5E-03
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	3.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-03	3.1E-03

## 1832 **3.2.4.4 Occupational Dermal Exposure Results**

1833 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The various "Exposure Concentration Types" from Table 3-11 are explained in Appendix B. Because dermal 1834 exposures to workers may occur in the neat liquid form during import and/or repackaging of DIDP, EPA 1835 assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see Appendix 1836 1837 D.2.1.1 for details). Table 3-11 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose 1838 (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily Dose (ADD) for both 1839 average adult workers and female workers of reproductive age. Because there are no dust or mist 1840 expected to be deposited on surfaces from this OES, dermal exposures to ONUs from contact with 1841 surfaces were not assessed. Dermal exposure parameters are described in Appendix D.

1842

#### 1843 Table 3-11. Summary of Estimated Worker Dermal Exposures for Import and Repackaging of 1844 DIDP

Worker Population	Exposure Concentration Type	Central	High-End
		Tendency	
Average Adult	Dose Rate (APDR, mg/day)	3.7	7.3
Worker	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.6E-02	6.3E-02
Female of	Dose Rate (APDR, mg/day)	3.1	6.1
Reproductive Age	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.4E-02	5.8E-02

#### 1845 3.2.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in Appendix 1846 1847 B to arrive at the aggregate worker and ONU exposure estimates in Table 3-12.

1848

#### 1849 Table 3-12. Summary of Estimated Worker Aggregate Exposures for Import and Repackaging of DIDP

1850

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	5.0E-02	0.10
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.7E-02	7.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	6.9E-02
	Acute (AD, mg/kg-day)	4.7E-02	9.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.5E-02	6.9E-02
8	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-02	6.5E-02
	Acute (AD, mg/kg-day)	4.5E-03	4.5E-03
ONU	Intermediate (IADD, mg/kg-day)	3.3E-03	3.3E-03
	Chronic, Non-cancer (ADD, mg/kg-day)	2.6E-03	3.1E-03

#### **3.3 Incorporation into Adhesives and Sealants** 1851

1852

## **3.3.1 Process Description**

1853 The Final Use Report for Diisodecyl Phthalate (DIDP) (1,2-Benzenedicarboxylic acid, 1,2-diisodecyl 1854 ester and 1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich) (CASRN 26761-40-0 1855 and 68515-49-1) states DIDP's use as a plasticizer for Processing, incorporation into formulation, 1856 mixture, or reaction product, "adhesive manufacturing" (U.S. EPA, 2021c).

1857

1858 DIDP is a plasticizer in adhesive and sealant products for industrial and commercial use, including

polymer sealants and industrial adhesives (see Appendix F for EPA identified DIDP-containing products 1859

1860 for this OES). Based on the 2009 ESD on the Manufacture of Adhesives, a typical adhesive

incorporation site receives and unloads DIDP into adhesive and sealant formulations in industrial mixing 1861

1862 vessels as a batch blending or mixing process, with no reactions or chemical changes occurring to the

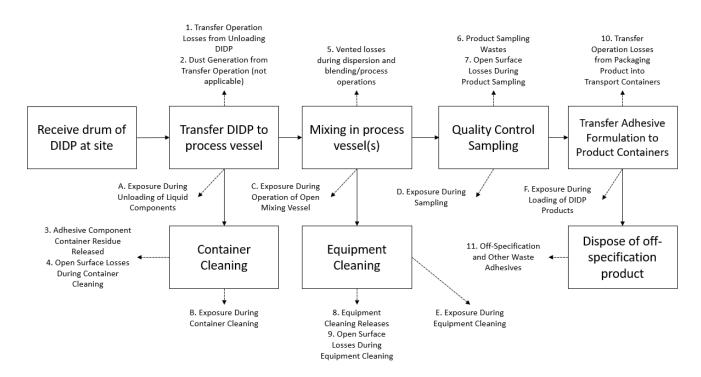
plasticizer (*i.e.*, DIDP) during the mixing process. Blending or mixing operations can take up to 8 hours 1863

a day. Process operations may also include quality control sampling. EPA expects that sites will load

1865 DIDP-containing products into bottles, small containers, or drums depending on the product type.

1866 Incorporation sites may dispose of off-specification product when the adhesive product does not meet 1867 quality or desired standards (OECD, 2009a). Figure 3-3 provides an illustration of the adhesive and

- quality or desired standards (<u>OECD, 2009a</u>). Fsealant manufacturing process.
- 1869



## 1870

## 1871 Figure 3-3. Incorporation into Adhesives and Sealants Flow Diagram (OECD, 2009a)

1872 **3.3.2 Facility Estimates** 

In the 2020 CDR, two sites reported adhesive and sealant manufacturing for DIDP, one of which reported their production volume as CBI. EPA did not identify any other data on sites that use DIDP in adhesives and sealants or production volumes from systematic review. Therefore, EPA attempted to develop a representative production volume range for DIDP processed into adhesive and sealant products.

1878

To estimate the low-end of the production volume range, EPA assumed that sites that reported a CBI production volume processed a minimum of 25,000 lb (11,340 kg) into adhesive and sealant products based on the CDR reporting thresholds. The one site that provided a non-CBI production volume, Tremco Inc. in Beachwood, OH, did not indicate the percentage of its yearly production volume associated with adhesive and sealant manufacture (U.S. EPA, 2020a). Therefore, EPA assumed that the site processed 100% of its 362,965 kg production volume into adhesive and sealant products. This resulted in a minimum production volume of 374,305 kg/year for this OES.

1886

1887 EPA estimated the high-end production volume and number of sites from systematic review due to the

1888 limitations of CDR reporting for downstream processes and uses. The 2003 *DIDP Risk Assessment* 

published by the European Union estimates a PV of approximately 1.1% to non-polymer uses (ECJRC,
 2003a). The 1.1% to non-polymer uses is split equally between paints/coatings, adhesives/sealants, and

1890 <u>2005a</u>). The 1.1% to non-polymer uses is split equally between paints/coalings, adhesives/searants, and 1891 inks, which is 0.37% for each. The American Chemistry Council indicated that the use rate of DIDP in

1892 the EU is similar to the use rate in the United States (ACC, 2020a). EPA calculated the high-end

production volume of DIDP in adhesives and sealants as 0.37% of the yearly production volume or
1,679,970 kg/year accounting for both CASRN (Note: 0.37% of the low-end national production volume
of DIDP was less than the minimum volume reported from CDR; therefore, EPA calculated the
minimum production volume as described above). The total production volume range for incorporation
into adhesives and sealants was 374,305–1,679,970 kg/year.

1898

1899 EPA did not identify operating information for this OES (*i.e.*, batch size or number of batches per year); 1900 EPA assumed a 4,000 kg batch size and 250 batches per year based on and the 2009 ESD on the Manufacture of Adhesives (OECD, 2009a). This is equivalent to a facility throughput of DIDP of 1,000-1901 1902 750,000 kg-DIDP/site-year based on a DIDP concentration in the Adhesive/ Sealant product of 0.1-60% (see Appendix F for EPA identified DIDP-containing products for this OES). Additionally, EPA 1903 1904 assumed the number of operating days was equivalent to the number of batches per year or 250 1905 days/year of 24 hour/day, 7 day/week (i.e., multiple shifts) operations for the given site throughput 1906 scenario. Incorporation sites receive DIDP in drums and totes ranging in size from 20-100 gallons with 1907 DIDP concentrations of 30-60% (U.S. EPA, 2020a). Sites receive DIDP as either a liquid or solid paste that is then incorporated as a liquid, with material in drums transferred to mixing vessels during 1908 1909 formulation (OECD, 2009a). EPA estimated the total number of sites that manufacture DIDP-containing 1910 adhesives and sealants using a Monte Carlo model (see Appendix E.4 for details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 6 to 50 sites. In contrast, the 2020 CDR identified two 1911

- 1912 incorporation sites.
- 1913**3.3.3 Release Assessment**
- 1914

## 3.3.3.1 Environmental Release Points

EPA assigned release points based on the 2009 ESD on the Manufacture of Adhesives (OECD, 2009a).
EPA assigned default models to quantify release from each release point and suspected fugitive air
release point. EPA expects fugitive air releases from unloading of DIDP containers, container cleaning,
sampling, and equipment cleaning. EPA expects stack air releases from vented losses during process
operations and packaging into transport containers. EPA expects releases to wastewater, incineration, or
landfill from container residue, sampling, equipment cleaning, and off-specification trimming.

- 1921 1922
- 3.3.3.2 Environmental Release Assessment Results
- Table 3-13. Summary of Modeled Environmental Releases for Incorporation into Adhesives and
   Sealants

Modeled Environmental Media		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario		Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
005 001	Fugitive Air	1.66E-06	8.32E-06			6.63E-09	3.35E-08
825,201- 3,703,700 lb	Stack Air	1.43E-06	2.01E-05			5.70E-09	8.04E-08
production volume	Wastewater, Incineration, or Landfill	1.04E04	2.71E04	250		4.16E01	1.08E02

## 1925**3.3.4** Occupational Exposure Assessment

## **3.3.4.1 Workers Activities**

During the formulation of adhesives and sealants containing DIDP, worker exposures may occur when
transferring DIDP from transport containers into process vessels, taking QC samples, and packaging
formulated products into containers. Worker exposures may also occur via inhalation of vapor or dermal
contact with liquids when cleaning residuals from transport containers or process vessels (OECD,
2009a). EPA did not identify information on engineering controls or worker PPE used at DIDP-

- 1932 containing adhesive and sealant formulation facilities.
- 1933

1934 For this OES, ONUs may include supervisors, managers, and other employees that work in the

1935 formulation area but do not directly contact DIDP that is received or processed onsite or handle the 1936 formulated product. ONUs are potentially exposed through the inhalation route while in the working

1937 area. However, dermal exposures to ONUs are not expected for this OES.

## 1938 3.3.4.2 Number of Workers and Occupational Non-users

1939 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 1940 to estimate the number of workers and ONUs that are potentially exposed to DIDP during the 1941 incorporation of DIDP into adhesives and sealants. This approach involved the identification of relevant 1942 SOC codes within the BLS data for select NAICS codes. Section 2.4.2 provides additional details on the 1943 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the 1944 NAICS code 325520 – Adhesive Manufacturing for this OES, based on the CDR reported NAICS codes 1945 for incorporation into adhesives or sealants (U.S. EPA, 2020a). Table 3-14 summarizes the per site estimates for this OES. As discussed in Section 3.3.2, EPA did not identify site-specific data for the 1946 1947 number of facilities in the United States that incorporate DIDP into adhesives and sealants.

1948

# 1949 Table 3-14. Estimated Number of Workers Potentially Exposed to DIDP during Incorporation 1950 into Adhesives and Sealants

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
325520 – Adhesive Manufacturing	6-50	18	108-903	7	41-338

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value representing the 50<sup>th</sup> and 95<sup>th</sup> percentile results

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

1951

## 3.3.4.3 Occupational Inhalation Exposure Results

1952 EPA did not identify inhalation monitoring data for the incorporation of DIDP into adhesives and

1953 sealants during systematic review. However, EPA estimated inhalation exposures for this OES using

1954 monitoring data for DIDP and DINP exposures during plastics converting. EPA expects that inhalation

exposures during plastics converting are comparable to inhalation exposures during incorporation intoadhesives and sealants.

1957

1958 The p-chem properties (*e.g.*, molecular weight and vapor pressure) of diisodecyl phthlate and di(2-

1959 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking.

1960 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure 1961 study conducted by SP Porras et al. (2020) in a PVC-coated cable manufacturing facility to estimate worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable 1962 1963 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic 1964 coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during 1965 adhesive and sealant manufacturing. The subject facility in the SP Porras et al. study sometimes used DIDP as a plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-1966 1967 propylheptyl) phthalate as the plasticizer on the day that sampling occurred (Porras et al., 2020). The 1968 study personnel collected stationary samples using the OVS sampler type, which measures a 1969 combination of vapor and particulate phases. SP Porras et al. collected two samples at cooling points 1970 near extruders and provided results as a single 8-hour TWA value for di(2-propylheptyl) phthalate, 1971 which was 0.03 mg/m<sup>3</sup>. Since the study conducted sampling near a high-temperature extruder, EPA 1972 expects that the monitoring data represents vapor concentrations of di(2-propylheptyl) phthalate from 1973 heated material as opposed to particulates containing the phthalate. To estimate ONU exposures for this OES, EPA used surrogate DINP monitoring data provided in an exposure study conducted by Irwin et 1974 1975 al. at a PVC roofing manufacturing site (Irwin, 2022) (hereinafter referred to as "Irwin 2022 study"). 1976 Irwin et al. collected PBZ samples with an unspecified sampling method. The study included one PBZ 1977 sample for ONU exposure to airborne oil mists (Irwin, 2022). This sample was below the LOD. 1978 Therefore, EPA could not create a full distribution of monitoring results to use in estimating central 1979 tendency and high-end exposures. To estimate high-end exposures to ONUs, EPA use the LOD reported 1980 in the study. To estimate central tendency ONU exposure, EPA used half of the LOD.

1981

Table 3-15 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during the incorporation into adhesives and sealants. The central tendency and highend exposures use 250 days per year as the exposure frequency since the 50<sup>th</sup> and 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days.

1987

1988	Table 3-15. Summary of Estimated Worker Inhalation Exposures for Incorporation into
1989	Adhesives and Sealants

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	Acute Dose (AD) (mg/kg/day)	3.8E-03	3.8E-03
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-03	2.8E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-03	2.6E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	Acute Dose (AD) (mg/kg/day)	4.1E-03	4.1E-03
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.0E-03	3.0E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.8E-03	2.8E-03
ONIL	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
ONU	Acute Dose (AD) (mg/kg/day)	3.8E-05	7.5E-05

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-05	5.5E-05
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-05	5.1E-05

## 1990 **3.3.4.4 Occupational Dermal Results**

1991 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 1992 various "Exposure Concentration Types" from Table 3-16 are explained in Appendix B. Because dermal 1993 exposures to workers may occur in a concentrated liquid form during the incorporation of DIDP into 1994 adhesives and sealants, EPA assessed the absorptive flux of DIDP according to dermal absorption data 1995 of neat DIDP (see Appendix D.2.1.1 for details). Table 3-16 summarizes the Acute Potential Dose Rate 1996 (APDR), the Acute Dose (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily 1997 Dose (ADD) for both average adult workers and female workers of reproductive age. Because there are 1998 no dust or mist expected to be deposited on surfaces from this OES, dermal exposures to ONUs from 1999 contact with surfaces were not assessed. Dermal exposure parameters are described in Appendix D.

2000

Table 3-16. Summary of Estimated Worker Dermal Exposures for Incorporation into Adhesives
 and Sealants

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult Worker	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	6.3E-02
Female of Reproductive Age	Dose Rate (APDR, mg/day)	3.1	6.1
	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	5.8E-02

2003

## 3.3.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in Appendix
B.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-17.

# Table 3-17. Summary of Estimated Worker Aggregate Exposures for Incorporation into Adhesives and Sealants

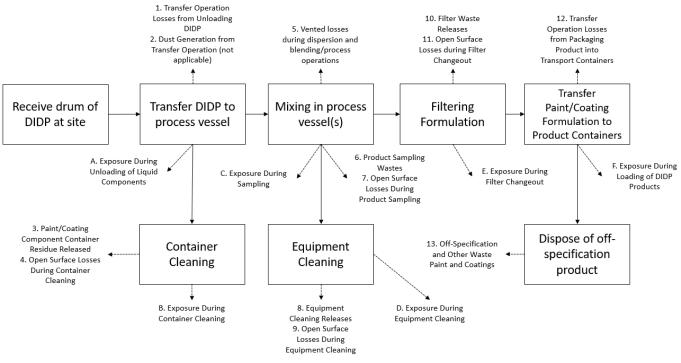
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	5.0E-02	9.5E-02
	Intermediate (IADD, mg/kg-day)	3.6E-02	7.0E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.4E-02	6.5E-02
	Acute (AD, mg/kg-day)	4.6E-02	8.8E-02

Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.4E-02	6.5E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.2E-02	6.1E-02
ONU	Acute (AD, mg/kg-day)	3.8E-05	7.5E-05
	Intermediate (IADD, mg/kg-day)	2.8E-05	5.5E-05
	Chronic, Non-cancer (ADD, mg/kg- day)	2.6E-05	5.1E-05

## **3.4 Incorporation into Paints and Coatings**

2010 **3.4.1 Process Description** 

DIDP is a plasticizer in paint and coating products for industrial and commercial use, including paints 2011 and colorants (see Appendix F for EPA identified DIDP-containing products for this OES). A typical 2012 incorporation site receives and unloads DIDP into industrial mixing vessels as a batch blending or 2013 2014 mixing process, with no reactions or chemical changes occurring to the plasticizer (*i.e.*, DIDP) during 2015 the mixing process. Blending or mixing operations can take up to eight hours a day. Process operations may include quality control sampling. In the case of waterborne coatings, the formulator will transfer the 2016 2017 blended formulation through an in-line filter. Following formulation, incorporation sites will load DIDP-2018 containing products into bottles, small containers, or drums depending on the product type. Sites may 2019 dispose of off-specification product when the product does not meet quality or desired standards (U.S. 2020 EPA, 2014a). Figure 3-4 provides an illustration of the paint and coating manufacturing process. 2021



2023 Figure 3-4. Incorporation into Paints and Coatings Flow Diagram (U.S. EPA, 2014a)

## 2024

2022

## 3.4.2 Facility Estimates

2025 In the 2020 CDR, four sites reported paint and coating manufacturing, three of which claimed their production volume as CBI. The one site that provided a non-CBI production volume, Troy Chemical 2026 2027 Corp. in Florham Park, NJ, reported that 100% of this production volume was allocated to paint and 2028 coating manufacturing (U.S. EPA, 2020a). However, EPA estimated the total production volume and the 2029 number of sites from systematic review due to the limitations of CDR reporting for downstream 2030 processes and uses. The 2003 *DIDP Risk Assessment* published by the European Union estimates a PV 2031 of approximately 1.1% to non-polymer uses (ECJRC, 2003a). The 1.1% to non-polymer uses is split 2032 equally between paints/coatings, adhesives/sealants, and inks, which is 0.37% for each. The American 2033 Chemistry Council indicated that the use rate of DIDP in the EU is similar to the use rate in the United 2034 States (ACC, 2020a). EPA calculated the production volume of DIDP in paints and coatings as 0.37% of the total DIDP production volume reported to CDR for both CASRN. The 2020 CDR reported a range 2035 2036 of national production volume for DIDP; therefore, EPA provided the paint and coating production 2037 volume as a range. The total production volume for incorporation into paints and coatings was 169,485-2038 1,679,970 kg/year. 2039

2040 EPA did not identify paint and coating site operating data (*i.e.*, batch size or number of batches per 2041 year); EPA assumed 5,030 kg per batch and 250 batches per year based on the 2014 GS on the 2042 Formulation of Waterborne Coatings (U.S. EPA, 2014a). This corresponds to a facility throughput of 2043 DIDP of 160-800,000 kg-DIDP/site-year based on a DIDP concentration in the paint/coating product of 2044 0.01-5%. Additionally, EPA assumed that the number of operating days was equivalent to the number of 2045 batches manufactured per year, or 250 days/year of 24 hour/day, 7 day/week operations (*i.e.*, multiple 2046 shifts) for the given site throughput scenario. Incorporation sites receive DIDP in drums and totes ranging in size from 20-100 gallons with DIDP concentrations of 1-90% (see Appendix F for EPA 2047 2048 identified DIDP-containing products for this OES) (U.S. EPA, 2020a). Sites receive DIDP as either a 2049 liquid or solid paste that is then incorporated into paints and coatings as a liquid, with material in drums

transferred to mixing vessels during formulation (U.S. EPA, 2014a). EPA estimated the total number of

sites that manufacture DIDP-containing paints and coatings using a Monte Carlo model (see Appendix

E.5 for details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 6-38 sites. In contrast, the 2020
 CDR identified four incorporation sites.

### **3.4.3 Release Assessment**

## 2055 **3.4.3.1 Environmental Release Points**

EPA assigned release points based on the 2014 GS on the Formulation of Waterborne Coatings (U.S.
EPA, 2014a). EPA assigned a default model to quantify releases from each identified release point and
fugitive air release point. EPA expects fugitive air releases from unloading DIDP containers, container
cleaning, sampling, equipment cleaning, and filter replacements. EPA expects stack air releases from
vented losses during process operations and from packaging paints and coatings into transport
containers. EPA expects releases to wastewater, incineration, or landfill from container residue,
sampling, equipment cleaning, filter wastes, and off-specification wastes.

2063 2064

### 3.4.3.2 Environmental Release Assessment Results

# Table 3-18. Summary of Modeled Environmental Releases for Incorporation into Paints and Coatings

Modeled Scenario	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Modeleu Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive Air	1.11E-06	3.99E-06	250		4.46E-09	1.59E-08
373,650-3,703,700	Stack Air	1.32E-07	1.28E-06			5.27E-10	5.12E-09
lb production volume	Wastewater, Incineration, or Landfill	8.37E03	2.71E04			3.35E01	1.08E02

2067

## 3.4.4 Occupational Exposure Assessment

2068 **3.4.4.1 Worker Activities** 

During the formulation of paints and coatings that contain DIDP, worker exposures to DIDP vapors may occur when packaging paint and coating products. Worker exposures may also occur via inhalation of vapors or dermal contact with liquids when unloading DIDP, cleaning transport containers, product sampling, equipment cleaning, and during filter media change out (U.S. EPA, 2014a). EPA did not identify information on engineering controls or worker PPE used at DIDP-containing paint and coating formulation sites.

2075

2076 ONUs include supervisors, managers, and other employees that work in the formulation area but do not

- 2077 directly contact DIDP received or processed onsite or handle the formulated product. ONUs are
- 2078 potentially exposed through the inhalation route while in the working area. However, dermal exposures
- to ONUs are not expected for this OES.

## 2080 **3.4.4.2** Number of Workers and Occupational Non-users

2081 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015)

to estimate the number of workers and ONUs that are potentially exposed to DIDP during the

2083 incorporation of DIDP into paints and coatings. This approach involved the identification of relevant

SOC codes within the BLS data for select NAICS codes. Section 2.4.2 provides additional details on the
methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the
NAICS codes 325320, 325510, 325613, 325998, and 444120 for this OES based on the *Generic Scenario on the Formulation of Waterborne Coatings* and CDR reported NAICS codes for incorporation
into paints and coatings (U.S. EPA, 2020a, 2014a). Table 3-19 summarizes the per site estimates for this
OES. As discussed in Section 3.4.2, EPA did not identify site-specific data on the number of facilities in

2090 the United States that incorporate DIDP into paints and coatings.

2091

# Table 3-19. Estimated Number of Workers Potentially Exposed to DIDP during Incorporation into Paints and Coatings

NAICS Code	Number of Sites <sup>b</sup>	Exposed Workers per Site <sup>a</sup>	Total Number of Exposed Workers <sup>b</sup>	Exposed Occupational Non- users per Site <sup>a</sup>	Total Number of Exposed ONUs <sup>b</sup>	
325320 – Pesticide and Other Agricultural Chemical Manufacturing		25		7		
325510 – Paint and Coating Manufacturing		14		5		
325613 – Surface Active Agent Manufacturing	N/A	22	N/A	5	N/A	
325998 – All Other Miscellaneous Chemical Product and Preparation		14		5		
444120 – Paint and Wallpaper Stores		0.16		0.02		
Total/Average	6-38	15	91-576	4	27-170	

<sup>a</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

<sup>b</sup> The result is expressed as a range between the central tendency and the high-end value representing the 50<sup>th</sup> and 95<sup>th</sup> percentile results. Results were not assessed by NAICS code for this scenario due to a lack of NAICS-specific number of sites data.

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## 3.4.4.3 Occupational Inhalation Exposure Results

EPA did not identify inhalation monitoring data for the incorporation of DIDP into paints and coatings during systematic review. However, EPA estimated inhalation exposures for this OES using monitoring data for DIDP and DINP exposures during plastics converting. EPA expects that inhalation exposures during plastics converting are comparable to inhalation exposures during the incorporation of DIDP into paints and coatings.

2100

2101 The p-chem properties (e.g., molecular weight and vapor pressure) of diisodecyl phthlate and di(2-2102 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking. 2103 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure 2104 study conducted by SP Porras et al. (2020) in a PVC-coated cable manufacturing facility to estimate 2105 worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable 2106 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic 2107 coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during 2108 paint and coating manufacturing. The subject facility in the SP Porras et al. study sometimes used DIDP 2109 as a plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) 2110 phthalate as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel 2111 collected stationary samples using the OVS sampler type, which measures a combination of vapor and 2112 particulate phases. SP Porras et al. collected two samples at cooling points near extruders and provided 2113 results as a single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the 2114 study conducted sampling near a high-temperature extruder, EPA expects that the monitoring data represents vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to 2115 2116 particulates containing the phthalate.

2118 To estimate ONU exposures for this OES, EPA used surrogate DINP monitoring data provided in an 2119 exposure study conducted by Irwin *et al.* at a PVC roofing manufacturing site (Irwin, 2022) (hereinafter 2120 referred to as "Irwin 2022 study"). Irwin et al. collected PBZ samples with an unspecified sampling 2121 method. The study included one PBZ sample for ONU exposure to airborne oil mists (Irwin, 2022). This 2122 data point was below the LOD. Therefore, EPA could not create a full distribution of monitoring results 2123 to estimate central tendency and high-end exposures. To estimate high-end exposures to ONUs, EPA 2124 used the LOD reported in this study. To estimate central tendency ONU exposures, EPA used half of the 2125 LOD.

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2132

Table 3-20 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
exposures to DIDP during incorporation into paints and coatings. The central tendency and high-end
exposures use 250 days per year as the exposure frequency since the 50<sup>th</sup> and 95<sup>th</sup> percentile of operating
days in the release assessment exceeded 250 days per year, which is the expected maximum for working
days.

2133	Table 3-20. Summary of	f Estimated Worker Inhalation Ex	posures for In	corporation into	Paints
2134	and Coatings				

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	Acute Dose (AD) (mg/kg/day)	3.8E-03	3.8E-03
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-03	2.8E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-03	2.6E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
Female of Reproductive Age	Acute Dose (AD) (mg/kg/day)	4.1E-03	4.1E-03
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.0E-03	3.0E-03

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.8E-03	2.8E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
ONU	Acute Dose (AD) (mg/kg/day)	3.8E-05	7.5E-05
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-05	5.5E-05
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-05	5.1E-05

## 3.4.4.4 Occupational Dermal Exposure Results

2135

EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 2136 2137 various "Exposure Concentration Types" from Table 3-21 are explained in Appendix B. Because dermal 2138 exposures to workers may occur in a concentrated liquid form during the incorporation of DIDP into paints and coatings, EPA assessed the absorptive flux of DIDP according to dermal absorption data of 2139 2140 neat DIDP (see Appendix D.2.1.1 for details). Table 3-21 summarizes the Acute Potential Dose Rate 2141 (APDR), the Acute Dose (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily 2142 Dose (ADD) for both average adult workers and female workers of reproductive age. Because there are 2143 no dust or mist expected to be deposited on surfaces from this OES, dermal exposures to ONUs from 2144 contact with surfaces were not assessed. Dermal exposure parameters are described in Appendix D. 2145

# Table 3-21. Summary of Estimated Worker Dermal Exposures for Incorporation into Paints and Coatings

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
Average Adult Worker	Dose Rate (APDR, mg/day)	3.7	7.3
	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Equals of Dong dusting A so	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	5.8E-02

## 3.4.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-22.

2151

2148

# Table 3-22. Summary of Estimated Worker Aggregate Exposures for Incorporation into Paints and Coatings

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	5.0E-2	9.5E-02
	Intermediate (IADD, mg/kg-day)	3.6E-02	7.0E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.4E-02	6.5E-02
Female of Reproductive	Acute (AD, mg/kg-day)	4.6E-02	8.8E-02
Age	Intermediate (IADD, mg/kg-day)	3.4E-02	6.5E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.2E-02	6.1E-02
ONU	Acute (AD, mg/kg-day)	3.8E-05	7.5E-05
	Intermediate (IADD, mg/kg-day)	2.8E-05	5.5E-05
	Chronic, Non-cancer (ADD, mg/kg- day)	2.6E-05	5.1E-05

2154 2155

## 3.5 Incorporation into Other Formulations, Mixtures, and Reaction Products Not Covered Elsewhere

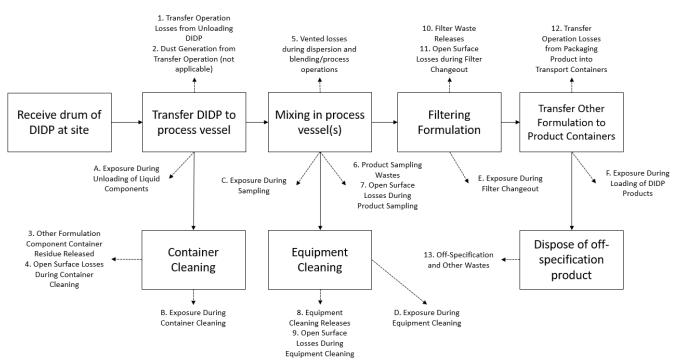
2156

## 3.5.1 Process Description

"Incorporation into other formulations, mixtures, and reaction products" is broad and includes 2157 2158 formulation of asphalt, hydraulic fluids, lubricants, penetrants, and other products. EPA expects that 2159 each use case is small; therefore, EPA assessed exposures as a group rather than individually. While 2160 EPA identified limited information on the formulation of these types of products, EPA expects that formulation follows the same processes regardless of end product type. Based on the 2014 GS on the 2161 2162 Formulation of Waterborne Coatings, EPA expects that a typical site will unload DIDP and incorporate 2163 it into other formulations, mixture, and reaction products within industrial mixing vessels, using a batch 2164 blending or mixing process, with no reactions or chemical changes occurring to DIDP during the mixing

process. Blending or mixing operations can take up to eight hours a day. Process operations may include quality control sampling and incorporation sites may transfer the blended formulation through an in-line filter. Following formulation, sites will load DIDP-containing products into bottles, small containers, or drums depending on the product type. Sites may dispose of off-specification product when the product does not meet quality or desired standards (U.S. EPA, 2014a). Figure 3-5 provides an illustration of the

- 2170 other formulations manufacturing process.
- 2171



### 2172

Figure 3-5. Incorporation into Other Formulations, Mixtures, and Reaction Products Flow Diagram (U.S. EPA, 2014a)

## 2175 **3.5.2 Facility Estimates**

2176 The 2020 CDR has one entry for "Incorporation into other formulations, mixtures, and reaction 2177 products" for Lanxess Solutions in Fords, NJ, which the site reported as "Petroleum Lubricating Oil and 2178 Grease Manufacturing; Lubricating Agent" (U.S. EPA, 2020a). However, EPA estimated the total 2179 production volume and the number of sites from systematic review due to the limitations of CDR 2180 reporting for downstream processes and uses. The 2003 DIDP Risk Assessment published by the European Union estimates a PV of approximately 1.1% to non-polymer uses (ECJRC, 2003a). The 1.1 2181 2182 % to non-polymer uses is split equally between paints/coatings, adhesives/sealants, and inks, which is 0.37% for each. The American Chemistry Council indicated that the use rate of DIDP in the EU is 2183 2184 similar to the use rate in the United States (ACC, 2020a). As a result, EPA calculated the production 2185 volume of DIDP in other formulations, mixtures, and reaction products as 0.37% of the yearly 2186 production volume of DIDP for both CASRN reported to CDR. The total production volume for other 2187 formulations was 169,485-1,679,970 kg/year.

2188

EPA did not identify other formulation operating information (*i.e.*, batch size or number of batches per year); EPA assumed 5,030 kg/batch and 250 batches/year based on the 2014 *ESD on the Formulation of* 

- 2190 year), EFA assumed 5,050 kg/batch and 250 batches/year based on the 2014 ESD on the Formulation of 2191 Waterborne Coatings (U.S. EPA, 2014a). This corresponds to a DIDP facility throughput of 12,575-
- 2192 1,131,750 kg-DIDP/site-year based on DIDP product concentrations of 1-90% (see Appendix F for EPA
- 2193 identified DIDP-containing products for this OES). Additionally, EPA assumed that the number of

operating days is equivalent to the number of batches per year, or 250 days/year with 24 hour/day and 7

- day/week operations (*i.e.*, multiple shifts) for the given site throughput scenario. According to CDR
   reports, other formulation sites receive DIDP in drums and totes ranging in size from 20-100 gallons
- 2197 with DIDP concentrations of 30-90% (U.S. EPA, 2020a). These sites receive DIDP as either a liquid or
- a solid paste that is then incorporated into other formulations as a liquid, with material in drums
- transferred to mixing vessels during formulation (U.S. EPA, 2014a). EPA estimated the total number of  $\frac{1}{2}$
- sites that manufacture other formulations using a Monte Carlo model (see Appendix E.6 for details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 1-2 sites. In contrast to 2020 CDR reports, in which
- 2202 a sole incorporation site was identified.

## 2203 **3.5.3 Release Assessment**

## 3.5.3.1 Environmental Release Points

EPA assigned release points based on the 2014 GS on the Formulation of Waterborne Coatings (U.S.
EPA, 2014a). EPA assigned default models to quantify potential releases from each release point and suspected fugitive air release point. EPA expects fugitive air releases from unloading of DIDP
containers, container cleaning, sampling, equipment cleaning, and filter replacements. EPA expects
stack air releases from vented losses during process operations and from packaging products into
transport containers. EPA expects releases to wastewater, incineration, or landfill from container
residue, sampling and equipment cleaning wastes, filter wastes, and off-specification wastes.

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2204

## 3.5.3.2 Environmental Release Assessment Results

# Table 3-23. Summary of Modeled Environmental Releases for Incorporation into Other Formulations, Mixtures, and Reaction Products

Modeled Environmental		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site- day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive Air	1.03E-04	2.61E-04	250		4.13E-07	1.04E-06
373,650- 3,703,700 lb	Stack Air	2.66E-05	1.24E-04			1.06E-07	4.97E-07
production W volume Ine	Wastewater, Incineration, or Landfill	2.14E04	2.20E04			7.39E02	1.29E03

## 2216 **3.5.4 Occupational Exposure Assessment**

2217

## 3.5.4.1 Worker Activities

During the formulation of other articles that contain DIDP, worker exposures to DIDP vapors may occur when packaging final products. Worker exposures may also occur via inhalation of vapors or dermal contact with liquids when unloading DIDP, cleaning transport containers, product sampling, equipment cleaning, and during filter media change out (U.S. EPA, 2014a). EPA did not identify information on engineering controls or workers PPE used at other formulation sites.

2224 ONUs include supervisors, managers, and other employees that work in the formulation area but do not 2225 directly contact DIDP received or processed onsite or handle of formulated product. ONUs are

2226 potentially exposed through the inhalation route while in the working area. However, dermal exposures

to ONUs are not expected for this OES.

## 3.5.4.2 Number of Workers and Occupational Non-users

2229 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 2230 to estimate the number of workers and ONUs potentially exposed to DIDP during the incorporation of 2231 DIDP into other formulations, mixtures, or reaction products not covered elsewhere. This approach 2232 involved the identification of relevant SOC codes within the BLS data for select NAICS codes. Section 2233 2.4.2 provides additional details on the methodology that EPA used to estimate the number of workers 2234 and ONUs per site. EPA assigned the NAICS codes 325110 and 325199 for this OES based on the 2235 Generic Scenario on the Formulation of Waterborne Coatings and CDR reported NAICS codes for 2236 incorporation into paints and coatings (U.S. EPA, 2020a, 2014a). Table 3-24 summarizes the per site 2237 estimates for this OES. As discussed in Section 3.5.2, EPA did not identify site-specific data for the 2238 number of facilities in the United States that incorporate DIDP into other formulations, mixtures, or 2239 reaction products not covered elsewhere.

2240

2228

# Table 3-24. Estimated Number of Workers Potentially Exposed to DIDP during Incorporation into Other Formulations, Mixtures, or Reaction Products not Covered Elsewhere

NAICS Code	Number of Sites <sup>b</sup>	Exposed Workers per Site <sup>a</sup>	Total Number of Exposed Workers <sup>b</sup>	Exposed ONUs per Site <sup>a</sup>	Total Number of Exposed ONUs <sup>b</sup>
325110 – Petrochemical Manufacturing	N/A	64		30	
325199 – All Other Basic Organic Chemical Manufacturing	N/A	39	N/A	18	N/A
Total/Average	1-2	51	51-102	24	24-48

<sup>a</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

<sup>b</sup> The result is expressed as a range between the central tendency and the high-end value representing the 50<sup>th</sup> and 95<sup>th</sup> percentile results. Results were not assessed by NAICS code for this scenario.

2243

## 3.5.4.3 Occupational Inhalation Exposure Results

EPA did not identify inhalation monitoring data for the incorporation of DIDP into other formulations,
 mixtures, and reaction products from systematic review. However, EPA estimated inhalation exposures
 for this OES using monitoring data for DIDP and DIN exposures during plastics converting. EPA
 expects that inhalation exposures during plastics converting are comparable to inhalation exposures
 during incorporation into other formulations, mixtures, and reaction products.

2249

2250 The p-chem properties (*e.g.*, molecular weight and vapor pressure) of diisodecyl phthlate and di(2-

- 2251 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking.
- 2252 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure
- study conducted by SP Porras *et al.* (2020) in a PVC-coated cable manufacturing facility to estimate
- worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable
- 2255 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic
- coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during
- formulation manufacturing. The subject facility in the SP Porras *et al.* study sometimes used DIDP as a plasticizer for manufacturing PVC costed cables, but the facility was using di/2 propulses the late
- 2258 plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) phthalate

2259 as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel collected 2260 stationary samples using the OVS sampler type, which measures a combination of vapor and particulate phases. SP Porras et al. collected two samples at cooling points near extruders and provided results as a 2261 2262 single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the study 2263 conducted sampling near a high-temperature extruder, EPA expects that the monitoring data represents 2264 vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to particulates containing the phthalate. To estimate ONU exposures for this OES, EPA used surrogate DINP 2265 2266 monitoring data provided in an exposure study conducted by Irwin et al. at a PVC roofing manufacturing site (Irwin, 2022) (hereinafter referred to as "Irwin 2022 study"). Irwin et al. collected 2267 2268 PBZ samples with an unspecified sampling method. The study included one PBZ sample for ONU 2269 exposures to airborne oil mists (Irwin, 2022). This data point was below the LOD. Therefore, EPA could 2270 not create a full distribution of monitoring results to estimate central tendency and high-end exposures. 2271 To estimate high-end exposures to ONUs, EPA use the LOD reported in the study. To estimate central 2272 tendency ONU exposure, EPA used half of the LOD.

2273 2274

Table 3-25 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker 2275 exposures to DIDP during incorporation into other formulations, mixtures, and reaction products not 2276 covered elsewhere. The central tendency and high-end exposures use 250 days per year as the exposure frequency since the 50<sup>th</sup> and 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 2277 days per year, which is the expected maximum for working days. 2278 2279

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	Acute Dose (AD) (mg/kg/day)	3.8E-03	3.8E-03
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-03	2.8E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-03	2.6E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	Acute Dose (AD) (mg/kg/day)	4.1E-03	4.1E-03
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.0E-03	3.0E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.8E-03	2.8E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
	Acute Dose (AD) (mg/kg/day)	3.8E-05	7.5E-05
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	2.8E-05	5.5E-05
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.6E-05	5.1E-05

#### 2280 Table 3-25. Summary of Estimated Worker Inhalation Exposures for Incorporation into Other 2281 Formulations, Mixtures, and Reaction Products Not Covered Elsewhere

## 3.5.4.4 Occupational Dermal Exposure Results

2283 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 2284 various "Exposure Concentration Types" from Table 3-26 are explained in Appendix B. Because dermal 2285 exposures to workers may occur in a concentrated liquid form during the incorporation of DIDP into 2286 other formulations, mixtures, and reaction products, EPA assessed the absorptive flux of DIDP 2287 according to dermal absorption data of neat DIDP (see Appendix D.2.1.1 for details). Table 3-26 2288 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate Average 2289 Daily Dose (IADD), and the Average Daily Dose (ADD) for both average adult workers and female 2290 workers of reproductive age. Because there are no dust or mist expected to be deposited on surfaces 2291 from this OES, dermal exposures to ONUs from contact with surfaces were not assessed. Dermal 2292 exposure parameters are described in Appendix D.

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2282

## Table 3-26. Summary of Estimated Worker Dermal Exposures for Incorporation into Other Formulations, Mixtures, and Reaction Products Not Covered Elsewhere

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Worker	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Female of Reproductive Age	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	5.8E-02

#### 2296

### 3.5.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-27.

2299

## 2300Table 3-27. Summary of Estimated Worker Aggregate Exposures for Incorporation into Other2301Formulations, Mixtures, or Reaction Products Not Covered Elsewhere

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	5.0E-2	9.5E-02
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.6E-02	7.0E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.4E-02	6.5E-02
	Acute (AD, mg/kg-day)	4.6E-02	8.8E-02
Female of Reproductive	Intermediate (IADD, mg/kg-day)	3.4E-02	6.5E-02
Age	Chronic, Non-cancer (ADD, mg/kg- day)	3.2E-02	6.1E-02
ONU	Acute (AD, mg/kg-day)	3.8E-05	7.5E-05
	Intermediate (IADD, mg/kg-day)	2.8E-05	5.5E-05

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Chronic, Non-cancer (ADD, mg/kg- day)	2.6E-05	5.1E-05

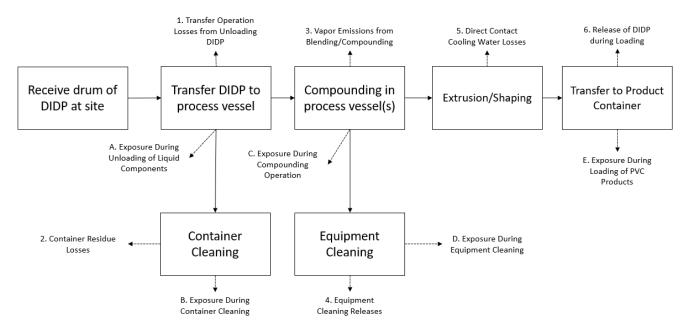
## **3.6 PVC Plastics Compounding**

#### 2303 **3.6.1 Process Description**

PVC Plastics Compounding involves the mixing of the polymer with the plasticizer and other chemical 2304 2305 such as, fillers and heat stabilizers. The plasticizer needs to be absorbed into the particle to impart 2306 flexibility to the polymer. For PVC Plastics Compounding scenarios, compounding occurs through 2307 mixing of ingredients to produce a powder (dry blending) or a liquid (Plastisol blending) (ACC, 2020b, 2308 c). The most common process for dry blending involves heating the ingredients in a high intensity mixer 2309 and transfer to a cold mixer. The Plastisol blending is done at ambient temperature using specific mixers 2310 that allow for the breakdown of the PVC agglomerates and the absorption of the plasticizer into the resin particle. The 2020 and 2012 CDR reports use of this chemical as a plasticizer in plastic material and 2311 2312 resin manufacturing (U.S. EPA, 2020a, 2019a).

2313 2314 As mentioned above, DIDP is used as a plasticizer in PVC including vinyl barriers and castable PVC 2315 plastics adhesives (see Appendix F for EPA identified DIDP-containing products for this OES). EPA 2316 expects that a typical compounding site receives DIDP as a pure liquid at 25°C in drums and totes 2317 ranging in size from 20-100 gallons (U.S. EPA, 2021e). The site unloads and transfers DIDP into mixing 2318 vessels to produce a compounded resin masterbatch. Following completion of the masterbatch, the site 2319 transfers the solid resin to an extruder that shapes and sizes the plastic and packages the final product for 2320 shipment to downstream conversion sites after cooling. Figure 3-6 provides an illustration of the PVC 2321 plastic compounding process (U.S. EPA, 2021e).

2322





## Figure 3-6. PVC Plastics Compounding Flow Diagram (U.S. EPA, 2021e)

2325

### **3.6.2 Facility Estimates**

In the 2020 CDR, seven sites reported using DIDP as a plasticizer for several industrial sectors including 2326 2327 plastic product manufacturing and plastic material and resin manufacturing. Two sites provided a non-2328 CBI production volume, whereas five sites indicated that their production volume was CBI. Due to the 2329 limitations of CDR reporting data for downstream processes and uses, EPA relied on data from the 2330 European Union and the American Chemistry Council to estimate the total production volume. The 2331 2003 DIDP Risk Assessment published by the European Union stated that the use rate of DIDP in PVC 2332 plastics is equal to 95.75% of the annual chemical production volume (ECJRC, 2003a). The American 2333 Chemistry Council indicated that the use rate of DIDP in the EU is similar to the use rate in the United 2334 States (ACC, 2020a). As a result, EPA calculated the production volume of DIDP in PVC plastics 2335 compounding as 95.75% of the yearly production volume of DIDP under both CASRN or 43,859,857-2336 434,749,009 kg/year. The 2020 CDR reported the national production volume of DIDP as a range; 2337 therefore, EPA also provided the plastics compounding production volume as a range. In addition, the 2338 Royal Society of Chemistry published a book chapter that stated that, "In 2008, more than 5 million 2339 tonnes of phthalates were used as plasticizers worldwide. Of the phthalates used 16% are used in North 2340 America... In 2008 DINP and DIDP had a market share of 38% and 21%, respectively" (Koch and 2341 Angerer, 2011). The annual North American DIDP production volume used in PVC plastics based on 2342 these market share values is 160,000,000 DIDP kg/year, which is generally consistent with the 2343 production volume range calculated based on the 2020 CDR data and EU Risk Assessment.

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The American Chemistry Council provided information on the concentration of DIDP in different types of PVC plastic products, as shown in Table 3-28 (<u>ACC, 2020a</u>).

2347 2348

#### Table 3-28. DIDP Concentration for Different PVC Products

Product Type	<b>Concentration Range by Weight</b>
Wire and Cable	25% DIDP
Film and Sheet	20-45% DIDP

Product Type	Concentration Range by Weight
Other	10-40% DIDP

#### 2349

2350 EPA did not identify site- or chemical-specific operating data for PVC plastics compounding (*i.e.*, 2351 facility production rate, number of batches, or operating days); EPA estimated an annual facility DIDP 2352 throughput of 1,489,327-4,146,286 kg/site-year based on the 2021 Generic Scenario on Plastic 2353 Compounding throughput of plastic additives, the mass fraction of DIDP in PVC products, and the mass 2354 fraction of all additives in compounded plastic resin (U.S. EPA, 2021e). EPA estimated the total number 2355 of PVC plastics compounding sites using a Monte Carlo model (see Appendix E.7 for details). The 50<sup>th</sup>-2356 95<sup>th</sup> percentile range of the number of sites was 98-195 sites. In contrast three of the seven sites from the 2357 2020 CDR reported their number of downstream sites as Not Known or Reasonably Ascertained 2358 (NKRA). The other four sites each reported a total number of downstream sites less than ten. EPA 2359 assessed the total number of operating days of 148-264 days/year, with 24 hour/day, 7 day/week (i.e., 2360 multiple shifts) operations for the given site throughput scenario. Additionally, EPA assumed the 2361 number of batches per site per year was equivalent to the number of operating days, or one batch per 2362 day.

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#### 3.6.3 Release Assessment

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#### 3.6.3.1 Environmental Release Points

2365 EPA assigned release points based on the 2021 Generic Scenario on Plastic Compounding (U.S. EPA, 2366 2021e). EPA assigned a default model to quantify releases at each release point and suspected fugitive 2367 air release point. EPA expects fugitive or stack air releases from unloading plastic additives and process 2368 operations. EPA expects releases to wastewater, incineration, or landfill from container residues and equipment cleaning wastes. EPA expects releases to wastewater from direct contact cooling. Sites may 2369 2370 utilize air capture technology. If a site uses air capture technology, EPA expects dust releases from 2371 product loading to be controlled and released to disposal facilities for incineration or landfill. EPA 2372 expects that the remaining uncontrolled dust is released to stack air. If the site does not use air control technology, EPA expects releases to fugitive air, wastewater, incineration, or landfill as described above. 2373

Summary of Modeled Environmental Releases for PVC Plastics Compounding							
Modeled Scenario	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
96,695,434- 958,457,500 lb production volume	Fugitive or Stack Air	7.18E03	3.10E04			3.29E01	1.45E02
	Fugitive Air, Wastewater, Incineration, or Landfill	1.81E04	5.87E04	223	254	8.29E01	2.73E02
	Wastewater, Incineration, or Landfill	9.36E04	1.41E05			4.29E02	6.80E02
	Wastewater	2.38E04	3.38E04			1.09E02	1.64E02

2374 <b>3.6.3.2 En</b>	vironmental Release Ass	essment Results
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Modeled Environmental		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Incineration or Landfill	4.83E03	2.39E04			2.21E01	1.11E02

#### **3.6.4 Occupational Exposure Assessment**

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#### 3.6.4.1 Worker Activities

Worker exposures during the compounding process may occur via inhalation of DIDP-containing dusts.
Dermal exposures to liquids may occur during equipment cleaning. Worker exposures may also occur
via dermal contact with liquids and inhalation of vapors during DIDP unloading and loading and
transport container cleaning (U.S. EPA, 2021e). EPA did not identify information on engineering
controls or worker PPE used at plastics compounding sites.

2384 ONUs include supervisors, managers, and other employees that work in the formulation area but do not

2385 directly contact DIDP received or processed onsite or handle compounded product. ONUs are

2386 potentially exposed through the inhalation route while in the working area. Also, dermal exposures from

contact with surfaces where dust has been deposited were assessed for ONUs.

### 3.6.4.2 Number of Workers and Occupational Non-users

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 2389 to estimate the number of workers and ONUs that are potentially exposed to DIDP during PVC plastics 2390 2391 compounding. This approach involved the identification of relevant SOC codes within the BLS data for 2392 the select NAICS codes. Section 2.4.2 provides additional details on the methodology EPA used to 2393 estimate the number of workers and ONUs per site. EPA assigned the NAICS code 326100 - Plastics 2394 Product Manufacturing for this OES based on the CDR reported NAICS codes for PVC plastics 2395 compounding (U.S. EPA, 2020a). Table 3-30 summarizes the per site estimates for this OES. As 2396 discussed in Section 3.6.2, EPA did not identify site-specific data for the number of facilities in the 2397 United States that compound PVC plastics. 2398

## Table 3-30. Estimated Number of Workers Potentially Exposed to DIDP during PVC Plastics Compounding

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non- users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
326100 – Plastics Product Manufacturing	98-195	18	1,798-3,578	5	509-1,012

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value representing the 50<sup>th</sup> and 95<sup>th</sup> percentile results.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

#### 3.6.4.3 Occupational Inhalation Exposure Results

EPA did not identify chemical-specific or OES-specific inhalation monitoring data for DIDP. EPA
estimated aggregate (*i.e.*, vapor and dust) worker inhalation exposures using both the surrogate
monitoring data for di(2-propylheptyl) phthalate during PVC-coated cable manufacturing and the
Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable
Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d).

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2401

2408 The p-chem properties (e.g., molecular weight and vapor pressure) of diisodecyl phthlate and di(2-2409 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking. 2410 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure 2411 study conducted by SP Porras et al. (2020) in a PVC-coated cable manufacturing facility to estimate 2412 worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable 2413 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic 2414 coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during 2415 PVC material compounding. The subject facility in the SP Porras et al. study sometimes used DIDP as a 2416 plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) phthalate 2417 as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel collected 2418 stationary samples using the OVS sampler type, which measures a combination of vapor and particulate 2419 phases. SP Porras *et al.* collected two samples at cooling points near extruders and provided results as a 2420 single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the study 2421 conducted sampling near a high-temperature extruder, EPA expects that the monitoring data represents 2422 vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to particulates 2423 containing the phthalate. For this reason, EPA decided to aggregate the surrogate monitoring data from 2424 SP Porras et al. (2020) with particulate inhalation exposure model estimates (discussed below).

2425

2426 DIDP is present in PVC materials (U.S. CPSC, 2015), so EPA expects worker inhalation exposures to 2427 DIDP via exposure to particulates of PVC materials. Therefore, EPA estimated worker inhalation 2428 exposures during PVC compounding using the Generic Model for Central Tendency and High-End 2429 Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2430 2021d). Model approaches and parameters are described in Appendix E.16. In the model, EPA used a 2431 subset of the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and 2432 Respirable Particulates Not Otherwise Regulated (PNOR) data that came from facilities with NAICS 2433 codes starting with 326 (Plastics and Rubber Manufacturing) to estimate PVC particulate concentrations 2434 in the air. EPA used the maximum expected concentration of DIDP in PVC plastic products to estimate 2435 the concentration of DIDP in particulates of PVC material. For this OES, EPA selected 45 percent by 2436 mass as the highest expected DIDP concentration based on the estimated plasticizer concentrations in 2437 flexible PVC given by the Use of Additives in Plastic Compounding Generic Scenario (U.S. EPA, 2438 2021e). The estimated exposures assume that DIDP is present in particulates of the PVC material at this 2439 fixed concentration throughout the working shift. The Generic Model for Central Tendency and High-2440 End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) uses an 2441 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. For example, if exposure was measured at  $5 \text{ mg/m}^3$  over a 7-hour duration, the 8-hr TWA exposure 2442 2443 value would be  $4.375 \text{ mg/m}^3$ . 2444

EPA assumes that the worker is exposed to DIDP in the form of PVC particulates and DIDP vapors.

2446 EPA aggregated estimates from the surrogate monitoring data and the *Generic Model for Central* 

2447 Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise

2448 *Regulated (PNOR)* (U.S. EPA, 2021d) to address these two physical forms of DIDP for the full 8-hour

2449 work shift. EPA added the 8-hour TWA concentration from the monitoring data and exposure estimates

- from the model to aggregate the exposures. EPA used the number of operating days determined in the
  release assessment for this OES to estimate exposure frequency, with a maximum exposure frequency of
  250 working days per year.
- 2453

Table 3-31 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during PVC plastics compounding. The high-end exposures use 250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 2457 250 days per year, which is the expected maximum for working days. The central tendency exposures use 223 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release assessment.

2460

2461 To estimate ONU exposure for this OES, EPA used surrogate DINP monitoring data provided in an 2462 exposure study conducted by Irwin et al. at a PVC roofing manufacturing site (Irwin, 2022) (hereinafter 2463 referred to as "Irwin 2022 study"). The study collected data via PBZ samples with an unspecified sampling method. The study included one PBZ sample for ONU exposure to airborne oil mists (Irwin, 2464 2465 2022). This data point was below the LOD. Therefore, EPA could not create a full distribution of 2466 monitoring results to estimate central tendency and high-end exposures. To estimate high-end exposures to ONUs, EPA used the LOD reported in the study. To estimate central tendency ONU exposures, EPA 2467 2468 used half of the LOD. Appendix B describes the approach for estimating AD, IADD, and ADD. 2469

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration to Vapors (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	2.1
Average Adult Worker	Acute Dose (AD) (mg/kg/day)	1.7E-02	0.27
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	0.20
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.0E-02	0.18
	8-hr TWA Exposure Concentration to Vapors (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	2.1
Female of	Acute Dose (AD) (mg/kg/day)	1.8E-02	0.30
Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.4E-02	0.22
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.1E-02	0.20
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
ONU	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	0.10
	Acute Dose (AD) (mg/kg/day)	1.3E-02	1.3E-02
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.5E-03	9.5E-03

## 2470 Table 3-31. Summary of Estimated Worker Inhalation Exposures for PVC Plastics Compounding

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	7.9E-03	8.9E-03

#### 2471 **3.6.4.4 Occupational Dermal Exposure Results**

2472 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 2473 various "Exposure Concentration Types" from Table 3-32 are explained in Appendix B. Because dermal exposures of DIDP to workers may occur in the neat form during PVC plastics compounding, EPA 2474 2475 assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see Appendix 2476 D.2.1.1 for details). Also, since there may be dust deposited on surfaces from this OES, dermal 2477 exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to ONU 2478 2479 exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 2480 Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP 2481 were assumed representative of ONU dermal exposure.

2482

Table 3-32 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

2485 2486

#### 2487 Table 3-32. Summary of Estimated Worker Dermal Exposures for PVC Plastics Compounding

Worker Population	<b>Exposure Concentration Type</b>	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.8E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Especial of Depreductive Acc	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.6E-02	5.8E-02
	Dose Rate (APDR, mg/day)	3.8E-02	3.8E-02
ONU	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	3.3E-04

### 2488 **3.6.4.5** Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-33.

2491

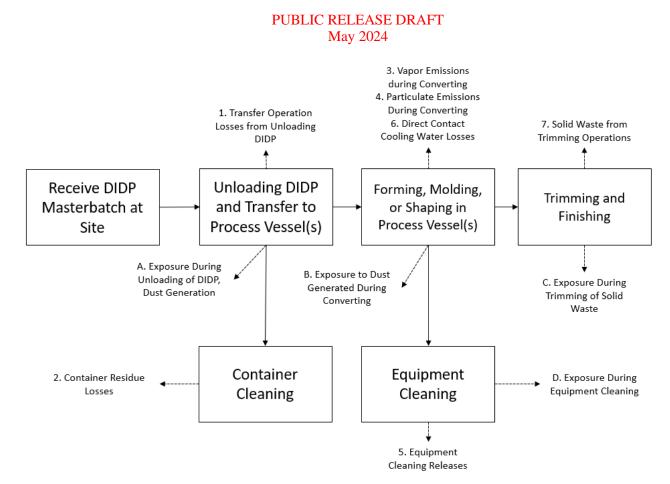
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	6.3E-02	0.36
	Intermediate (IADD, mg/kg-day)	4.6E-02	0.26
	Chronic, Non-cancer (ADD, mg/kg- day)	3.8E-02	0.25
Female of Reproductive	Acute (AD, mg/kg-day)	6.1E-02	0.38
Age	Intermediate (IADD, mg/kg-day)	4.4E-02	0.28
	Chronic, Non-cancer (ADD, mg/kg- day)	3.7E-02	0.26
ONU	Acute (AD, mg/kg-day)	1.3E-02	1.3E-02
	Intermediate (IADD, mg/kg-day)	9.9E-03	9.9E-03
	Chronic, Non-cancer (ADD, mg/kg- day)	8.2E-03	9.2E-03

#### 2492 Table 3-33. Summary of Estimated Worker Aggregate Exposures for PVC Plastics Compounding

## 2493 **3.7 PVC Plastics Converting**

#### 2494**3.7.1** Process Description

DIDP is used as a plasticizer in PVC plastics, including vinyl barriers and castable PVC plastic (see 2495 2496 Appendix F for EPA identified DIDP-containing products for this OES). EPA expects that DIDP will 2497 arrive at a typical converting site as a solid in containers ranging in size from 5-1000 gallons (U.S. EPA, 2004a). A typically converting site will unload DIDP in solid form, as a masterbatch, from PVC plastic 2498 2499 compounding sites where it is transferred to a shaping unit operation such as an extruder, injection 2500 molding unit, or blow molding unit to achieve the final product shape. The converting site may trim 2501 excess material from the final plastic product after it cools. Figure 3-7 provides an illustration of the 2502 plastic converting process (U.S. EPA, 2004a). 2503



## 2504

Figure 3-7. PVC Plastics Converting Flow Diagram (U.S. EPA, 2004a)

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2507 It is important to note that the Manufacturer request for risk evaluation: Diisodecyl phthalate (DIDP) 2508 and Final Use Report for Diisodecyl Phthalate (DIDP) (1,2-Benzenedicarboxylic acid, 1,2-diisodecyl 2509 ester and 1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich) (CASRN 26761-40-0 2510 and 68515-49-1) reported use of DIDP in inks and colorants (U.S. EPA, 2021c, 2019b). The Processing , incorporation into articles, "ink, toner, and colorant products manufacturing" COU describes the 2511 2512 incorporation of DIDP-containing colorants into material such as, polyurethane or plastisol. Plastisol 2513 mixed with DIDP-containing colorants are applied through processes such as dipping, roto-molding, or 2514 slush molding to produce coated fabrics, vinyl sealants, wall coverings, toys, and sporting goods (ACC, 2515 2020b). DIDP is also present in colorants used to color two-part polyurethane, foam, and epoxy resin 2516 systems used for production of prototypes, miniature models, and taxidermy (U.S. EPA, 2021c).

3.7.2 Facility Estimates

Since converting occurs immediately downstream of compounding, EPA expects the production volume
for PVC plastic converting to be identical to the production volume for the PVC plastics compounding
OES. The production volume of DIDP for use in PVC plastics compounding under both CASRN was
43,859,857-434,749,009 kg/year (see Section 3.6 for details).

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2517

The American Chemistry Council provided information on the concentration of DIDP in different types of PVC products as shown in Table 3-28 (ACC, 2020a).

2525

EPA did not identify PVC plastic converting site operating data (*i.e.*, facility production rate, number of batches, or operating days); EPA estimated an annual facility DIDP throughput of 68,542-182,547

2528 kg/site-year based on the 2004 Generic Scenario on Plastics Converting throughput of plastic additives,

2529 the mass fraction of DIDP in PVC products, and the mass fraction of all additives in plastic resin (U.S. 2530 EPA, 2004a). EPA estimated the total number of PVC plastics converting sites using a Monte Carlo model (see Appendix E.8 for details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 2,128-2531 2532 4,237 sites. In contrast to the 2020 CDR, in which three of the seven sites reported their number of 2533 downstream sites as NKRA, while the other four sites each reported a total number of downstream sites 2534 less than ten. EPA assessed the total number of operating days as 137-254 days/year, of 24 hour/day, 7 2535 day/week (i.e., multiple shifts) operations for the given site throughput scenario. Additionally, EPA 2536 assumed the number of batches completed per site per year was equivalent to the number of operating 2537 days, or one completed batch per day.

2538 **3.7.3 Release Assessment** 

#### 3.7.3.1 Environmental Release Points

2540 EPA assigned release points based on the 2004 Generic Scenario on Plastic Converting (U.S. EPA, 2541 2004a). EPA assigned default models to quantify releases from each release point and suspected fugitive 2542 air release point. EPA expects fugitive or stack air releases and particulate emissions to fugitive air, 2543 wastewater, incineration, or landfill from converting operations. EPA expects releases to wastewater, 2544 incineration, or landfill from container residues, and equipment cleaning. EPA expects releases to 2545 wastewater from direct contact cooling and incineration, and landfill releases from solid waste trimming. 2546 Converting sites may utilize air capture technology. If a site uses air capture technology, EPA expects 2547 dust releases from plastic unloading to be controlled and released to disposal facilities for incineration or 2548 landfill; The site would release the remaining uncontrolled dust to stack air. If the site does not use air 2549 control technology, EPA expects plastic unloading releases to fugitive air, wastewater, incineration, or 2550 landfill as described above.

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#### 3.7.3.2 Environmental Release Assessment Results

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## Table 3-34. Summary of Modeled Environmental Releases for PVC Plastics Converting

Modeled	Modeled Environmental Media		Annual Release (kg/site-yr)Number of Release DaysDaily Release (kg/site-day)				
Scenario	Environmental Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive or Stack Air	3.35E02	1.43E03			1.57	6.86
96,695,434-	Fugitive Air, Wastewater, Incineration, or Landfill	8.40E02	2.71E03			3.94	1.30E01
958,457,500 lb production volume	Wastewater, Incineration, or Landfill	3.28E03	4.66E03	219	251	1.54E01	2.35E01
volulile	Wastewater	1.10E03	1.55E03			5.14	7.84
	Incineration or Landfill	3.05E03	4.50E03			1.43E01	2.28E01

### 2554 **3.7.4 Occupational Exposure Assessment**

### **3.7.4.1 Worker Activities**

Workers are potentially exposed to DIDP via dust inhalation during the converting process and via
dermal contact with liquids during equipment cleaning. Additionally, workers may be exposed to DIDP
via dermal contact with liquids and inhalation of vapors during unloading and loading, transport

container cleaning, and trimming of excess plastic (U.S. EPA, 2021f). EPA did not identify information
 on engineering controls or worker PPE used at plastics converting sites.

2561

2562 ONUs include supervisors, managers, and other employees that work in the formulation area but do

directly contact DIDP that is received or processed onsite or handle the finished product. ONUs are
 potentially exposed through the inhalation route while in the working area. Also, dermal exposures from

2565 contact with surfaces where dust has been deposited were assessed for ONUs.

## 2566 **3.7.4.2 Number of Workers and Occupational Non-users**

2567 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 2568 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during PVC plastics converting. This approach involved the identification of relevant SOC codes withing the BLS 2569 2570 data for select NAICS codes. Section 2.4.2 provides additional details regarding the methodology that 2571 EPA used to estimate the number of workers and ONUs per site. EPA assigned the NAICS code 326100 2572 - Plastics Product Manufacturing for this OES based on the CDR reported NAICS codes for PVC 2573 plastics converting (U.S. EPA, 2020a). Table 3-35 summarizes the per site estimates for this OES. As 2574 discussed in Section 3.7.2, EPA did not identify site-specific data for the number of facilities in the 2575 United States that convert PVC plastics.

2576

## Table 3-35. Estimated Number of Workers Potentially Exposed to DIDP during PVC Plastics Converting

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non-users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
326100 – Plastics Product	2,128- 4,237	18	39,044- 77,739	5	11,049-22,000
Manufacturing	4,237		11,155		

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value representing the 50<sup>th</sup> and 95<sup>th</sup> percentile results.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

## 3.7.4.3 Occupational Inhalation Exposure Results

EPA identified one study with surrogate monitoring data collected during plastics converting at a cable
coating facility; however, as described below, the study had several limitations. Therefore, EPA
estimated aggregate (*i.e.*, vapor and dust) worker inhalation exposures using both the cable coating
surrogate monitoring data and the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d).

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2579

2586 The p-chem properties (*e.g.*, molecular weight and vapor pressure) of diisodecyl phthlate and di(2-

2587 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking.

2588 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure

2589 study conducted by SP Porras *et al.* (2020) in a PVC-coated cable manufacturing facility to estimate

2590 worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable

2591 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic

coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during

2593 PVC plastics converting. The subject facility in the SP Porras et al. study sometimes used DIDP as a 2594 plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) phthalate 2595 as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel collected 2596 stationary samples using the OVS sampler type, which measures a combination of vapor and particulate 2597 phases. SP Porras *et al.* collected two samples at cooling points near extruders and provided results as a single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the study 2598 2599 conducted sampling near a high-temperature extruder, EPA expects that the monitoring data represents 2600 vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to particulates 2601 containing the phthalate. For this reason, EPA decided to aggregate the surrogate monitoring data from 2602 SP Porras et al. (2020) with particulate inhalation exposure model estimates (discussed below).

2603

2604 DIDP is present in PVC materials (U.S. CPSC, 2015), so EPA expects worker inhalation exposures to DIDP via exposure to particulates of PVC materials. Therefore, EPA estimated worker inhalation 2605 2606 exposures during PVC plastic converting using the Generic Model for Central Tendency and High-End 2607 Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d). Model approaches and parameters are described in Appendix E.16. In the model, EPA used a 2608 2609 subset of the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and 2610 Respirable Particulates Not Otherwise Regulated (PNOR) data that came from facilities with NAICS 2611 codes starting with 326 (Plastics and Rubber Manufacturing) to estimate PVC plastic particulate 2612 concentrations in the air. EPA used the highest expected concentration of DIDP in PVC plastic products 2613 to estimate the concentration of DIDP in particulates. For this OES, EPA selected 45 percent by mass as 2614 the maximum expected DIDP concentration, based on the estimated plasticizer concentrations in flexible 2615 PVC given by the Use of Additives in Plastic Compounding Generic Scenario (U.S. EPA, 2021e). The estimated exposures assume that DIDP is present in particulates of the PVC plastic at this fixed 2616 2617 concentration throughout the working shift. The Generic Model for Central Tendency and High-End 2618 Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) uses an 8-2619 hour TWA for particulate concentrations, by assuming exposures outside the sample duration are zero. 2620 Exposures during individual worker activities are not determined using this model. 2621 2622 EPA assumed that the worker is exposed to DIDP in the form of PVC plastic particulates and DIDP

vapors. EPA aggregated estimates from the surrogate monitoring data and the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d) to address these two physical forms of DIDP for the
full 8-hour work shift. EPA added the 8-hour TWA from the monitoring data and exposure estimates
from the model to aggregate the exposures. EPA used the number of operating days determined in the
release assessment for this OES to estimate exposure frequency, with a maximum exposure frequency of
250 working days per year.

2630

Table 3-36 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during PVC plastics converting. The high-end exposures use 250 days per year as the exposure frequency, since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 2634 250 days per year, which is the expected maximum for working days. The central tendency exposures use 219 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release assessment.

2637

To estimate ONU exposure for this OES, EPA used surrogate DINP monitoring data provided in an exposure study conducted by Irwin *et al.* at a PVC roofing manufacturing site (Irwin, 2022) (hereinafter referred to as "Irwin 2022 study"). Irwin *et al.* collected PBZ samples using an unspecified sampling method. The study included one PBZ sample for ONU exposure to airborne oil mists (Irwin, 2022). This

data point was below the LOD. Therefore, EPA could not create a full distribution of monitoring results
to estimate central tendency and high-end exposures. To estimate high-end exposures to ONUs, EPA
used the LOD reported in the study. To estimate central tendency ONU exposures, EPA used half of the
LOD. EPA does not expect ONU exposures to dusts during PVC plastics converting. Appendix B
describes the approach for estimating AD, IADD, and ADD.

2647

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration to Vapors (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	2.1
Average Adult Worker	Acute Dose (AD) (mg/kg/day)	1.7E-02	0.27
Tronge Haut Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	0.20
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.0E-02	0.18
	8-hr TWA Exposure Concentration to Vapors (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	2.1
Female of	Acute Dose (AD) (mg/kg/day)	1.8E-02	0.30
Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.4E-02	0.22
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.1E-02	0.20
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.10	0.10
ONU	Acute Dose (AD) (mg/kg/day)	1.3E-02	1.3E-02
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.5E-03	9.5E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	7.8E-03	8.9E-03

#### 2648 Table 3-36. Summary of Estimated Worker Inhalation Exposures for PVC Plastics Converting

#### 2649

### 3.7.4.4 Occupational Dermal Exposure Results

2650 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The various "Exposure Concentration Types" from Table 3-37 are explained in Appendix B. Because dermal 2651 exposures of DIDP to workers is expected to occur through contact with solids or articles for this OES, 2652 EPA assessed the absorptive flux of DIDP according to dermal absorption modeling approach for solids 2653 outlined in Appendix D.2.1.2. Also, since there may be dust deposited on surfaces from this OES, 2654 dermal exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to 2655 2656 workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 2657 2658 Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP 2659 were assumed representative of ONU dermal exposure. 2660

Table 3-37 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate

2662 Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female

workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

2664

## 2665 **Table 3-37. Summary of Estimated Worker Dermal Exposures for PVC Plastics Converting**

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Equals of Derroductive Acc	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-04	6.1E-04
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONU	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	3.3E-04

2666

## 3.7.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-38.

2669

### 2670 Table 3-38. Summary of Estimated Worker Aggregate Exposures for PVC Plastics Converting

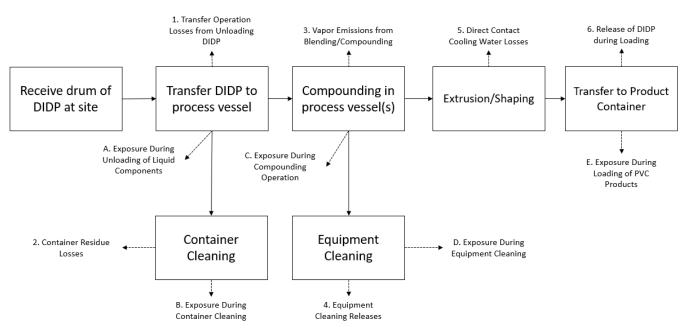
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	1.7E-02	0.27
	Intermediate (IADD, mg/kg-day)	1.3E-02	0.20
	Chronic, Non-cancer (ADD, mg/kg- day)	1.0E-02	0.18
Female of Reproductive	Acute (AD, mg/kg-day)	1.9E-02	0.30
Age	Intermediate (IADD, mg/kg-day)	1.4E-02	0.22
	Chronic, Non-cancer (ADD, mg/kg- day)	1.1E-02	0.20
ONU	Acute (AD, mg/kg-day)	1.3E-02	1.3E-02
	Intermediate (IADD, mg/kg-day)	9.9E-03	9.9E-03
	Chronic, Non-cancer (ADD, mg/kg- day)	8.1E-03	9.2E-03

## **3.8 Non-PVC Material Compounding**

## **3.8.1 Process Description**

The 2021 *Scope of the Risk Evaluation for Diisodecyl Phthalate* (U.S. EPA, 2021b) and CDR reports for plastic material and resin manufacturing indicate DIDP use in non-PVC polymers, such as rubber, vinyl resins, cellulose ester plastics, and flexible fibers (see Appendix F for EPA identified DIDP-containing

- 2676 products for this OES) (U.S. EPA, 2021b, 2020a; ECJRC, 2003a); however, EPA did not identify
- 2677 specific non-PVC polymer products that contain DIDP from the data sources that underwent systematic 2678 review.
- 2679
- 2680 EPA expects that a typical non-PVC material compounding site operates similar to a PVC plastic
- 2681 compounding site. Based on the 2021 Generic Scenario on Plastic Compounding, typical compounding
- sites receive DIDP as a pure liquid at 25°C in drums and totes ranging from 20-1,000 gallons in size.
- 2683 Typical compounding sites receive and unload DIDP and transfer it into mixing vessels to produce a
- 2684 compounded resin masterbatch. Following completion of the masterbatch, sites transfer the solid resin to
- extruders that shape and size the plastic and package the final product for shipment to downstream conversion sites after cooling (U.S. EPA, 2021e). Figure 3-8 provides an illustration of the plastic
- 2687 compounding process (U.S. EPA, 2021e).

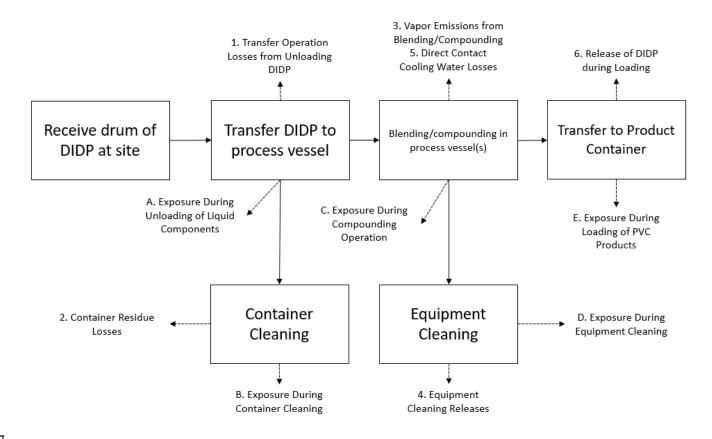


2688

## **Figure 3-8. Non-PVC Material Compounding Flow Diagram**

2690

Note that some materials, such as rubbers, may consolidate the compounding and converting operation as described in the SpERC Fact Sheet on Rubber Production and Processing. Figure 3-9 provides an illustration of the rubbers formulation process (ESIG, 2020; OECD, 2004a). However, it is the rate of consolidated operations for non-PVC materials is unknown; therefore, EPA assessed all formulations as separate compounding and converting steps. Figure 3-9 provides an illustration of the consolidated process.



2697

## **Figure 3-9. Consolidated Compounding and Converting Flow Diagram**

2699

### 3.8.2 Facility Estimates

2700 In the 2020 CDR two sites reported a production volume for the formulation of rubbers OES. Many sites 2701 reported plastic compounding activity; however, CDR does not allow reporters to specify PVC and non-PVC Plastics compounding. Therefore, EPA assessed all plastic compounding sites as PVC 2702 2703 compounding based on the majority use case. Due to additional limitations associated with using CDR 2704 data for downstream processes, EPA relied on data from the European Union and the American Chemistry Council to assess the total production volume. The 2003 DIDP Risk Assessment published by 2705 2706 the European Union stated that the downstream use rate in the other category, including non-PVC plastic 2707 and rubber manufacturing is equal to 3.2% of the annual chemical production volume (ECJRC, 2003a). 2708 The American Chemistry Council indicated that the use rate of DIDP in the EU is similar to the use rate 2709 in the United States (ACC, 2020a). The 2020 CDR reported a national production volume range for 2710 DIDP; therefore, EPA provided the formulation of rubbers and non-PVC polymers production volume as a range using the EU defined percentage of non-PVC polymer DIDP use. Since EPA was unable to 2711 2712 further refine this production volume into non-PVC polymer and rubber formulation, the OES were 2713 assessed together due to similarities in their respective production processes. EPA calculated the 2714 production volume of DIDP under both CASRN as 1,465,812 to 14,529,471 kg/year.

2715

2716 EPA did not identify site- or DIDP-specific non-PVC material compounding operating data (*i.e.*, facility

2717 production rate, number of batches, or operating days). EPA assessed non-PVC material compounding

2718 operating data based on PVC compounding operating data, as the operations are expected to be similar.

EPA based the DIDP facility use rate on the 2021 *Generic Scenario on Plastic Compounding* product throughput of plastic additives. EPA also considered the 2004 *ESD on Additives in the Rubber Industry* 

but determined the plastics compound GS to be more representative of the whole OES (OECD, 2004a).

2722 The GS based the facility use rate on the mass fraction of DIDP in non-PVC products, and the mass

- 2723 fraction of all additives in compounded plastic resin (U.S. EPA, 2021e). The estimated annual facility
- DIDP throughput was 1,489,327-4,146,286 kg/site-year. The GS estimated the total number of operating 2724 2725 days as 148-300 days/year, with 24 hour/day, 7 day/week (i.e., multiple shifts) operations for the given
- 2726 site throughput scenario. The number of batches completed per site year was equivalent to the number of
- operating days, or one batch per day (U.S. EPA, 2021e). EPA estimated the total number of sites that 2727
- participate in non-PVC plastic compounding using a Monte Carlo model (see Appendix E.9 for details). 2728
- 2729 The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 4-9. In contrast to 2020 CDR reports, in which one site reported the number of industrial use sites as NKRA and the other site reported a total number
- 2730
  - 2731 of industrial sites to be less than 10.
  - 2732 **Release Assessment** 3.8.3

#### 2733 3.8.3.1 Environmental Release Points

EPA assigned release points based on the 2021 Generic Scenario on Plastic Compounding (U.S. EPA, 2734 2735 2021e). EPA assigned default models to quantify releases from each release point and suspected fugitive air release point. EPA expects fugitive or stack air releases from unloading plastic additives, and process 2736 2737 operations. EPA expects releases to wastewater, incineration, or landfill from container residues and 2738 equipment cleaning wastes. EPA expects releases to wastewater from direct contact cooling. Sites may 2739 utilize air capture technology. If a site uses air capture technology, EPA expects dust releases from 2740 product loading to be controlled and released to disposal facilities for incineration or landfill. EPA 2741 expects the remaining uncontrolled dust to be released to stack air. If the site does not use air control 2742 technology, EPA expects releases to fugitive air, wastewater, incineration, or landfill as described above.

2743

## 3.8.3.2 Environmental Release Assessment Results

2744

#### 2745 Table 3-39. Summary of Modeled Environmental Releases for Non-PVC Material Compounding

Modeled	Environmental Media	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario		Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive or Stack Air	9.99E03	3.37E04			4.39E01	1.44E02
96,695,434- 958,457,500	Fugitive Air, Wastewater, Incineration, or Landfill	8.67E02	2.97E03			3.80	1.27E01
lb production volume	Wastewater, Incineration, or Landfill	2.08E05	3.97E05	234	280	9.07E02	1.66E03
	Wastewater	1.87E04	2.70E04			8.25E01	1.07E02
	Incineration or Landfill	1.45E04	4.41E04			6.35E01	1.87E02

#### 2746 3.8.4 **Occupational Exposure Assessment**

#### 2747 3.8.4.1 Worker Activities

2748 Worker exposures to DIDP dust may occur through inhalation during the compounding process, while 2749 dermal exposures to liquids may occur during equipment cleaning. Worker exposures may also occur 2750 via dermal contact with liquids and inhalation of vapors during unloading and loading of DIDP and

- transport container cleaning (<u>U.S. EPA, 2021e</u>). EPA did not identify information on engineering
   controls or worker PPE used at plastics compounding sites.
- 2753

2758 2759

ONUs include supervisors, managers, and other employees that work in the formulation area but do not directly contact DIDP that is received or processed onsite or handle of compounded product. ONUs are potentially exposed through the inhalation route while in the working area. Also, dermal exposures from contact with surfaces where dust has been deposited were assessed for ONUs.

## 3.8.4.2 Number of Workers and Occupational Non-users

2760 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the 2761 2762 compounding of non-PVC material. This approach involved the identification of relevant SOC codes 2763 within the BLS data for select NAICS codes. Section 2.4.2 provides additional details regarding the 2764 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the 2765 NAICS codes 325212, 326200, and 424690 for this OES based on the "Generic Scenario on the Use of 2766 Additives in Plastic Compounding" and CDR reported NAICS codes for non-PVC material 2767 compounding (U.S. EPA, 2021e, 2020a). Table 3-40 summarizes the per site estimates for this OES. As 2768 addressed in Section 3.8.2, EPA did not identify site-specific data for the number of facilities in the 2769 United States that compound non-PVC material.

2770

2773

## Table 3-40. Estimated Number of Workers Potentially Exposed to DIDP during Non-PVC Material Compounding

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
325212 – Synthetic Rubber Manufacturing		25		11	
326200 – Rubber Product Manufacturing	N/A	42	N/A	7	N/A
424690 – Other Chemical and Allied Products Merchant Wholesalers		1		0.4	
Total/Average	4-9	23	90-203	6	24-54

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

## 3.8.4.3 Occupational Inhalation Exposure Results

EPA did not identify chemical-specific or OES-specific inhalation monitoring data for DIDP. EPA
estimated aggregate (*i.e.*, vapor and dust) worker inhalation exposures using DIDP monitoring data
collected at a PVC-coated cable manufacturing facility and the Generic Model for Central Tendency and
High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)
(U.S. EPA, 2021d)

2778 (<u>U.S. EPA, 2021d</u>).

2779 2780 The p-chem properties (e.g., molecular weight and vapor pressure) of diisodecyl phthlate and di(2propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking. 2781 2782 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure 2783 study conducted by SP Porras et al. (2020) in a PVC-coated cable manufacturing facility to estimate worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable 2784 2785 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic 2786 coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during 2787 non-PVC material compounding. The subject facility in the SP Porras et al. study sometimes used DIDP 2788 as a plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) 2789 phthalate as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel 2790 collected stationary samples using the OVS sampler type, which measures a combination of vapor and 2791 particulate phases. SP Porras et al. collected two samples at cooling points near extruders and provided 2792 results as a single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the 2793 study conducted sampling near a high-temperature extruder. EPA expects that the monitoring data 2794 represents vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to 2795 particulates containing the phthalate. For this reason, EPA decided to aggregate the surrogate monitoring 2796 data from SP Porras et al. (2020) with particulate inhalation exposure model estimates (discussed 2797 below). 2798

2799 DIDP is present in non-PVC materials (U.S. CPSC, 2015), so EPA expects worker inhalation exposures to DIDP via exposure to particulates of non-PVC materials. Therefore, EPA estimated worker inhalation 2800 2801 exposures during non-PVC material compounding using the Generic Model for Central Tendency and 2802 High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) 2803 (U.S. EPA, 2021d). Model approaches and parameters are described in Appendix E.16. In the model, 2804 EPA used a subset of the Generic Model for Central Tendency and High-End Inhalation Exposure to 2805 Total and Respirable Particulates Not Otherwise Regulated (PNOR) data that came from facilities with 2806 NAICS codes starting with 326 (Plastics and Rubber Manufacturing) to estimate non-PVC material 2807 particulate concentrations in the air. EPA used the highest expected concentration of DIDP in non-PVC 2808 plastic products to estimate the concentration of DIDP present in the particulates of non-PVC material. 2809 For this OES, EPA selected 20 percent by mass as the maximum expected DIDP concentration based on 2810 the Emission Scenario Document on Additives in Rubber Industry (OECD, 2004a). The estimated 2811 exposures assume that DIDP is present in particulates of the non-PVC material at this fixed concentration throughout the working shift. The Generic Model for Central Tendency and High-End 2812 Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) estimates an 2813 2814 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. 2815 Exposures during individual worker activities are not determined using this model.

2816

EPA assumed that the worker is exposed to DIDP in the form of non-PVC material particulates and
DIDP vapors. EPA aggregated estimates from the surrogate monitoring data and the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d) to address these two physical forms of DIDP for the
full 8-hour work shift. EPA added the 8-hour TWA concentration from the monitoring data and the
exposure estimates from the model to aggregate the exposures. EPA used the number of operating days
determined in the release assessment for this OES to estimate exposure frequency, with a maximum

2824 exposure frequency of 250 working days per year.

2825

Table 3-41 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker

2827 exposures to DIDP during non-PVC material compounding. The high-end exposures use 250 days per

2828 year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment

exceeded 250 days per year, which is the expected maximum for working days. The central tendency

2830 exposures use 234 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days

2831 from the release assessment. Appendix B describes the approach for estimating AD, IADD, and ADD.

2832

## Table 3-41. Summary of Estimated Worker Inhalation Exposures for Non-PVC Material Compounding

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	0.94
	Acute Dose (AD) (mg/kg/day)	9.5E-03	0.12
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	7.0E-03	8.9E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	6.1E-03	8.3E-02
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	0.94
Female of	Acute Dose (AD) (mg/kg/day)	1.0E-02	0.13
Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	7.7E-03	9.8E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	6.7E-03	9.2E-02
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	4.6E-02
ONU	Acute Dose (AD) (mg/kg/day)	5.8E-03	5.8E-03
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	4.2E-03	4.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	3.7E-03	4.0E-03

2835

## 3.8.4.4 Occupational Dermal Exposure Results

2836 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 2837 various "Exposure Concentration Types" from Table 3-42 are explained in Appendix B. Because dermal 2838 exposures of DIDP to workers may occur in the neat form during non-PVC material compounding, EPA 2839 assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see Appendix 2840 D.2.1.1 for details). Also, since there may be dust deposited on surfaces from this OES, dermal 2841 exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to workers is 2842 generally expected to be greater than dermal exposure to ONUs. In absence of data specific to ONU 2843 exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 2844 Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP 2845 were assumed representative of ONU dermal exposure. 2846

Table 3-42 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate

Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female

workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

2850

## Table 3-42. Summary of Estimated Worker Dermal Exposures for Non-PVC Material Compounding

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Equals of Donno dusting A so	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-02	5.8E-02
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONU	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-04	3.3E-04

2853

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## 3.8.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-43.

## Table 3-43. Summary of Estimated Worker Aggregate Exposures for Non-PVC Material Compounding

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	5.5E-02	0.21
Average Adult Worker	Intermediate (IADD, mg/kg-day)	4.1E-02	0.16
Average Adult Worker	Chronic, Non-cancer (ADD, mg/kg- day)	3.5E-02	0.15
	Acute (AD, mg/kg-day)	5.3E-02	0.22
Female of Reproductive	Intermediate (IADD, mg/kg-day)	3.9E-02	0.16
Age	Chronic, Non-cancer (ADD, mg/kg- day)	3.4E-02	0.15
	Acute (AD, mg/kg-day)	6.3E-03	6.3E-03
ONU	Intermediate (IADD, mg/kg-day)	4.6E-03	4.6E-03
	Chronic, Non-cancer (ADD, mg/kg- day)	4.0E-03	4.3E-03

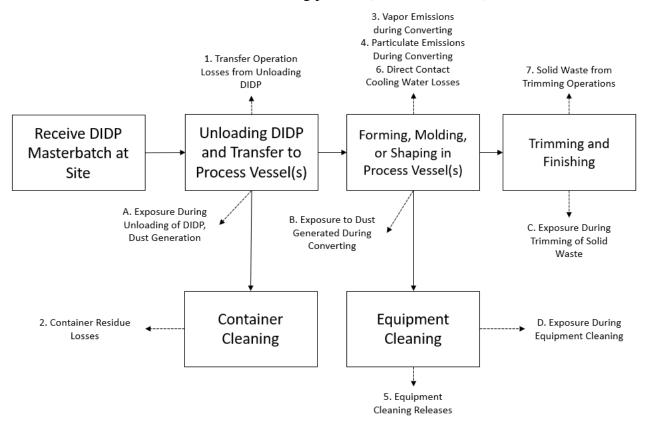
## 2859 **3.9 Non-PVC Material Converting**

#### 2860 **3.9.1 Process Description**

The 2021 *Scope of the Risk Evaluation for Diisodecyl Phthalate* (U.S. EPA, 2021b) and CDR reports in plastic material and resin manufacturing indicates DIDP use in non-PVC polymers, such as rubber, vinyl resins, cellulose ester plastics, and flexible fibers (see Appendix F for EPA identified DIDP-containing products for this OES) (U.S. EPA, 2021b, 2020a; ECJRC, 2003a); however, EPA did not identify specific DIDP-containing products from the data sources that underwent systematic review.

2866

EPA expects that typical non-PVC material converting site operates similar to PVC plastic converting sites. A typical converting site receives and unloads DIDP in solid form, as a masterbatch, from compounding sites. The converting sites then transfers the masterbatch to a shaping unit operation such as an extruder, injection molding unit, or blow molding unit to achieve the final product shape. The converting site may trim excess material from the final product after it cools. Figure 3-10 provides an illustration of the non-PVC material converting process (U.S. EPA, 2021e).



2873

## Figure 3-10. Non-PVC Material Converting Flow Diagram (U.S. EPA, 2004a)

2875 **3.9.2 Facility Estimates** 

Since converting occurs immediately downstream of compounding, EPA expects the production volume
for non-PVC material converting to be identical to the production volume for the non-PVC material
compounding OES. The production volume of DIDP for use in non-PVC material converting under both
CASRN is 1,465,812-14,529,471 kg/year (see Section 3.8.2 for details).

2880

EPA did not identify site- or chemical-specific plastic converting operating data (*i.e.*, facility production rate, number of batches, or operating days). EPA based the DIDP facility use rate on the 2021 *Revised* 

2883 Generic Scenario on Plastic Converting product throughput of plastic additives, the mass fraction of 2884 DIDP in non-PVC products, and the mass fraction of all additives in plastic resin. The estimated annual facility DIDP throughput is 68,542-190,822 kg/site-year. The GS estimated the total number of 2885 2886 operating days as 137-254 days/year, with 24 hour/day, 7 day/week (i.e., multiple shifts) operations for 2887 the given site throughput scenario. The number of batches per site year was equivalent to the number of operating days, or one batch per day (U.S. EPA, 2021e). EPA estimated the total number of sites that 2888 2889 participate in non-PVC material converting using a Monte Carlo model (see Appendix E.10 for details). 2890 The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 178-212. In contrast to 2020 CDR reports one 2891 site reported the number of industrial use sites as Not Known or Reasonably Ascertainable (NKRA) and 2892 the other site reported a total number of industrial sites to be less than 10.

#### 2893 **3.9.3 Release Assessment**

#### 3.9.3.1 Environmental Release Points

EPA assigned release points based on the 2021 Revised Generic Scenario on Plastic Converting (U.S. 2895 2896 EPA, 2021e). EPA assigned default models to quantify releases from each release point and suspected 2897 fugitive air release point. EPA expects fugitive or stack air releases and particulate emissions to fugitive 2898 air, wastewater, incineration, or landfill from converting operations. EPA expects releases to 2899 wastewater, incineration, or landfill from container residues, and equipment cleaning. EPA expects 2900 releases to wastewater from direct contact cooling and incineration or landfill releases from solid waste 2901 trimming. Sites may utilize air capture technology. If a site uses air capture technology, EPA expects 2902 dust releases from plastic unloading to be controlled and released to disposal facilities for incineration or 2903 landfill. EPA expects the remaining uncontrolled dust to be released to stack air. If the site does not use 2904 air control technology, EPA expects releases to fugitive air, wastewater, incineration, or landfill as 2905 described above.

Modeled		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Environmental Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
	Fugitive or Stack Air	2.37E02	8.05E02			1.11	3.86
96,695,434- 958,457,500 lb production volume	Fugitive Air, Wastewater, Incineration, or Landfill	2.30E01	7.35E01	219 251		1.08E-01	3.53E-01
	Wastewater, Incineration, or Landfill	1.50E03	2.58E03		7.79	1.41E01	
	Wastewater	4.38E02	6.66E02			2.05	3.31
	Incineration or Landfill	1.47E03	2.47E03			6.89	1.23E01

#### 2906 **3.9.3.2 Environmental Release Assessment Results**

2907

2894

#### 2908 **3.9.4 Occupational Exposure Assessment**

#### 2909 **3.9.4.1 Worker Activities**

Worker exposures to DIDP dust may occur via inhalation during the converting process. Dermal
 exposures may occur during equipment cleaning. Additionally, worker exposures may occur via dermal

2912 contact with liquids and inhalation of vapors during DIDP unloading and loading, transport container

- cleaning, and trimming of excess plastic (U.S. EPA, 2021f). EPA did not identify information on engineering controls or worker PPE used at plastics converting sites.
- 2915
- 2916 ONUs include supervisors, managers, and other employees that may work in the formulation area but do
- 2917 not directly contact DIDP that is received or processed onsite or handle the finished converted product.
- 2918 ONUs are potentially exposed through the inhalation route while in the working area. Also, dermal
- 2919 exposures from contact with surfaces where dust has been deposited were assessed for ONUs.

## 2920 **3.9.4.2** Number of Workers and Occupational Non-users

2921 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 2922 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the converting of non-PVC material. This approach involved the identification of relevant SOC codes within 2923 2924 the BLS data for select NAICS codes. Section 2.4.2 provides additional details regarding the 2925 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the 2926 NAICS codes 325212, 326200, and 424690 for this OES based on the "Generic Scenario on the Use of 2927 Additives in the Thermoplastic Converting Industry" and CDR reported NAICS codes for non-PVC 2928 material converting (U.S. EPA, 2020a, 2014d). Table 3-45 summarizes the per site estimates for this 2929 OES. As addressed in Section 3.9.2, EPA did not identify site-specific data for the number of facilities 2930 in the United States that convert non-PVC material. 2931

## 2932 Table 3-45. Estimated Number of Workers Potentially Exposed to DIDP during Non-PVC 2933 Material Converting

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>a</sup>	Total Number of Exposed ONUs <sup>a</sup>
325212 – Synthetic Rubber Manufacturing		25		11	
326200 – Rubber Product Manufacturing	N/A	42	N/A	7	N/A
424690 – Other Chemical and Allied Products Merchant Wholesalers		1		0.4	
Total/Average	178-212	23	4,016-4,783	6	1,068-1,272

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

2934

### 3.9.4.3 Occupational Inhalation Exposure Results

EPA identified one study with surrogate monitoring data for plastics converting processes from a cable coating facility; however, the study had several limitations as discussed below. Additionally, the cables in the study were coated with PVC, so the data was not OES-specific for non-PVC converting.

2938 Therefore, EPA estimated aggregate (*i.e.*, vapor and dust) worker inhalation exposures using both the

surrogate monitoring data and the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d).

2942 The p-chem properties (e.g., molecular weight and vapor pressure) of diisodecyl phthlate and di(2-2943 propylheptyl) phthalate are quite similar, and vapor inhalation monitoring data for DIDP were lacking. 2944 Therefore, EPA used surrogate monitoring data for di(2-propylheptyl) phthalate provided in an exposure 2945 study conducted by SP Porras et al. (2020) in a PVC-coated cable manufacturing facility to estimate 2946 worker vapor inhalation exposures to DIDP for this OES. Inhalation exposures during PVC-coated cable 2947 manufacturing occur when di(2-propylheptyl) phthalate additives are incorporated into the plastic 2948 coating, and EPA expects that these exposures are comparable to inhalation exposures to DIDP during 2949 non-PVC material converting. The subject facility in the SP Porras et al. study sometimes used DIDP as 2950 a plasticizer for manufacturing PVC-coated cables, but the facility was using di(2-propylheptyl) 2951 phthalate as the plasticizer on the day that sampling occurred (Porras et al., 2020). The study personnel 2952 collected stationary samples using the OVS sampler type, which measures a combination of vapor and 2953 particulate phases. SP Porras et al. collected two samples at cooling points near extruders and provided 2954 results as a single 8-hour TWA value for di(2-propylheptyl) phthalate, which was 0.03 mg/m<sup>3</sup>. Since the 2955 study conducted sampling near a high-temperature extruder, EPA expects that the monitoring data 2956 represents vapor concentrations of di(2-propylheptyl) phthalate from heated material as opposed to 2957 particulates containing the phthalate. For this reason, EPA decided to aggregate the surrogate monitoring 2958 data from SP Porras et al. (2020) with particulate inhalation exposure model estimates (discussed 2959 below).

DIDP is present in non-PVC materials (U.S. CPSC, 2015), so EPA expects worker inhalation exposures 2961 2962 to DIDP via exposure to particulates of non-PVC materials. Therefore, EPA estimated worker inhalation 2963 exposures during non-PVC plastic converting using the Generic Model for Central Tendency and High-2964 End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. 2965 EPA, 2021d). Model approaches and parameters are described in Appendix E.16. In the model, EPA 2966 used a subset of the Generic Model for Central Tendency and High-End Inhalation Exposure to Total 2967 and Respirable Particulates Not Otherwise Regulated (PNOR) data that came from facilities with 2968 NAICS codes starting with 326 (Plastics and Rubber Manufacturing) to estimate non-PVC particulate 2969 concentrations in the air. EPA used the highest expected concentration of DIDP in non-PVC plastic 2970 products to estimate the concentration of DIDP present in particulates. For this OES, EPA selected 20 2971 percent by mass as the maximum expected DIDP concentration based on the *Emission Scenario* 2972 Document on Additives in the Rubber Industry (OECD, 2004a). The estimated exposures assume that 2973 DIDP is present in particulates of the non-PVC plastic at this fixed concentration throughout the 2974 working shift. The Generic Model for Central Tendency and High-End Inhalation Exposure to Total 2975 and Respirable Particulates Not Otherwise Regulated (PNOR) uses an 8-hour TWA for particulate 2976 concentrations, by assuming exposures outside the sample duration are zero. Exposures during 2977 individual worker activities are not determined using this model.

2978

2960

EPA assumed that the worker is exposed to DIDP in the form of non-PVC plastic particulates and DIDP
vapors. EPA aggregated estimates from the surrogate monitoring data and the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d) to address these two physical forms of DIDP for the
full 8-hour work shift. EPA added the 8-hour TWA from the monitoring data and exposure estimates
from the model to aggregate the exposures. EPA used the number of operating days determined in the
release assessment for this OES to estimate exposure frequency, with a maximum exposure frequency of

2986 250 working days per year.

2987

Table 3-46 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during non-PVC material converting. The high-end exposures use 250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days. The central tendency exposures use 219 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release assessment. Appendix B describes the approach for estimating AD, IADD, and ADD.

2994

## Table 3-46. Summary of Estimated Worker Inhalation Exposures for Non-PVC Material Converting

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	0.94
	Acute Dose (AD) (mg/kg/day)	9.5E-03	0.12
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	7.0E-03	8.9E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	5.7E-03	8.3E-02
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-02	3.0E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	0.94
Female of	Acute Dose (AD) (mg/kg/day)	1.0E-02	0.13
Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	7.7E-03	9.8E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	6.3E-03	9.2E-02
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.0E-04	6.0E-04
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	4.6E-02	4.6E-02
ONU	Acute Dose (AD) (mg/kg/day)	5.8E-03	5.8E-03
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	4.2E-03	4.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	3.5E-03	4.0E-03

2997

## 3.9.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 2998 various "Exposure Concentration Types" from Table 3-47 are explained in Appendix B. Because dermal 2999 3000 exposures of DIDP to workers is expected to occur through contact with solids or articles for this OES, EPA assessed the absorptive flux of DIDP according to dermal absorption modeling approach for solids 3001 outlined in Appendix D.2.1.2. Also, since there may be dust deposited on surfaces from this OES, 3002 3003 dermal exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to 3004 3005 ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 3006 Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP 3007 were assumed representative of ONU dermal exposure. 3008

3009 Table 3-47 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate

3010 Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female

3011 workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

3012

#### 3013 Table 3-47. Summary of Estimated Worker Dermal Exposures for Non-PVC Material Converting

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Female of Reproductive Age	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
remaie of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-04	6.1E-04
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONU	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	3.3E-04

3014

## 3.9.4.5 Occupational Aggregate Exposure Results

3015 Inhalation and dermal exposure estimates were aggregated based on the approach described in Appendix3016 B.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-48.

3017

## 3018 **Table 3-48. Summary of Estimated Worker Aggregate Exposures for Non-PVC Material**

3019 Converting

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	1.0E-02	0.12
	Intermediate (IADD, mg/kg-day)	7.3E-03	9.0E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	6.0E-03	8.4E-02
Female of Reproductive	Acute (AD, mg/kg-day)	1.1E-02	0.13
Age	Intermediate (IADD, mg/kg-day)	8.0E-03	9.9E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	6.6E-03	9.2E-02
ONU	Acute (AD, mg/kg-day)	6.3E-03	6.3E-03
	Intermediate (IADD, mg/kg-day)	4.6E-03	4.6E-03
	Chronic, Non-cancer (ADD, mg/kg- day)	3.8E-03	4.3E-03

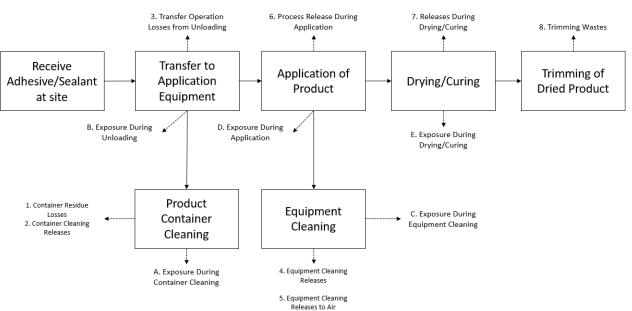
## 3020 **3.10 Application of Adhesives and Sealants**

## 3021 3.10.1 Process Description

3022 DIDP is a plasticizer in adhesive and sealant products for industrial and commercial use, including
 3023 polymer sealants and industrial adhesives and may arrive at end use sites in containers ranging in size

3024 from 1-5 gallons at concentrations of 0.1-75% DIDP (see Appendix F for EPA identified DIDPcontaining products for this OES). The application site transfers the Adhesive/ Sealant from the shipping 3025 3026 container to the application equipment, such as a caulk gun or syringe, and applies the sealant to the 3027 substrate (OECD, 2015a). Application methods include bead, roll, and syringe application. Application may occur over the course of an 8-hour workday for 1 or 2 days at a given site, accounting for drying or 3028 curing times and additional coats where necessary. The site may trim excess Adhesive/ Sealant from the 3029 3030 applied substrate area. Figure 3-11 provides an illustration of the process of applying adhesives and 3031 sealants (OECD, 2015a).





## 3033

## **Figure 3-11. Application of Adhesives and Sealants Flow Diagram**

3035

3036 In industrial settings, workers may apply adhesives and sealants by automated or mechanical spraying in 3037 facilities where exposure controls can be expected to be in place; however, products containing DIDP 3038 that are categorized as spray adhesives have not currently been identified by EPA. Workers may apply 3039 adhesives and sealants in commercial settings such as in construction. Most commonly, the products 3040 containing DIDP are applied using a syringe, caulk gun or spread on the surface using a trowel. 3041 According to the Manufacturer Request for Risk Evaluation: Diisodecyl Phthalate (DIDP), less than 5 percent of DIDP is used in non-PVC applications such as those associated with adhesives and sealants 3042 3043 (U.S. EPA, 2019b). Final Scope of the Risk Evaluation for Diisodecyl Phthalate (DIDP) states that 3044 DIDP is used as a plasticizer in the manufacture of industrial adhesives and sealant end products; 3045 however, DIDP is primarily used in commercial and consumer end products (concentrations ranging 3046 from 1 to 60 percent) such as automotive interiors, undercoats, electrical products, and plastic products 3047 (U.S. EPA, 2021b).

3048

### 3.10.2 Facility Estimates

Since the application of adhesives and sealants occurs immediately downstream of incorporation into adhesive and sealants, EPA expects the same production volume for the two OES. The production volume for adhesives and sealants use under both CASRN was 374,305 to 1,679,970 kg/year (see Section 3.3.2 for details).

3053

EPA did not identify site- or chemical-specific adhesive and sealant application operating data (*i.e.*, facility use rates, operating days). However, the 2015 *ESD on the Use of Adhesives* estimated an

adhesive use rate of 2,300-141,498 kg/site-year. Based on DIDP concentration in the product of 0.175%, EPA estimated a DIDP use rate 2.3-106,124 kg/site-year. Additionally, the ESD estimated the
number of operating days as 50-365 days/year of 8 hour/day operations for the given throughput
scenario (OECD, 2015a). EPA did not identify estimates on the number of sites that may apply adhesive
and sealant products containing DIDP. Therefore, EPA estimated the total number of application sites
that use DIDP-containing adhesives and sealants using a Monte Carlo model (see Appendix E.11 for
details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites was 84-1,056.

3063 **3.10.3 Release Assessment** 

### 3064 3.10.3.1 Environmental Release Points

EPA assigned release points based on the 2015 *ESD on the Use of Adhesives* (OECD, 2015a). EPA assigned default models to quantify releases from each release point and suspected fugitive air release point. EPA expects fugitive air releases from unloading of adhesives, container cleaning, equipment cleaning, and drying or curing processes. EPA expects releases to wastewater, incineration, or landfill from small container residue, equipment cleaning waste, adhesive application process waste, and trimming waste.

3071 3.10.3.2 Environmental Release Assessment Results

#### 3072 3073 **Tal**

## Table 3-49. Summary of Modeled Environmental Releases for Application of Adhesives and Sealants

Modeled Environmental Ma		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Environmental Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
825,201-	Fugitive or Stack Air	2.06E-06	7.71E-06			9.80E-09	3.24E-08
3,703,700 lb production volume	Wastewater, Incineration, or Landfill	5.66E02	2.80E03	232	325	2.61	1.45E01

#### 3075

### 3.10.4 Occupational Exposure Assessment

### **3076 3.10.4.1 Worker Activities**

3077 During the use of adhesives and sealants containing DIDP, workers exposures to DIDP mist may occur
3078 while spraying or roll coating adhesives and sealants. Worker exposures may also occur via inhalation of
3079 vapors or dermal contact with liquids during product unloading, product container cleaning, application
3080 equipment cleaning, adhesive application, and curing or drying (OECD, 2015a). EPA did not identify
3081 information on engineering controls or worker PPE used at DIDP-containing adhesive and sealant sites.

3082

3083 ONUs include supervisors, managers, and other employees that work in the application area but do not 3084 directly contact adhesives or sealants or handle or apply products. ONUs are potentially exposed via

- 3085 inhalation while present in the application area. Also, dermal exposures from contact with surfaces
- 3086 where mist has been deposited were assessed for ONUs.

## 3087 **3.10.4.2 Number of Workers and Occupational Non-users**

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the

- 3090 application of adhesives and sealants. This approach involved the identification of relevant SOC codes 3091 within the BLS data for select NAICS codes. Section 2.4.2 provides additional details regarding the 3002 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the
- methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the NAICS codes 322220, 334100, 334200, 334300, 334400, 334500, 334600, 335100, 335200, 335300,
- 3094 335900, 336100, 336200, 336300, 336400, 336500, 336600, 336900, and 327910 for this OES based on
- 3095 the *Emission Scenario Document on the Use of Adhesives* and CDR reported NAICS codes for
- application of adhesives and sealants (U.S. EPA, 2020a; OECD, 2015b). Table 3-50 summarizes the per
- 3097 site estimates for this OES. As discussed in Section 3.10.4.2, EPA did not identify site-specific data for 3098 the number of facilities in the United States that apply adhesives and sealants.
- 3099

## Table 3-50. Estimated Number of Workers Potentially Exposed to DIDP during Application of Adhesives and Sealants

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non-users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
322220 – Paper Bag and Coated and Treated Paper Manufacturing		35		5	
334100 – Computer and Peripheral Equipment Manufacturing		19		27	
334200 – Communications Equipment Manufacturing		13		14	
334300 – Audio and Video Equipment Manufacturing		10		7	
334400 – Semiconductor and Other Electronic Component Manufacturing	N/A	30	N/A	27	N/A
334500 – Navigational, Measuring, Electromedical, and Control Instruments		17		18	
334600 – Manufacturing and Reproducing Magnetic and Optical Media		5		5	
335100 – Electric Lighting Equipment Manufacturing		17		5	
335200 – Household Appliance Manufacturing		102		20	

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non-users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
335300 – Electrical Equipment Manufacturing		28		12	
335900 – Other Electrical Equipment and Component Manufacturing		23		8	
336100 – Motor Vehicle Manufacturing		447		59	
336200 – Motor Vehicle Body and Trailer Manufacturing		40		5	
336300 – Motor Vehicle Parts Manufacturing		51		15	
336400 – Aerospace Product and Parts Manufacturing		75		64	
336500 – Railroad Rolling Stock Manufacturing		35		15	
336600 – Ship and Boat Building		36		11	
336900 – Other Transportation Equipment Manufacturing		16		4	
327910 – Abrasive Product Manufacturing		24		5	
Total/Average	84- 1,056	54	4,523-56,857	17	1,433- 18,012

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

3102

#### 3.10.4.3 Occupational Inhalation Exposure Results

3103 EPA did not identify inhalation monitoring data for the use of adhesives and sealants use during

- 3104 systematic review of literature sources. However, EPA estimated inhalation exposures for this OES
- 3105 using the Automotive Refinishing Spray Coating Mist Inhalation Model from the ESD on Coating
- 3106 Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a).
- 3107

3108 Although adhesives and sealants can be applied in a variety of ways, EPA assesses exposures using

3109 spray application to encompass high-end exposures during this OES. The Automotive Refinishing Spray

3110 Coating Mist Inhalation Model estimates worker inhalation exposure based on the concentration of the

3111 chemical of interest in the nonvolatile portion of the sprayed product and the concentration of over 3112 sprayed mist/particles (OECD, 2011a). The model is based on PBZ monitoring data for mists during

3112 sprayed mist/particles (<u>OECD</u>, 2011a). The model is based on PBZ momorning data for mists during 3113 automotive refinishing. EPA used the 50<sup>th</sup> and 95<sup>th</sup> percentile mist concentration along with the

- 3113 automotive reminishing. EFA used the 50° and 95° percentile mist concentration along with the 3114 concentration of DIDP in the adhesives and sealants to estimate the central tendency and high-end
- 3115 inhalation exposures, respectively.
- 3116

Table 3-51 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during the use of adhesives and sealants. The high-end exposures use 250 days per

3119 year as the exposure frequency since the 95<sup>th</sup> percentiles of operating days in the release assessment 3120 exceeded 250 days per year, which is the expected maximum number of working days. The central 3121 tendency exposures use 232 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of 3122 operating days from the release assessment. Appendix B describes the approach for estimating AD,

3123 IADD, and ADD.

# 3124 3125 Table 3-51. Summary of Estimated Worker Inhalation Exposures for Application of Adhesives 3126 and Sealants

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	22
Average Adult Worker	Acute Dose (AD) (mg/kg/day)	1.7E-02	2.8
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	2.0
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.1E-02	1.9
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	22
	Acute Dose (AD) (mg/kg/day)	1.9E-02	3.1
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.4E-02	2.2
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.2E-02	2.1
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	0.14
	Acute Dose (AD) (mg/kg/day)	1.7E-02	1.7E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	1.2E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.1E-02	1.2E-02

## 3127 **3.10.4.4 Occupational Dermal Exposure Results**

EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The various "Exposure Concentration Types" from Table 3-52 are explained in Appendix B. Because dermal exposures of DIDP to workers may occur in a concentrated liquid form during the application of adhesives or sealants, EPA assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see Appendix D.2.1.1 for details). Also, since there may be mist deposited on surfaces from this OES, dermal exposures to ONUs from contact with mist on surfaces were assessed. Dermal

3134 exposure to workers is generally expected to be greater than dermal exposure to ONUs. In absence of

- 3135 data specific to ONU exposure, EPA assumes that worker central tendency exposure is representative of
- 3136 ONU exposure. Therefore, worker central tendency exposure values for dermal contact with liquids
- 3137 containing DIDP were assumed representative of ONU dermal exposure.
- 3138
- 3139 Table 3-52 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate
- Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female
- 3141 workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.
- 3142

## Table 3-52. Summary of Estimated Worker Dermal Exposures for Application of Adhesives and Sealants

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult Worker	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Formale of Donno dustive A as	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-02	5.8E-02
	Dose Rate (APDR, mg/day)	3.7	3.7
ONU	Acute (AD, mg/kg-day)	4.6E-02	4.6E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	3.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	3.1E-02

## 3.10.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-53.

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3145

## Table 3-53. Summary of Estimated Worker Aggregate Exposures for Application of Adhesives and Sealants

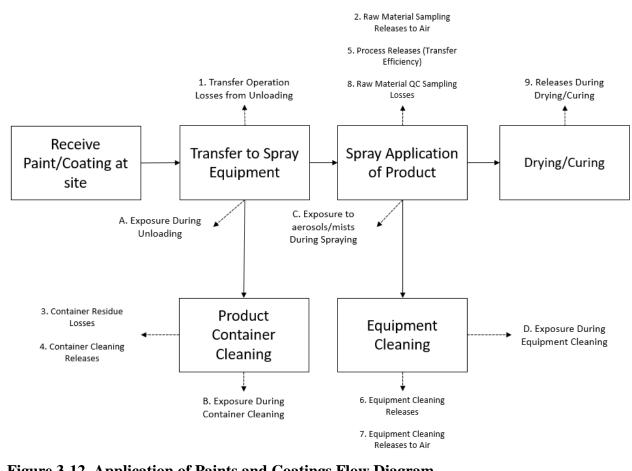
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	6.3E-02	2.9
Average Adult Worker	Intermediate (IADD, mg/kg-day)	4.6E-02	2.1
	Chronic, Non-cancer (ADD, mg/kg-day)	4.0E-02	2.0
Female of Reproductive	Acute (AD, mg/kg-day)	6.1E-02	3.1
-	Intermediate (IADD, mg/kg-day)	4.5E-02	2.3
Age	Chronic, Non-cancer (ADD, mg/kg-day)	3.9E-02	2.1
	Acute (AD, mg/kg-day)	6.3E-02	6.3E-02
ONU	Intermediate (IADD, mg/kg-day)	4.6E-02	4.6E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	4.0E-02	4.3E-02

## 3151 **3.11 Application of Paints and Coatings**

#### 3.11.1 Process Description

3152

3153 DIDP is a plasticizer in paint and coating products for industrial and commercial use, including paints 3154 and colorant products. Paint and coating products containing DIDP may arrive at end use sites in containers ranging from 5-20 gallons in size with DIDP concentrations of 0.01-5% (see Appendix F for 3155 3156 identified product information). Application sites transfer the paint/coating product from the shipping 3157 container to the application equipment and apply the coating to the substrate (U.S. EPA, 2014b; OECD, 2009c; U.S. EPA, 2004d). Application methods for DIDP-containing paints and coatings include spray, 3158 brush, and trowel coating. EPA did not identify information on the prevalence of these various 3159 3160 application methods. Manual spray equipment includes air (e.g., low volume/high pressure), air-assisted, 3161 and airless spray systems (U.S. EPA, 2014b; OECD, 2009c; U.S. EPA, 2004d). End use sites may utilize spray booth capture technologies when performing spray applications (OECD, 2011a). DIDP will 3162 remain in the dried/cured coating as an additive following application to the substrate. Applications may 3163 3164 occur over the course of an 8-hour workday for 1 or 2 days at a given site, accounting for multiple coats and typical drying or curing times. Figure 3-12 provides an illustration of the spray application of paints 3165 3166 and coatings (U.S. EPA, 2014b; OECD, 2011b, 2009c; U.S. EPA, 2004d). 3167



3169 Figure 3-12. Application of Paints and Coatings Flow Diagram

3170

3168

#### 3171 **3.11.2 Facility Estimates**

3172 Since application of paints and coatings occurs immediately downstream of incorporation into paints 3173 and coatings, EPA expects these OES to have the same production volume. The production volume for 3174 paint and coating use under both CASRN was 169,485-1,679,970 kg/year (see Section 3.4 for details).

3175

EPA did not identify site- or chemical-specific paint and coating use operating data (e.g., facility use 3176

- 3177 rates, operating days). EPA based the facility use rate on the 2011 ESD on Radiation Curable Coatings,
- 3178 Inks and Adhesives, the 2011 ESD on Coating Application via Spray-Painting in the Automotive 3179 Finishing Industry, the 2004 GS on Spray Coatings in the Furniture Industry, and the European Council
- 3180 of the Paint, Printing Ink, and Artist's Colours Industry (CEPE) SpERC Factsheet for Industrial 3181 Application of Coatings and Inks by Spraving. The ESDs, GSs, and SpERC estimated coating use rates
- 3182 of 2,694-446,600 kg/site-year. Based on a DIDP concentration in the paints and coatings of 0.01-5%,
- EPA estimated a DIDP use rate of 0.26-22,330 kg/site-year. Additionally, the ESDs, GSs, and SpERC 3183 3184 estimated the number of operating days as 225-300 days/year with 8 hour/day operations (CEPE, 2020;
- 3185 OECD, 2011a, b; U.S. EPA, 2004c). EPA did not identify estimates of the number of sites that may
- 3186 apply paint and coating products containing DIDP. Therefore, EPA estimated the total number of
- application sites that use DIDP-containing paints and coatings using a Monte Carlo model (see 3187
- Appendix E.10 for details). The 50<sup>th</sup> to 95<sup>th</sup> percentile range of the number of sites was 222 to 1,242. 3188

#### 3189 3.11.3 Release Assessment

3190

## **3.11.3.1 Environmental Release Points**

3191 EPA assigned release points based on the 2011 ESD on Radiation Curable Coatings, Inks and Adhesives 3192 (OECD, 2011b). EPA assigned default models to quantify releases from each release point and 3193 suspected fugitive air release point. EPA expects fugitive air releases from unloading, sampling, 3194 container cleaning, and equipment cleaning. EPA expects wastewater, incineration, or landfill releases 3195 from container residue losses, equipment cleaning, and sampling. Sites may utilize overspray control 3196 technology to prevent additional air releases during spray application. If a site uses overspray control 3197 technology, EPA expects stack air releases of approximately 10% of process related operational losses. 3198 EPA expects the site to release the remaining 90% of operational losses to wastewater, landfill, or 3199 incineration. If the site does not use control technology, EPA expects the site to release all process related operational losses to fugitive air, wastewater, incineration, or landfill in unknown percentages. 3200

3201 3202

## 3.11.3.2 Environmental Release Assessment Results

#### 3203 Table 3-54. Summary of Modeled Environmental Releases for Application of Paints and Coatings

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site- day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
373,650-	Fugitive Air	6.75E-07	1.79E-06	257	287	2.62E-09	6.90E-09
3,703,700 lb	Stack Air	1.64E02	5.22E02			6.34E-01	2.04
production volume Control Technology	Wastewater, Incineration, or Landfill	1.62E03	5.06E03			6.29	1.98E01
	Fugitive Air	6.75E-07	1.79E-06	257	287	2.62E-09	6.87E-09

Modeled Environmental		Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site- day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
373,650- 3,703,700 lb production	Wastewater, Incineration, or Landfill	1.44E02	3.99E02			5.58E-01	1.55
volume No Control Technology	Unknown	1.63E03	5.23E03			6.32	2.04E01

### 3204

## **3.11.4 Occupational Exposure Assessment**

3205 **3.11.4.1 Worker Activities** 

3206 During the use of DIDP-containing paints and coatings, workers are potentially exposed to DIDP mist 3207 when roll or curtain coating and to overspray inhalation during spray coating. Vapor inhalation exposures to DIDP for workers and ONUs may also occur from DIDP that volatilizes during product 3208 unloading, raw material sampling, application, and container and equipment cleaning. Workers may be 3209 3210 exposed via dermal contact to liquids containing DIDP during product unloading into application 3211 equipment, brush and trowel applications, raw material sampling, and container and equipment cleaning 3212 (OECD, 2011b). EPA did not find information on the extent to which engineering controls and worker 3213 PPE are used at facilities that use DIDP-containing paints and coatings.

3214

3215 For this OES, ONUs would include supervisors, managers, and other employees that do not directly

handle paint or coating equipment but may be present in the spray application area. ONUs are

3217 potentially exposed through the inhalation route while in the application area. Also, dermal exposures

3218 from contact with surfaces where mist has been deposited were assessed for ONUs.

### 3219 3.11.4.2 Number of Workers and Occupational Non-users

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the application of paints and coatings. This approach involved the identification of relevant SOC codes within the BLS data for select NAICS codes. Section 2.4.2 provides further details regarding the methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the NAICS codes 332431, 334416, 335931, 337124, 337214, 337127, 337215, 337122, 337211, 337212,

337110, and 811120 for this OES based on the *Emission Scenario Documents for the Coating Industry*and Automotive Refinishing as well as the Generic Scenario on Spray Coatings in the Furniture Industry
(OECD, 2011a, 2009c; U.S. EPA, 2004d). Table 3-55 summarizes the per site estimates for this OES.
As described in Section 3.11.2, EPA did not identify site-specific data for the number of facilities in the
United States that apply DIDP-containing paints and coatings.

## Table 3-55. Estimated Number of Workers Potentially Exposed to DIDP during Application of Paints and Coatings

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>	
332431 – Metal Can Manufacturing		31		11		
335931 – Current-Carrying Wiring Device Manufacturing		25		9		
337124 – Metal Household Furniture Manufacturing		8		6		
337214 – Office Furniture (except wood) Manufacturing		22		9	N/A	
337127 – Institutional Furniture Manufacturing	N/A	9	N/A	7		
337215 – Showcase, Partition, Shelving, and Locker Manufacturing		8		4		
337122 – Nonupholstered Wood Household Furniture Manufacturing		3		2		
337211 – Wood Office Furniture Manufacturing		9		4		
337212 – Custom Architectural Woodwork and Millwork Manufacturing		5		2		
337110 – Wood Kitchen Cabinet and Countertop Manufacturing		3		2		
811120 – Automotive Body, Paint, Interior, and Glass Repair		6		1		
Total/Average	222-1,242	12	2,615-14,631	5	1,140-6,375	

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

## 3234 **3.11.4.3 Occupational Inhalation Exposure Results**

EPA did not identify inhalation monitoring data for the use of paints and coatings use during systematic
review of literature sources. However, EPA estimated inhalation exposures for this OES using the
Automotive Refinishing Spray Coating Mist Inhalation Model from the ESD on Coating Application via
Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a).

3239

3240 Although paints and coatings can be applied in a variety of ways, EPA assesses exposures using spray 3241 application to encompass high-end exposures during this OES. The Automotive Refinishing Spray 3242 Coating Mist Inhalation Model estimates worker inhalation exposure based on the concentration of the 3243 chemical of interest in the nonvolatile portion of the sprayed product and the concentration of over 3244 sprayed mist/particles (OECD, 2011a). The model is based on PBZ monitoring data for mists during automotive refinishing. EPA used the 50<sup>th</sup> and 95<sup>th</sup> percentile mist concentration along with the 3245 concentration of DIDP in the paint to estimate the central tendency and high-end inhalation exposures, 3246 3247 respectively.

3248

Table 3-56 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during the use of paints and coatings. The central tendency and high-end exposures use 250 days per year as the exposure frequency since the 50<sup>th</sup> and 95<sup>th</sup> percentiles of operating days in the release assessment exceeded 250 days per year, which is the expected maximum number of working days. Appendix B describes the approach for estimating AD, IADD, and ADD.

3254

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	22
	Acute Dose (AD) (mg/kg/day)	1.7E-02	0.28
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	0.20
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.2E-02	0.19
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	22
	Acute Dose (AD) (mg/kg/day)	1.9E-02	0.31
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.4E-02	0.22
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.3E-02	0.21
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	0.14	0.14
	Acute Dose (AD) (mg/kg/day)	1.7E-02	1.7E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.2E-02	1.2E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	1.2E-02	1.2E-02

# Table 3-56. Summary of Estimated Worker Inhalation Exposures for Application of Paints and <u>Coatings</u>

## 3257 **3.11.4.4 Occupational Dermal Exposure Results**

3258 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 3259 various "Exposure Concentration Types" from Table 3-57 are explained in Appendix B. Because dermal exposures of DIDP to workers may occur in a concentrated liquid form during the application of paints 3260 3261 or coatings, EPA assessed the absorptive flux of DIDP according to dermal absorption data of neat 3262 DIDP (see Appendix D.2.1.1 for details). Also, since there may be mist deposited on surfaces from this 3263 OES, dermal exposures to ONUs from contact with mist on surfaces were assessed. Dermal exposure to 3264 workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 3265 3266 Therefore, worker central tendency exposure values for dermal contact with liquids containing DIDP 3267 were assumed representative of ONU dermal exposure.

3268

Table 3-57 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate
Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female
workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

3272

3273 Table 3-57. Summary of Estimated Worker Dermal Exposures for Application of Paints and
 3274 Coatings

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult Worker	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Equals of Donno dusting A so	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	5.8E-02
	Dose Rate (APDR, mg/day)	3.7	3.7
ONU	Acute (AD, mg/kg-day)	4.6E-02	4.6E-02
UNU	Intermediate (IADD, mg/kg-day)	3.4E-02	3.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	3.1E-02

## 3275

## 3.11.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-58.

3278

# Table 3-58. Summary of Estimated Worker Aggregate Exposures for Application of Paints and Coatings

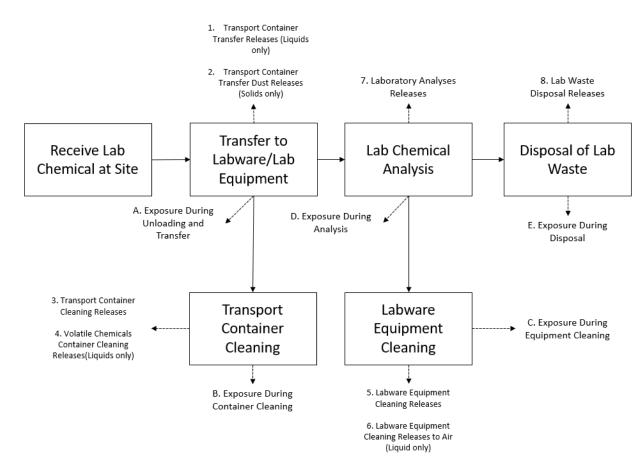
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	6.3E-02	0.37
	Intermediate (IADD, mg/kg-day)	4.6E-02	0.27
	Chronic, Non-cancer (ADD, mg/kg-	4.3E-02	0.25
	day)		
	Acute (AD, mg/kg-day)	6.1E-02	0.39

Female of Reproductive	Intermediate (IADD, mg/kg-day)	4.5E-02	0.29
Age	Chronic, Non-cancer (ADD, mg/kg- day)	4.2E-02	0.27
ONU	Acute (AD, mg/kg-day)	6.3E-02	6.3E-02
	Intermediate (IADD, mg/kg-day)	4.6E-02	4.6E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	4.3E-02	4.3E-02

## 3281 **3.12 Use of Laboratory Chemicals**

## 3282 3.12.1 Process Description

DIDP is a laboratory chemical used at commercial laboratory sites. Laboratory chemicals containing DIDP arrive at end use sites in containers ranging in size from 0.5-1 gallons or 0.5-1 kg, depending on the chemical form (see Appendix F for EPA identified DIDP-containing products for this OES). The end use site transfers the chemical to labware and lab equipment for analyses. After analysis, laboratory sites clean containers, labware, and lab equipment and dispose of laboratory waste and unreacted DIDPcontaining laboratory chemicals. Figure 3-13 provides an illustration of the use of laboratory chemicals (U.S. EPA, 2023c).



## 3291

3290

## 3292 Figure 3-13. Use of Laboratory Chemicals Flow Diagram

3293 **3.12.2 Facility Estimates** 

No sites reported the use of DIDP-containing laboratory chemicals in the 2020 CDR. Instead, EPA assumed that a portion the DIDP production volume from each CDR reporting site may be used in

3296 laboratory chemicals. Specifically, EPA estimated the total production volume of DIDP in laboratory

chemicals using the CDR reporting threshold limits of either 25,000 pounds (11,340 kg) or 5% of a
 site's reported production volume, whichever value was smaller. EPA considered every site that

reported using DIDP to CDR, regardless of assigned OES. EPA assumed that sites that claimed their

3300 production volume as CBI used 25,000 pounds of DIDP-containing laboratory chemicals annually.

Table 3-59 lists the sites and associated production volumes that EPA considered in calculating the total

production volume for this OES (U.S. EPA, 2020a). The total production volume for this OES was

3303 94,832 kg/year.

3304

# Table 3-59. CDR Reported Site Information for Use in Calculation of Laboratory Chemicals Production Volume

CASRN	Site Name	Site Location	Reported Production Volume (kg/year)	Threshold Limit Used	Production Volume Added to Total <sup>3</sup> (kg/year)
26761-40-0	3M	St. Paul, MN	CBI	11,340 kg	11,340
26761-40-0	LG Hausys, Inc.	Adairsville, GA	11,895	5%	595
26761-40-0	Harwick Standard Distribution Corp.	Akron, OH	19,447	5%	972
26761-40-0	LG Chem, Inc.	Atlanta, GA	CBI	11,340 kg	11,340
26761-40-0	Tremco Inc.	Beachwood, OH	362,965	11,340 kg	11,340
26761-40-0	Akrochem Corp.	Stow, OH	6,616	5%	331
26761-40-0	Chemspec, Ltd.	Uniontown, OH	23,801	5%	1,190
68515-49-1	3M	St. Paul, MN	CBI	11,340 kg	11,340
68515-49-1	ExxonMobil BR Chemical Plant	Baton Rouge, LA	CBI	11,340 kg	11,340
68515-49-1	Lanxess Solutions, Inc.	Fords, NJ	CBI	11,340 kg	11,340
68515-49-1	The Sherwin- Williams Co.	Cleveland, OH	CBI	11,340 kg	11,340
68515-49-1	Sika Corp.	Lyndhurst, NJ	CBI	11,340 kg	11,340
68515-49-1	Troy Chemical Corp.	Phoenix, AZ	20,507	5%	1,025

3307

3308 EPA did not identify site- or chemical-specific operating data for laboratory use of DIDP (*i.e.*, facility throughput, operating days, number of sites). For solid products, the 2023 GS on The Use of Laboratory 3309 3310 Chemicals provides an estimated throughput of 0.33 kg/site-day for solid laboratory chemicals. Based 3311 on the mass fraction of DIDP in the laboratory chemical of 0.03 kg/kg, EPA estimated a daily facility 3312 DIDP use rate of 0.01 kg/site-day. For liquid products, the 2023 GS provided an estimated throughput of 3313 0.017-4 L/site-day for liquid laboratory chemicals. Based on the concentration of DIDP in liquid 3314 laboratory chemicals of 90-100%, (see Appendix F for EPA identified DIDP-containing products for 3315 this OES) and the DIDP density of 0.9634 kg/L, EPA estimated a daily facility use rate of laboratory chemicals using Monte Carlo modeling, resulting in a 50<sup>th</sup>-95<sup>th</sup> percentile range of 1.83-3.47 kg/site-day. 3316

<sup>&</sup>lt;sup>3</sup> Values reported are rounded to the nearest whole number value, the sum of the column exceeds the reported production volume by 1 kg due to rounding effects.

Additionally, the GS estimated the number of operating days as 174-260 days/year, with 8 hour/day
operations (U.S. EPA, 2023c). EPA did not identify estimates of the number of sites that use laboratory
chemicals containing DIDP. Therefore, EPA estimated the total number of sites that use DIDPcontaining laboratory chemicals using a Monte Carlo model (see Appendix E.12 for details). The 50<sup>th</sup>-

3321 95<sup>th</sup> percentile range of the number of sites was 225-2,095 for the liquid use case. Based on the use rate,

- modeling results for number of sites exceeded the maximum indicated in the GS; therefore, EPA assessed the maximum number of sites of 36,873 as a bounding estimate. (U.S. EPA, 2023c).
- 3324 3.12.3 Release Assessment
- 3325

## 3.12.3.1 Environmental Release Points

EPA assigned release points based on the 2023 GS on the Use of Laboratory Chemicals (U.S. EPA, 3326 3327 2023c). EPA assigned default models to quantify releases from each release point and suspected fugitive 3328 air release point. Laboratory sites may use a combination of solid and liquid laboratory chemicals, but 3329 for release estimate EPA assumed each site used either the liquid or solid form of the DIDP-containing 3330 laboratory chemical. In the liquid laboratory chemical use case, EPA expects fugitive or stack air 3331 releases from unloading containers, container cleaning, labware cleaning, and during laboratory 3332 analysis. In the solid laboratory chemical use case, EPA expects sites to release dust emissions from 3333 unloading to stack air, incineration, or landfill. In both use cases, EPA expects wastewater, incineration, 3334 or landfill releases from container cleaning wastes, labware equipment cleaning wastes, and laboratory 3335 wastes.

3336 3337

## 3.12.3.2 Environmental Release Assessment Results

## 3338 Table 3-60. Summary of Modeled Environmental Releases for Use of Laboratory Chemicals

Modeled Scenario	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Wiodeled Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
209,068 lb production volume Liquid Laboratory Chemicals	Fugitive or Stack Air	4.47E-07	7.80E-07		258	1.94E-09	3.31E-09
	Wastewater, Incineration, or Landfill	4.20E02	8.22E02	235		1.83	3.47
209,068 lb	Stack Air	2.82E-02	6.17E-02	260		1.08E-04	2.37E-04
production volume Solid Laboratory Chemicals	Wastewater, Incineration, or Landfill	2.54	2.55			9.83E-03	9.88E-03

## 3339

## 3.12.4 Occupational Exposure Assessment

3340 3.12.4.1 Worker Activities

Worker exposures to DIDP may occur through the inhalation of solid powders while unloading and transferring laboratory chemicals and during laboratory analysis. Inhalation exposures to DIDP vapor and dermal exposure to liquid and solid chemicals may occur during laboratory chemical unloading, container cleaning, labware and labware equipment cleaning, chemical use during laboratory analysis, and disposal of laboratory wastes (U.S. EPA, 2023c). EPA did not find information on the extent to which laboratories that use DIDP-containing chemicals also use engineering controls and worker PPE.

3348 ONUs include supervisors, managers, and other employees that do not directly handle the laboratory 3349 chemical or laboratory equipment but may be present in the laboratory or analysis area. ONUs are 3350 potentially exposed through the inhalation route while in the laboratory area. Also, dermal exposures 3351 from contact with surfaces where dust has been deposited were assessed for ONUs.

## 3352 **3.12.4.2** Number of Workers and Occupational Non-users

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 3353 3354 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the 3355 use of laboratory chemicals. This approach involved the identification of relevant SOC codes within the BLS data for select NAICS codes. Section 2.4.2 provides further details regarding the methodology that 3356 3357 EPA used for estimating the number of workers and ONUs per site. EPA assigned the NAICS codes 3358 541380, 541713, 541714, 541715, and 621511 for this OES based on the Generic Scenario on the Use of 3359 Laboratory Chemicals (U.S. EPA, 2023c). Table 3-61 summarizes the per site estimates for this OES. 3360 NAICS codes 541713, 541714, and 541715 were all excluded from the table as they lacked worker data. 3361 As described in Section 3.12.2, EPA did not identify site-specific data for the number of facilities in the United States that use DIDP-containing laboratory chemicals. 3362

3363

3347

# 3364Table 3-61. Estimated Number of Workers Potentially Exposed to DIDP during Use of Laboratory3365Chemicals

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non-users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
541380 – Testing Laboratories	N/A	2	N/A	17	N/A
621511 – Medical Laboratories		0.1		0.2	
Total/Average (Liquid)	225-2,095	1	223-2,075	9	1,964- 18,290
Total/Average (Solid)	36,873	1	36,517	9	321,917

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

### 3366

## 3.12.4.3 Occupational Inhalation Exposure Results

3367 EPA did not identify inhalation monitoring data for the use of laboratory chemicals during systematic

review of literature sources. However, EPA estimated inhalation exposures for this OES using

3369 monitoring data for DIDP exposures during manufacturing (ExxonMobil, 2022a) and the Generic Model

3370 for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not

3371 *Otherwise Regulated (PNOR)* (U.S. EPA, 2021d). EPA expects that inhalation exposures during

3372 manufacturing are greater than inhalation exposures expected during use of laboratory chemicals and

3373 serve as a reasonable bounding estimate.

3375 For exposure to liquid laboratory chemicals, EPA used surrogate monitoring data provided in an 3376 exposure study conducted by ExxonMobil at their DIDP manufacturing site to estimate inhalation exposures for this OES. The ExxonMobil exposure study collected data via PBZ samples via an AIHA 3377 3378 validated method involving PTFE Teflon filters, extraction with acetonitrile, and HPLC analysis with 3379 UV detection. ExxonMobil took PBZ samples from plasticizer assistant operators, laboratory 3380 technicians, and maintenance operators (ExxonMobil, 2022a). EPA used the samples taken during filter change-out from maintenance workers to represent this OES, as this activity was determined to best 3381 3382 represent the activities that occur during manufacturing. EPA also used these samples to evaluate 3383 laboratory worker exposures. The study included two PBZ data points for DIDP. Both data points were 3384 below the LOD. Therefore, EPA could not create a full distribution of monitoring results to use in 3385 estimating central tendency and high-end exposures. To estimate high-end exposures to workers 3386 exposures, EPA use the LOD reported in the study. To estimate central tendency worker exposure, EPA used half of the LOD. 3387

3388

3389 DIDP is present in solid laboratory chemicals (see Appendix F for DIDP-containing product data), so 3390 EPA expects worker inhalation exposures to DIDP via exposure to particulates of laboratory chemicals. 3391 Therefore, EPA estimated worker inhalation exposures during the use of laboratory chemicals using the 3392 Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable 3393 Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d). Model approaches and parameters 3394 are described in Appendix E.16. In the model, EPA used a subset of the Generic Model for Central 3395 Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise 3396 Regulated (PNOR) data that came from facilities with NAICS codes starting with 54 (Professional, 3397 Scientific, and Technical Services) to estimate particulate concentrations in the air. EPA used the highest 3398 expected concentration of DIDP in laboratory chemicals to estimate the concentration of DIDP in 3399 particulates. For this OES, EPA selected 3 percent by mass as the highest expected DIDP concentration 3400 based on identified DIDP-containing products applicable to this OES (see Appendix F). EPA assumed 3401 that DIDP is present in particulates of solid laboratory chemicals at this fixed concentration throughout 3402 the working shift. The Generic Model for Central Tendency and High-End Inhalation Exposure to Total 3403 and Respirable Particulates Not Otherwise Regulated (PNOR) uses an 8-hour TWA for particulate 3404 concentrations, by assuming exposures outside the sample duration are zero. This model does not 3405 determine exposures during individual worker activities. 3406

EPA assumed that the worker is exposed to DIDP in the form of solid particulates and DIDP vapors.
EPA used estimates from the monitoring data and the *Generic Model for Central Tendency and High- End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S.
EPA, 2021d) to separately address these two physical forms of DIDP for the full 8-hour work shift. EPA
used the number of operating days determined in the release assessment for this OES to estimate
exposure frequency, with a maximum exposure frequency of 250 working days per year.

3413

Table 3-62 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
exposures to DIDP during the use of laboratory chemicals. The high-end and central tendency exposures
to solid laboratory chemicals use 250 days per year as the exposure frequency since the 95th and 50th
percentiles of operating days in the release assessment exceeded 250 days per year, which is the
expected maximum number of working days. The high-end and central tendency exposures to liquid
laboratory chemicals use 235 days per year and 250 days per year, respectively, as the exposure
frequencies. Appendix B describes the approach for estimating AD, IADD, and ADD.

# Table 3-62. Summary of Estimated Worker Inhalation Exposures for Use of Laboratory <u>Chemicals</u>

Modeled Scenario	Exposure Concentration Type	Central Tendency	High- End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	9.0E-03
Average Adult Worker – Liquids	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	6.6E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.9E-03	6.2E-03
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	5.7E-03	8.1E-02
Awaraa Adult Warkan	Acute Dose (AD) (mg/kg/day)	7.1E-04	1.0E-02
Average Adult Worker – Solids	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	5.2E-04	7.4E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	4.9E-04	6.9E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	5.0E-03	9.9E-03
Female of Reproductive Age - Liquids	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.6E-03	7.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	3.2E-03	6.8E-03
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	5.7E-03	8.1E-02
	Acute Dose (AD) (mg/kg/day)	7.9E-04	1.1E-02
Female of Reproductive Age - Solids	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	5.8E-04	8.2E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	5.4E-04	7.7E-03
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-03	3.6E-03
	Acute Dose (AD) (mg/kg/day)	4.5E-03	4.5E-03
ONU – Liquids	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-03	3.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.9E-03	3.1E-03
ONU - Solids	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	5.7E-03	5.7E-03
	Acute Dose (AD) (mg/kg/day)	7.1E-04	7.1E-04
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	5.2E-04	5.2E-04
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	4.9E-04	4.9E-04

## 3424 **3.12.4.4 Occupational Dermal Exposure Results**

3425 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 3426 various "Exposure Concentration Types" from Table 3-63 are explained in Appendix B. Because dermal 3427 exposures to workers may occur in the neat liquid form or solid form during the use of DIDP in 3428 laboratory settings, EPA assessed the absorptive flux of DIDP according to both dermal absorption data 3429 of neat DIDP (Appendix D.2.1.1) and dermal modeling results for solid materials (Appendix D.2.1.2). 3430 Also, since there may be dust deposited on surfaces from this OES, dermal exposures to ONUs from 3431 contact with dust on surfaces were assessed. Dermal exposure to workers is generally expected to be 3432 greater than dermal exposure to ONUs. In absence of data specific to ONU exposure, EPA assumes that 3433 worker central tendency exposure is representative of ONU exposure. Therefore, worker central 3434 tendency exposure values for dermal contact with solids containing DIDP were assumed representative 3435 of ONU dermal exposure.

3436

Table 3-63 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate
Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female
workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

3440

Worker Population	Exposure Concentration Type	Central Tendency	High- End
	Dose Rate (APDR, mg/day)	3.7	7.3
	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Average Adult Worker - Liquids	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	3.0E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Female of Reproductive Age -	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Liquids	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg- day)	2.7E-02	5.8E-02
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Average Adult Worker - Solids	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg- day)	3.3E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Famala of Danna dustive A sa	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
Female of Reproductive Age - Solids	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg- day)	3.0E-04	6.1E-04
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONU - Solids	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04

#### **Table 3-63. Summary of Estimated Worker Dermal Exposures for Use of Laboratory Chemicals**

Worker Population	Exposure Concentration Type	Central Tendency	High- End
	Chronic, Non-cancer (ADD, mg/kg- day)	3.3E-04	3.3E-04

### 3442

**3.12.4.5 Occupational Aggregate Exposure Results** 3443 Inhalation and dermal exposure estimates were aggregated based on the approach described in Appendix 3444 B.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-64.

3445

#### 3446 Table 3-64. Summary of Estimated Worker Aggregate Exposures for Use of Laboratory Chemicals 3447

Worker Population	Exposure Concentration Type	<b>Central Tendency</b>	High-End
	Acute (AD, mg/kg-day)	5.0E-02	0.10
Average Adult Worker - Liquids	Intermediate (IADD, mg/kg-day)	3.7E-02	7.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.2E-02	6.9E-02
	Acute (AD, mg/kg-day)	4.7E-02	9.4E-02
Female of Reproductive Age - Liquids	Intermediate (IADD, mg/kg-day)	3.5E-02	6.9E-02
rige - Enquitas	Chronic, Non-cancer (ADD, mg/kg-day)	3.0E-02	6.5E-02
	Acute (AD, mg/kg-day)	4.5E-03	4.5E-03
ONU - Liquids	Intermediate (IADD, mg/kg-day)	3.3E-03	3.3E-03
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-03	3.1E-03
	Acute (AD, mg/kg-day)	1.2E-03	1.1E-02
Average Adult Worker - Solids	Intermediate (IADD, mg/kg-day)	8.8E-04	8.1E-03
bonds	Chronic, Non-cancer (ADD, mg/kg-day)	8.2E-04	7.6E-03
	Acute (AD, mg/kg-day)	1.2E-03	1.2E-02
Female of Reproductive Age - Solids	Intermediate (IADD, mg/kg-day)	9.0E-04	8.8E-03
Age - Solids	Chronic, Non-cancer (ADD, mg/kg-day)	8.4E-04	8.3E-03
	Acute (AD, mg/kg-day)	1.2E-03	1.2E-03
ONU - Solids	Intermediate (IADD, mg/kg-day)	8.8E-04	8.8E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	8.2E-04	8.2E-04

#### 3.13 Use of Lubricants and Functional Fluids 3448

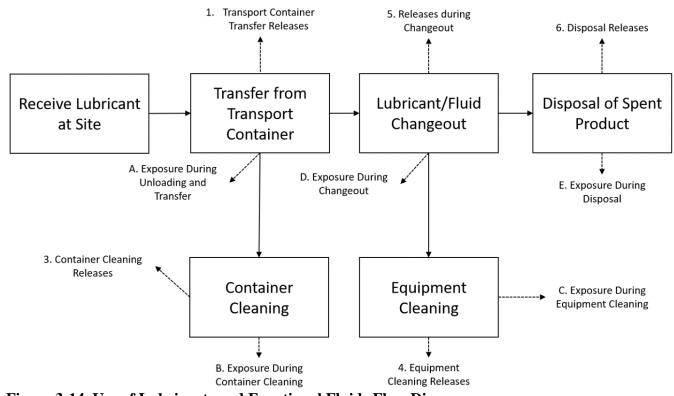
3449

## **3.13.1 Process Description**

DIDP is incorporated in lubricants and functional fluids for air compressors and found in functional 3450 fluids for heat exchanger processes in both commercial and industrial processes (see Appendix F for 3451 EPA identified DIDP-containing products for this OES). A typical end use site unloads the 3452 3453 lubricant/functional fluid when ready for changeout (OECD, 2004b). Sites incorporate the product into 3454 the system with a frequency ranging from once every 3 months to once every 5 years. After changeout,

3455 sites clean the transport containers and equipment, and dispose of used fluid. Figure 3-14 provides an

illustration of the expected use of lubricants and functional fluids process (<u>OECD, 2004b</u>).



3459 Figure 3-14. Use of Lubricants and Functional Fluids Flow Diagram

3460 **3.13.2 Facility Estimates** 

3458

3461 No sites reported the use of DIDP-containing lubricants or functional fluids to the 2020 CDR (U.S. EPA, 2020a). The American Chemistry Council indicated that the use rate of DIDP in the EU is similar 3462 to the use rate in the United States (ACC, 2020a), however, the 2003 DIDP Risk Assessment published 3463 3464 by the European Union (ECJRC, 2003a) did not estimate a production volume for lubricants and 3465 functional fluids. The smallest PV breakdown the EU risk assessment provided was 1.1% for inks, adhesives/sealants, and paints. Based on minimal data for the "lubricants and functional fluids" 3466 3467 breakdown, EPA uses one third of the 1.1% as an estimate for lubricants and functional fluid. As a 3468 result, EPA calculated the production volume of DIDP in lubricants as 0.37% of the total DIDP 3469 production volume reported to CDR for both CASRN. The 2020 CDR reported a national production 3470 volume range for DIDP; therefore, EPA provided the lubricant and functional fluid production volume 3471 as a range. The resulting total production volume was 169,485-1,679,970 kg/year. 3472

EPA did not identify site- or DIDP-specific lubricant and functional fluid use operating data (*e.g.*,
facility use rates, operating days). However, based on the 2004 *ESD on Lubricants and Lubricant Additives*, EPA assumed a product throughput equivalent to one container per lubricant/functional fluid
changeout (OECD, 2004b).

34773478 The ESD provides an estimate of 1-4 changeouts per year for different types of hydraulic fluids, and

3479 EPA assumed each changeout occurs over the course of 1 day. Based on this relationship, the EPA

assessed 1-4 operating days per year. Based on this operating day distribution, the 50<sup>th</sup> and 95<sup>th</sup>
 percentile range of the resulting product use rate was 921-2,903 kg/site-year. EPA did not identify any

estimates of the number of sites that may use lubricants/functional fluids containing DIDP. Therefore,

EPA estimated the total number of sites that use DIDP-containing lubricants/functional fluids using a
Monte Carlo model (see Appendix E.12 for details). The 50<sup>th</sup>-95<sup>th</sup> percentile range of the number of sites

3485 was 2,596-18,387 sites.

### 3486 3.13.3 Release Assessment

## 3487 **3.13.3.1 Environmental Release Points**

EPA assigned release points based on the 2004 *ESD on Lubricants and Lubricant Additives* (OECD,
2004b). EPA assigned default models to quantify releases from each release point and suspected fugitive
air release. EPA expects releases to wastewater, landfill, or incineration from the use of equipment.
Releases to wastewater, landfill, and incineration from fuel blending activities are expected from fluid
changeouts.

## 3493 **3.13.3.2 Environmental Release Assessment Results**

### 3494

## 34943495Table 3-65. Summary of Modeled Environmental Releases for Use of Lubricants and Functional

3496 Fluids

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High-End
373,650- 3,703,700	Wastewater	1.61E02	7.60E02	2	4	7.29E01	2.69E02
lb	Landfill	7.06E01	3.60E02			3.21E01	1.30E02
production	Recycling	2.56	1.72E01			1.19	6.31
volume	Fuel Blending (Incineration)	5.70E01	3.83E02			2.64E01	1.40E02

## 3497

## **3.13.4 Occupational Exposure Assessment**

3498 **3.13.4.1 Worker Activities** 

Workers are potentially exposed to DIDP from lubricant and functional fluid use when unloading
lubricants and functional fluids from transport containers, during changeout and removal of used
lubricants and functional fluids, and during any associated equipment or container cleaning activities.
Workers may be exposed via inhalation of DIDP vapors or dermal contact with liquids containing DIDP.
EPA did not identify chemical-specific information for engineering controls and worker PPE used at
facilities that perform changeouts of lubricants or functional fluids.

- 3505
- ONUs include supervisors, managers, and other employees that may be in the area when changeouts
   occur but do not perform changeout tasks. ONUs are potentially exposed via inhalation but have no
   expected dermal exposure.

## 3509 **3.13.4.2** Number of Workers and Occupational Non-users

3510 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015)

- to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the
- 3512 use of lubricants and functional fluids. This approach involved the identification of relevant SOC codes
- within the BLS data for the select NAICS codes. Section 2.4.2 provides further details regarding the
- 3514 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the

- 3515 NAICS codes 336100, 336200, 336300, 336400, 336500, 336600, 336900, and 811100 for this OES
- 3516 based on the *Emission Scenario Document on Lubricants and Lubricant Additives* (OECD, 2004b).
- 3517 Table 3-66 summarizes the per site estimates for this OES. As described in Section 3.13.2, EPA did not
- 3518 identify site-specific data for the number of facilities in the United States that use DIDP-containing
- 3519 lubricants and functional fluids.
- 3520

# Table 3-66. Estimated Number of Workers Potentially Exposed to DIDP during Use of Lubricants and Functional Fluids

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non- users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
336100 – Motor Vehicle Manufacturing		447		59	
336200 – Motor Vehicle Body and Trailer Manufacturing		40		5	
336300 – Motor Vehicle Parts Manufacturing		51		15	
336400 – Aerospace Product and Parts Manufacturing	N/A	75	NT/A	64	N/A
336500 – Railroad Rolling Stock Manufacturing		35	N/A	15	N/A
336600 – Ship and Boat Building		36		11	
336900 – Other Transportation Equipment Manufacturing		16		4	
811100 – Automotive Repair and Maintenance		6		1	
Total/Average	2,596- 18,387	88	228,779- 1,620,403	22 end value. Results were no	56,176- 397,887

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non- users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>		
<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.							

## 3.13.4.3 Occupational Inhalation Exposure Results

3523

3529

EPA did not identify inhalation monitoring data for use of lubricants and functional fluids during systematic review of literature sources. However, EPA estimated inhalation exposures for this OES using monitoring data for DIDP exposures during manufacturing (ExxonMobil, 2022a). EPA expects that inhalation exposures during manufacturing are greater than inhalation exposures expected during use of lubricants and functional fluids and serve as reasonable bounding estimates.

- 3530 EPA used surrogate monitoring data provided in an exposure study conducted by ExxonMobil at their 3531 DIDP manufacturing site to estimate inhalation exposure for this OES. ExxonMobil collected PBZ 3532 samples via an AIHA validated method involving PTFE Teflon filters, extraction with acetonitrile, and 3533 HPLC analysis with UV detection. ExxonMobil took PBZ samples from plasticizer assistant operators, 3534 laboratory technicians, maintenance operators (ExxonMobil, 2022a). EPA used the samples taken during 3535 filter change-out from maintenance workers to represent this OES, as this activity was determined to 3536 best represent the activities that occur during manufacturing. The study included two PBZ data points 3537 for DIDP. Both data points were below the LOD. Therefore, EPA could not create a full distribution of 3538 monitoring results to estimate central tendency and high-end exposures. To estimate high-end worker 3539 exposures, EPA used the LOD reported in the study. To estimate central tendency worker exposure, 3540 EPA used half of the LOD.
- Table 3-67 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
  exposures to DIDP during use of lubricants and functional fluids. The high-end exposures use 4 days per
  year as the exposure frequency based on the 95<sup>th</sup> percentile of operating days from the release
  assessment. The central tendency exposures use 2 days per year as the exposure frequency based on the
  50<sup>th</sup> percentile of operating days from the release assessment. Appendix B describes the approach for
  estimating AD, IADD, and ADD.
  - 3548
    3549 Table 3-67. Summary of Estimated Worker Inhalation Exposures for Use of Lubricants and
    3550 Functional Fluids

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	7.2E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	9.0E-03
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.0E-04	1.2E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.5E-05	9.9E-05
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )		7.2E-02
	Acute Dose (AD) (mg/kg/day)	5.0E-03	9.9E-03

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.3E-04	1.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.7E-05	1.1E-04
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	3.6E-02	3.6E-02
	Acute Dose (AD) (mg/kg/day)	4.5E-03	4.5E-03
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	3.0E-04	6.0E-04
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	2.5E-05	4.9E-05

3551

## 3.13.4.4 Occupational Dermal Exposure Results

3552 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The various "Exposure Concentration Types" from Table 3-68 are explained in Appendix B. Because dermal 3553 exposures to workers may occur in a concentrated liquid form during the use of lubricants and functional 3554 3555 fluids, EPA assessed the absorptive flux of DIDP according to dermal absorption data of neat DIDP (see 3556 Appendix D.2.1.1 for details). Table 3-68 summarizes the Acute Potential Dose Rate (APDR), the Acute 3557 Dose (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily Dose (ADD) for both average adult workers and female workers of reproductive age. Because there are no dust or mist 3558 3559 expected to be deposited on surfaces from this OES, dermal exposures to ONUs from contact with surfaces were not assessed. Dermal exposure parameters are described in Appendix D. 3560

#### 3561

# Table 3-68. Summary of Estimated Worker Dermal Exposures for Use of Lubricants and Functional Fluids

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Worker	Intermediate (IADD, mg/kg-day)	3.1E-03	1.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.5E-04	1.0E-03
	Dose Rate (APDR, mg/day)	3.1	6.1
Female of	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Reproductive Age	Intermediate (IADD, mg/kg-day)	2.8E-03	1.1E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.3E-04	9.2E-04

## 3564 **3.13.4.5 Occupational Aggregate Exposure Results**

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-69.

## Table 3-69. Summary of Estimated Worker Aggregate Exposures for Use of Lubricants and Functional Fluids

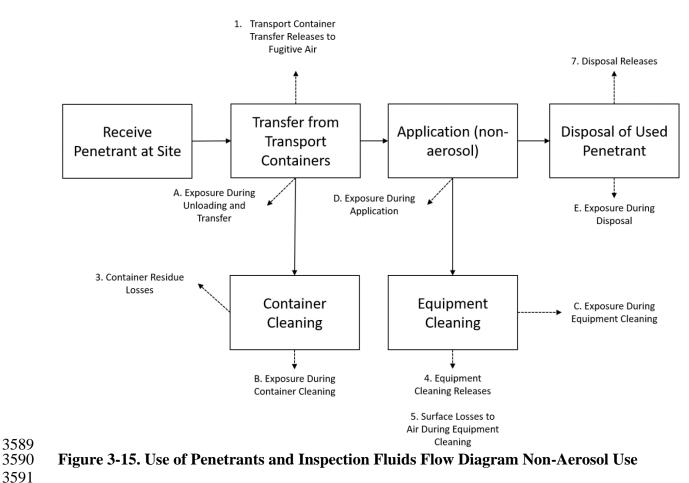
Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	5.0E-02	0.10
Average Adult Worker	Intermediate (IADD, mg/kg-day)	3.4E-03	1.3E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.8E-04	1.1E-03
	Acute (AD, mg/kg-day)	4.7E-02	9.4E-02
Female of Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-03	1.3E-02
ngo	Chronic, Non-cancer (ADD, mg/kg-day)	2.6E-04	1.0E-03
	Acute (AD, mg/kg-day)	4.5E-03	4.5E-03
ONU	Intermediate (IADD, mg/kg-day)	3.0E-04	6.0E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.5E-05	4.9E-05

## **3570 3.14 Use of Penetrants and Inspection Fluids**

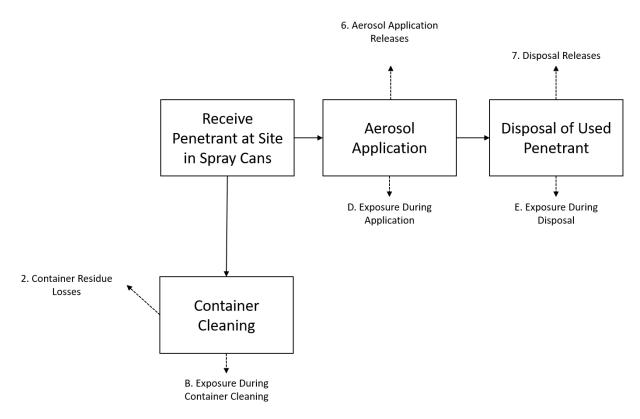
## 3571

## 3.14.1 Process Description

3572 DIDP is present in inspection fluids or penetrants that are commercially used to reveal surface defects 3573 (e.g., cracks, folds, pitting, etc.), typically on metal parts (see Appendix F for EPA identified DIDP-3574 containing products for this OES). EPA assessed aerosol-based penetrants and non-aerosol penetrants as separate processes with unique release points. EPA expects that sites receive non-aerosol penetrants in 3575 3576 bottles, cans, or drums, ranging in size from 0.08-55 gallons, with the maximum container size based on 3577 the ESD default for drums and the minimum based on a 10.5-ounce aerosol product can (OECD, 3578 2011d). The site transfers the non-aerosol penetrant from transport containers into process vessels and 3579 applies the product using brushing and/or immersion. EPA expects that non-aerosol penetrant 3580 application occurs over the course of an 8-hour workday A typical site that uses aerosol penetrants receives cans of penetrant and an operator sprays the aerosol penetrant and disposes of the used aerosol 3581 3582 can. EPA expects the operator to apply the aerosol in non-steady, instantaneous bursts at the start of 3583 each job, and allow the penetrant to remain on the surface as it reveals defects before eventually wiping 3584 it away. EPA expects that the penetrant product is self-contained and does not require transfer or 3585 cleaning from shipping containers or application equipment for this OES. Figure 3-15 and Figure 3-16 3586 provide illustrations of the use of inspection fluids or penetrants for the non-aerosol and aerosol use 3587 cases respectively (OECD, 2011d).



3591



3592

## **Figure 3-16.** Use of Penetrants and Inspection Fluids Flow Diagram Aerosol Use

3594 **3.14.2 Facility Estimates** 

No site reported the use of DIDP-containing inspection fluids or penetrants to the 2020 CDR. EPA 3595 estimated the total production volume using the CDR reporting threshold limits of either 25,000 pounds 3596 3597 (11,430 kg) or 5% of a site's reported production volume, whichever value was smaller (U.S. EPA, 3598 2020a). EPA considered every site that reported to CDR, regardless of assigned OES. EPA assumed that sites that claimed their production volume as CBI used 25,000 pounds of DIDP annually. Table 3-70 3599 provides each reported site and the associated production volume for use in calculating the total 3600 3601 production volume (U.S. EPA, 2020a). This resulted in a total production volume for this OES across both CASRN of 94,832 kg/year. 3602

3604	Table 3-70. CDR Reported Site Information for Use in Calculation of Use of Penetrants and
3605	Inspection Fluids Production Volume

CASRN	Site Name	Site Location	Reported Production Volume (kg/year)	Threshold Limit Used	Production Volume Added to Total <sup>4</sup> (kg/year)
26761-40-0	3M	St. Paul, MN	CBI	11,340 kg	11,340
26761-40-0	LG Hausys, Inc.	Adairsville, GA	11,895	5%	595
26761-40-0	Harwick Standard Distribution Corp.	Akron, OH	19,447	5%	972
26761-40-0	LG Chem, Inc.	Atlanta, GA	CBI	11,340 kg	11,340
26761-40-0	Tremco Inc.	Beachwood, OH	362,965	11,340 kg	11,340
26761-40-0	Akrochem Corp.	Stow, OH	6,616	5%	331
26761-40-0	Chemspec, Ltd.	Uniontown, OH	23,801	5%	1,190
68515-49-1	3M	St. Paul, MN	CBI	11,340 kg	11,340
68515-49-1	ExxonMobil BR Chemical Plant	Baton Rouge, LA	СВІ	11,340 kg	11,340
68515-49-1	Lanxess Solutions, Inc.	Fords, NJ	CBI	11,340 kg	11,340
68515-49-1	The Sherwin- Williams Co.	Cleveland, OH	CBI	11,340 kg	11,340
68515-49-1	Sika Corp.	Lyndhurst, NJ	CBI	11,340 kg	11,340
68515-49-1	Troy Chemical Corp.	Phoenix, AZ	20,507	5%	1,025

3606

3607 EPA did not identify site- or DIDP-specific inspection fluid/penetrant site operating data (*i.e.*, batch size 3608 or number of batches per year) from systematic review; therefore, EPA assessed the daily DIDP facility throughput of  $1.67 \times 10^{-2} - 3.34 \times 10^{-2}$  kg/site-day based on a penetrant product throughput of eight 10.5 3609 oz cans per day (one can of product per hour), and a concentration of DIDP in inspection fluid/penetrant 3610 products of 10-20% (See Appendix F for product data). EPA assessed the number of operating days 3611 3612 using the 2011 ESD on the Use of Metalworking Fluids, which cites general averages for facilities with a range of 246-249 operating days/year of 8 hour/day, 5 days/week operations up to the operating days for 3613 the given site throughput scenario (OECD, 2011d). EPA assessed the total number of sites that use 3614 3615 DIDP-containing inspection fluids/penetrants using a Monte Carlo model that considered the total production volume for this OES and the annual DIDP facility throughput of 4.10-8.31 kg/site-year. The 3616 50<sup>th</sup>- 95th percentile range of the number of sites was 15,315-21,892. 3617

<sup>&</sup>lt;sup>4</sup> Values reported are rounded to the nearest whole number value, the sum of the column exceeds the reported production volume by 1 kg due to rounding effects.

### 3618 3.14.3 Release Assessment

## 3619 **3.14.3.1 Environmental Release Points**

EPA assigned release points based on the 2011 ESD on the Use of Metalworking Fluids (OECD, 2011d). 3620 3621 EPA assigned default models to quantify releases from each release point and suspected fugitive air release. For the aerosol penetrant use case, EPA expects releases to wastewater, incineration, or landfill 3622 3623 from container residue losses and aerosol application processes. EPA also expects fugitive air releases 3624 from aerosol application. For the non-aerosol penetrant use case, EPA expects releases to fugitive air from unloading penetrant containers, container cleaning, and equipment cleaning. EPA expects 3625 3626 wastewater, incineration, or landfill releases from container residue losses, equipment cleaning, and 3627 disposal of used penetrant.

### 3.14.3.2 Environmental Release Assessment Results

3628 3629

## Table 3-71. Summary of Modeled Environmental Releases for Use of Penetrants and Inspection Fluids

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High- End	Central Tendency	High- End	Central Tendency	High- End
209,068 lb	Fugitive Air	9.10E-01	1.19			3.68E-03	4.80E-03
production volume Aerosol Based	Wastewater, Incineration, or Landfill	5.23	6.80	247	249	2.14E-02	2.77E-02
209,068 lb	Fugitive Air	6.09E-07	1.13E-06			2.46E-09	4.57E-09
production volume Non-aerosol Based	Wastewater, Incineration, or Landfill	5.72	7.78	247	249	2.50E-02	3.25E-02

### 3632

## 3.14.4 Occupational Exposure Assessment

3633 **3.14.4.1 Worker Activities** 

Worker exposures during the use of penetrant and inspection fluids may occur via dermal contact with liquids when applying the product to substrate from the container for non-aerosol application and inhalation and dermal contact when applying via aerosol application. Worker exposures may also occur via vapor inhalation and dermal contact with liquids during aerosol application, equipment cleaning, container cleaning, and disposal of used penetrants (OECD, 2011d). EPA did not identify chemicalspecific information on the use of engineering controls and worker PPE used at facilities that use DIDPcontaining penetrants and inspection fluids.

3641

3642 ONUs include supervisors, managers, and other employees that are in the application area but do not

directly use or contact penetrants. ONU exposure may occur via inhalation while the ONU is present in
 the application area. Also, dermal exposures from contact with surfaces where mist has been deposited
 were assessed for ONUs.

## 3646 **3.14.4.2 Number of Workers and Occupational Non-users**

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the

use of penetrants and inspection fluids. This approach involved the identification of relevant SOC codes
 within the BLS data for select NAICS codes. Section 2.4.2 provides further details regarding the

- 3651 methodology that EPA used to estimate the number of workers and ONUs per site. EPA assigned the
- 3652 NAICS codes 332100, 332200, 332300, 332400, 332500, 332600, 332700, 332800, 332900, 333100,
- 3653 333200, 333300, 333400, and 333900 for this OES based on the *Emission Scenario Document on the*
- 3654 Use of Metalworking Fluids (OECD, 2011d). Table 3-72 summarizes the per site estimates for this OES.
- 3655 As described in Section 3.14.2, EPA did not identify site-specific data for the number of facilities in the
- 3656 United States that use DIDP-containing penetrants and inspection fluids.
- 3657

# Table 3-72. Estimated Number of Workers Potentially Exposed to DIDP during Use of Penetrants and Inspection Fluids

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
332100 – Forging and Stamping		10		4	
332200 – Cutlery and Handtool Manufacturing		25		9	
332300 – Architectural and Structural Metals Manufacturing		5		2	
332400 – Boiler, Tank, and Shipping Container Manufacturing		17		13	
332500 – Hardware Manufacturing		12		4	
332600 – Spring and Wire Product Manufacturing		10		3	
332700 – Machine Shops; Turned Product; and Screw, Nut, and Bolt	N/A	2	N/A	1	N/A
332800 – Coating, Engraving, and Heat- Treating Metals		8		2	
332900 – Other Fabricated Metal Product Manufacturing		12		5	
333100 – Agriculture, Construction, and Mining Machinery Manufacturing		20		9	
333200 – Industrial Machinery Manufacturing		8		6	
333300 – Commercial and Service Industry		14		6	

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed ONUs per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
Machinery Manufacturing					
333400 – HVAC and Commercial Refrigeration Equipment		31		8	
333900 – Other General Purpose Machinery Manufacturing		13		6	
Total/Average	15,315- 21,892	13	203,772- 291,282	6	85,651-122,433

<sup>*a*</sup> The result is expressed as a range between the central tendency and the high-end value. Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

## 3660 **3.14.4.3 Occupational Inhalation Exposure Results**

EPA did not identify inhalation monitoring data for the use of penetrants and inspection fluids during 3661 3662 systematic review of literature sources. However, through review of the literature and consideration of 3663 existing EPA/OPPT exposure models, EPA identified the Brake Servicing Near-Field/Far-Field 3664 Inhalation Exposure Model as an appropriate approach for estimating occupational exposures to DIDP-3665 containing aerosols. The model is based on a near-field/far-field approach (AIHA, 2009), where aerosol 3666 application in the near-field generates a mist of droplets and indoor air movements lead to the 3667 convection of droplets between the near-field and far-field. The model assumes workers are exposed to 3668 DIDP droplets in the near-field, while ONUs are exposed in the far-field.

3669

Penetrant/inspection fluid application generates a mist of droplets in the near-field, resulting in worker exposures. The DIDP exposure concentration is directly proportional to the amount of penetrant applied by the worker standing in the near-field-zone (*i.e.*, the working zone). The ventilation rate for the nearfield-zone determines the rate of DIDP dissipation into the far-field (*i.e.*, the facility space surrounding the near-field), resulting in occupational bystander exposures to DIDP as well. The ventilation rate of the surroundings determines the rate of DIDP dissipation from the surrounding space into the outside air.

3676

Table 3-73 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker exposures to DIDP during the use of penetrants and inspection fluids. The high-end exposures use 249 days per year as the exposure frequency based on the 95<sup>th</sup> percentile of operating days from the release assessment. The central tendency exposures use 247 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release assessment. Appendix B describes the approach for estimating AD, IADD, and ADD.

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	1.5	5.6
	Acute Dose (AD) (mg/kg/day)	0.19	0.70
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	0.14	0.51
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	0.13	0.47
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	1.5	5.6
	Acute Dose (AD) (mg/kg/day)	0.21	0.77
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	0.15	0.56
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	0.14	0.52
	8-hr TWA Exposure Concentration (mg/m <sup>3</sup> )	5.1E-02	0.38
	Acute Dose (AD) (mg/kg/day)	6.4E-03	4.7E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	4.7E-03	3.5E-02

#### Table 3-73. Summary of Estimated Worker Inhalation Exposures for Use of Penetrants and 3684 36

### 3686

### 3.14.4.4 Occupational Dermal Exposure Results

(ADD) (mg/kg/day)

EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 3687 various "Exposure Concentration Types" from Table 3-74 are explained in Appendix B. Because dermal 3688 exposures of DIDP to workers may occur in a concentrated liquid form during the use of penetrants or 3689 3690 inspection fluids, EPA assessed the absorptive flux of DIDP according to dermal absorption data of neat 3691 DIDP (see Appendix D.2.1.1 for details). Also, since there may be mist deposited on surfaces from this 3692 OES, dermal exposures to ONUs from contact with mist on surfaces were assessed. Dermal exposure to 3693 workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to 3694 ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 3695 Therefore, worker central tendency exposure values for dermal contact with liquids containing DIDP 3696 were assumed representative of ONU dermal exposure.

Chronic Average Daily Dose, Non-cancer Exposures

4.3E-03

3.2E-02

3697

3698 Table 3-74 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate 3699 Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female 3700 workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D. 3701

## 3702

# Table 3-74. Summary of Estimated Worker Dermal Exposures for Use of Penetrants and Inspection Fluids

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.7	7.3
Average Adult	Acute (AD, mg/kg-day)	4.6E-02	9.2E-02
Worker	Intermediate (IADD, mg/kg-day)	3.4E-02	6.7E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	6.3E-02
	Dose Rate (APDR, mg/day)	3.1	6.1
Female of	Acute (AD, mg/kg-day)	4.2E-02	8.4E-02
Reproductive Age	Intermediate (IADD, mg/kg-day)	3.1E-02	6.2E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-02	5.7E-02
	Dose Rate (APDR, mg/day)	3.7	3.7
ONU	Acute (AD, mg/kg-day)	4.6E-02	4.6E-02
	Intermediate (IADD, mg/kg-day)	3.4E-02	3.4E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.1E-02	3.1E-02

3705

3708

## 3.14.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-75.

# Table 3-75. Summary of Estimated Worker Aggregate Exposures for Use of Penetrants and Inspection Fluids

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
Average Adult Worker	Acute (AD, mg/kg-day)	0.24	0.79
	Intermediate (IADD, mg/kg-day)	0.17	0.58
	Chronic, Non-cancer (ADD, mg/kg-day)	0.16	0.53
Female of Reproductive	Acute (AD, mg/kg-day)	0.25	0.85
Age	Intermediate (IADD, mg/kg-day)	0.18	0.62
	Chronic, Non-cancer (ADD, mg/kg-day)	0.17	0.58
ONU	Acute (AD, mg/kg-day)	5.2E-02	9.3E-02
	Intermediate (IADD, mg/kg-day)	3.8E-02	6.8E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	3.5E-02	6.3E-02

## **3711 3.15 Fabrication and Final Use of Products or Articles**

3712

**3.15.1 Process Description** 

3713 EPA expects DIDP to be present in a wide array of different final articles that are used both

3714 commercially and industrially, including automotive care products, abrasives, heat-resistant electric

3715 cords, interior leather for cars, roofing sheets, synthetic leather, tool handles, and hoses (see Appendix F

3716 for EPA identified DIDP-containing products for this OES) (U.S. CPSC, 2015). Also, the *Manufacturer* 

3717 *Request for Risk Evaluation: Diisodecyl Phthalate (DIDP)*, submission states that DIDP is used in

3718 general purpose plasticizers for PVC used in building and construction materials such as vinyl tiles,

resilient flooring, PVC-backed carpeting, scraper mats, and wall coverings (U.S. EPA, 2019b). These
 uses may require the worker handle, shape/cut, and install the DIDP-containing products.

3721

3749

3722 DIDP is present in products that are used for surface conditioning, which is a COU considered under the 3723 "Fabrication and Final Use of Products or Articles" OES. Specifically, the COU of Industrial use, -3724 abrasives, "abrasives (surface conditioning and finishing discs; semi-finished and finished goods)" is describing the use of finished, abrasive articles by workers to smooth surfaces, after the incorporation of 3725 3726 DIDP into the article. According to the Final Scope of the Risk Evaluation for Diisodecyl Phthalate 3727 (DIDP), surface conditioning is needed for such task as smoothing a surface prior to the application of 3728 paints and coatings or blending parting lines on cast parts. DIDP is present at low concentrations (less than 1.5 percent) in the line of non-woven abrasives supplied by Superior Abrasives (U.S. EPA, 2021b). 3729 3730 DIDP is also present in abrasive products at concentrations ranging from 1 to 8 percent with applications 3731 as an abrasive system for semi-finished and finished goods (EPA-HQ-OPPT-2018-0435-0012). 3732

3733 Also, data reported to the 2020 CDR indicates DIDP is used in a variety of automotive products (U.S. EPA, 2020a). According to the Manufacturer request for risk evaluation: Diisodecyl Phthalate (DIDP), 3734 3735 DIDP is primarily used as a plasticizer in automotive products such as upholstery and interior finishes 3736 (e.g., synthetic leather for car interiors), interior PVC skins (dashboards and shift boot covers), window 3737 glazing (urethane glass bonding adhesives and PVC window encapsulate), body-side molding, 3738 automotive undercoating, molded interior applications, insulation for wire and cable and wire harnesses 3739 (U.S. EPA, 2019b). However, the applications of any adhesives (e.g., window glazing) or sealants (e.g., 3740 automotive undercoating) are covered under the OES for "Application of Adhesives and Sealants". 3741

Lastly, regarding the commercial COU for furnishing, cleaning, treatment/care products – furniture and
furnishings, this COU is describing workers handling furniture and furnishings that already contain
DIDP and are transforming materials into final products. There is little product data to support this use
other than the 2012 CDR reported use of DIDP in commercial furniture and furnishings not covered
elsewhere and the *Final Scope of the Risk Evaluation for Diisodecyl Phthalate (DIDP)*. (U.S. EPA,
2019a, b)). Information for products that have DIDP incorporated into an adhesive and sealant chemical
or paint and coating that is used in the manufacture of furniture has not been currently identified.

## 3.15.2 Facility Estimates

3750 EPA identified multiple products for the fabrication and final use of products or articles OES. The 3751 concentration of DIDP in these products varies depending on the type of product and the necessary 3752 characteristics of that product. Therefore, EPA used the concentration from a single product, plastic 3753 vinyl flooring, to represent this scenario, with DIDP at a concentration ranging from 9-32% (WA DOE, 3754 2020). EPA did not identify representative site- or chemical-specific operating data for this OES (*i.e.*, 3755 facility throughput, number of sites, total production volume, operating days, product concentration), as 3756 DIDP-containing article use occurs at many disparate industrial and commercial sites, with different operating conditions. Use cases are expected to include welding or melting articles containing DIDP; 3757 drilling, cutting, grinding, or otherwise shaping articles containing DIDP; and the general use of DIDP-3758 3759 containing abrasives. Due to a lack of readily available information for this OES, the number of industrial or commercial use sites is unquantifiable and unknown. Total production volume for this OES 3760 3761 is also unquantifiable, and EPA assumed that each end use site utilizes a small number of finished 3762 articles containing DIDP. EPA assumed the number of operating days was 250 days/year with 5 3763 day/week operations and two full weeks of downtime each operating year.

### 3764 3.15.3 Release Assessment

### 3765 **3.15.3.1 Environmental Release Points**

EPA did not quantitatively assess environmental releases for this OES due to the lack of readily
available process-specific and DIDP-specific data; however, EPA expects releases from this OES to be
small and disperse in comparison to other upstream OES, as EPA expects DIDP to be present in smaller
amounts and predominantly remain in the final article, limiting the potential for release. Table 3-76
describes the expected fabrication and use activities that generate releases. All releases are nonquantifiable due to a lack of identified process- and product- specific data.

3772

### 3773 Table 3-76. Release Activities for Fabrication/Use of Final Articles Containing DIDP

Release Point	<b>Release Behavior</b>	Release Media
Cutting, Grinding, Shaping, Drilling, Abrading, and Similar Activities	Dust Generation	Fugitive or Stack Air, Water, Incineration, or Landfill
Heating/Plastic Welding Activities	Vapor Generation	Fugitive or Stack Air

### 3774 3.15.4 Occupational Exposure Assessment

### 3.15.4.1 Worker Activities

3776 During fabrication and final use of products or articles, worker exposures to DIDP may occur via dermal contact while handling and shaping articles containing DIDP additives. Worker exposures may also 3777 occur via particulate inhalation during activities such as cutting, grinding, shaping, drilling, and/or 3778 3779 abrasive actions that generate particulates from the product. Additionally, DIDP vapor inhalation 3780 exposure may occur during heating or plastic welding. EPA did not identify chemical-specific 3781 information on engineering controls and worker PPE used at final product or article formulation or use 3782 sites. Based on the presence of DIDP as an additive within solid articles or products, EPA expects 3783 particulate inhalation exposures to be higher than vapor exposures for this OES.

3784

3775

ONUs include supervisors, managers, and other employees that may be in manufacturing or use areas
but do not directly handle DIDP-containing materials or articles. ONU inhalation exposures may occur
when ONUs is present in the manufacturing area. Also, dermal exposures from contact with surfaces
where dust has been deposited were assessed for ONUs.

## 3789 **3.15.4.2** Number of Workers and Occupational Non-users

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 3790 3791 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during the 3792 fabrication and final use of products or articles. This approach involved the identification of relevant 3793 SOC codes within the BLS data for select NAICS codes. Section 2.4.2 provides further details regarding 3794 the methodology EPA used to estimating the number of workers and ONUs per site. EPA assigned the 3795 NAICS codes 236100, 236200, 237100, 237200, 237300, 237900, 337100, and 337200 for this OES 3796 based on NAICS codes that matched the relevant COUs for this scenario. Table 3-77 summarizes the per 3797 site estimates for this OES. As discussed in Section 3.15.2, EPA did not identify site-specific data for 3798 the number of facilities in the United States that fabricate or use final products or articles that contain 3799 DIDP.

# Table 3-77. Estimated Number of Workers Potentially Exposed to DIDP during the Fabrication and Final Use of Products or Articles

NAICS Code	Exposed Workers per Site <sup>a</sup>	Exposed ONUs per Site <sup>a</sup>
236100 – Residential Building Construction	2	1
236200 – Nonresidential Building Construction	9	4
237100 – Utility System Construction	12	3
237200 – Land Subdivision	1	1
237300 – Highway, Street, and Bridge Construction	20	4
237900 – Other Heavy and Civil Engineering Construction	13	3
337100 – Household and Institutional Furniture Manufacturing	5	4
337200 – Office Furniture (including Fixtures) Manufacturing	7	3
Total/Average	9	3

<sup>a</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

#### 3803

## 3.15.4.3 Occupational Inhalation Exposure Results

EPA did not identify inhalation monitoring data to assess exposures to DIDP during fabrication and final
use of products or articles containing DIDP. Based on the presence of DIDP as an additive in products
(U.S. CPSC, 2015), EPA assessed worker inhalation exposures to DIDP as an exposure to particulates of
final products. Therefore, EPA estimated worker inhalation exposures during fabrication and final use of
products using the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and
Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d). Model approaches and
parameters are described in Appendix E.16.

3811

3812 In the model, EPA used a subset of the Generic Model for Central Tendency and High-End Inhalation

3813 Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d)

data from facilities with NAICS codes starting with 337 (Furniture and Related Product Manufacturing)
 to estimate final product particulate concentrations in the air. Particulate exposures across end-use

3816 industries may include trimming, cutting, and/or abrasive actions on the DIDP-containing product, and

3817 EPA expects similar actions during furniture and related products manufacturing. EPA used the highest

3818 expected concentration of DIDP in final products to estimate the concentration of DIDP in the

3819 particulates. For this OES, EPA selected 45 percent by mass as the highest expected DIDP concentration

3820 based on the estimated plasticizer concentrations in relevant products given by the Use of Additives in

3821 Plastic Compounding Generic Scenario (U.S. EPA, 2021e). The estimated exposures assume that DIDP

is present in particulates at this fixed concentration throughout the working shift.

The *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d) estimates an 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. The model does not determine exposures during individual worker activities. EPA used the number of operating days estimated in the release assessment for this OES to estimate exposure frequency.

Table 3-78 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
exposure to DIDP during fabrication and final use of products. The high-end and central tendency
exposures both use 250 days per year as the exposure frequency based on the 95<sup>th</sup> and 50<sup>th</sup> percentiles of
operating days in the release assessment. Appendix B describes the approach for estimating AD, IADD,
and ADD. The estimated exposures assume that the worker is exposed to DIDP in the form of product
particulates and does not account for other potential inhalation exposure routes, such as from vapors.

3836

# Table 3-78. Summary of Estimated Worker Inhalation Exposures for Fabrication and Final Use of Products or Articles

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	9.0E-02	0.81
	Acute Dose (AD) (mg/kg/day)	1.1E-02	0.10
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	8.3E-03	7.4E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	7.7E-03	6.9E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	9.0E-02	0.81
Female of	Acute Dose (AD) (mg/kg/day)	1.2E-02	0.11
Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.1E-03	8.2E-02
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	8.5E-03	7.7E-02
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	9.0E-02	9.0E-02
	Acute Dose (AD) (mg/kg/day)	1.1E-02	1.1E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	8.3E-03	8.3E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	7.7E-03	7.7E-03

### 3839

## 3.15.4.4 Occupational Dermal Exposure Results

3840 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The various "Exposure Concentration Types" from Table 3-79 are explained in Appendix B. Because dermal 3841 3842 exposures of DIDP to workers is expected to occur through contact with solids or articles for this OES, 3843 EPA assessed the absorptive flux of DIDP according to dermal absorption modeling approach for solids 3844 outlined in Appendix D.2.1.2. Also, since there may be dust deposited on surfaces from this OES, 3845 dermal exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to 3846 workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to 3847 ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure.

- Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP
   were assumed representative of ONU dermal exposure.
- 3850
- 3851 Table 3-79 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate
- 3852 Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female
- 3853 workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.
- 3854

# Table 3-79. Summary of Estimated Worker Dermal Exposures for Fabrication and Final Use of Products or Articles

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
Average Adult	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Worker	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	3.3E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Female of	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
Reproductive Age	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	3.0E-04	6.1E-04
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONU.	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
ONU	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	3.3E-04	3.3E-04

3857

## 3.15.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-80.

3860

# Table 3-80. Summary of Estimated Worker Aggregate Exposures for Fabrication and Final Use of Products or Articles

Modeled Scenario	Exposure Concentration Type (mg/kg/day)	Central Tendency	High-End
	Acute (AD, mg/kg-day)	1.2E-02	0.10
Average Adult Worker	Intermediate (IADD, mg/kg-day)	8.6E-03	7.5E-02
-	Chronic, Non-cancer (ADD, mg/kg-day)	8.0E-03	7.0E-02
Female of Reproductive	Acute (AD, mg/kg-day)	1.3E-02	0.11
*	Intermediate (IADD, mg/kg-day)	9.4E-03	8.3E-02
Age	Chronic, Non-cancer (ADD, mg/kg-day)	8.8E-03	7.7E-02
	Acute (AD, mg/kg-day)	1.2E-02	1.2E-02
ONU	Intermediate (IADD, mg/kg-day)	8.6E-03	8.6E-03
	Chronic, Non-cancer (ADD, mg/kg-day)	8.0E-03	8.0E-03

#### 3.16 Recycling 3863

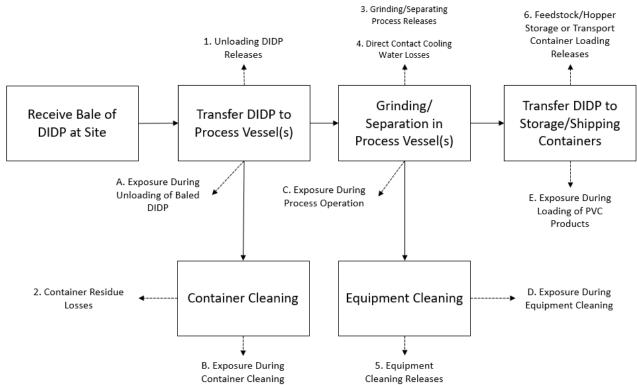
#### 3864 3.16.1 Process Description

DIDP is primarily recycled industrially in the form of DIDP-containing PVC waste streams, including 3865 roofing membranes, vinyl window frame profiles, and carpet squares. Based on a report by Sika 3866 Corporation, all roofing membrane recycling is completed using mechanical recycling technology, in the 3867 form of scrap regrinding and recycling (Irwin, 2022). While chemical/feedstock recycling is possible, 3868 3869 EPA did not identify any market share data indicating chemical/feedstock recycling processes for DIDP-3870 containing waste streams.

3871

The Association of Plastic Recyclers reported recycled PVC arrives at a typical recycling site tightly 3872 3873 baled as crushed finished articles ranging from 240 - 453 kg (APR, 2023). The bales are unloaded into process vessels, where the DIDP is grinded and separated from non-PVC fractions using electrostatic 3874 3875 separation, washing/floatation, or air/jet separation. Following cooling of grinded PVC, that the site 3876 transfers the product to feedstock storage for use in the plastics compounding or converting line or loaded into containers for shipment to downstream use sites. Figure 3-17 provides an illustration of the 3877

3878 PVC recycling process (U.S. EPA, 2021e).



3879 3880 Figure 3-17. DIDP-Containing PVC Recycling Flow Diagram

## **3.16.2 Facility Estimates**

3881 3882 ENF Recycling (ENF Plastic, 2024) estimated a total of 228 plastics recyclers operating in the United 3883 States of which 58 accept PVC wastes for recycling. It is unclear if the total number of sites includes 3884 some or all circular recycling sites - facilities where new PVC can be manufactured from recycled and virgin materials on the same site. A notice by the Sika Corporation indicated the use of sites with in-3885 3886 house post-consumer roofing membrane grinding capabilities (Irwin, 2022). Such sites would be 3887 identified primarily by the manufactured product, however compounding site parameters and release

3888 estimates are based on generic values specified in the Plastics Compounding GS and would thus 3889 incorporate all PVC material streams; recycled or virgin production (U.S. EPA, 2021e).

3890

3891 The Quantification and Evaluation of Plastic Waste in the United States estimated that of the 699 3892 kilotons of PVC waste managed in 2019, 3% was recycled or 20.970,000 kg-PVC (Milbrandt et al., 3893 2022). The 2010 technical report on the Evaluation of New Scientific Evidence Concerning DINP and 3894 DIDP estimated the fraction of DIDP-containing PVC used in the overall PVC market as 9.78% 3895 (ECHA, 2010). As a result, EPA calculated the use rate of recycled PVC plastics containing DIDP as 3896 9.78% of the yearly recycled production volume of PVC or 2,050,866 kg/year. This is comparable to the 3897 estimated production volume of DIDP-containing PVC of 43,859,857 – 434,749,009 kg/year. Plastics 3898 compounding sites may engage in the reformulation of plastics from recycled plastic products. The 2021 3899 Generic Scenario on Plastics Compounding estimated that the mass fraction of DIDP used as a 3900 plasticizer in PVC was 10 – 45% (U.S. EPA, 2021e), and EPA expects the 2021 GS to be representative 3901 of PVC recycling activities and their associated releases. EPA estimated the production volume of DIDP 3902 in PVC plastic recycled as 205,087 – 922,890 kg based on the use rate of DIDP-containing PVC in the 3903 overall market and the mass fraction of DIDP used as plasticizer in PVC. The GS estimated the total 3904 number of operating days of 148 – 264 days/year, with 24 hour/day, 7 day/week (*i.e.*, multiple shifts) 3905 operations for the given site throughput scenario (U.S. EPA, 2021e).

#### 3906 **3.16.3 Release Assessment**

#### 3907 3.16.3.1 Environmental Release Points

EPA assigned release points based on the 2021 Generic Scenario on Plastic Compounding (U.S. EPA, 3908 3909 2021e). EPA assigned default models to quantify releases from each release point and suspected fugitive 3910 air release. EPA does not expect recycling sites to utilize air pollution capture and control technologies. 3911 EPA expects fugitive air, wastewater, incineration, or landfill releases from unloading and loading, 3912 general recycling processing, container residue losses, and equipment cleaning. EPA expects wastewater 3913 releases from direct contact cooling and storage or loading of recycled plastic. EPA expects stack air 3914 releases expected from storage or loading of recycled plastic.

## 3915

## 3.16.3.2 Environmental Release Assessment Results

3916

#### 3917 Table 3-81. Summary of Modeled Environmental Releases for Recycling

Modeled	Environmental	Annual Release (kg/site-yr)		Number of Release Days		Daily Release (kg/site-day)	
Scenario	Media	Central Tendency	High-End	Central Tendency	High- End	Central Tendency	Central Tendency
	Stack Air	5.00	1.01E02			2.33E-02	4.68E-01
452,139 - 2,034,624 lb production volume	Fugitive Air, Wastewater, Incineration, or Landfill	3.60E02	6.68E02	223	254	1.84	3.36
	Wastewater	1.71E02	3.62E02			7.80E-01	1.70

### 3918 **3.16.4 Occupational Exposure Assessment**

## **3919 3.16.4.1 Worker Activities**

At PVC recycling sites, worker exposures from dermal contact with solids and inhalation may occur
 during the unloading of bailed PVC, loading of processed DIDP-containing PVC onto compounding or
 converting lines or into transport containers, processing of recycled PVC, and equipment cleaning (U.S.
 <u>EPA, 2004a</u>). EPA did not identify information on engineering controls or workers PPE used at
 recycling sites.

3925

ONUs include supervisors, managers, and other employees that work in the processing area but do not
 directly handle DIDP-containing PVC or the recycled compounded product. ONUs are potentially
 exposed through the inhalation route while in the working area. Also, dermal exposures from contact
 with surfaces where dust has been deposited were assessed for ONUs.

## 3930 **3.16.4.2** Number of Workers and Occupational Non-users

EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 3931 3932 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during 3933 recycling and disposal. This approach involved the identification of relevant SOC codes within the BLS 3934 data for select NAICS codes. Section 2.4.2 provides further details regarding the methodology EPA used 3935 to estimate the number of workers and ONUs per site. EPA assigned the NAICS codes 562212, 562213, 3936 and 562219 for this OES based on the NAICS codes that related to the process description in Section 3937 3.15.1. Table 3-82 summarizes the per site estimates for this OES. As described in Section 3.15.2, EPA 3938 did not identify site-specific data for the number of facilities in the United States that recycle and 3939 dispose of DIDP-containing materials.

3940

## Table 3-82. Estimated Number of Workers Potentially Exposed to DIDP during Recycling and Disposal

NAICS Code	Number of Sites <sup>a</sup>	Exposed Workers per Site <sup>b</sup>	Total Number of Exposed Workers <sup>a</sup>	Exposed Occupational Non- users per Site <sup>b</sup>	Total Number of Exposed ONUs <sup>a</sup>
562212 – Solid Waste Landfill		7		4	
562213 – Solid Waste Combustors and Incinerators	27 N/A	N/A	15	N/A	
562219 – Other Nonhazardous Waste Treatment and Disposal		6		3	
Total/Average	58	13	754	7	432

<sup>a</sup> Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

### 3.16.4.3 Occupational Inhalation Exposure Results

EPA did not identify inhalation monitoring data to assess exposures to DIDP during recycling processes.
Based on the presence of DIDP as an additive in plastics (U.S. CPSC, 2015), EPA assessed worker
inhalation exposures to DIDP as an exposure to particulates of recycled plastic materials. Therefore,
EPA estimated worker inhalation exposures during recycling using the *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d). Model approaches and parameters are described in Appendix
E.16.

- 3952 In the model, EPA used a subset of the Generic Model for Central Tendency and High-End Inhalation 3953 Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d) 3954 data that came from facilities with the NAICS code starting with 56 (Administrative and Support and 3955 Waste Management and Remediation Services) to estimate plastic particulate concentrations in the air. 3956 EPA used the highest expected concentration of DIDP in recyclable plastic products to estimate the 3957 concentration of DIDP present in particulates. For this OES, EPA selected 45 percent by mass as the 3958 highest expected DIDP concentration based on the estimated plasticizer concentrations in flexible PVC 3959 given by the Use of Additives in Plastic Compounding Generic Scenario (U.S. EPA, 2021e). The 3960 estimated exposures assume that DIDP is present in particulates of the plastic at this fixed concentration 3961 throughout the working shift.
- 3962

3943

3951

The *Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR)* (U.S. EPA, 2021d) estimates an 8-hour TWA for particulate concentrations by assuming exposures outside the sample duration are zero. The model does not determine exposures during individual worker activities. EPA used the number of operating days estimated in the release assessment for this OES to estimate exposure frequency, with a maximum exposure frequency of 250 working days per year.

3969

3970 Table 3-83 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker 3971 exposures to DIDP during recycling. The high-end exposures use 250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per 3972 year, which is the expected maximum number of working days. The central tendency exposures use 223 3973 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release 3974 3975 assessment. Appendix B describes the approach for estimating AD, IADD, and ADD. The estimated 3976 exposures assume that the worker is exposed to DIDP in the form of plastic particulates and does not 3977 account for other potential inhalation exposure routes, such as from the inhalation of vapors.

3978

## 3979 Table 3-83. Summary of Estimated Worker Inhalation Exposures for Recycling

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
Average Adult Worker	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	1.6
	Acute Dose (AD) (mg/kg/day)	1.4E-02	0.20
	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.9E-03	0.14
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	8.2E-03	0.13

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	1.6
Espela of Depreductive	Acute Dose (AD) (mg/kg/day)	1.5E-02	0.22
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.1E-02	0.16
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	9.1E-03	0.15
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	0.11
	Acute Dose (AD) (mg/kg/day)	1.4E-02	1.4E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.9E-03	9.9E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	8.2E-03	9.2E-03

#### 3980

## 3.16.4.4 Occupational Dermal Exposure Results

3981 EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The 3982 various "Exposure Concentration Types" from Table 3-84 are explained in Appendix B. Because dermal 3983 exposures of DIDP to workers is expected to occur through contact with solids or articles for this OES, 3984 EPA assessed the absorptive flux of DIDP according to dermal absorption modeling approach for solids 3985 outlined in Appendix D.2.1.2. Also, since there may be dust deposited on surfaces from this OES, 3986 dermal exposures to ONUs from contact with dust on surfaces were assessed. Dermal exposure to 3987 workers is generally expected to be greater than dermal exposure to ONUs. In absence of data specific to 3988 ONU exposure, EPA assumes that worker central tendency exposure is representative of ONU exposure. 3989 Therefore, worker central tendency exposure values for dermal contact with solids containing DIDP 3990 were assumed representative of ONU dermal exposure.

workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.

3991

Table 3-84 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female

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3995

2000	T-11. 2 04 C	- f T-Alera - A - J	Western Design	F	D
3996	Table 3-84. Summary	of Estimated	worker Dermai	Exposures for	Kecychng

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
Average Adult	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Worker	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Female of	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
Reproductive Age	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-04	6.1E-04
ONU	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	3.3E-04

#### 3997

#### 3.16.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-85.

4000 4001

### Table 3-85. Summary of Estimated Worker Aggregate Exposures for Recycling

Modeled Scenario	Exposure Concentration Type	Exposure Concentration Type Central	
	(mg/kg/day)	Tendency	
	Acute (AD, mg/kg-day)	1.4E-02	0.20
Average Adult Worker	Intermediate (IADD, mg/kg-day)	1.0E-02	0.15
-	Chronic, Non-cancer (ADD, mg/kg-day)	8.5E-03	0.14
Female of Reproductive Age	Acute (AD, mg/kg-day)	1.5E-02	0.22
	Intermediate (IADD, mg/kg-day)	1.1E-02	0.16
	Chronic, Non-cancer (ADD, mg/kg-day)	9.4E-03	0.15
	Acute (AD, mg/kg-day)	1.4E-02	1.4E-02
ONU	Intermediate (IADD, mg/kg-day)	1.0E-02	1.0E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	8.5E-03	9.6E-03

## 4002 **3.17 Disposal**

#### 4003

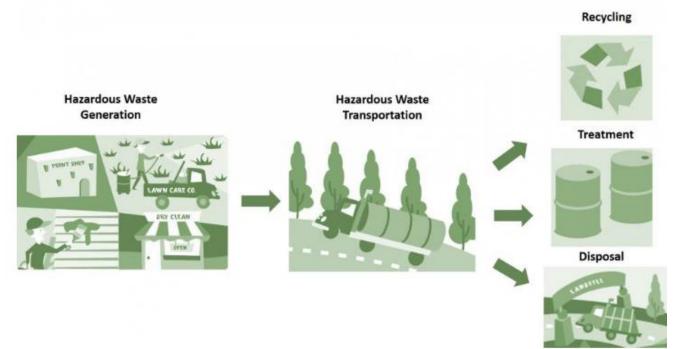
## 3.17.1 Process Description

4004 Each of the conditions of use of DIDP may generate waste streams of the chemical that are collected and 4005 transported to third-party sites for disposal, treatment, or recycling. Wastes of DIDP that are generated 4006 during a condition of use and sent to a third-party site for treatment, disposal, or recycling may include 4007 the following:

Wastewater: DIDP may be contained in wastewater discharged to POTW or other, non-public
treatment works for treatment. Industrial wastewater containing DIDP discharged to a POTW may
be subject to EPA or authorized NPDES state pretreatment programs. The assessment of wastewater
discharges to POTWs and non-public treatment works of DIDP is included in each of the condition
of use assessments in Sections 3.1 through 3.16.

4013 **Solid Wastes**: Solid wastes are defined under RCRA as any material that is discarded by being: 4014 abandoned; inherently waste-like; a discarded military munition; or recycled in certain ways (certain instances of the generation and legitimate reclamation of secondary materials are exempted as solid 4015 4016 wastes under RCRA). Solid wastes may subsequently meet RCRA's definition of hazardous waste by either being listed as a waste at 40 CFR §§ 261.30 to 261.35 or by meeting waste-like 4017 4018 characteristics as defined at 40 CFR §§ 261.20 to 261.24. Solid wastes that are hazardous wastes are 4019 regulated under the more stringent requirements of Subtitle C of RCRA, whereas non-hazardous 4020 solid wastes are regulated under the less stringent requirements of Subtitle D of RCRA. DIDP is not 4021 listed as a toxic chemical as specified in Subtitle C of RCRA, and not subject to hazardous waste 4022 regulation. However, solid wastes containing DIDP may require regulation if the waste leaches 4023 constituents, specified in the toxicity characteristic leaching procedure (TLCP), in excess of the 4024 regulatory limit. This could include toxins such as lead and cadmium, which are used as stabilizers

- 4025 in PVC. The assessment of solid waste discharges of DIDP is included in each of the condition of 4026 use assessments in Sections 3.1 through 3.16.
- 4027
- Off-site transfers of DIDP and DIDP-containing substances to land disposal, wastewater treatment, 4028 incineration, and recycling facilities are expected based on industry supplied data, and published EPA
- 4029 and OECD emission documentation such as Generic Scenarios and Emission Scenario Documents. Off-
- 4030 site transfers are incinerated, sent to land disposal, sent to wastewater treatment, are recycled off-site,
- 4031 and or are sent to other or unknown off-site disposal/treatment. See Figure 3-18.



#### 4032 4033 Figure 3-18. Typical Waste Disposal Process

4034 Source: (U.S. EPA, 2017) (https://www.epa.gov/hw/learn-basics-hazardous-waste)

4035

#### 4036 **Municipal Waste Incineration**

4037 Municipal waste combustors (MWCs) that recover energy are generally located at large facilities 4038 comprising an enclosed tipping floor and a deep waste storage pit. Typical large MWCs may range in 4039 capacity from 250 to over 1,000 tons per day. At facilities of this scale, waste materials are not generally 4040 handled directly by workers. Trucks may dump the waste directly into the pit, or waste may be tipped to 4041 the floor and later pushed into the pit by a worker operating a front-end loader. A large grapple from an 4042 overhead crane is used to grab waste from the pit and drop it into a hopper, where hydraulic rams feed 4043 the material continuously into the combustion unit at a controlled rate. The crane operator also uses the 4044 grapple to mix the waste within the pit, in order to provide a fuel consistent in composition and heating 4045 value, and to pick out hazardous or problematic waste.

4046

4047 Facilities burning refuse-derived fuel (RDF) conduct on-site sorting, shredding, and inspection of the 4048 waste prior to incineration to recover recyclables and remove hazardous waste or other unwanted 4049 materials. Sorting is usually an automated process that uses mechanical separation methods, such as 4050 trommel screens, disk screens, and magnetic separators. Once processed, the waste material may be 4051 transferred to a storage pit, or it may be conveyed directly to the hopper for combustion.

4052

4053 Tipping floor operations may generate dust. Air from the enclosed tipping floor, however, is

4054 continuously drawn into the combustion unit via one or more forced air fans to serve as the primary

4055 combustion air and minimize odors. Dust and lint present in the air is typically captured in filters or 4056 other cleaning devices to prevent the clogging of steam coils, which are used to heat the combustion air

- 4057 and help dry higher-moisture inputs.<sup>5</sup>
- 4058

## 4059 Hazardous Waste Incineration

4060 Commercial scale hazardous waste incinerators are generally two-chamber units, a rotary kiln followed 4061 by an afterburner, that accept both solid and liquid waste. Liquid wastes are pumped through pipes and 4062 are fed to the unit through nozzles that atomize the liquid for optimal combustion. Solids may be fed to 4063 the kiln as loose solids gravity fed to a hopper, or in drums or containers using a conveyor<sup>6,7</sup>.

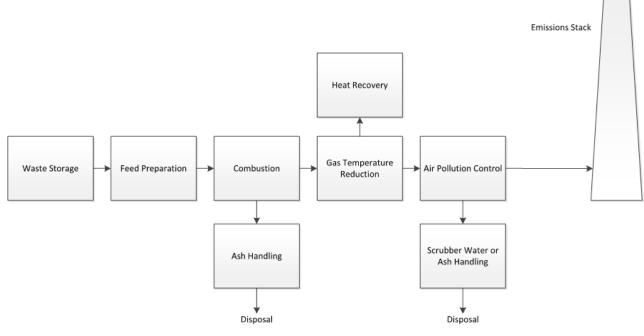
4064

Incoming hazardous waste is usually received by truck or rail, and an inspection is required for all waste
received. Receiving areas for liquid waste generally consist of a docking area, pumphouse, and some
kind of storage facilities. For solids, conveyor devices are typically used to transport incoming waste.

4068

4069 Smaller scale units that burn municipal solid waste or hazardous waste (such as infectious and hazardous

- 4070 waste incinerators at hospitals) may require more direct handling of the materials by facility personnel.
- 4071 Units that are batch-loaded require the waste to be placed on the grate prior to operation and may
- 4072 involve manually dumping waste from a container or shoveling waste from a container onto the grate.
- 4073 See Figure 3-19 for a typical incineration process.



4074

4075 Figure 3-19. Typical Industrial Incineration Process

- 4076
- 4077 Municipal Waste Landfill

<sup>&</sup>lt;sup>5</sup> J.B. Kitto, Eds., Steam: Its Generation and Use, 40th Edition, Babcock and Wilcox/American Boiler Manufacturers Association, 1992.

<sup>&</sup>lt;sup>6</sup> Environmental Technology Council's Hazardous Waste Resource Center;

http://www.etc.org/advanced-technologies/high-temperature-incineration.aspx

<sup>&</sup>lt;sup>7</sup> Incineration Services; Heritage; https://www.heritage-enviro.com/services/incineration/

- 4078 Municipal solid waste landfills are discrete areas of land or excavated sites that receive household
- 4079 wastes and other types of non-hazardous wastes (e.g., industrial and commercial solid wastes).
- 4080 Standards and requirements for municipal waste landfills include location restrictions, composite liner
- 4081 requirements, leachate collection and removal system, operating practices, groundwater monitoring
- 4082 requirements, closure-and post-closure care requirements, corrective action provisions, and financial
- 4083 assurance. Non-hazardous solid wastes are regulated under RCRA Subtitle D, but state may impose
   4084 more stringent requirements.
- 4085
- 4086 Municipal solid wastes may be first unloaded at waste transfer stations for temporary storage, prior to 4087 being transported to the landfill or other treatment or disposal facilities.
- 4088

## 4089 Hazardous Waste Landfill

Hazardous waste landfills are excavated or engineered sites specifically designed for the final disposal of non-liquid hazardous wastes. Design standards for these landfills require double liner, double leachate collection and removal systems, leak detection system, run on, runoff and wind dispersal controls, and construction quality assurance program.<sup>8</sup> There are also requirements for closure and post-closure, such as the addition of a final cover over the landfill and continued monitoring and maintenance. These standards and requirements prevent potential contamination of groundwater and nearby surface water resources. Hazardous waste landfills are regulated under Part 264/265, Subpart N.

4097 **3.17.2 Facility Estimates** 

4098 EPA assumes that all DIDP-containing products from all OES will be disposed of in some fashion. The 4099 concentration of DIDP in these products varies depending on the type of product and the necessary 4100 characteristics of that product. EPA did not identify representative site- or chemical-specific operating 4101 data for this OES (*i.e.*, facility throughput, number of sites, total production volume, operating days, 4102 product concentration), as DIDP-containing wastes occur at all levels of the DIDP life cycle. EPA 4103 expects disposal routes to include POTW and non-publicly owned treatment works; municipal and 4104 hazardous waste incineration; and municipal and hazardous waste landfill. Due to a lack of readily 4105 available information for this OES, the number of industrial or commercial use sites is unquantifiable 4106 and unknown. Total production volume for this OES is also unquantifiable, and EPA assumed that each 4107 end use site utilizes a small number of finished articles containing DIDP. EPA assumed the number of 4108 operating days was 250 days/year with 5 day/week operations and two full weeks of downtime each 4109 operating year.

- 4110 **3.17.3 Release Assessment**
- 4111

# 3.17.3.1 Environmental Release Points

EPA did not quantitatively assess environmental releases for this OES due to the lack of readily available process-specific and DIDP-specific data; however, EPA expects releases from this OES to be small and disperse in comparison to other upstream OES, as EPA expects DIDP to be present in smaller amounts and predominantly remain in the disposed article, solution, or material, limiting the potential for release. Releases to all media are possible and all releases are non-quantifiable due to a lack of identified process- and product- specific data.

<sup>&</sup>lt;sup>8</sup> https://www.epa.gov/hwpermitting/hazardous-waste-management-facilities-and-units.

#### 4118 **3.17.4 Occupational Exposure Assessment**

#### 4119 3.17.4.1 Worker Activities

4120 At waste disposal sites, workers are potentially exposed via dermal contact with waste containing DIDP 4121 or via inhalation of DIDP vapor or dust. Depending on the concentration of DIDP in the waste stream, 4122 the route and level of exposure may be similar to that associated with container unloading activities. See

- 4123 3.2.4.1 for the assessment of worker exposure from chemical unloading activities.
- 4124

#### 4125 Municipal Waste Incineration

4126 At municipal waste incineration facilities, there may be one or more technicians present on the tipping 4127 floor to oversee operations, direct trucks, inspect incoming waste, or perform other tasks as warranted by 4128 individual facility practices. These workers may wear protective gear such as gloves, safety glasses, or dust masks. Specific worker protocols are largely up to individual companies, although state or local 4129 4130 regulations may require certain worker safety standards be met. Federal operator training requirements 4131 pertain more to the operation of the regulated combustion unit rather than operator health and safety.

4132

4133 Workers are potentially exposed via inhalation to vapors while working on the tipping floor. Potentially 4134 exposed workers include workers stationed on the tipping floor, including front-end loader and crane

4135 operators, as well as truck drivers. The potential for dermal exposures is minimized by the use of trucks 4136 and cranes to handle the wastes.

#### 4138 Hazardous Waste Incineration

4139 More information is needed to determine the potential for worker exposures during hazardous waste 4140 incineration and any requirements for personal protective equipment. There is likely a greater potential 4141 for worker exposures for smaller scale incinerators that involve more direct handling of the wastes.

4142

4137

#### 4143 Municipal and Hazardous Waste Landfill

4144 At landfills, typical worker activities may include operating refuse vehicles to weigh and unload the 4145 waste materials, operating bulldozers to spread and compact wastes, and monitoring, inspecting, and 4146 surveying and landfill site.<sup>9</sup>

## 3.17.4.2 Number of Workers and Occupational Non-users

4147 EPA used data from the BLS and the U.S. Census' SUSB (U.S. BLS, 2016; U.S. Census Bureau, 2015) 4148 4149 to estimate the number of workers and ONUs per site that are potentially exposed to DIDP during 4150 recycling and disposal. This approach involved the identification of relevant SOC codes within the BLS 4151 data for select NAICS codes. Section 2.4.2 provides further details regarding the methodology EPA used 4152 to estimate the number of workers and ONUs per site. EPA assigned the NAICS codes 562212, 562213, 4153 and 562219 for this OES based on the NAICS codes that related to the process description in Section 4154 3.17.1. Table 3-86 summarizes the per site estimates for this OES. As described in Section 3.17.2, EPA 4155 did not identify site-specific data for the number of facilities in the United States that recycle and

- dispose of DIDP-containing materials. 4156
- 4157

<sup>&</sup>lt;sup>9</sup> http://www.calrecycle.ca.gov/SWfacilities/landfills/needfor/Operations.htm

7 27	N/A	4	
27	N/A	15	
	IN/A	15	N/A
6		3	
13	754	7	432
	13	13 754	13 754 7

#### Table 3-86. Estimated Number of Workers Potentially Exposed to DIDP during Recycling and 4158 Disposal

4159

<sup>a</sup> Results were not assessed by NAICS code for this scenario.

<sup>b</sup> Number of workers and occupational non-users per site are calculated by dividing the total number of exposed workers or occupational non-users by the total number of establishments for a given NAICS code. The number of workers and occupational non-users are rounded to the nearest integer. Values which would otherwise be displayed as "0" are left unrounded.

#### 4160

## 3.17.4.3 Occupational Inhalation Exposure Results

EPA did not identify inhalation monitoring data to assess exposures to DIDP during disposal processes. 4161 Based on the presence of DIDP as an additive in plastics (U.S. CPSC, 2015), EPA assessed worker 4162 4163 inhalation exposures to DIDP as an exposure to particulates of discarded plastic materials. Therefore, EPA estimated worker inhalation exposures during disposal using the Generic Model for Central 4164 Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise 4165 4166 Regulated (PNOR) (U.S. EPA, 2021d). Model approaches and parameters are described in Appendix E.16. 4167

4168

4169 In the model, EPA used a subset of the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d) 4170

data that came from facilities with the NAICS code starting with 56 (Administrative and Support and 4171

4172 Waste Management and Remediation Services) to estimate plastic particulate concentrations in the air.

4173 EPA used the highest expected concentration of DIDP in plastic products to estimate the concentration

4174 of DIDP present in particulates. For this OES, EPA selected 45 percent by mass as the highest expected DIDP concentration based on the estimated plasticizer concentrations in flexible PVC given by the Use 4175

of Additives in Plastic Compounding Generic Scenario (U.S. EPA, 2021e). The estimated exposures 4176

- 4177 assume that DIDP is present in particulates of the plastic at this fixed concentration throughout the 4178 working shift.
- 4179

4180 The Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable

4181 Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d) estimates an 8-hour TWA for

particulate concentrations by assuming exposures outside the sample duration are zero. The model does 4182

- 4183 not determine exposures during individual worker activities. EPA used the number of operating days
- 4184 estimated in the release assessment for this OES to estimate exposure frequency, with a maximum 4185
- 4185 exposure frequency of 250 working days per year.
- 4186
- 4187 Table 3-87 summarizes the estimated 8-hour TWA concentration, AD, IADD, and ADD for worker
- 4188 exposures to DIDP during disposal. The high-end exposures use 250 days per year as the exposure
- 4189 frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per
- 4190 year, which is the expected maximum number of working days. The central tendency exposures use 223 4191 days per year as the exposure frequency based on the  $50^{\text{th}}$  percentile of operating days from the release
- 4192 assessment. Appendix B describes the approach for estimating AD, IADD, and ADD. The estimated
- 4193 exposures assume that the worker is exposed to DIDP in the form of plastic particulates and does not
- 4195 exposures assume that the worker is exposed to DIDP in the form of plastic particulates and 4194 account for other potential inhalation exposure routes, such as from the inhalation of vapors.
  - 4194

Modeled Scenario	Exposure Concentration Type	Central Tendency	High-End
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	1.6
	Acute Dose (AD) (mg/kg/day)	1.4E-02	0.20
Average Adult Worker	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.9E-03	0.14
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	8.2E-03	0.13
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	1.6
Famala of Barraduativa	Acute Dose (AD) (mg/kg/day)	1.5E-02	0.22
Female of Reproductive Age	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	1.1E-02	0.16
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	9.1E-03	0.15
	8-hr TWA Exposure Concentration to Dust (mg/m <sup>3</sup> )	0.11	0.11
	Acute Dose (AD) (mg/kg/day)	1.4E-02	1.4E-02
ONU	Intermediate Non-cancer Exposures (IADD) (mg/kg/day)	9.9E-03	9.9E-03
	Chronic Average Daily Dose, Non-cancer Exposures (ADD) (mg/kg/day)	8.2E-03	9.2E-03

## 4196 **Table 3-87. Summary of Estimated Worker Inhalation Exposures for Disposal**

## 4197 **3.17.4.4 Occupational Dermal Exposure Results**

EPA estimated dermal exposures for this OES using the methodology outlined in Appendix D. The
 various "Exposure Concentration Types" from .

4200

Table 3-88 are explained in Appendix B. Because dermal exposures of DIDP to workers is expected to
occur through contact with solids or articles for this OES, EPA assessed the absorptive flux of DIDP
according to dermal absorption modeling approach for solids outlined in Appendix D.2.1.2. Also, since

4204 there may be dust deposited on surfaces from this OES, dermal exposures to ONUs from contact with

4205 dust on surfaces were assessed. Dermal exposure to workers is generally expected to be greater than

- 4206 dermal exposure to ONUs. In absence of data specific to ONU exposure, EPA assumes that worker
- 4207 central tendency exposure is representative of ONU exposure. Therefore, worker central tendency
- 4208 exposure values for dermal contact with solids containing DIDP were assumed representative of ONU4209 dermal exposure..
- 4210
- 4211 Table 3-88 summarizes the Acute Potential Dose Rate (APDR), the Acute Dose (AD), the Intermediate
- 4212 Average Daily Dose (IADD), and the Average Daily Dose (ADD) for average adult workers, female
- 4213 workers of reproductive age, and ONUs. Dermal exposure parameters are described in Appendix D.
- 4214

Worker Population	Exposure Concentration Type	Central Tendency	High-End
	Dose Rate (APDR, mg/day)	3.9E-02	7.7E-02
Average Adult	Acute (AD, mg/kg-day)	4.8E-04	9.6E-04
Worker	Intermediate (IADD, mg/kg-day)	3.5E-04	7.1E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	6.6E-04
	Dose Rate (APDR, mg/day)	3.2E-02	6.4E-02
Female of Reproductive Age	Acute (AD, mg/kg-day)	4.4E-04	8.8E-04
	Intermediate (IADD, mg/kg-day)	3.2E-04	6.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.7E-04	6.1E-04
	Dose Rate (APDR, mg/day)	3.9E-02	3.9E-02
ONIT	Acute (AD, mg/kg-day)	4.8E-04	4.8E-04
ONU	Intermediate (IADD, mg/kg-day)	3.5E-04	3.5E-04
	Chronic, Non-cancer (ADD, mg/kg-day)	2.9E-04	3.3E-04

## 4215 Table 3-88. Summary of Estimated Worker Dermal Exposures for Disposal

## 3.17.4.5 Occupational Aggregate Exposure Results

Inhalation and dermal exposure estimates were aggregated based on the approach described in AppendixB.3 to arrive at the aggregate worker and ONU exposure estimates in Table 3-89.

4219

4216

## 4220 Table 3-89. Summary of Estimated Worker Aggregate Exposures for Disposal

Modeled Scenario	Exposure Concentration Type	Central	High-End
	(mg/kg/day)	Tendency	
Average Adult Worker	Acute (AD, mg/kg-day)	1.4E-02	0.20
	Intermediate (IADD, mg/kg-day)	1.0E-02	0.15
	Chronic, Non-cancer (ADD, mg/kg-day)	8.5E-03	0.14
Female of Reproductive	Acute (AD, mg/kg-day)	1.5E-02	0.22
Age	Intermediate (IADD, mg/kg-day)	1.1E-02	0.16
	Chronic, Non-cancer (ADD, mg/kg-day)	9.4E-03	0.15
ONU	Acute (AD, mg/kg-day)	1.4E-02	1.4E-02
	Intermediate (IADD, mg/kg-day)	1.0E-02	1.0E-02
	Chronic, Non-cancer (ADD, mg/kg-day)	8.5E-03	9.6E-03

## 4221 **3.18 Distribution in Commerce**

## 3.18.1 Process Description

Distribution in commerce involves loading and unloading activities (throughout various life cycle stages), transit activities, temporary storage, warehousing, and spill cleanup of DIDP. Loading and unloading activities are generally interpreted as part of distribution in commerce; however, the releases and exposures resulting from these activities are covered within each individual OES where the activity occurs (*i.e.*, unloading of imported DIDP is covered under the import OES). Similarly, tank cleaning activities which occur after unloading of DIDP are also assessed as part of individual OESs where the activity occurs.

4230

4222

4231 Some worker activities associated with distribution in commerce (*e.g.*, loading and unloading) are

- 4232 expected to be similar to other OESs such as manufacturing or import; however, it is also expected that
- 4233 workers involved in distribution in commerce spend less time exposed to DIDP than workers in
- 4234 manufacturing or import facilities since only part of the workday is spent in an area with potential
- 4235 exposure. In conclusion, occupational exposures associated with the distribution in commerce COU are
- 4236 expected to be less than other COUs including manufacturing and import.

# 4237 **4 WEIGHT OF SCIENTIFIC EVIDENCE CONCLUSIONS**

## 4238 **4.1 Environmental Releases**

For each OES, EPA considered the assessment approach; the quality of the data and models; and the 4239 4240 strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to 4241 determine a weight of scientific evidence rating. EPA considered factors that increase or decrease the strength of the evidence supporting the release estimate (e.g., quality of the data/information), the 4242 4243 applicability of the release or exposure data to the OES (*e.g.*, temporal relevance, locational relevance), 4244 and the representativeness of the estimate for the whole industry. EPA used the descriptors of robust, 4245 moderate, slight, or indeterminant to categorize the available scientific evidence using its best 4246 professional judgment, according to EPA's Application of Systematic Review in TSCA Risk Evaluations 4247 (U.S. EPA, 2021a). For example, EPA used moderate to categorize measured release data from a limited 4248 number of sources, such that there is a limited number of data points that may not cover most or all the 4249 sites within the OES. EPA used slight to describe limited information that does not sufficiently cover all 4250 sites within the OES, and for which the assumptions and uncertainties are not fully known or 4251 documented. See EPA's Application of Systematic Review in TSCA Risk Evaluations (U.S. EPA, 2021a) 4252 for additional information on weight of scientific evidence conclusions. 4253

Table 4-1 provides a summary of EPA's overall confidence in its inhalation exposure estimates for eachOES.

## 4256 Table 4-1. Summary of Assumptions, Uncertainty, and Overall Confidence in Release Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Release Estimates
Manufacturing	EPA found limited chemical specific data for the manufacturing OES and assessed environmental releases using models and model parameters derived from CDR, the <i>2023 Methodology for Estimating Environmental Releases from Sampling Wastes</i> (U.S. EPA, 2023b), and sources identified through systematic review (including industry supplied data). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from EPA/OPPT models and industry supplied data. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than a discrete value. Additionally, Monte Carlo modeling uses a large number of data points (simulation runs) and considers the full distributions of input parameters. EPA used facility-specific DIDP manufacturing volumes for all facilities that reported this information to CDR and DIDP-specific operating parameters derived using data with a high data quality ranking from a current U.S. manufacturing site to provide more accurate estimates than the generic values provided by the EPA/OPPT models. The primary limitation of EPA's approach is the uncertainty in the representativeness of release estimates toward the true distribution of potential releases. In addition, EPA lacks DIDP facility production volume data for some DIDP manufacturing sites that claim this information as CBI for the purposes of CDR reporting; therefore, throughput estimates for these sites are based on the CDR reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of magnitude. Additional limitations include uncertainties in the representativeness of the industry-provided operating parameters and the generic EPA/OPPT models for all DIDP manufacturing sites. Based on this information, EPA concluded that the weight of scientific evidence for th
Import and Repackaging	EPA found limited chemical specific data for the import and repackaging OES and assessed releases to the environment using the assumptions and values from the <i>Chemical Repackaging GS</i> , which the systematic review process rated high for data quality ( <u>U.S. EPA, 2022a</u> ). EPA also referenced the <i>2023 Methodology for Estimating Environmental Releases from Sampling Wastes</i> ( <u>U.S. EPA, 2023b</u> ) and used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment. EPA assessed the media of release using assumptions from the ESD and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases at sites than discrete value. Additionally, Monte Carlo modeling uses a high number of data points (simulation runs) and the full distributions of input parameters. EPA used facility specific DIDP import volumes for all facilities that reported this information to CDR. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, because the default values in the ESD are generic, there is uncertainty in the representativeness of these generic site estimates in characterizing actual releases from real-world sites that import and repackaging sites that claim this information as CBI; therefore, throughput estimates for these sites are based on the CDR reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of magnitude. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
Incorporation into Adhesives	EPA found limited chemical specific data for the incorporation into adhesives and sealants OES and assessed releases to the environment using the <i>ESD on the Formulation of Adhesives</i> , which has a high data quality rating based on the systematic review process (OECD, 2009a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment and assessed the media of release using assumptions from the ESD and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases at sites than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in adhesive and sealant products in the analysis to provide more accurate estimates than the generic values provided by the ESD. EPA based the production volume for the OES on use rates cited by the ACC (2020a) and referenced the <i>2003 EU Risk Assessment Report</i> (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario.
and Sealants	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the default values in the ESD may not be representative of actual releases from real-world sites that incorporate DIDP into adhesives and sealants. In addition, EPA lacks data on DIDP-specific facility production volume and number of formulation sites; therefore, EPA based throughput estimates on CDR which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of magnitude. The respective share of DIDP use for each OES (as presented in the <i>EU Risk Assessment Report</i> ) may differ from actual conditions adding additional uncertainty to estimated releases. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Incorporation into Paints and Coatings	EPA found limited chemical specific data for the incorporation into paints and coatings OES and assessed releases to the environment using the <i>Draft GS for the Formulation of Waterborne Coatings</i> , which has a medium data quality rating based on systematic review (U.S. EPA, 2014a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment and assessed the media of release using assumptions from the GS and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than a discrete value. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in paint and coating products to provide more accurate estimates of DIDP concentrations than the generic values provided by the GS. EPA based the production volume for the OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment <i>Report</i> (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS are specific to waterborne coatings and may not be representative of releases from real-world sites that incorporate DIDP into paints and coatings, particularly for sites formulation other coating types ( <i>e.g.</i> , solvent-borne coatings). In addition, EPA lacks data on DIDP-specific facility production volume and number of formulation sites; therefore, EPA based throughput estimates on CDR which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	<ul> <li>magnitude. The share of DIDP use for each OES presented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases.</li> <li>Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.</li> </ul>
Incorporation into Other Formulations, Mixtures, and Reaction Products Not Covered Elsewhere	EPA found limited chemical specific data for the incorporation into other formulations, mixtures, and reaction products not covered elsewhere OES and assessed releases to the environment using the <i>Draft GS for the Formulation of Waterborne Coatings</i> , which has a medium data quality rating based on systematic review process (U.S. EPA, 2014a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in other formulation, mixture, and reaction products in the analysis to provide more accurate estimates than the generic values provided by the GS. The safety and product data sheets that EPA obtained these values from have high data quality ratings based on the systematic review process. EPA based the production volume for the OES on rates cited by the ACC (2020a) and referenced the <i>2003 EU Risk Assessment Report</i> (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of paths and coatings and may not represent releases from real-world sites that incorporate DIDP into other formulations, mixtures, or reaction products. In addition, EPA lacks data on DIDP-specific facility production volume and number of formulation sites; therefore, EPA based the throughput estimates on CDR which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases.
PVC Plastics Compounding	EPA found limited chemical specific data for the PVC plastics compounding OES and assessed releases to the environment using the <i>Revised Draft GS for the Use of Additives in Plastic Compounding</i> , which has a medium data quality rating based on systematic review (U.S. EPA, 2021e). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in different DIDP-containing PVC plastic products and PVC-specific additive throughputs in the analysis. These data provide more accurate estimates than the generic values provided by the GS. The safety and product data sheets that EPA obtained these values from have high data quality ratings based on systematic review. EPA based production volumes for the OES on rates cited by the ACC (2020a) and referenced the 2003 <i>EU Risk Assessment Report</i> (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD consider all types of plastic compounding and may not represent releases from real-world sites that compound DIDP into PVC plastic raw material. In addition, EPA lacks data on DIDP-specific facility production volume and number of compounding sites; therefore, EPA estimated throughput based on CDR which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of magnitude. The respective share of DIDP use for each OES presented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
PVC Plastics Converting	EPA found limited chemical specific data for the PVC plastics converting OES and assessed releases to the environment using the <i>Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry</i> , which has a medium data quality rating based on systematic review (U.S. EPA, 2021f). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values is more likely to capture actual releases than discrete values. Monte Carlo also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in different DIDP-containing PVC plastic products and PVC-specific additive throughputs in the analysis. These data provide more accurate estimates than the generic values provided by the GS. The safety and product data sheets that EPA used to obtain these values have high data quality ratings based on systematic review. EPA based the production volume for the OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD are based on all types of thermoplastics converting sites and processes and may not represent actual releases from real-world sites that convert DIDP-containing PVC raw material into PVC articles using a variety of methods, such as extrusion or calendaring. In addition, EPA lacks data on DIDP-specific facility production volume and number of converting sites; therefore, EPA estimated throughput based on CDR which has
Non-PVC Material Compounding	EPA found limited chemical specific data for the non-PVC material compounding OES and assessed releases to the environment using the <i>Revised Draft GS for the Use of Additives in Plastic Compounding</i> and the <i>ESD on Additives in the Rubber Industry</i> . Both sources have a medium data quality rating based on the systematic review process (U.S. EPA, 2021e; OECD, 2004a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS, ESD, and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific concentration data for different DIDP-containing rubber products in the analysis. These data provide more accurate estimates than the generic values provided by the GS and ESD. The safety and product data sheets that EPA obtained these values from have high data quality ratings based on systematic review. EPA based the production volume for the OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario.
	The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS and ESD are based on all types of plastic compounding and rubber manufacturing, and the DIDP-specific concentration data only consider rubber products. As a result, these values may not be representative of actual releases from real-world sites that compound DIDP into non-PVC material. In addition, EPA lacks data on DIDP-specific facility production volume and number of compounding sites; therefore, EPA estimated throughput based on CDR which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented) and an annual DIDP production volume range that spans an order of magnitude. The respective share of DIDP use for each OES presented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.
Non-PVC Material Converting	EPA found limited chemical specific data for the non-PVC material converting OES and assessed releases to the environment using the <i>Revised Draft GS on the Use of Additives in the Thermoplastics Converting Industry</i> and the <i>ESD on Additives in the Rubber Industry</i> . Both documents have a medium data quality rating based on systematic review (U.S. EPA, 2021f; OECD, 2004a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS, ESD, and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in different DIDP-containing rubber products in the analysis. These data provide more accurate estimates than the generic values provided by the GS and ESD. The safety and product data sheets that EPA obtained these values from have high data quality ratings based on the systematic review process. EPA based the production volume for the OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specific ally, the generic default values in the GS and ESD consider all types of plastic converting and rubber manufacturing sites, and the DIDP-specific facility production volume and number of converting sites; therefore, EPA based throughput estimates on values from industry SeBCC documents, CDR data (which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented), and

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	<ul> <li>magnitude. The share of DIDP use for each OES presented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases.</li> <li>Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of the reasonably available data.</li> </ul>
Application of Adhesives and Sealants	EPA found limited chemical specific data for the application of adhesives and sealants OES and assessed releases to the environment using the <i>ESD on the Use of Adhesives</i> , which has a medium data quality rating based on systematic review (OECD, 2015a). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the ESD and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentration and application methods for different DIDP-containing adhesives and sealant products in the analysis. These data provide more accurate estimates than the generic values provided by the ESD. The safety and product data sheets from which these values were obtained have high data quality ratings from the systematic review process. EPA based OES PV on rates cited by the ACC (2020a), which references the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD may not represent releases from real-world sites that incorporate DIDP into adhesives and sealants. In addition, EPA lacks data on DIDP-specific facility use volume and number of use sites; therefore, EPA based throughput estimates on values from industry SpERC documents, CDR data (which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential releases. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is mod
Application of Paints and Coatings	EPA found limited chemical specific data for the application of paints and coatings OES and assessed releases to the environment using the <i>ESD on the Application of Radiation Curable Coatings, Inks and Adhesives,</i> the <i>GS on Coating Application via Spray Painting in the Automotive Refinishing Industry</i> , the <i>GS on Spray Coatings in the Furniture Industry</i> . These documents have a medium data quality rating based on the systematic review process (U.S. EPA, 2014b; OECD, 2011b; U.S. EPA, 2004d). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment. EPA assessed media of release using assumptions from the ESD, GS, and EPA/OPPT models and a default assumption that all paints and coatings are applied via spray application. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentration and application methods for different DIDP-containing paints and coatings in the analysis. These data provide more accurate estimates than the generic values provided by the GS and ESDs. The safety and product data sheets that EPA obtained these values from have high data quality ratings based on the systematic review process. EPA based production volumes for these

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario.         The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS and ESDs may not represent releases from real-world sites that incorporate DIDP into paints and coatings. Additionally, EPA assumes spray applications of the coatings, which may not be representative of other coating application methods. In addition, EPA lacks data on DIDP-specific facility use volume and number of use sites; therefore, EPA based throughput estimates on values from industry SpERC documents, CDR data (which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented), and an annual DIDP production volume range that spans an order of magnitude. The share of DIDP use for each OES presented in the EU Risk Assessment Report may differ from actual conditions adding some uncertainty to estimated releases.
	Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data
Use of Laboratory Chemicals	EPA found limited chemical specific data for the use of laboratory chemicals OES and assessed releases to the environment using the <i>Draft GS on the Use of Laboratory Chemicals</i> , which has a high data quality rating based on systematic review (U.S. EPA, 2023c). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models for solid and liquid DIDP materials. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. EPA used SDSs from identified laboratory DIDP products to inform product concentration and material states. EPA believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks data on DIDP laboratory chemical throughput and number of laboratories; therefore, EPA based the number of laboratories and throughput estimates on stock solution throughputs from the <i>Draft GS on the Use of Laboratory Chemicals</i> and on CDR reporting thresholds. Additionally, because no entries in CDR indicate a laboratory use case and there were no other sources to estimate the volume of DIDP used in this OES, EPA developed a high-end bounding estimate based on the CDR reporting threshold, which by definition is expected to over-estimate the average release case. Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data.
Use of Lubricants and Functional Fluids	EPA found limited chemical specific data for the use of lubricants and functional fluids OES and assessed releases to the environment using the <i>ESD on the Lubricant and Lubricant Additives</i> , which has a medium data quality rating based on systematic review (OECD, 2004b). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the ESD and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentration and uses of different DIDP-containing lubricants and functional fluid products in the analysis. These data provide more accurate estimates than the generic

OES	Weight of Scientific Evidence Conclusion in Release Estimates
	values provided by the ESD. The safety and product data sheets that EPA used to obtain these values have high data quality ratings based on systematic review. EPA based production volumes for the OES on rates cited by the ACC (2020a) and referenced the 2003 <i>EU Risk Assessment Report</i> (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD may not represent releases from real-world sites using DIDP-containing lubricants and functional fluids. In addition, EPA lacks information on the specific facility use rate of DIDP-containing products and number of use sites; therefore, EPA estimated the number of sites and throughputs based on CDR, which has a reporting threshold of 25,000 lbs ( <i>i.e.</i> , not all potential sites represented), and an annual DIDP production volume range that spans an order of magnitude. The respective share of DIDP use for each OES presented in the <i>EU Risk Assessment Report</i> may differ from actual conditions adding some uncertainty to estimated releases.
	Based on this information, EPA concluded that the weight of scientific evidence for this assessment is moderate, and the assessment provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.
Use of Penetrants and Inspection Fluids	EPA found limited chemical specific data for the use of penetrants and inspection fluids OES and assessed releases to the environment using the <i>ESD on the Use of Metalworking Fluids</i> , which has a medium data quality rating based on systematic review (OECD, 2011d). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the ESD, and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also consider a large number of data points (simulation runs) and the full distributions of input parameters. Because there were no DIDP-containing penetrant products identified, EPA assessed an aerosol and non-aerosol application method based on surrogate DINP-specific penetrant data which also provided DINP concentration. The safety and product data sheets that EPA used to obtain these values have high data quality ratings based on systematic review and provide more accurate estimates than the generic values provided by the ESD. EPA based production volumes for the OES on rates cited by the ACC (2020a) and referenced the 2003 EU Risk Assessment Report (ECJRC, 2003a) for the expected U.S. DIDP use rates per use scenario. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the ESD and the surrogate material parameters may not be representative of releases from real-world sites that use DIDP-containing inspection fluids and penetrants. Additionally, because no entries in CDR indicate this OES use case and there were no other sources to estimate the volume of DIDP used in this OES, EPA developed a high-end bounding estimate based on CDR reporting threshold, which by definition
Fabrication and Final Use of Products or Articles	provides a plausible estimate of releases, considering the strengths and limitations of reasonably available data. No data were available to estimate releases for this OES and there were no suitable surrogate release data or models. This release is described qualitatively.

OES	Weight of Scientific Evidence Conclusion in Release Estimates
Recycling and Disposal	EPA found limited chemical specific data for the recycling and disposal OES. EPA assessed releases to the environment from recycling activities using the <i>Revised Draft GS for the Use of Additives in Plastic Compounding</i> as surrogate for the recycling process. The GS has a medium data quality rating based on systematic review ( <u>U.S. EPA, 2021e</u> ). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, and media of release using assumptions from the GS and EPA/OPPT models. EPA believes the strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential release values are more likely to capture actual releases than discrete values. Monte Carlo modeling also considers a large number of data points (simulation runs) and the full distributions of input parameters. Additionally, EPA used DIDP-specific data on concentrations in different DIDP-containing PVC plastic products in the analysis to provide more accurate estimates than the generic values provided by the GS. The safety and product data sheets that EPA used to obtain these values have high data quality ratings based on systematic review. EPA referenced the <i>Quantification and evaluation of plastic waste in the United States</i> , which has a medium quality rating based on systematic review (Milbrandt et al., 2022), to estimate the rate of PVC recycling in the U.S. and applied it to DIDP PVC market share to define an approximate recycling volume of PVC containing DIDP. The primary limitation of EPA's approach is the uncertainty in the representativeness of estimated release values toward the true distribution of potential releases at all sites in this OES. Specifically, the generic default values in the GS represent all types of plastic compounding sites and may not represent sites that recycle PVC products containing DIDP. In addition, EPA lacks DIDP-specific PVC recycling rates and facility production volume data; therefore, EPA based throughput estimates on PVC plastics c

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# 4258 **4.2 Occupational Exposures**

For each OES, EPA considered the assessment approach, the quality of the data and models, and the 4259 4260 strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to determine a weight of scientific evidence rating. EPA considered factors that increase or decrease the 4261 4262 strength of the evidence supporting the release estimate—including quality of the data/information, 4263 applicability of the release or exposure data to the OES (including considerations of temporal relevance, 4264 locational relevance) and the representativeness of the estimate for the whole industry. The best professional judgment is summarized using the descriptors of robust, moderate, slight, or indeterminant, 4265 4266 according to EPA's Application of Systematic Review in TSCA Risk Evaluations (U.S. EPA, 2021a). For example, a conclusion of moderate is appropriate where there is measured release data from a limited 4267 4268 number of sources such that there is a limited number of data points that may not cover most or all the 4269 sites within the OES. A conclusion of slight is appropriate where there is limited information that does 4270 not sufficiently cover all sites within the OES, and the assumptions and uncertainties are not fully 4271 known or documented. See EPA's Application of Systematic Review in TSCA Risk Evaluations (U.S. 4272 EPA, 2021a) for additional information on weight of scientific evidence conclusions. 4273

- 4274 Table 4-2 provides a summary of EPA's overall confidence in its inhalation and dermal exposure
- 4275 estimates for each of the Occupational Exposure Scenarios assessed.

## 4276 Table 4-2. Summary of Assumptions, Uncertainty, and Overall Confidence in Inhalation Exposure Estimates by OES

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Manufacturing	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the full-shift TWA inhalation exposure estimates for the Manufacturing OES. The primary strength is the use of directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process (ExxonMobil, 2022a). Data from these sources were DIDP-specific from a DIDP manufacturing facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. A further strength of the data is that it was compared against an EPA developed Monte Carlo model and the data points from ExxonMobil were found to be more protective.
	The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario, that the data come from one industry-source, and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. EPA also assumed 8 exposure hours per day and 180 exposure days per year based on a manufacturing site reporting half-year DIDP campaign runs (ExxonMobil, 2022a); it is uncertain whether this captures actual worker schedules and exposures at that and other manufacturing sites. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a plausible estimate of exposures.
Import and Repackaging	EPA used surrogate manufacturing data to estimate worker inhalation exposures due to limited data. Import and repackaging inhalation exposures were estimated using the manufacturing inhalation exposure as a surrogate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process (ExxonMobil, 2022a). Data from these sources were DIDP-specific from a DIDP manufacturing facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; that the data come from one industry-source; and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. The high-end exposures are based on 250 days per year as the exposure frequency since the 95 <sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days. The central tendency exposures use 208 days per year as the exposure frequency based on the 50 <sup>th</sup> percentile of operating days in the release and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into Adhesives and Sealants	EPA used surrogate data to estimate worker inhalation exposures due to limited data. Incorporation into adhesives and sealants exposures were estimated using the PVC plastics converting OES inhalation exposure as a surrogate estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario, that the data come from one datapoint from each source, and that 100% of the data for both
	workers and ONUs from the source were reported as below the LOD. EPA also assumed 8 exposure hours per day and 250 exposure days per year based on continuous DIDP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.
	Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into Paints and Coatings	EPA used surrogate data to estimate worker inhalation exposures due to limited data. Incorporation into paints and coatings exposures were estimated using the PVC plastics converting OES inhalation exposure as a surrogate estimate. The primary strength is the use of monitoring data, which is preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry.
	The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario, that the data come from one datapoint from each source, and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. EPA also assumed 8 exposure hours per day and 250 exposure days per year based on continuous DIDP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Incorporation into Other Formulations, Mixtures, and Reaction Products Not	EPA used surrogate data to estimate or exposures. EPA used surrogate data to estimate worker inhalation exposures due to limited data. Incorporation into other formulations, mixtures, and reaction products not covered elsewhere exposures were estimated using the PVC plastics converting OES inhalation exposure as a surrogate estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin,

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
Covered Elsewhere	<ul> <li><u>2022</u>; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry.</li> <li>The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario, that the data come from one datapoint from each source, and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. EPA also assumed 8 exposure hours per day and 250 exposure days per year based on continuous DIDP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.</li> <li>Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.</li> </ul>
PVC Plastics Compounding	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used surrogate data to estimate worker inhalation exposures due to limited data. PVC plastics compounding exposures were estimated using the PVC plastics converting OES inhalation exposures as a surrogate bounding estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate from for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. Compounding activities are also expected to generate dust from the solid product; therefore, EPA incorporated the Generic Model for Central Tendency and High-End Inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA CEHD data sets, which the systematic review process rated high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DIDP in plastic using industry provided data on DIDP concentration in PVC, which were also rated high for data come from one datapoint from each source, that 100% of the data for both workers and ONUs from the source were reported as below the LOD, and that the OSHA CEHD data are not specific to DIDP. The high-end exposure as as a respecific evidence for this assessment from each source, that 100% of the data for both workers and ONUs from the source were reported as below the LOD, and that the OSHA CEHD data are not

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
PVC Plastics Converting	<ul> <li>EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the full-shift TWA inhalation exposure estimates for the PVC Plastics Converting OES. The primary strength is the use of directly applicable monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate from for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. Converting activities are also expected to generate dust from the solid product; therefore, EPA incorporated the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates. Not Otherwise Regulated (PNOR) into the assessment to estimate worker inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA CEHD data sets, which the systematic review process.</li> <li>The primary limitations of these data include the uncertainty of the representativeness of the monitoring data and PNOR model toward the true distribution of inhalation concentrations in this scenario, that the monitoring data are of below the LOD, and that the OSHA CEHD data are not specific to DIDP. The high-end exposures are based on 250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days. The central tendency exposures use 219 days per year as the exposure frequency based on the 50<sup>th</sup></li></ul>
Non-PVC Material Compounding	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used surrogate data to estimate worker inhalation exposures due to limited data. Non-PVC material compounding exposures were estimated using the PVC plastics converting OES inhalation exposure as a surrogate bounding estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate from for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. Compounding activities are also expected to generate dust from the solid product; therefore, EPA incorporated the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) into the assessment to estimate worker inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	CEHD data sets, which the systematic review process rated high for data quality ( <u>OSHA, 2020</u> ). EPA estimated the highest expected concentration of DIDP in plastic using industry provided data on DIDP concentration in PVC, which were also rated high for data quality in the systematic review process.
	<ul> <li>The primary limitations of these data include the uncertainty of the representativeness of the monitoring data and PNOR model toward the true distribution of inhalation concentrations in this scenario, that the monitoring data come from one datapoint from each source, that 100% of the data for both workers and ONUs from the source were reported as below the LOD, and that the OSHA CEHD data are not specific to DIDP. The high-end exposures are based on 250 days per year as the exposure frequency since the 95<sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days. The central tendency exposures use 234 days per year as the exposure frequency based on the 50<sup>th</sup> percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures.</li> <li>Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.</li> </ul>
Non-PVC Material Converting	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used surrogate data to estimate worker inhalation exposures due to limited data. Non-PVC material converting exposures were estimated using the PVC plastics converting OES inhalation exposure as a surrogate bounding estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used both PBZ and stationary air concentration data to assess inhalation exposures. The PBZ data are surrogate from for an ONU exposed to DINP and the area sample is a DPHP sample taken adjacent to two extruders in plastic cable manufacturing. Both data sources have a high data quality rating from the systematic review process (Irwin, 2022; Porras et al., 2020). Data from these sources are specific to a PVC plastic converting facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. Converting activities are also expected to generate dust from the solid product; therefore, EPA incorporated the Generic Model for Central Tendency and High-End Inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA CEHD data sets, which the systematic review process rated high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DIDP in plastic using industry provided data on DIDP concentrations in this scenario, that the monitoring data come from one datapoint from each source, that 100% of the data for both workers and ONUs from the source were reported as below the LOD, and that the OSHA CEHD data are not specific to DIDP. The high-end exposures are based on 250 days per year as the exposure frequency since the 95 <sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for worki

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	<ul><li>from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures.</li><li>Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.</li></ul>
Application of Adhesives and Sealants	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used surrogate monitoring data from the <i>ESD</i> on Coating Application via Spray-Painting in the Automotive Refinishing Industry, which the systematic review process rated high for data quality, to estimate inhalation exposures (OECD, 2011a). EPA used SDSs and product data sheets from identified DIDP-containing adhesives and sealant products to identify product concentrations.
	The primary limitation is the lack of DIDP-specific monitoring data, with the ESD serving as a surrogate source of monitoring data representing the level of exposure that could be expected at a typical work site for the given spray application method. EPA assumes spray applications of the adhesives and sealants, so the estimates may not be representative of exposure during other application methods. Additionally, it is uncertain whether the substrates bonded, and products used to generate the surrogate data are representative of those associated with DIDP-containing adhesives and sealants. EPA only assessed mist exposures to DIDP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in vapor exposures other than mist and application duration may be variable depending on the job site. The high-end exposures are based on 250 days per year as the exposure frequency since the 95 <sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum for working days. The central tendency exposures use 232 days per year as the exposure frequency based on the 50 <sup>th</sup> percentile of operating whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Application of Paints and Coatings	<ul> <li>EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used surrogate monitoring data from the <i>ESD</i> on <i>Coating Application via Spray-Painting in the Automotive Refinishing Industry</i>, which the systematic review process rated high for data quality, to estimate inhalation exposures (OECD, 2011a). EPA used SDSs and product data sheets from identified DIDP-containing products to identify product concentrations.</li> <li>The primary limitation is the lack of DIDP-specific monitoring data, with the ESD serving as a surrogate source of monitoring data representing the level of exposure that could be expected at a typical work site for the given spray application method. EPA assumes spray applications of the coatings, so the estimates may not be representative of exposure during other coating application methods. Additionally, it is uncertain whether the substrates coated, and products used to generate the surrogate data are representative of those associated with DIDP-containing coatings. EPA only assessed mist exposures to DIDP over a full 8-hour work shift to estimate the level of exposure, though other activities may result in vapor exposures other than mist and application duration may be variable</li> </ul>

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	depending on the job site. EPA assessed 250 days of exposure per year based on workers applying coatings on every working day, however, application sites may use DIDP-containing coatings at much lower or variable frequencies. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
	EPA used surrogate data to estimate worker vapor inhalation exposures due to limited data. Use of laboratory chemicals inhalation exposures were estimated using the manufacturing inhalation exposure as a surrogate bounding estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process (ExxonMobil, 2022a). Data from these sources were DIDP-specific from a DIDP manufacturing facility, though it is uncertain whether the measured concentrations accurately represent the entire industry.
Use of Laboratory Chemicals	The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; that the data come from one industry-source; and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. The high-end and central tendency exposures to solid laboratory chemicals use 250 days per year as the exposure frequency since the 95th and 50th percentiles of operating days in the release assessment exceeded 250 days per year, which is the expected maximum number of working days. The high-end and central tendency exposure to liquid laboratory chemicals use 235 days per year and 250 days per year, respectively, as the exposure frequencies. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate
	and provides a plausible estimate of exposures.
Use of Lubricants and Functional Fluids	EPA used surrogate data to estimate worker inhalation exposures due to limited data. Use of lubricants and functional fluids inhalation exposures were estimated using the manufacturing inhalation exposure as a surrogate bounding estimate. The primary strength is the use of monitoring data, which are preferrable to other assessment approaches such as modeling or the use of OELs. EPA used PBZ air concentration data to assess inhalation exposures, with the data source having a high data quality rating from the systematic review process (ExxonMobil, 2022a). Data from these sources were DIDP-specific from a DIDP manufacturing facility, though it is uncertain whether the measured concentrations accurately represent the entire industry. The primary limitations of these data include the uncertainty of the representativeness of these data toward this OES and the true distribution of inhalation concentrations in this scenario; that the data come from one industry-source; and that 100% of the data for both workers and ONUs from the source were reported as below the LOD. The high-end exposures use 4 days per year as the exposure frequency based on the 50 <sup>th</sup> percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Use of Penetrants and Inspection Fluids	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA utilized a near-field/far-field approach (AIHA, 2009), and the inputs to the model were derived from references that received ratings of medium-to-high for data quality in the systematic review process. EPA combined this model with Monte Carlo modeling to estimate occupational exposures in the near-field (worker) and far-field (ONU) inhalation exposures. A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential exposure values is more likely than a discrete value to capture actual exposure at sites, the high number of data points (simulation runs), and the full distributions of input parameters. EPA identified and used a DINP-containing penetrant/inspection fluid product as surrogate to estimate concentrations, application methods, and use rate. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. EPA lacks facility and DIDP-specific product use rates, concentrations, and application methods, therefore, estimates are made based on surrogate DINP-containing product. EPA only found one product to represent this use scenario, however, and its representativeness of all DIDP-containing penetrants and inspection fluids is not known. The high-end exposures use 249 days per year as the exposure frequency based on the 95 <sup>th</sup> percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures.
Fabrication and Final Use of Products or Articles	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA utilized the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) to estimate worker inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA CEHD data sets, which the systematic review process rated high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DIDP in plastic using industry provided data on DIDP concentration in PVC, which were also rated high for data quality in the systematic review process. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Additionally, the representativeness of the CEHD data set and the identified DIDP concentrations in plastics for this specific fabrication and final use of products or articles is uncertain. EPA lacks facility and DIDP-containing product fabrication and use rates, methods, and operating times and EPA assumed eight exposure hours per day and 250 exposure days per year based on continuous DIDP exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.
Recycling and Disposal	EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA utilized the Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise Regulated (PNOR) to estimate worker inhalation exposure to solid particulate. The respirable PNOR range was refined using OSHA CEHD data sets, which the systematic review process rated high for data quality (OSHA, 2020). EPA estimated the highest expected concentration of DIDP in plastic using industry provided data on DIDP concentration in PVC, which were also rated high for data quality in the systematic review process. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. Additionally, the representativeness of the CEHD data set and the identified DIDP concentrations in plastics for this specific recycling end-use is uncertain. The high-end exposures use 250 days per year as the exposure frequency since the 95 <sup>th</sup> percentile of operating days in the release assessment exceeded 250 days per year, which is the expected maximum number of working days. The central tendency exposures use 223 days per year as the exposure frequency based on the 50 <sup>th</sup> percentile of operating days from the release assessment. Also, it was assumed that each worker is potentially exposed for 8 hours per workday; however, it is uncertain whether this captures actual worker schedules and exposures.
	and provides a plausible estimate of exposures.
Dermal – Liquids	EPA used <i>in vivo</i> rat absorption data for neat DIDP (Elsisi et al., 1989) to estimate occupational dermal exposures to workers since exposures to the neat material or concentrated formulations are possible for occupational scenarios. Because rat skin generally has greater permeability than human skin (Scott et al., 1987), the use of <i>in vivo</i> rat absorption data is assumed to be a conservative assumption. Also, it is acknowledged that variations in chemical concentration and co-formulant components affect the rate of dermal absorption. However, it is assumed that absorption of the neat chemical serves as a reasonable upper bound across chemical compositions and the data received a medium rating through EPA's systematic review process. For occupational dermal exposure assessment, EPA assumed a standard 8-hour workday and that the chemical is contacted at least once per day. Because DIDP has low volatility and low absorption of DIDP from occupational dermal contact with materials containing DIDP may extend up to 8 hours per day (U.S. EPA, 1991a). For average adult workers, the surface area of contact was assumed equal to the area of one hand ( <i>i.e.</i> , 535 cm <sup>2</sup> ), or two hands ( <i>i.e.</i> , 1,070cm <sup>2</sup> ), for central tendency exposures, or high-end exposures, respectively (U.S. EPA, 2011). The standard sources for exposure duration and area of contact received high ratings through EPA's systematic review process.

OES	Weight of Scientific Evidence Conclusion in Exposure Estimates
	Based on the strengths and limitations of these inputs, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of occupational dermal exposures.
Dermal – Solids	EPA used dermal modeling of aqueous materials (U.S. EPA, 2023a, 2004b) to estimate occupational dermal exposures of workers and ONUs to solid materials as described in Appendix D.2.1.2. However, the modeling approach for determining the aqueous permeability coefficient was used outside the range of applicability given the p-chem parameters of DIDP. Also, it is acknowledged that variations in chemical concentration and co-formulant components affect the rate of dermal absorption. However, it is assumed that absorption of aqueous DIDP serves as a reasonable upper bound for the dermal absorption of DIDP from solid matrices, and the modeling approach received a medium rating through EPA's systematic review process. For occupational dermal exposure assessment, EPA assumed a standard 8-hour workday and that the chemical is contacted at least once per day. Because DIDP has low volatility and low absorption, it is possible that the chemical remains on the surface of the skin after a dermal contact until the skin is washed. Therefore, absorption of DIDP from occupational dermal contact with materials containing DIDP may extend up to 8 hours per day (U.S. EPA, 1991a). For average adult workers, the surface area of contact was assumed equal to the area of one hand ( <i>i.e.</i> , 535 cm <sup>2</sup> ), or two hands ( <i>i.e.</i> , 1,070cm <sup>2</sup> ), for central tendency exposures, or high-end exposures, respectively (U.S. EPA, 2011). The standard sources for exposure duration and area of contact received high ratings through EPA's systematic review process. The occupational dermal exposure assessment for contact with solid materials containing DIDP was based on dermal absorption modeling of aqueous DIDP, as well as standard occupational inputs for exposure duration and area of contact, as described above. Based on the strengths and limitations of these inputs, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of occupational dermal exposures.

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# 4278 **REFERENCES**

4279	ACC. (2020a). ACC Presentation to EPA: DIDP and DINPConditions of use and proposed approach for
4280	addressing exposure data gaps.
4281	ACC. (2020b). Stakeholder meeting with the American Chemistry Council's High Phthalates Panel on
4282	May 15, 2020: Conditions of use for Diisononyl Phthalate (DINP) and Diisodecyl Phthalate
4283	(DIDP). https://www.regulations.gov/document/EPA-HQ-OPPT-2018-0435-0021
4284	ACC. (2020c). Stakeholder meeting with the American Chemistry Council's High Phthalates Panel on
4285	May 22, 2020: Conditions of use for Diisononyl Phthalate (DINP) and Diisodecyl Phthalate
4286	(DIDP). https://www.regulations.gov/document/EPA-HQ-OPPT-2018-0435-0022
4287	AIHA. (2009). Mathematical models for estimating occupational exposure to chemicals. In CB Keil; CE
4288	Simmons; TR Anthony (Eds.), (2nd ed.). Fairfax, VA: AIHA Press. https://online-
4289	ams.aiha.org/amsssa/ecssashop.show_product_detail?p_mode=detail&p_product_serno=889
4290	APR. (2023). Model Bale Specifications: 1-7 ALL Rigid Plastics. Washington, DC.
4291	Arnold, F; Engel, AJ. (2001). Evaporation of pure liquids from open surfaces. In JBHJ Linders (Ed.), (pp.
4292	61-71). The Netherlands: Kluwer Academic Publishers. http://dx.doi.org/10.1007/978-94-010-
4293	0884-6 6
4294	Associates. (1988). Releases during cleaning of equipment. Washington, DC: U.S. Environmental
4295	Protection Agency, Office of Pesticides and Toxic Substances.
4296	https://ofmpub.epa.gov/apex/guideme_ext/guideme/file/releases%20during%20cleaning%20of%2
4297	<u>0equipment.pdf</u>
4298	Baldwin, PE; Maynard, AD. (1998). A survey of wind speed in indoor workplaces. Ann Occup Hyg 42:
4299	303-313. http://dx.doi.org/10.1016/S0003-4878(98)00031-3
4300	<u>CARB.</u> (2000). Initial statement of reasons for the proposed airborne toxic control measure for emissions
4301	of chlorinated toxic air contaminants from automotive maintenance and repair activities.
4302	<u>CEPE.</u> (2020). SpERC fact sheet: Industrial application of coatings by spraying. Brussels, Belgium.
4303	https://echa.europa.eu/documents/10162/8718351/cepe_sperc_4.1_5.1_5.2_factsheet_Dec2020_en
4304	.pdf/b52857d5-1d76-bf5a-a5fb-8f05cdc84d99?t=1610988863215
4305	Cherrie, JW; Semple, S; Brouwer, D. (2004). Gloves and Dermal Exposure to Chemicals: Proposals for
4306	Evaluating Workplace Effectiveness. Ann Occup Hyg 48: 607-615.
4307	http://dx.doi.org/10.1093/annhyg/meh060
4308	Demou, E; Hellweg, S; Wilson, MP; Hammond, SK; McKone, TE. (2009). Evaluating indoor exposure
4309	modeling alternatives for LCA: A case study in the vehicle repair industry. Environ Sci Technol
4310	43: 5804-5810. <u>http://dx.doi.org/10.1021/es803551y</u>
4311	EC/HC. (2017). Draft screening assessment: Phthalate substance grouping. Ottawa, Ontario: Government
4312	of Canada, Environment Canada, Health Canada. <u>http://www.ec.gc.ca/ese-</u>
4313	ees/default.asp?lang=En&n=516A504A-1
4314	ECHA. (2010). Evaluation of new scientific evidence concerning the restrictions contained in Annex
4315	XVII to Regulation (EC) No 1907/2006 (REACH): Review of new available information for di-
4316	'isononyl' phthalate (DINP).
4317	https://echa.europa.eu/documents/10162/13641/dinp_echa_review_report_2010_6_en.pdf/2157a9
4318	<u>67-5565-4f2a-8c6c-c93d27989b52</u>
4319	ECJRC. (2003a). European Union risk assessment report, vol 36: 1,2-Benzenedicarboxylic acid, Di-C9-
4320 4321	11-Branched alkyl esters, C10-Rich and Di-"isodecyl"phthalate (DIDP). In 2nd Priority List.
4321	(EUR 20785 EN). Luxembourg, Belgium: Office for Official Publications of the European
4 <i>322</i> 4323	Communities.
4 <i>323</i> 4324	<u>http://publications.jrc.ec.europa.eu/repository/bitstream/JRC25825/EUR%2020785%20EN.pdf</u> <u>ECJRC.</u> (2003b). European Union risk assessment report: 1,2-Benzenedicarboxylic acid, di-C8-10-
4324 4325	branched alkyl esters, C9-rich - and di-"isononyl" phthalate (DINP). In 2nd Priority List, Volume:
4323	oranched arkyresters, C9-nen - and di- isononyr philiaiate (Dinr). In 2nd rhonty List, volume:

4326	35. (EUR 20784 EN). Luxembourg, Belgium: Office for Official Publications of the European
4327	Communities. http://bookshop.europa.eu/en/european-union-risk-assessment-report-
4328	pbEUNA20784/
4329	Elsisi, AE; Carter, DE; Sipes, IG. (1989). Dermal absorption of phthalate diesters in rats. Fundam Appl
4330	Toxicol 12: 70-77. http://dx.doi.org/10.1016/0272-0590(89)90063-8
4331	ENF Plastic. (2024). Plastic recycling plants in the United States [Website].
4332	https://www.enfplastic.com/directory/plant/United-States?plastic_materials=pl_PVC
4333	ESIG. (2012). SPERC fact sheet – Manufacture of substance – Industrial (Solvent-borne). (ESVOC
4334	1.1.v1). Brussels, Belgium.
4335	ESIG. (2020). SPERC Factsheet – Use in rubber production and processing. Brussels, Belgium.
4336	https://www.esig.org/wp-content/uploads/2020/05/19_industrial_rubber-
4337	production_processing.pdf
4338	ExxonMobil. (2022a). Data submission from ExxonMobil regarding DINP and DIDP exposure. Houston,
4339	TX.
4340	ExxonMobil. (2022b). EM BRCP DINP/DIDP facility – virtual tour (sanitized). Houston, TX.
4341	Fehrenbacher, MC; Hummel, AA. (1996). Evaluation of the Mass Balance Model Used by the EPA for
4342	Estimating Inhalation Exposure to New Chemical Substances. Am Ind Hyg Assoc J 57: 526-536.
4343	Golsteijn, L; Huizer, D; Hauck, M; van Zelm, R; Huijbregts, MA. (2014). Including exposure variability
4344	in the life cycle impact assessment of indoor chemical emissions: the case of metal degreasing.
4345	Environ Int 71: 36-45. http://dx.doi.org/10.1016/j.envint.2014.06.003
4346	Hellweg, S; Demou, E; Bruzzi, R; Meijer, A; Rosenbaum, RK; Huijbregts, MA; McKone, TE. (2009).
4347	Integrating human indoor air pollutant exposure within Life Cycle Impact Assessment [Review].
4348	Environ Sci Technol 43: 1670-1679. http://dx.doi.org/10.1021/es8018176
4349	Howard, PH; Banerjee, S; Robillard, KH. (1985). Measurement of water solubilities octanol-water
4350	partition coefficients and vapor pressures of commercial phthalate esters. Environ Toxicol Chem
4351	4: 653-662. http://dx.doi.org/10.1002/etc.5620040509
4352	Irwin, JA. (2022). Letter from IRWIN Engineers, Inc with information regarding DINP usage by Sika
4353	Corporation. Natick, MA: IRWIN Engineers.
4354	ITW Inc. (2018). Safety data sheet: Spotcheck ® SKL-SP2. Glenview, IL: Illinois Tool Works, Inc.
4355	https://magnaflux.eu/EU-Files/Safety-Data-Sheets/SPOTCHECKSKL-
4356	SP2ENUKEUCLPGHSSDS2018-10-31.pdf
4357	Kirk-Othmer. (1993). Kirk-Othmer Encyclopedia of Chemical Technology (4th ed.). New York, NY:
4358	John Wiley and Sons.
4359	Kissel, JC. (2011). The mismeasure of dermal absorption. J Expo Sci Environ Epidemiol 21: 302-309.
4360	http://dx.doi.org/10.1038/jes.2010.22
4361	Koch, HM; Angerer, J. (2011). Phthalates: Biomarkers and human biomonitoring. In LE Knudsen; DF
4362	Merlo (Eds.), Issues in Toxicology (pp. 179-233). Cambridge, UK: Royal Society of Chemistry.
4363	http://dx.doi.org/10.1039/9781849733373-00179
4364	Lansink, CJM; Breelen, MSC; Marquart, J; van Hemmen, JJ. (1996). Skin exposure to calcium carbonate
4365	in the paint industry. Preliminary modelling of skin exposure levels to powders based on field
4366	data. (V96.064). Rijswijk, The Netherlands: TNO Nutrition and Food Research Institute.
4367	Letinski, DJ; Connelly Jr, MJ; Peterson, DR; Parkerton, TF. (2002). Slow-stir water solubility
4368	measurements of selected alcohols and diesters. Chemosphere 43: 257-265.
4369	http://dx.doi.org/10.1016/S0045-6535(02)00086-3
4370	Marquart, H; Franken, R; Goede, H; Fransman, W; Schinkel, J. (2017). Validation of the dermal exposure
4371	model in ECETOC TRA. Ann Work Expo Health 61: 854-871.
4372	http://dx.doi.org/10.1093/annweh/wxx059

4373	Midwest Research Institute. (1983). Dermal disposition of 14C-diisononyl phthalate in rats, final report
4374	with cover letter [TSCA Submission]. (OTS0206328. 878213843). Exxon Corporation.
4375	https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/OTS0206328.xhtml
4376	Milbrandt, A; Coney, K; Badgett, A; Beckham, GT. (2022). Quantification and evaluation of plastic
4377	waste in the United States. Resour Conservat Recycl 183: 106363.
4378	http://dx.doi.org/10.1016/j.resconrec.2022.106363
4379	NICNAS. (2015). Priority existing chemical draft assessment report: Diisodecyl Phthalate & Di-n-octyl
4380	Phthalate. Sydney, Australia: Australian Department of Health and Ageing, National Industrial
4381	Chemicals Notification and Assessment Scheme.
4382	https://www.industrialchemicals.gov.au/sites/default/files/PEC39-Diisodecyl-phthalate-DIDP-Di-
4383	<u>n-octyl-phthalate-DnOP.pdf</u>
4384	NIOSH. (2003). Respirator Usage in Private Sector Firms. Washington D.C.: United States Department of
4385	Labor, Bureau of Labor Statistics and National Institute for Occupational Safety and Health.
4386	https://www.cdc.gov/niosh/docs/respsurv/
4387	NLM. (2020). PubChem database: compound summary: Diisodecyl phthalate.
4388	https://pubchem.ncbi.nlm.nih.gov/compound/Diisodecyl-phthalate
4389	NTP-CERHR. (2003). NTP-CERHR monograph on the potential human reproductive and developmental
4390	effects of di-isodecyl phthalate (DIDP). (NIH 03-4485). Research Triangle Park, NC: National
4391	Toxicology Program Center for the Evaluation of Risks to Human Reproduction.
4392	http://ntp.niehs.nih.gov/ntp/ohat/phthalates/didp/didp_monograph_final.pdf
4393	OECD. (2004a). Emission scenario document on additives in rubber industry.
4394	(ENV/JM/MONO(2004)11). Paris, France.
4395	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2004)11&
4396	<u>doclanguage=en</u>
4397	OECD. (2004b). Emission scenario document on lubricants and lubricant additives. (JT00174617). Paris,
4398	France.
4399	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2004)21&
4400	<u>doclanguage=en</u>
4401	OECD. (2004c). Test No. 428: Skin absorption: In vitro method. Paris, France.
4402	http://dx.doi.org/10.1787/9789264071087-en
4403	OECD. (2009a). Emission scenario document on adhesive formulation. (ENV/JM/MONO(2009)3;
4404	JT03263583). Paris, France.
4405	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2009)3&d
4406	<u>oclanguage=en</u>
4407	OECD. (2009b). Emission scenario document on plastic additives. (JT03267870). Paris, France: OECD
4408	Environmental Health and Safety Publications.
4409	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2004)8/re
4410	<u>v1&amp;doclanguage=en</u>
4411	OECD. (2009c). Emission scenario documents on coating industry (paints, lacquers and varnishes).
4412	(JT03267833). Paris, France.
4413	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env%20/jm/mono(2009)
4414	24&doclanguage=en
4415	OECD. (2011a). Emission scenario document on coating application via spray-painting in the automotive
4416	refinishing industry. In OECD Series on Emission Scenario Documents No 11.
4417	(ENV/JM/MONO(2004)22/REV1). Paris, France: Organization for Economic Co-operation and
4418	Development.
4419	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2004)22/r
4420	ev1&doclanguage=en

4421	OECD. (2011b). Emission Scenario Document on the application of radiation curable coatings, inks, and
4422	adhesives via spray, vacuum, roll, and curtain coating.
4423	OECD. (2011c). Emission scenario document on the chemical industry. (JT03307750).
4424	http://www.oecd.org/env/ehs/risk-assessment/48774702.pdf
4425	OECD. (2011d). Emission scenario document on the use of metalworking fluids. (JT03304938).
4426	Organization for Economic Cooperation and Development.
4427	OECD. (2011e). Guidance notes on dermal absorption. (ENV/JM/MONO(2011)36).
4428	https://www.oecd.org/env/ehs/testing/48532204.pdf
4429	OECD. (2015a). Emission scenario document on the use of adhesives. In Series on Emission Scenario
4430	Documents No 34. (JT03373626). Paris, France.
4431	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/JM/MONO(2015)
4432	<u>4&amp;doclanguage=en</u>
4433	OECD. (2015b). Emission scenario document on use of adhesives. In Series on Emission Scenario
4434	Documents No 34. (Number 34). Paris, France.
4435	http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/JM/MONO(2015)
4436	<u>4&amp;doclanguage=en</u>
4437	OECD. (2022). Series on Testing & Assessment, No. 156: Guidance notes on dermal absorption studies
4438	(Second edition). (ENV/JM/MONO(2011)36/REV1). Paris, France: Organisation for Economic
4439	Co-operation and Development (OECD).
4440	https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV-JM-
4441	MONO(2011)36%20&doclanguage=en
4442	Porras, SP; Hartonen, M; Koponen, J; Ylinen, K; Louhelainen, K; Tornaeus, J; Kiviranta, H; Santonen, T.
4443	(2020). Occupational exposure of plastics workers to diisononyl phthalate (DiNP) and di(2-
4444	propylheptyl) phthalate (DPHP) in Finland. Int J Environ Res Public Health 17: 2035.
4445	http://dx.doi.org/10.3390/ijerph17062035
4446	Scott, RC; Dugard, PH; Ramsey, JD; Rhodes, C. (1987). In vitro absorption of some o-phthalate diesters
4447	through human and rat skin. Environ Health Perspect 74: 223-227.
4448	http://dx.doi.org/10.2307/3430452
4449	SRC. (1983). Measurement of the water solubilities of phthalate esters (final report) [TSCA Submission].
4450	(EPA/OTS Doc #40-8326142). Chemical Manufacturers Association.
4451	https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/OTS0508401.xhtml
4452	ten Berge, W. (2009). A simple dermal absorption model: Derivation and application. Chemosphere 75:
4453	1440-1445. http://dx.doi.org/10.1016/j.chemosphere.2009.02.043
4454	U.S. BLS. (2016). May 2016 Occupational Employment and Wage Estimates: National Industry-Specific
4455	Estimates [Website]. <u>http://www.bls.gov/oes/tables.htm</u>
4456	U.S. Census Bureau. (2015). Statistics of U.S. Businesses (SUSB).
4457	https://www.census.gov/data/tables/2015/econ/susb/2015-susb-annual.html
4458	U.S. CPSC. (2015). Exposure assessment: Composition, production, and use of phthalates. Cincinnati,
4459	OH: Prepared by: Toxicology Excellence for Risk Assessment Center at the University of
4460	Cincinnati. https://web.archive.org/web/20190320060357/https://www.cpsc.gov/s3fs-
4461	public/pdfs/TERAReportPhthalates.pdf
4462	<u>U.S. EPA.</u> (1991a). Chemical engineering branch manual for the preparation of engineering assessments.
4463	(68-D8-0112). Cincinnati, OH: US Environmental Protection Agency, Office of Toxic Substances.
4464	https://nepis.epa.gov/Exe/ZyNET.exe/P10000VS.txt?ZyActionD=ZyDocument&Client=EPA&In
4465	dex=1991%20Thru%201994&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestr
1111	
4466	ict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&
4467	ict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=& IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DA
	ict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&

4 4 7 0	
4470	<u>&amp;MaximumDocuments=1&amp;FuzzyDegree=0&amp;ImageQuality=r75g8/r75g8/x150y150g16/i425&amp;Dis</u>
4471	play=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%2
4472	<u>Opage&amp;MaximumPages=233&amp;ZyEntry=1</u>
4473	<u>U.S. EPA.</u> (1991b). Chemical engineering branch manual for the preparation of engineering assessments.
4474	Volume I. Ceb Engineering Manual. Washington, DC: Office of Pollution Prevention and Toxics,
4475	US Environmental Protection Agency.
4476	https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P10000VS.txt
4477	U.S. EPA. (1992a). Guidelines for exposure assessment. Federal Register 57(104):22888-22938 [EPA
4478	Report]. (EPA/600/Z-92/001). Washington, DC.
4479	http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=15263
4480	U.S. EPA. (1992b). A laboratory method to determine the retention of liquids on the surface of hands
4481	[EPA Report]. (EPA/747/R-92/003). Washington, DC.
4482	U.S. EPA. (1994). Guidelines for Statistical Analysis of Occupational Exposure Data: Final. United States
4483	Environmental Protection Agency :: U.S. EPA.
4484	U.S. EPA. (1996). Generic scenario for automobile spray coating: Draft report. (EPA Contract No. 68-
4485	D2-0157). Washington, DC: U.S. Environmental Protection Agency.
4486	U.S. EPA. (2004a). Additives in plastics processing (converting into finished products) -generic scenario
4487	for estimating occupational exposures and environmental releases. Draft. Washington, DC.
4488	U.S. EPA. (2004b). Risk Assessment Guidance for Superfund (RAGS), volume I: Human health
4489	evaluation manual, (part E: Supplemental guidance for dermal risk assessment).
4490	(EPA/540/R/99/005). Washington, DC: U.S. Environmental Protection Agency, Risk Assessment
4491	Forum. https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e
4492	U.S. EPA. (2004c). Spray coatings in the furniture industry - generic scenario for estimating occupational
4493	exposures and environmental releases.
4494	U.S. EPA. (2004d). Spray coatings in the furniture industry - generic scenario for estimating occupational
4495	exposures and environmental releases: Draft. Washington, DC. https://www.epa.gov/tsca-
4496	screening-tools/using-predictive-methods-assess-exposure-and-fate-under-tsca
4497	U.S. EPA. (2011). Exposure factors handbook: 2011 edition [EPA Report]. (EPA/600/R-090/052F).
4498	Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development,
4499	National Center for Environmental Assessment.
4500	https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100F2OS.txt
4501	U.S. EPA. (2013). Final peer review comments for the OPPT trichloroethylene (TCE) draft risk
4502	assessment [Website]. <u>https://www.epa.gov/sites/production/files/2017-</u>
4503	<u>06/documents/tce_consolidated_peer_review_comments_september_5_2013.pdf</u>
4504	U.S. EPA. (2014a). Formulation of waterborne coatings - Generic scenario for estimating occupational
4505	exposures and environmental releases -Draft. Washington, DC. <u>https://www.epa.gov/tsca-</u>
4506	screening-tools/using-predictive-methods-assess-exposure-and-fate-under-tsca
4507	<u>U.S. EPA.</u> (2014b). Generic scenario on coating application via spray painting in the automotive
4508	refinishing industry.
4508	<u>U.S. EPA.</u> (2014c). Use of additive in plastic compounding - generic scenario for estimating occupational
4510	exposures and environmental releases: Draft. Washington, DC. https://www.epa.gov/tsca-
4510	
	screening-tools/using-predictive-methods-assess-exposure-and-fate-under-tsca
4512	<u>U.S. EPA.</u> (2014d). Use of additives in the thermoplastic converting industry - generic scenario for
4513	estimating occupational exposures and environmental releases. Washington, DC.
4514	https://www.epa.gov/tsca-screening-tools/using-predictive-methods-assess-exposure-and-fate-
4515	<u>under-tsca</u> U.S. EDA (2015) ChamSTEEP user guide. Chamical corresping tool for exposures and environmental
4516	U.S. EPA. (2015). ChemSTEER user guide - Chemical screening tool for exposures and environmental
4517	releases. Washington, D.C. <u>https://www.epa.gov/sites/production/files/2015-</u>
4518	05/documents/user_guide.pdf

4519	U.S. EPA. (2017). Learn the Basics of Hazardous Waste. https://www.epa.gov/hw/learn-basics-
4520	hazardous-waste
4521	U.S. EPA. (2019b). Manufacturer request for risk evaluation: Diisodecyl phthalate (DIDP).
4522	https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/manufacturer-requested-risk-
4523	evaluation-diisodecyl-0
4524	U.S. EPA. (2021a). Draft systematic review protocol supporting TSCA risk evaluations for chemical
4525	substances, Version 1.0: A generic TSCA systematic review protocol with chemical-specific
4526	methodologies. (EPA Document #EPA-D-20-031). Washington, DC: Office of Chemical Safety
4527	and Pollution Prevention. https://www.regulations.gov/document/EPA-HQ-OPPT-2021-0414-
4528	0005
4529	U.S. EPA. (2021b). Final scope of the risk evaluation for di-isodecyl phthalate (DIDP) (1,2-
4530	benzenedicarboxylic acid, 1,2-diisodecyl ester and 1,2-benzenedicarboxylic acid, di-C9-11-
4531	branched alkyl esters, C10-rich); CASRN 26761-40-0 and 68515-49-1 [EPA Report]. (EPA-740-
4532	R-21-001). Washington, DC: Office of Chemical Safety and Pollution Prevention.
4533	https://www.epa.gov/system/files/documents/2021-08/casrn-26761-40-0-di-isodecyl-phthalate-
4534	final-scope.pdf
4535	U.S. EPA. (2021c). Final Use Report for Di-isodecyl Phthalate (DIDP) (1,2-Benzenedicarboxylic acid,
4536	1,2-diisodecyl ester and 1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)
4537	(CASRN 26761-40-0 and 68515-49-1). Washington, DC.
4538	U.S. EPA. (2021d). Generic model for central tendency and high-end inhalation exposure to total and
4539	respirable Particulates Not Otherwise Regulated (PNOR). Washington, DC: Office of Pollution
4540	Prevention and Toxics, Chemical Engineering Branch.
4541	U.S. EPA. (2021e). Use of additives in plastic compounding – Generic scenario for estimating
4542	occupational exposures and environmental releases (Revised draft) [EPA Report]. Washington,
4543	DC: Office of Pollution Prevention and Toxics, Risk Assessment Division.
4544	U.S. EPA. (2021f). Use of additives in plastics converting – Generic scenario for estimating occupational
4545	exposures and environmental releases (revised draft). Washington, DC: Office of Pollution
4546	Prevention and Toxics.
4547	U.S. EPA. (2022a). Chemical repackaging - Generic scenario for estimating occupational exposures and
4548	environmental releases (revised draft) [EPA Report]. Washington, DC.
4549	U.S. EPA. (2022b). Chemicals used in furnishing cleaning products - Generic scenario for estimating
4550	occupational exposures and environmental releases (revised draft). Washington, DC: Office of
4551	Pollution Prevention and Toxics.
4552	U.S. EPA. (2023a). Consumer Exposure Model (CEM) Version 3.2 User's Guide. Washington, DC.
4553	https://www.epa.gov/tsca-screening-tools/consumer-exposure-model-cem-version-32-users-guide
4554	U.S. EPA. (2023b). Methodology for estimating environmental releases from sampling waste (revised
4555	draft). Washington, DC: Office of Pollution Prevention and Toxics, Chemical Engineering
4556	Branch.
4557	U.S. EPA. (2023c). Use of laboratory chemicals - Generic scenario for estimating occupational exposures
4558	and environmental releases (Revised draft generic scenario) [EPA Report]. Washington, DC: U.S.
4559	Environmental Protection Agency, Office of Pollution Prevention and Toxics, Existing Chemicals
4560	Risk Assessment Division.
4561	U.S. EPA. (2024). Draft Risk Evaluation for Diisodecyl Phthalate. Washington, DC: Office of Pollution
4562	Prevention and Toxics.
4563	WA DOE. (2020). Priority consumer products report to the Legislature: Safer products for Washington
4564	implementation phase 2. (Publication 20-04-019). Olympia, WA: Hazardous Waste and Toxics
4565	Reduction Program. https://apps.ecology.wa.gov/publications/documents/2004019.pdf
4566	

### 4567 **APPENDICES**

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# 4569 Appendix A EXAMPLE OF ESTIMATING NUMBER OF WORKERS 4570 AND OCCUPATIONAL NON-USERS

4571 This appendix summarizes the methods that EPA used to estimate the number of workers who are
4572 potentially exposed to DIDP in each of its conditions of use. The method consists of the following steps:
4573 1. Check relevant emission scenario documents (ESDs) and Generic Scenarios (GSs) for estimates
4574 on the number of workers potentially exposed.

- 4575 2. Identify the NAICS codes for the industry sectors associated with each condition of use.
  - 3. Estimate total employment by industry/occupation combination using the Bureau of Labor Statistics' Occupational Employment Statistics (OES) data (U.S. BLS, 2016).
- 4578
  4. Refine the OES estimates where they are not sufficiently granular by using the U.S. BLS (2016)
  4579
  4579 Statistics of U.S. Businesses (SUSB) data on total employment by 6-digit NAICS.
- 4580
  4580
  5. Estimate the percentage of employees likely to be using DIDP instead of other chemicals (*i.e.*, the market penetration of DIDP in the condition of use).
- 4582 6. Estimate the number of sites and number of potentially exposed employees per site.
- 4583 7. Estimate the number of potentially exposed employees within the condition of use.

#### 4585 Step 1: Identifying Affected NAICS Codes

4586 As a first step, EPA identified NAICS industry codes associated with each condition of use. EPA 4587 generally identified NAICS industry codes for a condition of use by:

- Querying the <u>U.S. Census Bureau's *NAICS Search* tool</u> using keywords associated with each condition of use to identify NAICS codes with descriptions that match the condition of use.
- Referencing EPA Generic Scenarios (GS's) and Organisation for Economic Co-operation and
   Development (OECD) Emission Scenario Documents (ESDs) for a condition of use to identify
   NAICS codes cited by the GS or ESD.
- Reviewing CDR data for the chemical, identifying the industrial sector codes reported for downstream industrial uses, and matching those industrial sector codes to NAICS codes using Table D-2 provided in the CDR reporting instructions (U.S. EPA, 2019a).
- 4596

Each condition of use section in the main body of this report identifies the NAICS codes EPA identifiedfor the respective condition of use.

4599

#### 4600 Step 2: Estimating Total Employment by Industry and Occupation

U.S. BLS (2016) OES data provide employment data for workers in specific industries and occupations.
The industries are classified by NAICS codes (identified previously), and occupations are classified by
Standard Occupational Classification (SOC) codes.

4604

Among the relevant NAICS codes (identified previously), EPA reviewed the occupation description and identified those occupations (SOC codes) where workers are potentially exposed to DIDP. Table Apx

- 4607 A-1 shows the SOC codes EPA classified as occupations potentially exposed to DIDP. These occupations
- 4608 are classified as workers (W) and occupational non-users (O). All other SOC codes are assumed to
- 4609 represent occupations where exposure is unlikely.

SOC	Occupation	Designati
11-9020	Construction Managers	0
17-2000	Engineers	0
17-3000	Drafters, Engineering Technicians, and Mapping Technicians	0
19-2031	Chemists	0
19-4000	Life, Physical, and Social Science Technicians	0
47-1000	Supervisors of Construction and Extraction Workers	0
47-2000	Construction Trades Workers	W
49-1000	Supervisors of Installation, Maintenance, and Repair Workers	0
49-2000	Electrical and Electronic Equipment Mechanics, Installers, and Repairers	W
49-3000	Vehicle and Mobile Equipment Mechanics, Installers, and Repairers	W
49-9010	Control and Valve Installers and Repairers	W
49-9020	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	W
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W
49-9060	Precision Instrument and Equipment Repairers	W
49-9070	Maintenance and Repair Workers, General	W
49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W
51-1000	Supervisors of Production Workers	0
51-2000	Assemblers and Fabricators	W
51-4020	Forming Machine Setters, Operators, and Tenders, Metal and Plastic	W
51-6010	Laundry and Dry-Cleaning Workers	W
51-6020	Pressers, Textile, Garment, and Related Materials	W
51-6030	Sewing Machine Operators	0
51-6040	Shoe and Leather Workers	0
51-6050	Tailors, Dressmakers, and Sewers	0
51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	0
51-8020	Stationary Engineers and Boiler Operators	W
51-8090	Miscellaneous Plant and System Operators	W
51-9000	Other Production Occupations	W

#### 4610 Table\_Apx A-1. SOCs With Worker and ONU Designation for All COUs Except Dry Cleaning

4611

For dry cleaning facilities, due to the unique nature of work expected at these facilities and that different workers may be expected to share among activities with higher exposure potential (*e.g.*, unloading the dry-cleaning machine, pressing/finishing a dry-cleaned load), EPA made different SOC code worker and ONU assignments for this condition of use. Table\_Apx A-2 summarizes the SOC codes with worker and ONU designations used for dry cleaning facilities.

4617

SOC	Occupation	Designation
41-2000	Retail Sales Workers	0
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W
49-9070	Maintenance and Repair Workers, General	W
49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W
51-6010	Laundry and Dry-Cleaning Workers	W
51-6020	Pressers, Textile, Garment, and Related Materials	W
51-6030	Sewing Machine Operators	0
51-6040	Shoe and Leather Workers	0
51-6050	Tailors, Dressmakers, and Sewers	0
51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	0
W = worker des	signation; O = ONU designation	

#### 4618 **Table\_Apx A-2. SOCs with Worker and ONU Designations for Dry Cleaning Facilities**

4619

After identifying relevant NAICS and SOC codes, EPA used BLS data to determine total employment by industry and by occupation based on the NAICS and SOC combinations. For example, there are 110,640 employees associated with 4-digit NAICS 8123 (*Drycleaning and Laundry Services*) and SOC 51-6010 (*Laundry and Dry-Cleaning Workers*).

4624

Using a combination of NAICS and SOC codes to estimate total employment provides more accurate estimates for the number of workers than using NAICS codes alone. Using only NAICS codes to estimate number of workers typically result in an overestimate, because not all workers employed in that industry sector will be exposed. However, in some cases, BLS only provide employment data at the 4-digit or 5digit NAICS level; therefore, further refinement of this approach may be needed (see next step).

4630

#### 4631 Step 3: Refining Employment Estimates to Account for lack of NAICS Granularity

The third step in EPA's methodology was to further refine the employment estimates by using total employment data in the (U.S. Census Bureau, 2015) SUSB. In some cases, BLS OES's occupationspecific data are only available at the 4-digit or 5-digit NAICS level, whereas the SUSB data are available at the 6-digit level (but are not occupation-specific). Identifying specific 6-digit NAICS will ensure that only industries with potential DIDP exposure are included. As an example, OES data are available for the 4-digit NAICS 8123 *Drycleaning and Laundry Services*, which includes the following 6-digit NAICS:

- NAICS 812310 Coin-Operated Laundries and Drycleaners;
- NAICS 812320 Drycleaning and Laundry Services (except coin-operated);
- NAICS 812331 Linen Supply; and
- NAICS 812332 Industrial Launderers.
- 4642

In this example, only NAICS 812320 may be of interest. The Census data allow EPA to calculate
employment in the specific 6-digit NAICS of interest as a percentage of employment in the BLS 4-digit
NAICS.

4646

The 6-digit NAICS 812320 comprises 46 percent of total employment under the 4-digit NAICS 8123.

4648 This percentage can be multiplied by the occupation-specific employment estimates given in the BLS

4649 OES data to further refine our estimates of the number of employees with potential exposure. Table\_Apx

4650 A-3. illustrates this granularity adjustment for NAICS 812320.

4651

# 4652 Table\_Apx A-3. Estimated Number of Potentially Exposed Workers and ONUs under NAICS 4653 812320

NAICS	SOC CODE	SOC Description	Occupation Designation	Employment by SOC at 4- digit NAICS level	% of Total Employment	Estimated Employment by SOC at 6- digit NAICS level
8123	41-2000	Retail Sales Workers	0	44,500	46.0%	20,459
8123	49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W	1,790	46.0%	823
8123	49-9070	Maintenance and Repair Workers, General	W	3,260	46.0%	1,499
8123	49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W	1,080	46.0%	497
8123	51-6010	Laundry and Dry- Cleaning Workers	W	110,640	46.0%	50,867
8123	51-6020	Pressers, Textile, Garment, and Related Materials	W	40,250	46.0%	18,505
8123	51-6030	Sewing Machine Operators	0	1,660	46.0%	763
8123	51-6040	Shoe and Leather Workers	Ο	Not Reported for this NAICS Code		
8123	51-6050	Tailors, Dressmakers, and Sewers	0	2,890	46.0%	1,329
8123	51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	0	0	46.0%	0
Total Pot	tentially Ex	xposed Employees		206,070		94,740
Total Wo						72,190
Total Oc	cupational	Non-users				22,551

4654

#### 4655 **Step 4: Estimating the Percentage of Workers Using DIDP Instead of Other Chemicals**

In the final step, EPA accounted for the market share by applying a factor to the number of workers determined in Step 3. This accounts for the fact that DIDP may be only one of multiple chemicals used for the applications of interest. EPA did not identify market penetration data for any conditions of use. In the absence of market penetration data for a given condition of use, EPA assumed DIDP may be used at up to all sites and by up to all workers calculated in this method as a bounding estimate. This assumes a market penetration of 100 percent. Market penetration is discussed for each condition of use in the main body of this report.

4663

#### 4664 Step 5: Estimating the Number of Workers per Site

4665 EPA calculated the number of workers and occupational non-users in each industry/occupation
4666 combination using the formula below (granularity adjustment is only applicable where SOC data are not
4667 available at the 6-digit NAICS level):

- 4668
- 4669 Number of Workers or ONUs in NAICS/SOC (Step 2) × Granularity Adjustment Percentage (Step 3) =
   4670 Number of Workers or ONUs in the Industry/Occupation Combination
- 4671
  4672 EPA then estimated the total number of establishments by obtaining the number of establishments
  4673 reported in the U.S. Census Bureau's SUSB (U.S. Census Bureau, 2015) data at the 6-digit NAICS level.
  - 4674
    4675 EPA then summed the number of workers and occupational non-users over all occupations within a
    4676 NAICS code and divided these sums by the number of establishments in the NAICS code to calculate the
    4677 average number of workers and occupational non-users per site.

#### 4679 Step 6: Estimating the Number of Workers and Sites for a Condition of Use

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4687

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- 4681 EPA estimated the number of workers and occupational non-users potentially exposed to DIDP and the 4682 number of sites that use DIDP in a given condition of use through the following steps:
- 1. Obtaining the total number of establishments by:
- 4684a.Obtaining the number of establishments from SUSB (U.S. Census Bureau, 2015) at the 6-<br/>digit NAICS level (Step 5) for each NAICS code in the condition of use and summing<br/>these values; or
  - b. Obtaining the number of establishments from the TRI, DMR, NEI, or literature for the condition of use.
- 468946902. Estimating the number of establishments that use DIDP by taking the total number of establishments from 1a and multiplying it by the market penetration factor from Step 4.
- 4691
  4692
  4692
  4693
  3. Estimating the number of workers and occupational non-users potentially exposed to DIDP by taking the number of establishments calculated in 1b and multiplying it by the average number of workers and ONUs per site from Step 5.

# 4694 Appendix B EQUATIONS FOR CALCULATING ACUTE, 4695 INTERMEDIATE, AND CHRONIC (NON-CANCER) 4696 INHALATION AND DERMAL EXPOSURES

4697 This report assesses DIDP inhalation exposures to workers in occupational settings, presented as 8-hr time weighted average (TWA). The full-shift TWA exposures are then used to calculate acute doses 4698 4699 (AD), intermediate average daily doses (IADD), and average daily doses (ADD) for chronic non-cancer risks. This report also assesses DIDP dermal exposures to workers in occupational settings, presented as 4700 a dermal acute potential dose rate (APDR). The APDRs are then used to calculate acute retained doses 4701 4702 (AD), intermediate average daily doses (IADD), and average daily doses (ADD) for chronic non-cancer risks. This appendix presents the equations and input parameter values used to estimate each exposure 4703 4704 metric.

# 4705 B.1 Equations for Calculating Acute, Intermediate, and Chronic (Non 4706 cancer) Inhalation Exposure

4707 EPA used AD to estimate acute risks (*i.e.*, risks occurring as a result of exposure for less than one day)
4708 from workplace inhalation exposures for, per Equation B-1.

4710 **Equation B-1**.

4711

4709

$$AD = \frac{C \times ED \times BR}{BW}$$

4712 Where:

= Acute dose (mg/kg/day)4713 AD 4714 С = Contaminant concentration in air (TWA  $mg/m^3$ ) 4715 ED = Exposure duration (hr/day) 4716 BR = Breathing rate  $(m^3/hr)$ BW = Body weight (kg) 4717 4718 4719 EPA used IADD to estimate intermediate risks from workplace exposures as follows: 4720 4721 **Equation B-2.**  $IADD = \frac{C \times ED \times EF_{int} \times BR}{BW \times ID}$ 4722 4723 Where: 4724 IADD = Intermediate average daily dose (mg/kg/day)4725 = Intermediate exposure frequency (day) EFint 4726 ID = Days for intermediate duration (day) 4727 4728 EPA used ADD to estimate chronic non-cancer risks from workplace exposures. EPA estimated ADD as 4729 follows: 4730

4731 Equation B-3.

4732 
$$ADD = \frac{C \times ED \times EF \times WY \times BR}{BW \times 365 \frac{days}{vr} \times WY}$$

4733 Where:

4734 ADD = Average daily dose for chronic non-cancer risk calculations

4735 EF = Exposure frequency (day/yr)

4736	WY = Working years per lifetime (yr) – used in the denominator for ADD
4737	B.2 Equations for Calculating Acute, Intermediate, and Chronic (Non-
4738	cancer) Dermal Exposures
4739	EPA used AD to estimate acute risks from workplace dermal exposures using Equation B-4.
4740	
4741	Equation B-4.
4742	$AD = \frac{APDR}{BW}$
4743	Where:
4744	AD = Acute retained dose (mg/kg-day)
4745	APDR = Acute potential dose rate $(mg/day)$
4746	BW = Body weight (kg)
4747	
4748 4740	EPA used IADD to estimate intermediate risks from workplace dermal exposures using Equation B-5.
4749 4750	Equation B-5.
4730	
4751	$IADD = \frac{APDR \times EF_{int}}{BW \times ID}$
4752	Where:
4753	IADD = Intermediate average daily dose (mg/kg/day)
4754	$EF_{int}$ = Intermediate exposure frequency (day)
4755	ID = Days for intermediate duration (day)
4756	
4757	EPA used ADD to estimate chronic non-cancer risks from workplace dermal exposures using Equation
4758	B-6.
4759	
4760	Equation B-6.
4761	$APDR \times EF \times WY$
4/01	$ADD = \frac{APDR \times EF \times WY}{BW \times 365 \frac{days}{yr} \times WY}$
4762	Where:
4762	ADD = Average daily dose for chronic non-cancer risk calculations
4764	EF = Exposure frequency (day/yr)
4765	WY = Working years per lifetime (yr)
1705	
4766	B.3 Calculating Aggregate Exposure
4767	EPA combined the expected dermal and inhalation exposures for each OES and worker type into a
4768	single aggregate exposure to reflect the potential total dose from both exposure routes.
4769	
4770	Equation B-7.
4771	$AD_{aggregate} = AD_{dermal} + AD_{inhalation}$
4772	Where:
4773	$AD_{Dermal}$ = Dermal exposure acute retained dose (mg/kg-day)
4774	$AD_{Inhalation} =$ Inhalation exposure acute retained dose (mg/kg-day)
4775	$AD_{Aggregate}$ = Aggregated acute retained does (mg/kg-day).
4776	
4777	IADD and ADD also follow the same approach for defining aggregate exposures.

# 4778 **B.4** Acute, Intermediate, and Chronic (Non-cancer) Equation Inputs

EPA used the input parameter values in Table\_Apx B-1 to calculate acute, intermediate, and chronic
inhalation exposure risks. Where EPA calculated exposures using probabilistic modeling, EPA
integrated the calculations into a Monte Carlo simulation. The EF and EF<sub>int</sub> used for each OES can differ,
and the appropriate sections of this report describe these values and their selection. This section
describes the values that EPA used in the equations in Appendix B.1 and B.2 and summarized in
Table\_Apx B-1.

4785

#### 4786

4787

 Table\_Apx B-1. Parameter Values for Calculating Inhalation Exposure

 Estimates

Estimates						
Parameter Name	Symbol	Value	Unit			
Exposure Duration	ED	8	hr/day			
Breathing Rate	BR	1.25	m <sup>3</sup> /hr			
Exposure Frequency	EF	2–250 <sup><i>a</i></sup>	days/yr			
Exposure Frequency, Intermediate	EF <sub>int</sub>	22	days			
Days for Duration, Intermediate	ID	30	days			
Working years	WY	31 (50th percentile) 40 (95th percentile)	years			
Body Weight	BW	80 (average adult worker) 72.4 (female of reproductive age)	kg			
<sup><i>a</i></sup> Depending on OES	-	· · · · · · · · · · · · · · · · · · ·	-			

#### 4788

#### **B.4.1** Exposure Duration (ED)

- 4789 EPA generally used an exposure duration of eight hours per day for averaging full-shift exposures.
- 4790 **B.4.2 Breathing Rate**

4791 EPA used a breathing rate, based on average worker breathing rates. The breathing rate accounts for the 4792 amount of air a worker breathes during the exposure period. The typical worker breathes about 10 m<sup>3</sup> of 4793 air in 8 hours or  $1.25 \text{ m}^3/\text{hr}$  (U.S. EPA, 1991b).

#### 4794 **B.4.3 Exposure Frequency (EF)**

EPA generally used a maximum exposure frequency of 250 days per year. However, for some OES
where a range of exposure frequency was possible, EPA used probabilistic modeling to estimate
exposures and the associated exposure frequencies, resulting in exposure frequencies below 250 days
per year. The relevant sections of this report describe EPA's estimation of exposure frequency and the
associated distributions for each OES.

4800 EF is expressed as the number of days per year a worker is exposed to the chemical being assessed. In 4801 some cases, it may be reasonable to assume a worker is exposed to the chemical on each working day. In 4802 other cases, it may be more appropriate to assume a worker's exposure to the chemical occurs during a 4803 subset of the worker's annual working days. The relationship between exposure frequency and annual 4804 working days can be described mathematically as follows:

4805

#### 4806 **Equation B-8.**

4807

 $EF = AWD \times f$ 

#### 4809 Where:

- 4810 EF = exposure frequency, the number of days per year a worker is exposed to the chemical 4811 (day/yr)
- 4812 AWD = annual working days, the number of days per year a worker works (day/yr)
- 4813 f = fractional number of annual working days during which a worker is exposed to the 4814 chemical (unitless)
  - 4815
  - 4816 BLS (2018) provides data on the total number of work hours and total number of employees by each
  - 4817 industry NAICS code. BLS provides these data from the 3- to 6-digit NAICS level (where 3-digit
  - 4818 NAICS are less granular and 6-digit NAICS are the most granular). Dividing the total, annual hours
    4819 worked by the number of employees yields the average number of hours worked per employee per year
- 4819 worked by the number of employees y4820 for each NAICS.
  - 4821 EPA identified approximately 140 NAICS codes applicable to the multiple conditions of use for the first 4822 ten chemicals that underwent risk evaluation. For each NAICS code of interest, EPA looked up the
  - 4823 average hours worked per employee per year at the most granular NAICS level available (*i.e.*, 4-digit, 5-
  - 4824 digit, or 6-digit). EPA converted the working hours per employee to working days per year per
  - 4825 employee assuming employees work an average of eight hours per day. The average number of working
  - 4826 days per year, or AWD, ranges from 169 to 282 days per year, with a 50<sup>th</sup> percentile value of 250 days
  - 4827 per year. EPA repeated this analysis for all NAICS codes at the 4-digit level. The average AWD for all
    4828 4-digit NAICS codes ranges from 111 to 282 days per year, with a 50<sup>th</sup> percentile value of 228 days per
  - 4829 year. 250 days per year is approximately the  $75^{th}$  percentile of the distribution AWD for the 4-digit
  - 4830 NAICS codes. In the absence of industry- and DIDP-specific data, EPA assumed the parameter, f, is4831 equal to one for all OES.

#### 4832

4835

#### **B.4.4** Intermediate Exposure Frequency (EF<sub>int</sub>)

For DIDP, the ID was set at 30 days. EPA estimated the maximum number of working days within theID, using the following equation and assuming 5 working days/wk:

#### 4836 **Equation B-9.**

# 4837 $EF_{int}(max) = 5 \frac{working \, days}{wk} \times \frac{30 \, total \, days}{7 \frac{total \, days}{wk}} = 21.4 \, days, rounded \, up \, to \, 22 \, days$

- 4838 **B.4.5 Intermediate Duration (ID)**
- 4839 EPA assessed an intermediate duration of 30 days based on the available health data.
- 4840 **B.4.6 Working Years (WY)**
- 4841 EPA developed a triangular distribution for number of lifetime working years using the following4842 parameters:
- **Minimum value:** BLS CPS tenure data with current employer as a low-end estimate of the number of lifetime working years: 10.4 years;
- 4845
   Mode value: The 50<sup>th</sup> percentile of the tenure data with all employers from SIPP as a mode value for the number of lifetime working years: 36 years; and
- 4847
   Maximum value: The maximum of the average tenure data with all employers from SIPP as a high-end estimate on the number of lifetime working years: 44 years.
- 4849

This triangular distribution has a 50<sup>th</sup> percentile value of 31 years and a 95<sup>th</sup> percentile value of 40 years.
EPA uses these values to represent the central tendency and high-end number of working years in the

4852 ADC calculations.4853

The BLS (2014b) provides information on employee tenure with *current employer* obtained from the Current Population Survey (CPS). CPS is a monthly sample survey of about 60,000 households that provides information on the labor force status of the civilian non-institutional population age 16 and over. BLS releases CPS data every two years. The data are available by demographic characteristics and by generic industry sectors, but not by NAICS codes.

4859 4860 The U.S. Census' (2016a) Survey of Income and Program Participation (SIPP) provides information on 4861 *lifetime tenure with all employers.* SIPP is a household survey that collects data on income, labor force 4862 participation, social program participation and eligibility, and general demographic characteristics 4863 through a continuous series of national panel surveys of between 14,000 and 52,000 households 4864 (Census, 2016b). EPA analyzed the 2008 SIPP Panel Wave 1, a panel that began in 2008 and covers the interview months of September 2008 through December 2008 (Census, 2016a-b). For this panel, lifetime 4865 4866 tenure data are available by Census Industry Codes, which can be cross walked with NAICS codes. 4867 SIPP data include fields for the industry in which each surveyed, employed individual works (TJBIND1); worker age (TAGE); and years of work experience with all employers over the surveyed 4868 individual's lifetime<sup>10</sup> Census household surveys use different industry codes than the NAICS codes, so 4869 4870 EPA converted these industry codes to NAICS using a published crosswalk (Census Bureau, 2012b). EPA calculated the average tenure for the following age groups: 1) workers aged 50 and older; 2) 4871 4872 workers aged 60 and older; and 3) workers of all ages employed at time of survey. EPA used tenure data 4873 for age group "50 and older" to determine the high-end lifetime working years, because the sample size 4874 in this age group is often substantially higher than the sample size for age group "60 and older". For 4875 some industries, the number of workers surveyed, or the *sample size*, was too small to provide a reliable representation of the worker tenure in that industry. Therefore, EPA excluded data where the sample 4876 4877 size is less than five from our analysis.

4878

Table\_Apx B-2 summarizes the average tenure for workers aged 50 and older from SIPP data. Although
the tenure may differ for any given industry sector, there is no significant variability between the 50<sup>th</sup>
and 95<sup>th</sup> percentile values of average tenure across manufacturing and non-manufacturing sectors.

4882

#### 4883 **Table\_Apx B-2. Overview of Average Worker Tenure from U.S. Census SIPP (Age Group 50+)**

	Working Years						
Industry Sectors	Average	50th Percentile	95th Percentile	Maximum			
Manufacturing sectors (NAICS 31–33)	35.7	36	39	40			
Non-manufacturing sectors (NAICS 42–81)	36.1	36	39	44			
Source: Census Bureau, 2016a.							
Note: Industries where sample size is less than five	e are exclude	d from this analy	ysis.				

4884

4885 BLS CPS data provide the median years of tenure that wage and salary workers had been with their 4886 current employer. Table\_Apx B-3 presents CPS data for all demographics (men and women) by age 4887 group from 2008 to 2012. To estimate the low-end value for number of working years, EPA used the

<sup>&</sup>lt;sup>10</sup> To calculate the number of years of work experience EPA took the difference between the year first worked (TMAKMNYR) and the current data year (*i.e.*, 2008). EPA then subtracted any intervening months when not working (ETIMEOFF).

4888 most recent (2014) CPS data for workers aged 55 to 64 years, which indicates a median tenure of 10.4

- 4889 years with their current employer. The use of this low-end value represents a scenario where workers are
- 4890 only exposed to the chemical of interest for a portion of their lifetime working years, as they may
- 4891 change jobs or move from one industry to another throughout their career.

Age	January 2008	January 2010	January 2012	January 2014
6 years and over	4.1	4.4	4.6	4.6
16 to 17 years	0.7	0.7	0.7	0.7
18 to 19 years	0.8	1.0	0.8	0.8
20 to 24 years	1.3	1.5	1.3	1.3
25 years and over	5.1	5.2	5.4	5.5
25 to 34 years	2.7	3.1	3.2	3.0
35 to 44 years	4.9	5.1	5.3	5.2
45 to 54 years	7.6	7.8	7.8	7.9
55 to 64 years	9.9	10.0	10.3	10.4
65 years and over	10.2	9.9	10.3	10.3

#### 4892 **Table\_Apx B-3. Median Years of Tenure with Current Employer by Age Group**

#### 4893 **B.4.7** Body Weight (BW)

4894 EPA assumes a BW of 80 kg for average adult workers. EPA assumed a BW of 72.4 kg for females of 4895 reproductive age, per Chapter 8 of the Exposure Factors Handbook (U.S. EPA, 2011).

# 4896 Appendix C 4897 ACUTE, INTERMEDIATE, AND CHRONIC (NON-CANCER) OCCUPATIONAL EXPOSURES

4899 Sample calculations for high-end and central tendency acute, intermediate, and chronic (non-cancer)
4900 doses for one condition of use, Processing – Incorporation – PVC Plastics Compounding, are
4901 demonstrated below for an average adult worker. The explanation of the equations and parameters used
4902 is provided in Appendix B.

4903 C.1 Inhalation Exposures

4904	C.1.1 Example High-End AD, IADD, and ADD Calculations
4905	
4906	Calculating AD <sub>HE</sub> :
4907	$AD_{HE} = rac{C_{HE} \times ED \times BR}{BW}$
4908	
4909	$AD_{HE} = \frac{2.1 \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr}}{80 \ kg} = 0.27 \frac{mg}{day}$
4910	
4911	
4912	Calculating IADD <sub>HE</sub> :
4913	$IADD = \frac{C_{HE} \times ED \times BR \times EF_{int}}{BW \times ID}$
4914	
4915	$IADD_{HE} = \frac{2.1 \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr} \times 22 \frac{days}{year}}{80 kg \times 30 \frac{days}{year}} = 0.20 \frac{\frac{mg}{kg}}{day}$
4916	
4917	
4918	Calculating ADD <sub>HE</sub> :
4919	$ADD_{HE} = \frac{C_{HE} \times ED \times BR \times EF \times WY}{BW \times 365 \frac{days}{vear} \times WY}$
4020	yeur
4920	ma ha m <sup>3</sup> dava
4921	$ADD_{HE} = \frac{2.1 \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr} \times 250 \frac{days}{year} \times 40 \text{ years}}{80 \text{ kg} \times 365 \frac{days}{year} \times 40 \text{ years}} = 0.18 \frac{\frac{mg}{kg}}{day}$
4922	y e un
4923	
т <i>у 2</i> Ј	
4924	C.1.2 Example Central Tendency AD, IADD, and ADD Calculations
4925	
4926	Calculating AD <sub>CT</sub> :

$$AD_{CT} = \frac{C_{CT} \times ED \times BR}{BW}$$

4928

4929 
$$AD_{CT} = \frac{0.13 \ \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr}}{80 \ kg} = 1.7 \ \times 10^{-2} \ \frac{mg}{day}}$$

- 4930
- 4931

4932 Calculating IADD<sub>CT</sub>:

4933 
$$IADD_{CT} = \frac{C_{CT} \times ED \times BR \times EF_{int}}{BW \times ID}$$

4935 
$$IADD_{CT} = \frac{0.13 \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr} \times 22 \frac{days}{year}}{80 kg \times 30 \frac{days}{year}} = 1.2 \times 10^{-2} \frac{\frac{mg}{kg}}{day}$$

4936

4937

4938 Calculating ADD<sub>CT</sub>:

4939 
$$ADD_{CT} = \frac{C_{CT} \times ED \times BR \times EF \times WY}{BW \times 365 \frac{days}{year} \times WY}$$

4940

4941 
$$ADD_{CT} = \frac{0.13 \frac{mg}{m^3} \times 8 \frac{hr}{day} \times 1.25 \frac{m^3}{hr} \times 223 \frac{days}{year} \times 31 \text{ years}}{80 \text{ } kg \times 365 \frac{days}{year} \times 31 \text{ years}} = 1.0 \times 10^{-2} \frac{\frac{mg}{kg}}{day}$$

4942

4943

#### 4944 C.2 Dermal Exposures

#### 4945 C.2.1 Example High-End AD, IADD, and ADD Calculations

4947 Calculating AD<sub>HE</sub>:

$$AD_{HE} = \frac{APDR}{BW}$$

4948 4949

4946

4950 
$$AD_{HE} = \frac{7.3 \frac{mg}{day}}{80 \ kg} = 9.2 \times 10^{-2} \frac{mg}{kg \cdot day}$$

4951 4952

4953 Calculate IADD<sub>HE</sub>:

$$IADD_{HE} = \frac{APDR \times EF_{int}}{BW \times ID}$$

Page 194 of 335

 $AD_{CT} = \frac{APDR}{BW}$ 

 $IADD_{HE} = \frac{7.3 \frac{mg}{day} \times 22 \frac{day}{yr}}{80 \ kg \times 30 \frac{day}{yr}} = 6.7 \times 10^{-2} \frac{mg}{kg \cdot day}$ 

4959 Calculate ADD<sub>HE</sub> (non-cancer):

$$ADD_{HE} = \frac{APDR \times EF \times WY}{BW \times 365 \frac{day}{yr} \times WY}$$

4962 
$$ADD_{HE} = \frac{7.3 \frac{mg}{day} \times 250 \frac{day}{yr} \times 40 \text{ years}}{80 \text{ } kg \times 365 \frac{day}{yr} \times 40 \text{ years}} = 6.3 \times 10^{-2} \frac{mg}{\text{ } kg\text{-} day}$$

 4964
 C.2.2 Example Central Tendency AD, IADD, and ADD Calculations

 4965
 10000

4966 Calculating AD<sub>CT</sub>:

 $AD_{CT} = \frac{3.7 \frac{mg}{day}}{80 \ kg} = 4.6 \times 10^{-2} \frac{mg}{kg \cdot day}$ 

4972 Calculating IADD<sub>CT</sub>:

$$IADD_{CT} = \frac{APDR \times EF_{int}}{BW \times ID}$$

 $IADD_{CT} = \frac{3.7 \frac{mg}{day} \times 22 \frac{days}{yr}}{80 \ kg \times 30 \frac{days}{yr}} = 3.4 \times 10^{-2} \frac{mg}{kg \cdot day}$ 

4979 Calculate ADD<sub>CT</sub> (non-cancer):

$$ADD_{CT} = \frac{APDR \times EF \times WY}{BW \times AT}$$

4983 
$$ADD_{CT} = \frac{3.7 \frac{mg}{day} \times 223 \frac{days}{yr} \times 31 \text{ years}}{80 \text{ } kg \times 365 \frac{day}{yr} \times 31 \text{ years}} = 2.8 \times 10^{-2} \frac{mg}{\text{ } kg\text{-} day}$$

#### Page 195 of 335

## 4985 Appendix D DERMAL EXPOSURE ASSESSMENT METHOD

#### 4986 **D.1 Dermal Dose Equation**

As described in Section 2.4.4, occupational dermal exposures to DIDP are characterized using a fluxbased approach to dermal exposure estimation. Therefore, EPA used Equation D-1 to estimate the acute
potential dose rate (APDR) from occupational dermal exposures. The APDR (units of mg/day)
characterizes the quantity of chemical that is potentially absorbed by a worker on a given workday.

#### 4992 **Equation D-1**.

4993 4994

4991

$$APDR = \frac{J \times S \times t_{abs}}{PF}$$

4995 4996 Where

4996	Where:		
4997	J	=	Average absorptive flux through and into skin (mg/cm <sup>2</sup> /hr);
4998	S	=	Surface area of skin in contact with the chemical formulation (cm <sup>2</sup> );
4999	$t_{abs}$	=	Duration of absorption (hr/day)
5000	PF	=	Glove protection factor (unitless, $PF \ge 1$ )
5001			

5002 The inputs to the dermal dose equation are described in Appendix D.2.

#### 5003 **D.2 Parameters of the Dermal Dose Equation**

Table\_Apx D-1summarizes the dermal dose equation parameters and their values for estimating dermal
 exposures. Additional explanations of EPA's selection of the inputs for each parameter are provided in
 the subsections after Table\_Apx D-1.

5007

#### 5008 **Table\_Apx D-1. Summary of Dermal Dose Equation Values**

Input Parameter	Symbol	Value	Unit	Rationale
Absorptive Flux	J	Dermal Contact with Liquids: 8.57E–04 Dermal Contact with Solids: 8.99E–06	mg/cm²/hr	See Appendix D.2
Surface Area	S	Workers: 535 (central tendency) 1,070 (high-end) Females of reproductive age: 445 (central tendency) 890 (high-end)	cm <sup>2</sup>	See Appendix D.2.2
Absorption time	$t_{abs}$	8	hr	See Appendix D.2.3
Glove Protection Factor	PF	1; 5; 10; or 20	unitless	See Appendix D.2.4

5009

#### 5010 D.2.1 Absorptive Flux

#### 5011 **D.2.1.1** Dermal Contact with Liquids or Formulations Containing DIDP 5012 As described in Section 2.4.4.1, the work of Elsisi (1989) shows that the steady-state absorptive flux of neat DIDP ranges from 5.36E–04 to 8.57E–04 mg/cm<sup>2</sup>/hr. Because the individual data were not 5013 available from Elsisi (1989), EPA has chosen the upper-bound value of flux of 8.57E–04 mg/cm<sup>2</sup>/hr as 5014 5015 the representative value for occupational dermal exposure assessment of the contact with liquids or 5016 formulations containing DIDP. Though it is possible that lower concentration materials exhibit higher 5017 fluxes than the neat material due to the properties of the vehicle of absorption, the flux of the neat 5018 material serves as a reasonable upper bound of potential flux across concentrations. Using flowchart 5019 presented in Figure 3 in OECD 156 (OECD, 2011e), it is suggested that an exposure assessor should use 5020 dermal absorption data from a realistic surrogate formulation or material if there are no data on 5021 absorption of the exact material under investigation. Because there are only dermal absorption data for 5022 neat DIDP, and workers are reasonably exposed to the neat material or concentrated formulations, EPA 5023 considers the dermal absorption of neat DIDP to be representative across chemical concentrations. 5024 5025 Using the work of Kissel (2011) to interpret the absorption data from Elsisi (1989), it was determined 5026 that dermal absorption of DIDP may be flux-limited, even for finite doses (*i.e.*, less than 10 $\mu$ L/cm<sup>2</sup> for liquids (OECD, 2004c)). Therefore, the steady-state flux (*i.e.*, 8.57E–04 mg/cm<sup>2</sup>/hr) reported by Elsisi *et* 5027 5028 al, was assumed for the duration of chemical retention on the skin, which is expected to last up to 8 5029 hours in occupational settings. However, it is also important to consider the magnitude of dermal 5030 loading of DIDP in occupational settings to ensure there is enough material present on the skin to 5031 support the assumption of the steady-state flux for an 8-hour shift. For contact with liquids in occupational settings, EPA assumes a range of dermal loading of $0.7 - 2.1 \text{ mg/cm}^2$ (U.S. EPA, 1992b) 5032 5033 for tasks such as product sampling, loading/unloading, and cleaning as shown in the ChemSTEER 5034 Manual (U.S. EPA, 2015). More specifically, EPA has utilized the raw data of the U.S. EPA (1992b) study to determine a central tendency (50<sup>th</sup> percentile) dermal loading value of 1.4 mg/cm<sup>2</sup> and a high-5035 end (95<sup>th</sup> percentile) dermal loading value of 2.1 mg/cm<sup>2</sup> for dermal exposure to liquids. For scenarios 5036 5037 where liquid immersion occurs, EPA assumes a range of dermal loading of $1.3 - 10.3 \text{ mg/cm}^2$ (U.S. 5038 EPA, 1992b) for tasks such as spray coating as shown in the ChemSTEER Manual (U.S. EPA, 2015). 5039 More specifically, EPA has utilized the raw data of the U.S. EPA (1992b) study to determine a central tendency (50<sup>th</sup> percentile) value of 3.8 mg/cm<sup>2</sup> and a high-end (95<sup>th</sup> percentile) value of 10.3 mg/cm<sup>2</sup> for 5040 5041 scenarios aligned with dermal immersion in liquids. 5042

The high-end absorptive flux of DIDP reported by Elsisi (<u>1989</u>) would result in maximum absorption of 6.86E–03 mg/cm<sup>2</sup> over an 8-hour period. Therefore, the high-end dermal exposure estimate for liquids containing DIDP is quite reasonable with respect to the amount of material that may be available for absorption in an occupational setting.

5047

#### D.2.1.2 Dermal Contact with Solids or Articles Containing DIDP

5048 As described in Section 2.4.4.2, the average absorptive flux of DIDP from solid matrices is expected to 5049 vary between 0.005 and 0.025  $\mu$ g/cm<sup>2</sup>/hr for durations between 1-hour and 1-day based on aqueous absorption modeling from U.S. EPA (2004b). Using Equation 2-2 from Section 2.4.4.2, the average 5050 5051 absorptive flux of DIDP over an 8-hour exposure period was calculated as  $8.99E-06 \text{ mg/cm}^2/\text{hr}$ . 5052 Because it is assumed that DIDP must first migrate from the solid matrix to a thin film of moisture on 5053 the surface of the skin, and that solubility of DIDP by the moisture layer limits absorption, the 8-hr time 5054 weighted average (TWA) aqueous flux value of  $8.99E-06 \text{ mg/cm}^2/\text{hr}$  was chosen as a representative 5055 value for dermal exposures to solids or articles containing DIDP.

5056 Using the work of Kissel (2011) to interpret the dermal modeling results for aqueous DIDP, it was

- determined that dermal absorption of DIDP may be flux-limited, even for finite doses (*i.e.*, typically 1 to 5058 5 mg/cm<sup>2</sup> for solids(OECD, 2004c)). Therefore, the 8-hr TWA flux (*i.e.*, 8.99E–06 mg/cm<sup>2</sup>/hr) of
- 5059 aqueous DIDP was assumed for the duration of chemical retention on the skin, which is expected to last
- 5060 up to 8 hours in occupational settings. However, it is also important to consider the magnitude of dermal
- 5061 loading of DIDP in occupational settings to ensure there is enough material present on the skin to
- 5062 support the assumption of the steady-state flux for an 8-hour shift. For contact with solids or powders in
- 5063 occupational settings, EPA generally assumes a range of dermal loading of 900 3,100 mg/day ( $50^{\text{th}} 95^{\text{th}}$  percentile from Lansink *et al.* (1996)) as shown in the ChemSTEER manual (U.S. EPA, 2015). For
- 5065 contact with materials such as solder/pastes in occupational settings, EPA assumes a range of dermal
- 5066 loading of 450 1,100 mg/day ( $50^{\text{th}} 95^{\text{th}}$  percentile from Lansink *et al.* (<u>1996</u>)) as shown in the 5067 ChemSTEER Manual (<u>U.S. EPA, 2015</u>).
- 5068

5069 The average absorptive flux of DIDP for an 8-hour absorption period, as determined through modeling 5070 efforts (U.S. EPA, 2023a, 2004b), would result in maximum absorption of 7.19E–05 mg/cm<sup>2</sup> over an 8-5071 hour period. Therefore, the high-end dermal exposure estimate for solids containing DIDP is quite 5072 reasonable with respect to the amount of material that may be available for absorption in an occupational 5073 setting.

5074 D.2.2 Surface Area

Regarding surface area of occupational dermal exposure, EPA assumed a high-end value of 1070 cm<sup>2</sup>
for male workers and 890 cm<sup>2</sup> for female workers. These high-end occupational dermal exposure
surface area values are based on the mean two-hand surface area for adults of age 21 or older from
Chapter 7 of EPA's *Exposure Factors Handbook* (U.S. EPA, 2011). For central tendency estimates,
EPA assumed the exposure surface area was equivalent to only a single hand (or one side of two hands)
and used half the mean values for two-hand surface areas (*i.e.*, 535 cm<sup>2</sup> for male workers and 445 cm<sup>2</sup>
for female workers).

5082

5083 It should be noted that while the surface area of exposed skin is derived from data for hand surface area, 5084 EPA did not assume that only the workers hands may be exposed to the chemical. Nor did EPA assume 5085 that the entirety of the hands is exposed for all activities. Rather, EPA assumed that dermal exposures 5086 occur to some portion of the hands plus some portion of other body parts (*e.g.*, arms) such that the total 5087 exposed surface area is approximately equal to the surface area of one or two hands for the central 5088 tendency and high-end exposure scenario, respectively.

5089

5095

#### **D.2.3** Absorption Time

5090 Though a splash or contact-related transfer of material onto the skin may occur instantaneously, the 5091 material may remain on the skin surface until the skin is washed. Because DIDP does not rapidly absorb 5092 or evaporate, and the worker may contact the material multiple times throughout the workday, EPA 5093 assumes that absorption of DIDP in occupational settings may occur throughout the entirety of an 8-hour 5094 work shift (U.S. EPA, 1991a).

#### **D.2.4** Glove Protection Factors

5096 Gloves may mitigate dermal exposures, if used correctly and consistently. However, data about the 5097 frequency of effective glove use – that is, the proper use of effective gloves – is very limited in industrial 5098 settings. Initial literature review suggests that there is unlikely to be sufficient data to justify a specific 5099 probability distribution for effective glove use for a chemical or industry. Instead, the impact of effective 5100 glove use should be explored by considering different percentages of effectiveness (*e.g.*, 25 percent vs. 5101 50 percent effectiveness).

- 5102 Gloves only offer barrier protection until the chemical breaks through the glove material. Using a
- 5103 conceptual model, Cherrie *et al.* (2004) proposed a glove workplace protection factor the ratio of
- 5104 estimated uptake through the hands without gloves to the estimated uptake though the hands while
- 5105 wearing gloves; this protection factor is driven by flux, and thus varies with time. The ECETOC TRA 5106 model represents the protection factor of gloves as a fixed, APF equal to 5, 10, or 20 (Marguart et al.,
- 5107 2017). Similar to the APR for respiratory protection, the inverse of the protection factor is the fraction of
- 5108 the chemical that penetrates the glove.
- 5109
- 5110 Given the limited state of knowledge about the protection afforded by gloves in the workplace, it is
- reasonable to utilize the PF values of the ECETOC TRA model (Marquart et al., 2017), rather than
  attempt to derive new values.
- 5113

Table\_Apx D-2 presents the PF values from ECETOC TRA model (Version 3). In the exposure data
used to evaluate the ECETOC TRA model, (Marquart et al., 2017) reported that the observed glove
protection factor was 34, compared to PF values of 5 or 10 used in the model.

5117

# 5118 Table\_Apx D-2. Exposure Control Efficiencies and Protection Factors for Different Dermal 5119 Protection Strategies from ECETOC TRA v3

Dermal Protection Characteristics	Affected User Group	Indicated Efficiency (%)	Protection Factor (PF)
a. Any glove / gauntlet without permeation data and without employee training		0	1
b. Gloves with available permeation data indicating that the material of construction offers good protection for the substance	Both industrial and professional users	80	5
c. Chemically resistant gloves ( <i>i.e.</i> , as b above) with "basic" employee training		90	10
d. Chemically resistant gloves in combination with specific activity training ( <i>e.g.</i> , procedure for glove removal and disposal) for tasks where dermal exposure can be expected to occur	Industrial users only	95	20

5120

# 5121 Appendix E MODEL APPROACHES AND PARAMETERS

5122 This appendix section presents the modeling approach and model equations used in estimating environmental releases and occupational exposures for each of the applicable OESs. The models were 5123 5124 developed through review of the literature and consideration of existing EPA/OPPT models, ESDs, 5125 and/or GSs. An individual model input parameter could either have a discrete value or a distribution of values. EPA assigned statistical distributions based on reasonably available literature data. A Monte 5126 5127 Carlo simulation (a type of stochastic simulation) was conducted to capture variability in the model 5128 input parameters. The simulation was conducted using the Latin hypercube sampling method in @Risk 5129 Industrial Edition, Version 7.0.0. The Latin hypercube sampling method generates a sample of possible 5130 values from a multi-dimensional distribution and is considered a stratified method, meaning the 5131 generated samples are representative of the probability density function (variability) defined in the 5132 model. EPA performed the model at 100,000 iterations to capture a broad range of possible input values, 5133 including values with low probability of occurrence.

5134

5139

- 5135 EPA used the 95<sup>th</sup> and 50<sup>th</sup> percentile Monte Carlo simulation model result values for assessment. The
- 5136 95<sup>th</sup> percentile value represents the high-end release amount or exposure level, whereas the 50<sup>th</sup>
- 5137 percentile value represents the typical release amount or exposure level. The following subsections
- 5138 detail the model design equations and parameters for each of the OESs.

## E.1 EPA/OPPT Standard Models

This appendix section discusses the standard models used by EPA to estimate environmental releases of 5140 5141 chemicals and occupational inhalation exposures. All the models presented in this section are models 5142 that were previously developed by EPA and are not the result of any new model development work for 5143 this risk evaluation. Therefore, this appendix does not provide the details of the derivation of the model 5144 equations which have been provided in other documents such as the *ChemSTEER User Guide* (U.S. 5145 EPA, 2015), Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1 (U.S. EPA, 1991b), Evaporation of pure liquids from open surfaces (Arnold and Engel, 2001), 5146 Evaluation of the Mass Balance Model Used by the References Environmental Protection Agency for 5147 Estimating Inhalation Exposure to New Chemical Substances (Fehrenbacher and Hummel, 1996), and 5148 5149 Releases During Cleaning of Equipment (Associates, 1988). The models include loss fraction models as 5150 well as models for estimating chemical vapor generation rates used in subsequent model equations to estimate the volatile releases to air and occupational inhalation exposure concentrations. The parameters 5151 5152 in the equations of this appendix section are specific to calculating environmental releases and 5153 occupational inhalation exposures to DIDP. 5154

5155 The *EPA/OPPT Penetration Model* estimates releases to air from evaporation of a chemical from an 5156 open, exposed liquid surface. This model is appropriate for determining volatile releases from activities 5157 that are performed indoors or when air velocities are expected to be less than or equal to 100 feet per 5158 minute. The *EPA/OPPT Penetration Model* calculates the average vapor generation rate of the chemical 5159 from the exposed liquid surface using the following equation:

5160 5161

**Equation E-1.** 

5162  $G_{activity} = \frac{(8.24 \times 10^{-8}) * (MW_{DIDP}^{0.835}) * F_{correction\_factor} * VP * \sqrt{Rate_{air\_speed}} * (0.25\pi D_{opening}^2)^4 \sqrt{\frac{1}{29} + \frac{1}{MW_{DIDP}}}}{T^{0.05} * \sqrt{D_{opening}} * \sqrt{P}}$ 5163 Where: 5164  $G_{activity} = Vapor \text{ generation rate for activity } [g/s]$ 5165  $MW_{DIDP} = DIDP \text{ molecular weight } [g/mol]$ 

5166	$F_{correction_factor}$	=	Vapor pressure correction factor [unitless]
5167	VP	=	DIDP vapor pressure [torr]
5168	$Rate_{air\_speed}$	=	Air speed [cm/s]
5169	D <sub>opening</sub>	=	Diameter of opening [cm]
5170	T	=	Temperature [K]
5171	Р	=	Pressure [torr]
5172			

5173 The *EPA/OPPT Mass Transfer Coefficient Model* estimates releases to air from the evaporation of a 5174 chemical from an open, exposed liquid surface. This model is appropriate for determining this type of 5175 volatile release from activities that are performed outdoors or when air velocities are expected to be 5176 greater than 100 feet per minute. The *EPA/OPPT Mass Transfer Coefficient Model* calculates the 5177 average vapor generation rate of the chemical from the exposed liquid surface using the following 5178 equation:

#### 5180 **Equation E-2.**

$$G_{activity} = \frac{(1.93 \times 10^{-7}) * (MW_{DIDP}^{0.78}) * F_{correction\_factor} * VP * Rate_{air\_speed}^{0.78} * (0.25\pi D_{opening}^2) \sqrt[3]{\frac{1}{29} + \frac{1}{MW_{DIDP}}}{T^{0.4} D_{opening}^{0.11} (\sqrt{T} - 5.87)^{2/3}}$$

5182 Where:

5183	$G_{activity}$	=	Vapor generation rate for activity [g/s]
5184	MW <sub>DIDP</sub>	=	DIDP molecular weight [g/mol]
5185	$F_{correction_factor}$	=	Vapor pressure correction factor [unitless]
5186	VP	=	DIDP vapor pressure [torr]
5187	Rate <sub>air_speed</sub>	=	Air speed [cm/s]
5188	D <sub>opening</sub>	=	Diameter of opening [cm]
5189	T	=	Temperature [K]

5190

5179

5181

5191 The EPA's Office of Air Quality Planning and Standards (OAQPS) AP-42 Loading Model estimates 5192 releases to air from the displacement of air containing chemical vapor as a container/vessel is filled with 5193 a liquid. This model assumes that the rate of evaporation is negligible compared to the vapor loss from 5194 the displacement and is used as the default for estimating volatile air releases during both loading 5195 activities and unloading activities. This model is used for unloading activities because it is assumed 5196 while one vessel is being unloaded another is assumed to be loaded. The EPA/OAQPS AP-42 Loading 5197 Model calculates the average vapor generation rate from loading or unloading using the following 5198 equation:

#### 5199 5200 **Equation E-3.**

	F <sub>saturatio</sub>	on_factor <sup>:</sup>	* <i>MW</i> <sub>DIDP</sub> * <i>V</i> <sub>container</sub> *3785.4 $\frac{cm^3}{gal}$ * <i>F</i> <sub>correction_factor*<i>VP</i>*<math>\frac{RATE_{fill}}{3600\frac{S}{hr}}</math></sub>
5201	$G_{activity} =$		R*T
5202	Where:		
5203	$G_{activity}$	=	Vapor generation rate for activity [g/s]
5204	$F_{saturation\_factor}$	=	Saturation factor [unitless]
5205	$MW_{DIDP}$	=	DIDP molecular weight [g/mol]
5206	$V_{container}$	=	Volume of container [gal/container]
5207	$F_{correction_factor}$	=	Vapor pressure correction factor [unitless]
5208	VP	=	DIDP vapor pressure [torr]
5209	<i>RATE<sub>fill</sub></i>	=	Fill rate of container [containers/hr]

5210	R	= Universal gas constant [L*torr/mol-K]
5211	Т	= Temperature [K]

5212

5213 For each of the vapor generation rate models, the vapor pressure correction factor ( $F_{correction_factor}$ )

5214 can be estimated using Raoult's Law and the mole fraction of DIDP in the liquid of interest. However, in

5215 most cases, EPA did not have data on the molecular weights of other components in the liquid 5216 formulations; therefore, EPA approximated the mole fraction using the mass fraction of DIDP in the 5217 liquid of interest. Using the mass fraction of DIDP to estimate mole fraction does create uncertainty in 5218 the vapor generation rate model. If other components in the liquid of interest have similar molecular 5219 weights as DIDP, then mass fraction is a reasonable approximation of mole fraction. However, if other 5220 components in the liquid of interest have much lower molecular weights than DIDP, the mass fraction of 5221 DIDP will be an overestimate of the mole fraction. If other components in the liquid of interest have

- much higher molecular weights than DIDP, the mass fraction of DIDP will underestimate the molefraction.
- 5224 If calculating an environmental release, the vapor generation rate calculated from one of the above 5225 models (Equation E-1, Equation E-2, and Equation E-3) is then used along with an operating time to 5226 calculate the release amount:
- **5227 Equation E-4.**
- 5228

$$Release\_Year_{activity} = Time_{activity} * G_{activity} * 3600 \frac{s}{hr} * 0.001 \frac{kg}{g}$$

5229 Where:

5230 $Release\_Year_{activity} =$ DIDP released for activity per site-year [kg/site-yr]5231 $Time_{activity} =$ Operating time for activity [hr/site-yr]5232 $G_{activity} =$ Vapor generation rate for activity [g/s]

5233

5234 In addition to the vapor generation rate models, EPA uses various loss fraction models to calculate 5235 environmental releases, including the following:

- 5236 EPA/OPPT Small Container Residual Model
- EPA/OPPT Drum Residual Model
- 5238 EPA/OPPT Bulk Transport Residual Model
- EPA/OPPT Multiple Process Vessel Residual Model
- EPA/OPPT Single Process Vessel Residual Model
- EPA/OPPT Solid Residuals in Transport Containers Model
- March 2023 Methodology for Estimating Environmental Releases from Sampling Waste
- 5243

5249

The loss fraction models apply a given loss fraction to the overall throughput of DIDP for the given process. The loss fraction value or distribution of values differs for each model; however, each model follows the same general equation based on the approaches described for each OES: 5247

5248 **Equation E-5.** 

 $Release_Year_{activity} = PV * F_{activity loss}$ 

5250	Where:	
5251	$Release_Year_{activity} =$	DIDP released for activity per site-year [kg/site-yr]
5252	PV =	Production volume throughput of DIDP [kg/site-yr]
5253	$F_{activity\_loss} =$	Loss fraction for activity [unitless]

5255 The EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading

5256 *Operations of Solid Powders* estimates a loss fraction of dust that may be generated during the

5257 transferring/unloading of solid powders. This model can be used to estimate a loss fraction of dust both

5258 when the facility does not employ capture technology (*i.e.*, local exhaust ventilation, hoods) or dust 5259 control/removal technology (*i.e.*, cyclones, electrostatic precipitators, scrubbers, or filters), and when the

5260 facility does employ capture and/or control/removal technology. The model explains that when dust is

5261 uncaptured, the release media is fugitive air, water, incineration, or landfill. When dust is captured but

5262 uncontrolled, the release media is to stack air. When dust is captured and controlled, the release media is

to incineration or landfill. The *EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading Operations of Solid Powders* calculates the amount of dust not captured,
captured but not controlled, and both captured and controlled, using the following equations (U.S. EPA,
2021d):

5267 5268 Equation E-6

5254

5268	Equation E-6.	
5269	Elocal <sub>dust_not_cap</sub>	$r_{btured} = Elocal_{dust_generation} * (1 - F_{dust_capture})$
5270	Where:	
5271	$Elocal_{dust\_not\_captured} =$	Daily amount emitted from transfers/unloading that is not
5272		captured [kg not captured/site-day]
5273	$Elocal_{dust\_generation} =$	Daily release of dust from transfers/unloading [kg generated/site-
5274	~	day]
5275	$F_{dust\_capture} =$	Capture technology efficiency [kg captured/kg generated]
5276		
5277	Equation E-7.	
5278	$Elocal_{dust\_cap\_uncontrol} =$	$= Elocal_{dust\_generation} * F_{dust\_capture} * (1 - F_{dust\_control})$
5279	Where:	
5280	$Elocal_{dust\_cap\_uncontrol} =$	Daily amount emitted from control technology from
5281		transfers/unloading [kg not controlled/site-day]
5282	$Elocal_{dust\_generation} =$	Daily release of dust from transfers/unloading [kg generated/site-
5283		day]
5284	$F_{dust\_capture} =$	Capture technology efficiency [kg captured/kg generated]
5285	$F_{dust\_control} =$	Control technology removal efficiency [kg controlled/kg captured]
5286		
5287	Equation E-8.	
5288		$= Elocal_{dust\_generation} * F_{dust\_capture} * F_{dust\_control}$
5289	Where:	
5290	$Elocal_{dust\_cap\_control} =$	Daily amount captured and removed by control technology from
5291		transfers/unloading [kg controlled/site-day]
5292	$Elocal_{dust\_generation} =$	Daily release of dust from transfers/unloading [kg generated/site-
5293		day]
5294	$F_{dust\_capture} =$	Capture technology efficiency [kg captured/kg generated]
5295	$F_{dust\_control} =$	Control technology removal efficiency [kg controlled/kg captured]
5296		
5297		<i>lation Model</i> estimates a worker inhalation exposure to an estimated
5298	-	ithin the worker's breathing zone using a one box model. The model
5299	estimates the amount of chemical in	haled by a worker during an activity in which the chemical has

5300 volatilized and the airborne concentration of the chemical vapor is estimated as a function of the source

vapor generation rate or the saturation level of the chemical in air. First, the applicable vapor generation
rate model (Equation E-1, Equation E-2, and Equation E-3) is used to calculate the vapor generation rate
for the given activity. With this vapor generation rate, the *EPA/OPPT Mass Balance Inhalation Model*calculates the volumetric concentration of DIDP using the following equation:

5305

**Equation E-9.** 

5307

$$Cv_{activity} = Minimum: \begin{cases} \left[\frac{170,000 * T * G_{activity}}{MW_{DIDP} * Q * k}\right] \\ \left[\frac{1,000,000ppm * F_{correction\_factor} * VP}{P}\right] \end{cases}$$

5308 Where:

5309	Cv <sub>activity</sub>	=	Exposure activity volumetric concentration [ppm]
5310	$G_{activity}$	=	Exposure activity vapor generation rate [g/s]
5311	MW <sub>DIDP</sub>	=	DIDP molecular weight [g/mol]
5312	Q	=	Ventilation rate [ft <sup>3</sup> /min]
5313	k	=	Mixing factor [unitless]
5314	Т	=	Temperature [K]
5315	$F_{correction_factor}$	=	Vapor pressure correction factor [unitless]
5316	VP	=	DIDP vapor pressure [torr]
5317	Р	=	Pressure [torr]
5318			

5319 Mass concentration can be estimated by multiplying the volumetric concentration by the molecular 5320 weight of DIDP and dividing by molar volume at standard temperature and pressure.

5321 EPA uses the above equations in the DIDP environmental release and occupational exposure models, 5322 and EPA references the model equations by model name and/or equation number within Appendix E.

# 5323 E.2 Manufacturing Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases and occupational exposures for DIDP during the manufacturing OES. This approach utilizes the *Virtual Tour of the Exxon Mobil Baton Rouge Chemical Plant DIDP/DIDP Production Facility* (ExxonMobil virtual tour) (ExxonMobil, 2022b) and CDR data (U.S. EPA, 2020a) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on ExxonMobil's virtual tour (ExxonMobil, 2022b), EPA identified the following release sources
 from manufacturing operations:

- Release source 1: Vented Losses to Air During Reaction/Separations/Other Process Operations.
- Release source 2: Process Waste from Reaction/Separations/Other Process Operations.
- Release source 3: Crude and Final Filtrations.
- Release source 4: Product Sampling Wastes.
- Release source 5: Open Surface Losses to Air During Product Sampling.
- Release source 6: Equipment Cleaning Wastes.
- Release source 7: Open Surface Losses to Air During Equipment Cleaning.
- Release source 8: Transfer Operation Losses to Air from Packaging Manufactured DIDP into Transport Containers.
- Release source 9: Container Cleaning Wastes.

5341 Environmental releases for DIDP during manufacturing are a function of DIDP's physical properties, 5342 container size, mass fractions, and other model parameters. While physical properties are fixed, some

5343 model parameters are expected to vary. EPA used a Monte Carlo simulation to capture variability in the 5344 following model input parameters: production rate, DIDP concentration, air speed, diameter of openings, 5345 saturation factor, container size, and loss fractions. EPA used the outputs from a Monte Carlo simulation

- 5346 with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release
- amounts and exposure concentrations for this OES.

#### E.2.1 Model Equations

5348

- Table\_Apx E-1 provides the models and associated variables used to calculate environmental releases 5349 5350 for each release source within each iteration of the Monte Carlo simulation. EPA used these 5351 environmental releases to develop a distribution of release outputs for the manufacturing OES. The 5352 variables used to calculate each of the following values include deterministic or variable input 5353 parameters, known constants, physical properties, conversion factors, and other parameters. The values 5354 for these variables are provided in Appendix E.2.2. The Monte Carlo simulation calculated the total 5355 DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency 5356
- 5357 and high-end releases, respectively.

<b>Release source</b>	Model(s) Applied	Variables Used	
Release source 1: Vented Losses to Air During Reaction/Separations/Other Process Operations.	See Equation E-10	Q <sub>DIDP_day</sub> ; F <sub>DIDP_SPERC</sub>	
Release source 2: Process Waste from Reaction/Separations/Other Process Operations.	See Equation E-11	$Q_{DIDP\_day}; WS_{DIDP}$	
Release source 3: Crude and Final Filtrations.	See Equation E-12	$Q_{DIDP\_day}; LF_{filtration}$	
Release source 4: Product Sampling Wastes.	March 2023 Methodology for Estimating Environmental Releases from Sampling Waste (Appendix E.1)	$Q_{DIDP\_day}; LF_{sampling}$	
Release source 5: Open Surface Losses to Air During Product Sampling.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP</sub></i> <i>MW</i> ; <i>VP</i> ; <i>RATE<sub>air_speed</sub></i> ; <i>D<sub>sampling</sub></i> ; <i>T</i> ; <i>P</i>	
		Operating Time: <i>OH<sub>sampling</sub></i>	
Release source 6: Equipment Cleaning Wastes.	<i>EPA/OPPT Multiple Process</i> <i>Vessel Residual Model</i> (Appendix E.1)	$Q_{DIDP\_day}; LF_{equip\_clean}$	
Release source 7: Open Surface Losses to Air During Equipment Cleaning.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ MW; VP; RATE <sub>air_speed</sub> ; $D_{equip\_clean}$ ; T; P	
		Operating Time: <i>OH<sub>equip_clea</sub></i>	

5358 Table\_Apx E-1. Models and Variables Applied for Release Sources in the Manufacturing OES

Release source	Model(s) Applied	Variables Used
Release source 8: Transfer Operation Losses to Air from Packaging Manufactured DIDP into Transport Containers.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP</sub></i> ; <i>VP</i> ; <i>f<sub>sat</sub>; MW</i> ; <i>R</i> ; <i>T</i> ; <i>RATE<sub>fill_drum</sub></i> Operating Time: <i>N<sub>prodcont_yr</sub></i> ; <i>RATE<sub>fill_cont</sub></i> ; <i>RATE<sub>fill_drum</sub></i> ; <i>OD</i>
Release source 9: Container Cleaning Wastes.	EPA/OPPT Bulk Transport Residual Model (Appendix E.1)	$Q_{DIDP\_day}; LF_{bulk}$

5359

5362

Release source 1 daily release (Vented Losses to Air During Reaction/Separations/Other ProcessOperations) is calculated using the following equation:

#### 5363 **Equation E-10.**

$Release_perDay_{RP1} =$	$Q_{DIDP\_day} * F_{DIDP\_SPERC}$
--------------------------	-----------------------------------

5364 5365

Where: 5366  $Release\_perDay_{RP1} =$ DIDP released for release source 1 [kg/site-day] Facility throughput of DIDP [kg/site-day] 5367  $Q_{DIDP_day}$ =Loss fraction for unit operations [unitless]Release source 2 daily 5368 = F<sub>DIDP</sub> SPERC release (Process Waste from Reaction/Separations/Other Process Operations) is calculated using the 5369 5370 following equation: 5371 5372 **Equation E-11.**  $Release\_perDay_{RP2} = Q_{DIDP_{day}} * \frac{WS_{DIDP}}{1000}$ 5373 5374 Where: 5375  $Release\_perDay_{RP2} =$ DIDP released for release source 2 [kg/site-day] 5376 = Facility throughput of DIDP [kg/site-day]  $Q_{DIDP \ dav}$ 5377 = Water solubility for DIDP [g/L]WSDIDP 5378 5379 Release source 3 daily release (Crude and Final Filtrations) is calculated using the following equation. Note that this release point is calculated differently for the site with a known production volume, and for 5380 5381 the other three sites that claimed their production volumes (PVs) as CBI: 5382 5383 **Equation E-12.**  $Release\_perDay_{RP3} = Q_{DIDP_{day}} * LF_{filtration}$  (1 site with known PV) 5384 5385 5386 or 5387  $Release\_perDay_{RP3} = Q_{filtration\_release}$  (3 sites with CBI PVs) 5388 5389 5390 Where: 5391  $Release\_perDay_{RP3} =$ DIDP released for release source 3 [kg/site-day] 5392  $Q_{DIDP \ day}$ = Facility throughput of DIDP [kg/site-day] *LF*<sub>filtration</sub> Loss fraction for filtration [unitless] 5393 =

5394	$Q_{filtration\_release}$	=	Estimated daily filtration releases from ExxonMobil virtual tour
5395	, _		[kg/site-day]
5396			

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#### 5397 E.2.2 Model Input Parameters

- 5398 Table\_Apx E-2 summarizes the model parameters and their values for the Manufacturing Monte Carlo
- simulation. Additional explanations of EPA's selection of the distributions for each parameter areprovided after Table\_Apx E-2.

Input	S 1 1	<b>T</b> I. •4	Deterministic Values	Uncertainty Analysis Distribution Parameters				
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Facility Production Rate – Known Site 1	PV	kg/site-yr	20,507	_	_	_	_	See Section E.2.4
Facility Production Rate – Unknown Sites	PV	kg/site-yr	75,595,310	7556454.71	75595310.2		Uniform	See Section E.2.4
Manufactured DIDP Concentration	F <sub>DIDP</sub>	kg/kg	0.995	0.9	1	0.995	Triangular	See Section E.2.7
Air Speed	RATE <sub>air_speed</sub>	ft/min	19.7	2.56	398	—	Lognormal	See Section E.2.8
Diameter of Sampling Opening	D <sub>sampling</sub>	cm	2.5	2.5	10	2.5	Triangular	See Section E.2.9
Diameter of Equipment Opening	D <sub>equip_clean</sub>	cm	92					See Section E.2.9
Saturation Factor	f <sub>sat</sub>	dimensionless	0.5	0.5	1.45	0.5	Triangular	See Section E.2.10
Drum Size	V <sub>drum</sub>	gal	55	20	100	55	Triangular	See Section E.2.11
Bulk Container Size	V <sub>cont</sub>	gal	20000	5000	20000	20000	Triangular	See Section E.2.11
Bulk Container Loss Fraction	LF <sub>bulk</sub>	kg/kg	0.0007	0.0002	0.002	0.0007	Triangular	See Section E.2.12
Loss Fraction for Filtration Releases (PV1)	LF <sub>filtration</sub>	kg/kg	0.0207	0.00207	0.0207		Uniform	See Section E.2.13

#### 5401 Table\_Apx E-2. Summary of Parameter Values and Distributions Used in the Manufacturing Models

Input	Symbol	Unit	Deterministic Values	Uncertain	nty Analysis D	Distribution	Rationale / Basis	
Parameter			Value	Lower Bound	Upper Bound	Mode	Distribution Type	Kationale / Dasis
Fraction of DIDP Lost During Sampling - 1 (Q <sub>DIDP_day</sub> < 50 kg/site-day)	F <sub>sampling_1</sub>	kg/kg	0.02	0.002	0.02	0.02	Triangular	See Section E.2.14
Fraction of DIDP Lost During Sampling - 2 (Q <sub>DIDP_day</sub> 50- 200 kg/site- day)	F <sub>sampling_2</sub>	kg/kg	0.005	0.0006	0.005	0.005	Triangular	See Section E.2.14
Fraction of DIDP Lost During Sampling - 3 (Q <sub>DIDP_day</sub> 200- 5000 kg/site- day)	F <sub>sampling_3</sub>	kg/kg	0.004	0.0005	0.004	0.004	Triangular	See Section E.2.14
Fraction of DIDP Lost During Sampling - 4 (Q <sub>DIDP_day</sub> > 5000 kg/site- day)	F <sub>sampling_4</sub>	kg/kg	0.0004	0.00008	0.0004	0.0004	Triangular	See Section E.2.14
Number of Sites	Ns	sites	4	—	-	-	—	See Section E.2.3
Operating Days	OD	days/yr	180	_	_	-	_	See Section E.2.15

Input	Symbol	Unit	Deterministic Values	Uncertair	nty Analysis I			
Parameter			Value	LowerUpperBoundBound		Mode	Distribution Type	- Rationale / Basis
Vapor Pressure at 25C	VP	mmHg	5.28E-07	-	_	-	_	Physical property
Vapor Pressure at 140F	VP <sub>140</sub>	mmHg	5.21E-05	-	_	-	_	Physical property
Vapor Pressure at 250F	VP <sub>250</sub>	mmHg	6.16E-03	-	_	-	-	Physical property
Vapor Pressure at 375F	VP <sub>375</sub>	mmHg	0.283	_	_	_	-	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	_	-	Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05	_	_	-	-	Universal constant
Process Operation Emission Factor	F <sub>DIDP_SPERC</sub>	kg/kg	0.001	_	-	-	-	See Section E.2.16
Water Solubility of DIDP	WS <sub>DIDP</sub>	g/L	0.00028	_	-	-	-	Physical property
Exxon Filtration Release Amount	Qfiltration_release	kg/day	869	_	-	-	_	See Section E.2.13
Temperature	Т	К	298	_	_	_	_	Process parameter
Pressure	Р	atm	1	_	_	_	_	Process parameter
Equipment cleaning loss fraction	LF <sub>equip_clean</sub>	kg/kg	0.02	_	-	_	-	See Section E.2.17
Drum Fill Rate	RATE <sub>fill_drum</sub>	drums/hr	20	_	_	_	_	See Section E.2.18

Input	G I I	<b>.</b>	Deterministic Values	Uncertainty Analysis Distribution Parameters				Define la / Desia
Parameter	Symbol	Unit	Value		Upper Bound	Mode	Distribution Type	<b>Rationale / Basis</b>
Bulk Container Fill Rate	RATE <sub>fill_cont</sub>	containers/hr	1	_	_	-	_	See Section E.2.18
Density of DIDP	RHO	kg/L	0.9634				_	Physical property
Mixing Factor	F <sub>mixing</sub>	dimensionless	0.5	0.1	1	0.5	Triangular	See Section E.2.19

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#### 5403 E.2.3 Number of Sites

5404 EPA used 2020 CDR data (U.S. EPA, 2020a) to identify the number of sites that manufacture DIDP. In
5405 CDR, four sites reported domestic manufacturing of DIDP. Table\_Apx E-3 presents the names and
5406 locations of these sites.

5407 5408

#### Table\_Apx E-3. Sites Reporting to CDR for Domestic Manufacture of DIDP

Facility Name	Facility Location		
Troy Chemical Corp.	Phoenix, AZ		
ExxonMobil	Baton Rouge, LA		
LANXESS Solutions	Fords, NJ		
Teknor Apex	Brownsville, TN		

5409

#### 5410 E.2.4 Throughput Parameters

5411 EPA ran the Monte Carlo model once to estimate releases and exposures from the single site with a 5412 known production volume, and once to estimate releases and exposures from the other three sites that 5413 claimed their production volumes (PVs) as CBI. EPA used 2020 CDR data (U.S. EPA, 2020a) to 5414 identify annual facility PV for each site. Out of the four sites that reported domestic manufacturing of 5415 DIDP in CDR, only one site provided a production volume. Troy Chemical Corporation reported 45,211

5416 pounds (20,507 kg) of DIDP manufactured.

5417

5418 For the other three sites, EPA used a uniform distribution set within the national PV range for each 5419 CASRN (DIDP encompasses two CASRNs). EPA calculated the bounds of the range by taking the total 5420 PV range in CDR and subtracting out the PVs that belonged to known sites (both MFG and import). 5421 Then, for each bound of the PV range for the remaining unknown sites, EPA divided the value by the 5422 number of unknown sites for each CASRN. CDR estimates a total national DIDP PV of 100,000,000 to 1,000,000,000 lb Based on the known PVs from importers and manufacturers, the total PV associated 5423 5424 with the three sites with CBI PVs is 16,659,131 to 166,659,131 lbs/site-yr. Based on this (while 5425 converting pounds to kilograms). EPA set a uniform distribution with lower bound of 7.556.455 kg/site-5426 yr, and an upper bound of 75,595,310 kg/site-yr.

The daily throughput of DIDP is calculated using Equation E-13 by dividing the annual production
volume by the number of operating days. The number of operating days is determined according to
Section E.2.15.

#### 5432 **Equation E-13.**

5433

5427

$$Q_{DIDP\_day} = \frac{PV}{OD}$$

5434 5435 Where:

5436	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
5437	PV	=	Annual production volume [kg/site-yr]
5438	OD	=	Operating days (see Section E.2.15) [days/yr]
5439			

The number of manufa	ctured DIDP product containers filled by a site per year is calculated using the					
following equation:						
Equation E-14.						
	$N = - \frac{PV}{PV}$					
	$N_{prodcont\_yr} = \frac{PV}{RHO * \left(3.79 \ \frac{L}{gal}\right) * V_{drum/cont}}$					
<b>XX</b> 71	(and gal) varam/cont					
Where:						
N <sub>prodcont_yr</sub>	= Annual number of product containers [container/site-year]					
V <sub>drum/cont</sub>	= Product container volume (see Section E.2.11) [gal/container]					
PV	= Facility production rate (see Section E.2.4) [kg/site-year]					
RHO	= DIDP density [kg/L]					
E.2.6 Operat	ing Hours					
EPA estimated operation	ng hours using ExxonMobil's virtual tour (ExxonMobil, 2022b), and through					
	parameters. Worker activities with operating hours provided from ExxonMobil's					
virtual tour include pro	duct sampling, equipment cleaning, and loading.					
For product sampling (release point 5), ExxonMobil stated via their virtual tour that one hr/day is spent						
	ExxonMobil, 2022b). This is consistent with the default value provided in the					
ChemSTEER User Gui	de (U.S. EPA, 2015).					
Zan aguinneant alaguin	a (malagas maint 7) the Chan STEED User Cride manides on estimate of four					
1 1	g (release point 7), the <i>ChemSTEER User Guide</i> provides an estimate of four ing multiple vessels (U.S. EPA, 2015).					
nours per day for clean	$\frac{1}{100} \frac{1}{100} \frac{1}$					
The operating hours fo	r loading of DIDP into transport containers (release point 8) is calculated based					
1 0	uct containers filled at the site and the fill rate using the following equation:					
1						
Equation E-15.						
	$Time_{RP8} = \frac{N_{prodcont\_yr}}{RATE_{fill\_drum/cont} * OD}$					
	$RATE_{fill\_drum/cont} * OD$					
Where:						
$Time_{RP8}$	= Operating time for release point 8 [hrs./site-day]					
RATE <sub>fill_drum/</sub>	<i>cont</i> = Fill rate of container, dependent on volume (see Section E.2.18)					
	[containers/hr]					
$N_{prodcont\_yr}$	= Annual number of product containers (see Section E.2.5)					
	[containers/site-year]					
OD	= Operating days (see Section E.2.15) [days/site-year]					
E.2.7 Manufa	actured DIDP Concentration					
	ed details in CDR (Troy Chemical Corporation), EPA used the manufactured					
1	ported in CDR (U.S. EPA, $2020a$ ) to make a uniform distribution of 1-30% DIDF					
CDR Data from the ren	naining three sites indicated a concentration range of 90-100% DIDP (U.S. EPA					
	maining three sites indicated a concentration range of 90-100% DIDP ( <u>U.S. EPA</u> , he Australian Assessment Report, DIDP is manufactured at or above 99.5%. In					
2020a). According to taddition, during Exxon	maining three sites indicated a concentration range of 90-100% DIDP (U.S. EPA, he Australian Assessment Report, DIDP is manufactured at or above 99.5%. In Mobil's virtual tour of the DIDP/DINP production facility, the company indicate is DIDP Based on this information EPA modeled the manufactured DIDP					

5482 a concentration of 99.6% DIDP. Based on this information, EPA modeled the manufactured DIDP

- 5483 concentration for the other three sites using a triangular distribution with a lower bound of 90%, upper
- 5484 bound of 100%, and mode of 99.5%.

#### E.2.8 Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
surveys into settings representative of industrial facilities and representative of commercial facilities.
EPA fit separate distributions for these industrial and commercial settings and used the industrial
distribution for this OES.

5492

5485

5493 EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air 5494 speed measurements within a surveyed location were lognormally distributed and the population of the 5495 mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since 5496 lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the 5497 largest observed value among all of the survey mean air speeds.

5498

5499 EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the 5500 following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, 5501 the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed 5502 value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the 5503 model from sampling values that approach infinity or are otherwise unrealistically small or large 5504 (Baldwin and Maynard, 1998).

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
individual measurements within each survey. Therefore, these distributions represent a distribution of
mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
However, a mean air speed (averaged over a work area) is the required input for the model. EPA

- 5509 However, a mean an speed (averaged over a work area) is the required input 5510 converted the units to ft/min prior to use within the model equations.
- 5511

#### E.2.9 Diameters of Opening

5512 The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold 5513 liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For 5514 equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm 5515 (U.S. EPA, 2015).

5516

5517 For sampling activities, the ChemSTEER User Guide indicates that the typical diameter of opening for 5518 vaporization of the liquid is 2.5 cm (U.S. EPA, 2015). Additionally, the ChemSTEER User Guide 5519 provides ten cm as a high-end value for the diameter of opening during sampling (U.S. EPA, 2015). The 5520 underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution 5521 based on the estimated lower bound, upper bound, and mode of the parameter. EPA assigned the value 5522 of 2.5 cm as a lower bound for the parameter and ten cm as the upper bound based on the values 5523 provided in the *ChemSTEER User Guide* (U.S. EPA, 2015). EPA also assigned 2.5 cm as the mode 5524 diameter value for sampling liquids based on the typical value described in *ChemSTEER User Guide* 5525 (U.S. EPA, 2015).

#### 5526 E.2.10 Saturation Factor

5527 The *Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1* 5528 [CEB Manual] indicates that during splash filling, the saturation concentration was reached or exceeded

- by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual indicates
- that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 1991b). The
- underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution
- based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided
- 5533 for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling minimizes 5534 volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in the
- 535 ChemSTEER User Guide for the EPA/OAOPS AP-42 Loading Model (U.S. EPA, 2015).

#### E.2.11 Container Size

5537 For the site with a known PV, (Troy Chemical Corporation), EPA assumed that manufactured DIDP was 5538 packaged into drums, based on the reported PV of 20,507 kg/site-yr. According to the *ChemSTEER User* 5539 *Guide*, drums are defined as containing between 20 and 100 gallons of liquid, and the default drum size 5540 is 55 gallons (U.S. EPA, 2015). Therefore, EPA modeled drum size using a triangular distribution with a 5541 lower bound of 20 gallons, an upper bound of 100 gallons, and a mode of 55 gallons.

- 5543 For the other three sites, EPA assumed that DIDP was packaged into bulk containers, based on the larger 5544 PV range of 7,556,455 to 75,595,310 kg/site-yr. According to ExxonMobil's virtual tour (ExxonMobil, 5545 2022b), DIDP is transported via marine vessels (58.5%), rail cars (28.5%), and trucks (13%) at the 5546 facility. According to the ChemSTEER User Guide (U.S. EPA, 2015), the default tank truck size is 5,000 5547 gallons, and the default rail car size is 20,000 gallons. Therefore, EPA modeled bulk container size using 5548 a triangular distribution with a lower bound of 5,000 gallons, an upper bound of 20,000 gallons, and a mode of 20,000 gallons. The mode was set at 20,000 gallons since ExxonMobil listed that the majority 5549 5550 of transport methods were rail cars or marine vessels.
- 5551

5536

5542

### E.2.12 Bulk Container Residue Loss Fraction

5552 EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data for emptying tanks by gravity-draining was aligned with the default central tendency and high-end 5553 5554 values from the *EPA/OPPT Bulk Transport Residual Model*. For unloading tanks by gravity-draining in 5555 the PEI Associates Inc. study, EPA found that the average percent residual from the pilot-scale 5556 experiments showed a range of 0.02 percent to 0.19 percent and an average of 0.06 percent (Associates, 5557 1988). The EPA/OPPT Bulk Transport Residual Model from the ChemSTEER User Guide (U.S. EPA, 5558 2015) recommends a default central tendency loss fraction of 0.07 percent and a high-end loss fraction 5559 of 0.2 percent.

5560 5561 The underlying distribution of the loss fraction parameter for bulk containers is not known; therefore, 5562 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 5563 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 5564 the loss fraction probability distribution using the central tendency and high-end values, respectively, 5565 prescribed by the EPA/OPPT Bulk Transport Residual Model in the ChemSTEER User Guide (U.S. 5566 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum 5567 average percent residual measured in the PEI Associates, Inc. study for emptying tanks by gravity-5568 draining (Associates, 1988).

#### 5569 E.2.13 Filtration Loss Fraction

5570 For the three sites with unknown PVs, EPA used estimates from ExxonMobil's virtual tour

- 5571 (ExxonMobil, 2022b) to estimate environmental releases from filtration losses. In the virtual tour,
- 5572 ExxonMobil stated that during DIDP/DINP production, crude filtration losses are 397 kg/day, and final
- 5573 filtration losses are 472 kg/day, for a total of 869 kg/day for filtration losses. As the PV of ExxonMobil

- is expected to be on the same scale as the PV estimate for the three unknown sites, this release estimateof 869 kg/day is used directly.
- 5576

5583

5577 For the site with a known PV (Troy Chemical Corporation), EPA did not expect the ExxonMobil

5578 filtration loss estimates to be accurate due to the smaller PV of DIDP. Therefore, EPA developed a

5579 uniform distribution of loss fractions from ExxonMobil's filtration loss estimates. EPA divided 869

5580 kg/day by the range of daily production volumes for the sites with CBI PVs. This resulted in a uniform

distribution of filtration loss fractions with a lower bound of 2.07E–03 kg/kg and an upper bound of

5582 2.07E–02 kg/kg.

### E.2.14 Sampling Loss Fraction

5584 Sampling loss fractions were estimated using the March 2023 Methodology for Estimating 5585 Environmental Releases from Sampling Wastes (U.S. EPA, 2023b). In this methodology, EPA 5586 completed a search of over 300 IRERs completed in the years 2021 and 2022 for sampling release data, including a similar proportion of both PMNs and Low Volume Exemptions (LVEs). Of the searched 5587 IRERs, 60 data points for sampling release loss fractions, primarily for sampling releases from 5588 5589 submitter-controlled sites (~75% of IRERs), were obtained. The data points were analyzed as a function 5590 of the chemical daily throughput and industry type. This analysis showed that the sampling loss fraction 5591 generally decreased as the chemical daily throughput increased. Therefore, the methodology provides 5592 guidance for selecting a loss fraction based on chemical daily throughput. Table Apx E-4 presents a 5593 summary of the chemical daily throughputs and corresponding loss fractions.

5594

5595	Table_Apx E-4. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating
5596	Environmental Releases from Sampling Waste

Chemical Daily Throughput (kg/site-	Number of Data	-	Quantity lical/day)	Sampling Loss Fraction (LF <sub>sampling</sub> )	
day) (Qchem_site_day)	Points	50th Percentile	95th Percentile	50th Percentile	95th Percentile
<50	13	0.03	0.20	0.002	0.02
50 to <200	10	0.10	0.64	0.0006	0.005
200 to <5,000	25	0.37	3.80	0.0005	0.004
≥5,000	10	1.36	6.00	0.00008	0.0004
All	58	0.20	5.15	0.0005	0.008

5597

For each range of daily throughputs, EPA estimated sampling loss fractions using a triangular
distribution of the 50<sup>th</sup> percentile value as the lower bound, and the 95<sup>th</sup> percentile value as the upper
bound and mode. The sampling loss fraction distribution was chosen based on the calculation of daily
throughput, as shown in Section E.2.4.

#### 5602 E.2.15 Operating Days

According to ExxonMobil's virtual tour (ExxonMobil, 2022b), DIDP production occurs continuously for half a year (180 days). The other half year is dedicated to DINP production. EPA used this value as a constant for the number of operating days for DIDP production.

#### 5606 E.2.16 Process Operations Emission Factor

5607 In order to estimate releases from reactions, separations, and other process operations, EPA used an 5608 emission factor from the European Solvents Industry Group (ESIG). According to the ESD on Plastic 5609 Additives, the processing temperature during manufacture of plasticizers is 375°F (OECD, 2009b). At 5610 this temperature, DIDP has a vapor pressure of 37.8 Pa. ESIG's Specific Environmental Release

- 5611 Category for Industrial Substance Manufacturing (solvent-borne) states that a chemical with a vapor
- 5612 pressure between 10-100 Pa will have an emission factor of 0.001 (ESIG, 2012). Therefore, EPA used
- this emission factor as a constant value for process operation releases.

#### 5614 E.2.17 Equipment Cleaning Loss Fraction

5615 EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment 5616 cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide* 5617 (U.S. EPA, 2015), provides an overall loss fraction of 2 percent from equipment cleaning.

#### 5618 E.2.18 Container Fill Rates

5619 The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for 5620 containers with 20 to 100 gallons of liquid and a typical fill rate of one container per hour for containers 5621 with over 10,000 gallons of liquid.

#### 5622 E.2.19 Mixing Factor

5623 The CEB Manual (U.S. EPA, 1991b) indicates mixing factors may range from 0.1 to 1, with 1 representing ideal mixing. The CEB Manual references the 1988 ACGIH Ventilation Handbook, which 5624 5625 suggests the following factors and descriptions: 0.67 to 1 for best mixing; 0.5 to 0.67 for good mixing; 0.2 to 0.5 for fair mixing; and 0.1 to 0.2 for poor mixing (U.S. EPA, 1991b). The underlying distribution 5626 5627 of this parameter is not known; therefore, EPA assigned a triangular distribution based on the defined 5628 lower and upper bound and estimated mode of the parameter. The mode for this distribution was not 5629 provided in the CEB Manual; therefore, EPA assigned a mode value of 0.5 based on the typical value provided in the ChemSTEER User Guide for the EPA/OPPT Mass Balance Inhalation Model (U.S. 5630 5631 EPA, 2015).

# 5632 E.3 Import and Repackaging Model Approaches and Parameters

5633 This appendix presents the modeling approach and equations used to estimate environmental releases for 5634 DIDP during the import and repackaging OES. This approach utilizes the *Generic Scenario for* 5635 *Chemical Repackaging* (U.S. EPA, 2022a) and CDR data (U.S. EPA, 2020a) combined with Monte 5636 Carlo simulation (a type of stochastic simulation).

5637

5638 Based on the GS, EPA identified the following release sources from import and repackaging operations:

- Release source 1: Transfer Operation Losses to Air from Unloading DIDP.
- Release source 2: Product Sampling Wastes.
- Release source 3: Container Cleaning Wastes.
- Release source 4: Open Surface Losses to Air During Container Cleaning.
- Release source 5: Equipment Cleaning Wastes.
- Release source 6: Open Surface Losses to Air During Equipment Cleaning.
- Release source 7: Transfer Operation Losses to Air from Loading DIDP.
- Environmental releases for DIDP during import and repackaging are a function of DIDP's physical
  properties, container size, mass fractions, and other model parameters. While physical properties are
  fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture
  variability in the following model input parameters: production rate, operating days, DIDP
  concentration, air speed, saturation factor, container size, and loss fractions. EPA used the outputs from
  a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk
- 5652 to calculate release amounts for this OES.

#### 5653 E.3.1 Model Equations

Table\_Apx E-5 provides the models and associated variables used to calculate environmental releases 5654 5655 for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the import and repackaging OES. 5656 The variables used to calculate each of the following values include deterministic or variable input 5657 5658 parameters, known constants, physical properties, conversion factors, and other parameters. The values 5659 for these variables are provided in Appendix E.3.2. The Monte Carlo simulation calculated the total 5660 DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency 5661 5662 and high-end releases, respectively.

5663

#### 5664 Table\_Apx E-5. Models and Variables Applied for Release Sources in the Import and **Repackaging OES** 5665

Release source	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading DIDP.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{tote}$ ; $RATE_{fill\_tote}$ ; $V_{rail}$ ; $RATE_{fill\_rail}$
		Operating Time: N <sub>tote/rail_unload_yr</sub> ; RATE <sub>fill_tote</sub> ; RATE <sub>fill_rail</sub> ; OD
Release source 2: Product Sampling Wastes.	March 2023 Methodology for Estimating Environmental Releases from Sampling Waste (Appendix E.1)	$Q_{DIDP\_day}; LF_{sampling}$
Release source 3: Container Cleaning Wastes.	EPA/OPPT Bulk Transport Residual Model (Appendix E.1)	$Q_{DIDP\_day}; LF_{bulk}$
Release source 4: Open Surface Losses to Air During Container Cleaning.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP</sub></i> ; <i>MW</i> ; <i>VP</i> ; <i>RATE<sub>air_speed</sub></i> ; <i>D<sub>cont_clean_tote</sub></i> ; <i>D<sub>cont_clean_rail</sub></i> ; <i>T</i> ; <i>P</i>
		Operating Time: N <sub>tote/rail_unload_yr</sub> ; RATE <sub>fill_tote</sub> ; RATE <sub>fill_rail</sub> ; OD
Release source 5: Equipment Cleaning Wastes	<i>EPA/OPPT Multiple Process</i> <i>Vessel Residual Model</i> (Appendix E.1)	$Q_{DIDP\_day}; LF_{equip\_clean}$
Release source 6: Open Surface Losses to Air During Equipment Cleaning.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; MW; VP; RATE <sub>air_speed</sub> ; $D_{equip\_clean}$ ; T; P
	Speed (Cippendin 201)	Operating Time: <i>OH<sub>equip_clean</sub></i>
Release source 7: Transfer Operation Losses to Air from Loading DIDP.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: <i>F</i> <sub>DIDP</sub> ; <i>VP</i> ; <i>f</i> <sub>sat</sub> ; <i>MW</i> ; <i>R</i> ; <i>T</i> ; <i>V</i> <sub>drum</sub> ; <i>RATE</i> <sub>fill_drum</sub> ; <i>V</i> <sub>rail</sub> ; <i>RATE</i> <sub>fill_rail</sub>
		Operating Time: N <sub>drum/rail_load_yr</sub> ; RATE <sub>fill_drum</sub> ; RATE <sub>fill_rail</sub> ; OD

#### **E.3.2** Model Input Parameters 5666

5667

Table Apx E-6 summarizes the model parameters and their values for the Import and Repackaging 5668 Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after Table Apx E-6. 5669

			Deterministic Values	Uncertai	nty Analysis	s Distribut	ion Parameters		
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis	
Facility Production Rate	PV	kg/site-yr	Multiple distribution	ons based on	CDR data.		Uniform	See Section E.3.4	
Operating Days	OD	days/yr	208	174	260	—	Discrete	See Section E.3.7	
Manufactured DIDP Concentration	F <sub>DIDP</sub>	kg/kg	Multiple distribution	ons based on	CDR data.		Triangular	See Section E.3.8	
Air Speed	RATE <sub>air_speed</sub>	ft/min	19.7	2.56	398	_	Lognormal	See Section E.3.9	
Saturation Factor	f <sub>sat</sub>	dimensionle ss	0.5	0.5	1.45	0.5	Triangular	See Section E.3.10	
Drum Size	V <sub>drum</sub>	gal	55	20	100	55	Triangular	See Section E.3.11	
Tote Size	V <sub>tote</sub>	gal	550	100	1000	550	Triangular	See Section E.3.11	
Rail Car Size	V <sub>rail</sub>	gal	20000	10000	20000	20000	Triangular	See Section E.3.11	
Bulk Container Loss Fraction	LF <sub>bulk</sub>	kg/kg	0.0007	0.0002	0.002	0.0007	Triangular	See Section E.3.12	
Fraction of DIDP Lost During Sampling - 1 (Q <sub>DIDP_day</sub> < 50 kg/site- day)	$F_{sampling_1}$	kg/kg	0.02	0.002	0.02	0.02	Triangular	See Section E.3.13	
Fraction of DIDP Lost During Sampling - 2 (Q <sub>DIDP_day</sub> 50-200 kg/site-day)	F <sub>sampling_2</sub>	kg/kg	0.005	0.0006	0.005	0.005	Triangular	See Section E.3.13	
Fraction of DIDP Lost During Sampling - 3 (Q <sub>DIDP_day</sub> 200-5000 kg/site-day)	Fsampling_3	kg/kg	0.004	0.0005	0.004	0.004	Triangular	See Section E.3.13	
Fraction of DIDP Lost During Sampling - 4 $(Q_{DIDP_{day}} > 5000$ kg/site-day)	Fsampling_4	kg/kg	0.0004	0.00008	0.0004	0.0004	Triangular	See Section E.3.13	
Number of Sites	Ns	sites	11	_	_	—	_	See Section E.3.3	

#### 5670 **Table\_Apx E-6. Summary of Parameter Values and Distributions Used in the Import and Repackaging Model**

Input Parameter Symbol Unit			Deterministic Values	Uncertain	nty Analysis			
		Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis	
Diameter of Tote Opening	D <sub>cont_clean_tot</sub>	cm	5.08	_	_	-	-	See Section E.3.14
Diameter of Rail Car Opening	D <sub>cont_clean_rail</sub>	cm	7.6	-	_	-	-	See Section E.3.14
Diameter of Opening for Equipment Cleaning	D <sub>equip_clean</sub>	cm	92	-	_	-	_	See Section E.3.14
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	—	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	—	—	Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05	-	-	-	_	Universal constant
Temperature	Т	K	298	_	_	—	—	Process parameter
Pressure	Р	atm	1	_	_	_	—	Process parameter
Equipment cleaning loss fraction	LF <sub>equip_clean</sub>	kg/kg	0.02	_	_	-	-	See Section E.3.15
Drum Fill Rate	RATE <sub>fill_drum</sub>	drums/hr	20	_	_	_	—	See Section E.3.16
Tote Fill Rate	$RATE_{fill\_tote}$	totes/hr	20	_	_	_	—	See Section E.3.16
Rail Car Fill Rate	RATE <sub>fill_cont</sub>	rail car/hr	1	_	_	—	—	See Section E.3.16
Density of DIDP	RHO	kg/L	0.9634		—		—	Physical property

5671

#### 5672 E.3.3 Number of Sites

5673 EPA used 2020 CDR data (U.S. EPA, 2020a) to identify the number of sites that import DIDP. In CDR,
5674 10s sites reported importing DIDP. Table\_Apx E-7 presents the names and locations of these sites.

5675 5676

#### Table\_Apx E-7. Sites Reporting to CDR for Domestic Manufacture of DIDP

Facility Name	Facility Location
L.G. Hausys America, Inc.	Adairsville, GA
Harwick Standard Distribution Corp.	Akron, OH
Tremco Incorporated	Beachwood, OH
Akrochem Corp.	Stow, OH
Chemspec, Ltd.	Uniontown, OH
ICC Chemical Corp.	New York, NY
3M Company	St. Paul, MN
The Sherwin-Williams Company	Cleveland, OH
Sika Corp.	Lyndhurst, NJ
LG Chem America, Inc.	Atlanta, GA

#### 5677 E.3.4 Throughput Parameters

EPA ran seven unique scenarios for the import and repackaging OES: one unique scenario for each of
the sites with known PVs, one scenario to estimate releases from three sites with CBI PVs for CASRN
26761-40-0, and one scenario to estimate releases from three sites with CBI PVs for CASRN 68515-491. Note that 3M Company reported manufacture of both CASRNs, so this site is included with both CBI
estimates. EPA used 2020 CDR data (U.S. EPA, 2020a) to identify annual facility PVs for each site. Out
of the 11 sites that reported importing DIDP in CDR, five sites provided a production volume.
Table\_Apx E-8 presents the known facilities and their DIDP production volumes.

5685

#### 5686 **Table\_Apx E-8. Sites with Known Production Volumes in CDR**

Facility Name	Facility Location	Production Volume (lbs)		
LG Huasys America, Inc.	Adairsville, GA	26,223		
Harwick Standard Distribution Corporation	Akron, OH	42,873		
Tremco Incorporated	Beachwood, OH	800,201		
Akrochem Corporation	Stow, OH	14,585		
Chemspec, Ltd.	Uniontown, OH	52,472		

5687

5688 For the other five sites, EPA used a uniform distribution set within the national PV range for each

5689 CASRN (DIDP encompasses two CASRNs). EPA calculated the bounds of the uniform distribution by

5690 taking the total PV range in CDR and subtracting out the known PVs (both MFG and import). Then, for

5691 each adjusted bound of the CDR range, EPA divided this value by the number of sites with CBI PVs for

5692 each CASRN.

5693 For CASRN 26761-40-0, CDR estimates a total national DIDP PV of <1,000,000 lb EPA used this as a 5694 maximum value. Based on the known PVs from importers and manufacturers, the total PV associated 5695 with the remaining three sites with CBI PVs is 63,646 lb When divided equally among the three sites, 5696 this resulted in an estimated PV of 21,215 lbs (9,623 kg).

For CASRN 68515-49-1, CDR estimates a total national DIDP PV of 100,000,000 to 1,000,000,000 lb
Based on the known PVs from importers and manufacturers, the total PV associated with the three sites
with CBI PVs is 16,659,131 to 166,659,131 lbs/site-yr. Based on this (while converting pounds to
kilograms), EPA set a uniform distribution with lower bound of 7,556,455 kg/site-yr, and an upper
bound of 75,595,310 kg/site-yr.

5704 The daily throughput of DIDP is calculated using Equation E-16 by dividing the annual production 5705 volume by the number of operating days. The number of operating days is determined according to 5706 Section E.3.7.

5708 Equation E-16.

$$Q_{DIDP\_day} = \frac{PV}{OD}$$

5710 5711 Where:

5697

5703

5707

5709

5/11	where.		
5712	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
5713	PV	=	Annual production volume [kg/site-yr]
5714	OD	=	Operating days (see Section E.3.7) [days/yr]
5715			

#### E.3.5 Number of Containers per Year

5717 The number of imported DIDP totes or rail cars unloaded by a site per year is calculated using the5718 following equation:

5719 5720

5721

5716

 $N_{tote/rail\_unload\_yr} = \frac{PV}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{tote/rail}}$ 

5722 Where:

**Equation E-17.** 

5723	V <sub>tote/rail</sub>	=	Product container volume (see Section E.3.11) [gal/container]
5724	PV	=	Facility production rate (see Section E.3.4) [kg/site-year]
5725	RHO	=	DIDP density [kg/L]
5726	N <sub>tote/rail_unload_yr</sub>	=	Annual number of totes or rail cars [tote or rail car/site-year]

5728 The number of DIDP drums or rail cars loaded by a site per year is calculated using the following 5729 equation:

5730

5727

5731 **Equation E-18.** 

5732 
$$N_{drum/rail\_load\_yr} = \frac{PV}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{drum/rail}}$$

5733	Where:		
5734	V <sub>drum/rail</sub>	=	Product container volume (see Section E.3.11) [gal/container]
5735	PV	=	Facility production rate (see Section E.3.4) [kg/site-year]
5736	RHO	=	DIDP density [kg/L]
5737	$N_{drum/rail\_load\_yr}$	=	Annual number of drums or rail cars [drum or rail car/site-year]
5738			

5739 E.3.6 Operating Hours

# EPA estimated operating hours or hours of duration using data provided from the *ChemSTEER User Guide* (U.S. EPA, 2015) and/or through calculation from other parameters. Release points with operating hours provided from the *ChemSTEER User Guide* include unloading, container cleaning, equipment cleaning, and loading into transport containers.

5745 For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based 5746 on the number of imported totes or rail cars unloaded at the site and the unloading rate using the 5747 following equation:

#### 5749 **Equation E-19**.

$$OH_{RP1/RP4} = \frac{N_{tote/rail\_unload\_yr}}{RATE_{fill\_tote/rail} * OD}$$

5751 5752

5744

5748

5750

5752	Where:		
5753	$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 [hrs/site-day]
5754	$RATE_{fill\_tote/rail}$	=	Fill rate of container, dependent on volume (see Section E.3.16)
5755			[containers/hr]
5756	$N_{tote/rail\_unload\_yr}$	=	Annual number of totes or rail cars (see Section E.3.5) [tote or rail
5757			car/site-year]
5758	OD	=	Operating days (see Section E.3.7) [days/site-year]
5759			

5760 For equipment cleaning (release point 6), the *ChemSTEER User Guide* provides an estimate of four 5761 hours per day for cleaning multiple vessels (U.S. EPA, 2015).

5763 For loading into transport containers (release point 7), the operating hours are calculated based on 5764 number of product containers filled per year, or on remaining time after accounting for container 5765 unloading. The operating hours are calculated using the following equation:

#### 5767 Equation E-20.

5768

5769

5766

5762

$$OH_{RP7} = \frac{N_{drum/rail\_load\_yr}}{RATE_{fill\_drum/rail} * OD}$$

5770 Where:

5771 5772	OH <sub>RP7</sub> RATE <sub>fill_drum/rail</sub>	=	Operating time for release point 7 [hrs/site-day] Fill rate of container, dependent on volume (see Section E.3.16)
5773	j tit_ar ant r att		[containers/hr]
5774	N <sub>drum/rail_load_yr</sub>	=	Annual number of drums or rail cars (see Section E.3.5) [drum or
5775	,		rail car/site-year]
5776	OD	=	Operating days (see Section E.3.7) [days/site-year]

#### 5777 **E.3.7 Operating Days**

EPA assessed the number of operating days associated with import and repackaging using employment 5778 5779 data obtained through the U.S. BLS Occupational Employment Statistics (U.S. BLS, 2016). Per the U.S. 5780 BLS website, operating duration for each NAICS code is assumed as a 'year-round, full-time' hours 5781 figure of 2,080 hours (U.S. BLS, 2016). Therefore, dividing this time by an assumed working duration 5782 of 8-12 hours/day yields a number of operating days between 174-260 days/year. In order to account for differences in operating days, EPA assumed three types of shift durations with corresponding operating 5783 5784 days per year: 8-hour, 10-hour, and 12-hour shifts. These shift durations correspond to 260, 208, and 5785 174 operating days per year, respectively. Therefore, EPA used a discrete distribution with equal 5786 probability for each shift length/operating days combination to model this parameter.

5787 E.3.8 Manufactured DIDP Concentration

5788 For the five sites that had non-CBI production volumes in CDR, their DIDP concentration ranges were 5789 also listed in CDR. For each site, EPA used a uniform distribution with the upper and lower bounds as 5790 presented in Table\_Apx E-9.

5791

#### 5792 Table\_Apx E-9. Sites with Known DIDP Concentrations in CDR

Facility Name	Facility Location	<b>DIDP</b> Concentration (%)	
LG Huasys America, Inc.	Adairsville, GA	30-60	
Harwick Standard Distribution Corporation	Akron, OH	90-100	
Tremco Incorporated	Beachwood, OH	1-30	
Akrochem Corporation	Stow, OH	30-60	
Chemspec, Ltd.	Uniontown, OH	90-100	

5793

5794 CDR Data from the remaining six sites indicated a concentration range of 1-100% DIDP (U.S. EPA, 5795 2020a). According to the Australian Assessment Report and the European Risk Report for DIDP 5796 (NICNAS, 2015; ECJRC, 2003a), neat DIDP is typically handled at 99% or higher. Based on this 5797 information, EPA modeled the manufactured DIDP concentration for the other six sites using a 5798 triangular distribution with a lower bound of 1%, upper bound of 100%, and mode of 99%.

#### 5799 **E.3.9** Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
surveys into settings representative of industrial facilities and representative of commercial facilities.
EPA fit separate distributions for these industrial and commercial settings and used the industrial
distribution for this OES.

5806

5807 EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air
5808 speed measurements within a surveyed location were lognormally distributed and the population of the
5809 mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since
5810 lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the

5811 largest observed value among all of the survey mean air speeds.

- 5812 EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the
- following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed
- 5815 value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the
- 5816 model from sampling values that approach infinity or are otherwise unrealistically small or large
- 5817 (Baldwin and Maynard, 1998).
- 5818

5824

- 5819 Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the 5820 individual measurements within each survey. Therefore, these distributions represent a distribution of
- 5821 mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
- 5822 However, a mean air speed (averaged over a work area) is the required input for the model. EPA
- 5823 converted the units to ft/min prior to use within the model equations.
  - E.3.10 Saturation Factor

5825 The CEB Manual indicates that during splash filling, the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 5826 5827 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 5828 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 5829 5830 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 5831 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in 5832 the ChemSTEER User Guide for the EPA/OAOPS AP-42 Loading Model (U.S. EPA, 2015).

### 5833 E.3.11 Container Size

EPA assessed container size based on the PV of each model run. For example, a site with a PV of over 5834 5835 100 million kg would likely use rail cars for transportation, as the volume would require an 5836 unreasonable number of smaller drums. Drums, totes, and rail cars were all used in this model. 5837 According to the *ChemSTEER User Guide*, drums are defined as containing between 20 and 100 gallons 5838 of liquid, and the default drum size is 55 gallons (U.S. EPA, 2015). Therefore, EPA modeled drum size 5839 using a triangular distribution with a lower bound of 20 gallons, an upper bound of 100 gallons, and a 5840 mode of 55 gallons. Totes are defined as containing between 100 and 1,000 gallons, with a default of 5841 550 gallons. Therefore, EPA modeled tote size using a triangular distribution with a lower bound of 100 5842 gallons, an upper bound of 1,000 gallons, and a mode of 550 gallons. Rail cars are defined as containing 5843 10,000 or more gallons. The default rail car size is 20,000 gallons (U.S. EPA, 2015). Therefore, EPA modeled rail car size using a triangular distribution with a lower bound of 10,000 gallons and an upper 5844 5845 bound and mode of 20,000 gallons.

# 5846 E.3.12 Bulk Container Residue Loss Fraction

5847 EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data for emptying tanks by gravity-draining was aligned with the default central tendency and high-end 5848 5849 values from the EPA/OPPT Bulk Transport Residual Model. For unloading tanks by gravity-draining in the PEI Associates Inc. study, EPA found that the average percent residual from the pilot-scale 5850 5851 experiments showed a range of 0.02 percent to 0.19 percent and an average of 0.06 percent (Associates, 5852 1988). The EPA/OPPT Bulk Transport Residual Model from the ChemSTEER User Guide (U.S. EPA, 5853 2015) recommends a default central tendency loss fraction of 0.07 percent and a high-end loss fraction 5854 of 0.2 percent. 5855

5856 The underlying distribution of the loss fraction parameter for bulk containers is not known; therefore, 5857 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are

completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 5858

- 5859 the loss fraction probability distribution using the central tendency and high-end values, respectively, 5860 prescribed by the EPA/OPPT Bulk Transport Residual Model in the ChemSTEER User Guide (U.S.
- 5861 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum
- 5862 average percent residual measured in the PEI Associates, Inc. study for emptying tanks by gravity-
- 5863 draining (Associates, 1988).

#### **E.3.13 Sampling Loss Fraction**

Sampling loss fractions were estimated using the March 2023 Methodology for Estimating 5865 Environmental Releases from Sampling Wastes (U.S. EPA, 2023b). In this methodology, EPA 5866 5867 completed a search of over 300 IRERs completed in the years 2021 and 2022 for sampling release data, 5868 including a similar proportion of both PMNs and Low Volume Exemptions (LVEs). Of the searched 5869 IRERs, 60 data points for sampling release loss fractions, primarily for sampling releases from 5870 submitter-controlled sites (~75% of IRERs), were obtained. The data points were analyzed as a function of the chemical daily throughput and industry type. This analysis showed that the sampling loss fraction 5871 generally decreased as the chemical daily throughput increased. Therefore, the methodology provides 5872 5873 guidance for selecting a loss fraction based on chemical daily throughput. Table Apx E-10 presents a 5874 summary of the chemical daily throughputs and corresponding loss fractions.

5875

5864

#### 5876 Table Apx E-10. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating 5877 **Environmental Releases from Sampling Waste**

Chemical Daily Throughput	Number of Data	Sampled (kg chem	Quantity iical/day)		Loss Fraction
(kg/site-day) (Q <sub>chem_site_day</sub> )	Points	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile
<50	13	0.03	0.20	0.002	0.02
50 to <200	10	0.10	0.64	0.0006	0.005
200 to <5,000	25	0.37	3.80	0.0005	0.004
≥5,000	10	1.36	6.00	0.00008	0.0004
All	58	0.20	5.15	0.0005	0.008

5878

For each range of daily throughputs, EPA estimated sampling loss fractions using a triangular 5879 distribution of the 50<sup>th</sup> percentile value as the lower bound, and the 95<sup>th</sup> percentile value as the upper 5880 bound and mode. The sampling loss fraction distribution was chosen based on the calculation of daily 5881 5882 throughput, as shown in Section E.3.4

#### 5883 E.3.14 Diameters of Opening

- The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold 5884 5885 liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For 5886 equipment cleaning operations, the ChemSTEER User Guide indicates a single default value of 92 cm 5887 (U.S. EPA, 2015).
- 5888

5889 For container cleaning activities, the ChemSTEER User Guide indicates a single default value of 5.08

5890 cm for containers less than 5,000 gallons, and 7.6 cm for containers greater than or equal to 5,000

5891 gallons (U.S. EPA, 2015).

	May 2024
5892	E.3.15 Equipment Cleaning Loss Fraction
5893	EPA used the EPA/OPPT Multiple Process Residual Model to estimate the releases from equipment
5894	cleaning. The EPA/OPPT Multiple Process Residual Model, as detailed in the ChemSTEER User Guide
5895	(U.S. EPA, 2015), provides an overall loss fraction of 2 percent from equipment cleaning.
5896	E.3.16 Container Fill Rates
5897	The <i>ChemSTEER User Guide</i> (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for
5898	containers with 20 to 100 gallons of liquid and a typical fill rate of one container per hour for containers
5899	with over 10,000 gallons of liquid.
5900	E.4 Incorporation into Adhesives and Sealants Model Approaches and
5901	Parameters
5902	
5902 5903	This appendix presents the modeling approach and equations used to estimate environmental releases for DIDP during the incorporation into adhesives and sealants OES. This approach utilizes the <i>Emission</i>
5903 5904	Scenario Document on Adhesive Formulation (OECD, 2009a) and CDR data (U.S. EPA, 2020a)
5905	combined with Monte Carlo simulation (a type of stochastic simulation).
5906	comonica with fronte carlo sinialation (a type of stochastic sinialation).
5907	Based on the ESD, EPA identified the following release sources from incorporation into adhesives and
5908	sealants:
5909	• Release source 1: Transfer Operation Losses to Air from Unloading Adhesive Component.
5910	Release source 2: Dust Generation from Transfer Operations.
5911	Release source 3: Container Cleaning Wastes.
5912	Release source 4: Open Surface Losses to Air During Container Cleaning.
5913	• Release source 5: Vented Losses to Air During Dispersion and Blending.
5914	Release source 6: Product Sampling Wastes.
5915	Release source 7: Open Surface Losses to Air During Product Sampling.
5916	Release source 8: Equipment Cleaning Wastes.
5917	Release source 9: Open Surface Losses to Air During Equipment Cleaning.
5918	Release source 10: Transfer Operation Losses to Air from Packaging Adhesive/ Sealant into
5919	Transport Containers.
5920	Release source 11: Off-Spec and Other Waste Adhesive.
5921	
5922	Environmental releases for DIDP during incorporation into adhesives and sealants are a function of
5923	DIDP's physical properties, container size, mass fractions, and other model parameters. While physical
5924	properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation
5925	to capture variability in the following model input parameters: production volume, DIDP concentrations,
5926	air speed, saturation factor, container size, loss fractions, diameters of openings, and operating durations.
5927	EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube
5928	sampling method in @Risk to calculate release amounts for this OES.

- sampling method in @Risk to calculate release amounts for this OES.
- 5929 E.4.1 Model Equations

5930 Table\_Apx E-11 provides the models and associated variables used to calculate environmental releases

5931 for each release source within each iteration of the Monte Carlo simulation. EPA used these

5932 environmental releases to develop a distribution of release outputs for the incorporation into adhesives

- and sealants OES. The variables used to calculate each of the following values include deterministic or
   variable input parameters, known constants, physical properties, conversion factors, and other
- 5935 parameters. The values for these variables are provided in Appendix E.4.2. The Monte Carlo simulation

5936 calculated the total DIDP release (by environmental media) across all release sources during each

5937 iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the

- 5938 central tendency and high-end releases, respectively.
- 5939

# Table\_Apx E-11. Models and Variables Applied for Release Sources in the Incorporation into Adhesives and Sealants OES

<b>Release source</b>	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Adhesive Component.EPA/OAQPS AP-42 Loading Model (Appendix E.1)		Vapor Generation Rate: $F_{DIDP\_import}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $RATE_{fill\_drum\_tote}$ Operating Time: $Q_{DIDP\_year}$ ; $V_{cont}$ ; $RATE_{fill\_drum\_tote}$ ; $RHO$ ; $OD$
Release source 2: Dust Generation from Transfer Operations.	Not Assessed for liquid DIDP.	N/A
Release source 3: Container Cleaning Wastes.	EPA/OPPT Drum Residual Model (Appendix E.1)	$Q_{DIDP\_year}; LF_{drum}; V_{cont}; RHO; OD$
Release source 4: Open Surface Losses to Air During Container Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP\_import}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cont\_clean}$ ; $T$ ; $P$ Operating Time: $Q_{DIDP\_year}$ ; $V_{cont}$ ; $RATE_{fill\_drum\_tote}$ ; $RHO$ ; $OD$
Release source 5: Vented Losses to Air During Dispersion and Blending.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; MW; VP; RATE <sub>air_speed</sub> ; D <sub>blend</sub> ; T; P Operating Time: $Q_{DIDP_year}$ ; $Q_{batch}$ ; OD
Release source 6: Product Sampling Wastes.	March 2023 Methodology for Estimating Environmental Releases from Sampling Waste (Appendix E.1)	$Q_{DIDP\_day}; LF_{sampling}$
Release source 7: Open Surface Losses to Air During Product Sampling.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP_final</sub></i> ; <i>MW</i> ; <i>VP</i> ; <i>RATE<sub>air_speed</sub></i> ; <i>D<sub>sampling</sub></i> ; <i>T</i> ; <i>P</i> Operating Time: <i>OH<sub>sampling</sub></i>
Release source 8: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP\_day}; LF_{equip\_clean}$
Release source 9: Open Surface Losses to Air During Equipment Cleaning.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; MW; VP; RATE <sub>air_speed</sub> ; $D_{equip_clean}$ ; T; P Operating Time: $OH_{equip_clean}$
Release source 10: Transfer Operation Losses to Air from Packaging Adhesive/ Sealant into Transport Containers.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{cont\_packaged}$ ; $RATE_{fill\_cont}$ ; $RATE_{fill\_drum\_tote}$ ; $OD$ ;

Release source	Model(s) Applied	Variables Used
		Operating Time: $PV; V_{cont\_packaged}; RATE_{fill\_cont}; RHO; OD;$ $Q_{DIDP\_year}; V_{cont}; RATE_{fill\_drum\_tote}; RATE_{fill\_adjusted}$
Release source 11: Off- Spec and Other Waste Adhesive.	See Equation E-21	$Q_{DIDP\_day}; LF_{offspec}$

5942

5947

Release source 11 daily release (Off-Spec and Other Waste Adhesive) is calculated using the followingequation:

# 59455946 Equation E-21.

 $Release\_perDay_{RP11} = Q_{DIDP\_day} * LF_{offspec}$ 

5948 Where:

5710	Where.		
5949	Release_perDay <sub>RI</sub>	<sub>11</sub> =	DIDP released for release source 11 [kg/site-day]
5950	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
5951	LFoffspec	=	Loss fraction for off-spec and waste adhesive [unitless]

5952 E.4.2 Model Input Parameters

Table\_Apx E-12 summarizes the model parameters and their values for the Incorporation into Adhesives and Sealants Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after Table\_Apx E-12.

			Deterministic Values	Uncertainty Analysis Distribution Parameters				
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Total PV of DIDP at All Sites	PV <sub>total</sub>	kg/yr	1,679,970	374,305	1,679,97 0		Uniform	See Section E.4.3
Initial DIDP Concentration	$F_{DIDP\_import}$	kg/kg	0.6	0.3	0.6		Uniform	See Section E.4.7
Final DIDP Concentration	$F_{DIDP\_final}$	kg/kg	0.01	0.001	0.6	0.01	Triangular	See Section E.4.8
Air Speed	RATE <sub>air_spee</sub>	ft/min	19.7	2.56	398		Lognormal	See Section E.4.9
Saturation Factor	$\mathbf{f}_{sat}$	dimensionl ess	0.5	0.5	1.45	0.5	Triangular	See Section E.4.10
Import Container Size	V <sub>cont</sub>	gal	55	20	100	55	Triangular	See Section E.4.11
Drum Residual Loss Fraction	LF <sub>drum</sub>	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section E.4.12
Fraction of DIDP Lost During Sampling - 1 (Q <sub>DIDP_day</sub> < 50 kg/site-day)	F <sub>sampling_1</sub>	kg/kg	0.02	0.002	0.02	0.02	Triangular	See Section E.4.13
Fraction of DIDP Lost During Sampling - 2 (Q <sub>DIDP_day</sub> 50-200 kg/site-day)	F <sub>sampling_2</sub>	kg/kg	0.005	0.0006	0.005	0.005	Triangular	See Section E.4.13
Fraction of DIDP Lost During Sampling - 3 (Q <sub>DIDP_day</sub> 200-5000 kg/site-day)	F <sub>sampling_3</sub>	kg/kg	0.004	0.0005	0.004	0.004	Triangular	See Section E.4.13

#### 5956 <u>Table\_Apx E-12. Summary of Parameter Values and Distributions Used in the Incorporation into Adhesives and Sealants Model</u>

			Deterministic Values	Uncertai	nty Analysis			
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Fraction of DIDP Lost During Sampling - 4 (Q <sub>DIDP_day</sub> > 5000 kg/site-day)	$F_{sampling\_4}$	kg/kg	0.0004	0.00008	0.0004	0.0004	Triangular	See Section E.4.13
Diameter of Opening- Blending	D <sub>blend</sub>	cm	10	10	168.92		Uniform	See Section E.4.14
Diameter of Opening – Sampling	D <sub>sampling</sub>	cm	2.5	2.5	10	_	Uniform	See Section E.4.14
Hours per Batch for Equipment Cleaning	OH <sub>batch_equip</sub>	hours/batch	4	1	4	4	Triangular	See Section E.4.15
Packaged Container Size	$V_{cont\_packaged}$	gal	55	0.10	100	55	Triangular	See Section E.4.11
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	_	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	—	_	Physical property
Gas Constant	R	atm- cm3/gmol- L	82.05	_	_	_	-	Universal constant
Density of DIDP	RHO	kg/L	0.9634					Physical property
Temperature	Т	Κ	298	_	_	_	_	Process parameter
Pressure	Р	atm	1	-	—	—	-	Process parameter
Operating Days	OD	days/yr	250	-	—	-	—	See Section E.4.16
Batch Size	Qbatch	kg/batch	4000	_	_	—	-	See Section E.4.17
Drum and Tote Fill Rate	RATE <sub>fill_dru</sub>	containers/ hr	20	_	_	_	_	See Section E.4.18
Small Container Fill Rate	$\underset{t}{RATE_{fill\_con}}$	containers/ hr	60	_	_	_	_	See Section E.4.18

I (D)		<b>T</b> T */	Deterministic Values	Uncertain	nty Analysis	on Parameters		
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Diameter of Opening – Container Cleaning	$D_{cont\_clean}$	cm	5.08	_	_	_	—	See Section E.4.14
Diameter of Opening – Equipment Cleaning	$D_{equip\_clean}$	cm	92	_	_	_	_	See Section E.4.14
Sampling Duration	OH <sub>sampling</sub>	hr/day	1	-	-	-	—	See Section E.4.6
Equipment Cleaning Loss Fraction	$LF_{equip\_clean}$	kg/kg	0.02	-	_	-	_	See Section E.4.19
Off-Spec and Waste Loss Fraction	LF <sub>offspec</sub>	kg/kg	0.01	_	_	_	_	See Section E.4.20

5957

5958	E.4.3 Number	of Sites	
5959	Per 2020 U.S. Census B	ureau data f	for NAICS code 32552 (Adhesives Manufacturing), there are 540
5960	Adhesive/ Sealant formu	lation sites	(U.S. BLS, 2016). Therefore, this value is used as a bounding limit,
5961	not to be exceeded by th	e calculatio	n. Number of sites is calculated using the following equation.:
5962	-		
5963	Equation E-22.		
5064	_		PV
5964			$N_s = \frac{PV}{Q_{DIDP \ vear}}$
5965	Where:		
5966	Ns	=	Number of sites [sites]
5967	PV	=	Production volume (see Section E.4.4) [kg/year]
5968	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.4.4) [kg/site-yr]
5969			
5970	E.4.4 Through	put Param	leters
5971	EPA estimated the total	production	volume for all sites using a uniform distribution with a lower bound
5972	of 374,305 kg/yr and an	-	•
5973		11	
5974	The lower bound is base	d on CDR (	data (U.S. EPA, 2020a). Three entries in CDR list adhesive and

5975 sealant use as the expected end use for DIDP. However, two entries are for the same company (Sika 5976 Corporation). Tremco Incorporated did not report how much of their PV is used in adhesives and sealants, but there were no other entries from this company in CDR. Therefore, EPA assumed 100% of 5977 5978 the site's PV is used in adhesives and sealants. The two entries for Sika Corporation list the PV as CBI. 5979 For their two sites, EPA assumes a combined PV of 25,000 lbs based on the reporting threshold for 5980 reporting processing and use information in CDR. Therefore, EPA calculates the lower bound for 5981 national PV used in adhesive and sealants as the sum of the non-CBI PV (800,201 lbs or 362,965 kg) 5982 and the combined site CDR threshold PV (25,000 lb. or 11,340 kg) for a total of 374,305 kg/yr used in 5983 adhesives and sealants.

5985 The upper bound is based on CDR data (U.S. EPA, 2020a) and the 2003 European Union Risk 5986 Assessment on DIDP (ECJRC, 2003b). The EU Risk Assessment found that only 1.1% of the DIDP produced goes to non-PVC, non-polymer end use categories. As this Risk Evaluation includes three 5987 5988 OESs that fall under this category, EPA assumes that each category accounts for an equal amount to this 5989 percentage (*i.e.*, 0.37% each). CDR states that the total U.S. national production volume of DIDP is 5990 1.001 billion lbs/yr. Multiplying this figure by 0.37% results in 3,703,700 lbs/yr (1,679,970 kg/yr). 5991

5992 The annual throughput of DIDP is calculated using Equation E-23 by multiplying batch size by the 5993 concentration of DIDP in the final adhesive product and by operating days. Batch size is determined 5994 according to Section E.4.17 and operating days is determined according to Section E.4.16. EPA assumes 5995 the number of batches is equal to the number of operating days. 5006

5996 5997 5998	Equation E-23.	$Q_{DIDP\_year}$	$r = Q_{batch} * OD * F_{DIDP_{final}} * N_{batch_{day}}$
5999 6000	Where:		
6001 6002	$Q_{DIDP\_year} \ Q_{batch}$	=	Facility annual throughput of DIDP [kg/site-yr] Adhesive/ Sealant batch size (see Section E.4.17) [kg/batch]

5984

6003	OD	=	Operating days (see Section E.4.16) [days/yr]
6004	F <sub>DIDP_final</sub>	=	Concentration of DIDP in final Adhesive/ Sealant (see Section
6005	_,		E.4.8) [kg/kg]
6006	$N_{batch\_day}$	=	Number of batches per day of Adhesive/ Sealant (default of 1)
6007			[batch/day]
6008 6009	The daily throughput of <b>D</b>	IDP is cal	lculated using Equation E-24 by dividing the annual production
6010			days. The number of operating days is determined according to
6011	Section E.4.16.	operating	aufs. The number of operating aufs is determined according to
6012			
6013	Equation E-24.		
6014			$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD}$
			$QDIDP_{aay} = OD$
6015 6016	Where:		
6016 6017		_	Facility throughput of DIDP [kg/site-day]
6017 6018	$Q_{DIDP\_day}$	=	• • • • • •
6018 6019	$Q_{DIDP\_year}$ OD		Facility annual throughput of DIDP [kg/site-yr] Operating days (see Section E.4.16) [days/yr]
0019	OD	=	Operating days (see Section E.4.10) [days/y1]
6020	E.4.5 Number o	f Contain	ers per Year
6021	The number of DIDP raw	material o	containers received and unloaded by a site per year is calculated
6022	using the following equation	ion:	
6023			
6024	Equation E-25.		0
6025		N <sub>cont</sub>	$v_{DIDP_year} = \frac{Q_{DIDP_year}}{Q_{DIDP_year}}$
		00110	$_{unload\_yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{cont}}$
6026	Where:		
6027	$V_{cont}$	=	Import container volume (see Section E.4.11) [gal/container]
6028	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.4.3) [kg/site-yr]
6029	RHO	=	DIDP density [kg/L]
6030	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year]
6031		. • • •	
6032 6033	The number of product co	ontainers lo	oaded by a site per year is calculated using the following equation:
6033 6034	Equation E-26.		
	Equation E 20.		$Q_{DIDP \ vear}$
6035		N <sub>cont_load</sub>	$d_{yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{cont\_packaged}}$
6026	Where:		(Sur gal) (cont_packagea
6036 6037		_	Product container volume (see Section E.4.11) [gal/container]
6037 6038	$V_{cont\_packaged}$	=	
	Q <sub>DIDP_</sub> year RHO	=	Facility annual throughput of DIDP (see Section E.4.3) [kg/site-yr]
6039 6040		=	DIDP density [kg/L] Annual number of containers loaded [container/site-year]
6040 6041	$N_{cont\_load\_yr}$	_	Annual number of containers loaded [container/site-year]
0041			

#### 6042 E.4.6 Operating Hours

6043 EPA estimated operating hours or hours of duration using data provided from the ESD for Adhesive 6044 Formulation (OECD, 2009a), ChemSTEER User Guide (U.S. EPA, 2015), and/or through calculation 6045 from other parameters. Release points with operating hours provided from these sources include 6046 unloading, container cleaning, blending/process operations, product sampling, equipment cleaning, and 6047 loading into transport containers. 6048

6049 For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based 6050 on the number of containers unloaded at the site and the unloading rate using the following equation: 6051

#### 6052 **Equation E-27.**

$$OH_{RP1/RP4} = \frac{N_{cont\_unload\_yr}}{RATE_{fill\_drum\_tote} * OD}$$

6054

6053

6055	Where:		
6056	$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 [hrs/site-day]
6057	$RATE_{fill\_drum\_tote}$	=	Fill rate of drums and totes (see Section E.4.18) [containers/hr]
6058	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded (see Section E.4.5)
6059			[container/site-year]
6060	OD	=	Operating days (see Section E.4.16) [days/site-year]
6061			

6062 For blending/process operations (release point 5), the ESD for Adhesive Formulation (OECD, 2009a) 6063 recommends using the following equation: 6064

#### 6065 **Equation E-28.**

$$OH_{RP5} = \left(\frac{Q_{DIDP\_year}}{Q_{batch} * OD}\right) * 8\frac{hrs}{day}$$

6066 6067

6068	
0000	

6068	Where:		
6069	$OH_{RP5}$	=	Operating time for release point 5 [hrs/site-day]
6070	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.4.3) [kg/site-yr]
6071	$Q_{batch}$	=	Average batch size (see Section E.4.17) [kg/batch]
6072	OD	=	Operating days (see Section E.4.16) [days/site-year]

For product sampling (release point 7), the ChemSTEER User Guide (U.S. EPA, 2015) indicates a value 6074 6075 of 1 hour/day.

6076

6073

6077 For equipment cleaning (release point 9), the ESD for Adhesive Formulation (OECD, 2009a) provides an estimate of four hours per batch based on the value for cleaning multiple vessels from the 6078 6079 ChemSTEER User Guide (U.S. EPA, 2015). The ESD for Adhesive Formulation also states that a case study conducted by the Pollution Prevention Assistance Division indicated a range of equipment 6080 6081 cleaning times between one and three hours per batch. The underlying distribution of this parameter is 6082 not known; therefore, EPA assigned a triangular distribution based on a lower bound, upper bound, and mode for equipment cleaning operating hours. EPA assigned the lower bound as one hour based on the 6083 lower end cleaning time observed in the case study (OECD, 2009a) and the upper bound as four hours 6084 6085 based on the ChemSTEER User Guide default value for this worker activity. For the mode, EPA assigned four hours based on the ESD for Adhesive Formulation (OECD, 2009a). EPA calculated the 6086

6087 equipment cleaning operating hours using the following equation:

6088 6089 **Equation E-29.**  $OH_{RP9} = \left(\frac{Q_{DIDP\_year}}{O_{batch} * OD}\right) * OH_{batch\_equip\_clean}$ 6090 6091 6092 Where:  $OH_{RP9}$ 6093 Operating time for release point 9 [hrs/site-day] =Q<sub>DIDP\_year</sub> Q<sub>batch</sub> OD Facility annual throughput of DIDP (see Section E.4.3) [kg/site-yr] 6094 = 6095 Average batch size (see Section E.4.17) [kg/batch] = Operating days (see Section E.4.16) [days/site-year] 6096 = OH<sub>batch</sub> equip clean Duration for batch equipment cleaning (see Section E.4.6) 6097 = 6098 [hrs/batch] 6099 6100 For loading into transport containers (release point 10), the operating hours are calculated based on number of product containers filled per year unless the operating hours per day exceeds 24 hours. If the 6101 6102 total operating hours exceeds 24 hours, the duration for loading containers is estimated as the remaining 6103 time after accounting for container unloading. The operating hours are calculated using the following 6104 equation: 6105 6106 **Equation E-30.** 6107  $OH_{RP10} = \begin{cases} \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * 0D}, & \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * 0D} \leq \left[24 - OH_{RP1/RP4}\right] \\ 24 - OH_{RP1/RP4}, & \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * 0D} > \left[24 - OH_{RP1/RP4}\right] \end{cases}$ 6108 6109 Where:  $OH_{RP10}$ RATE<sub>fill\_cont</sub> 6110 Operating time for release point 10 [hrs/site-day] = = Fill rate of containers (see Section E.4.18) [containers/hr] 6111 N<sub>cont load vr</sub> Annual number of containers loaded (see Section E.4.5) 6112 = 6113 [container/site-year]

- 6114
- 6115 6116

#### 6117 E.4.7 Initial DIDP Concentration

=

=

0D

 $OH_{RP1/RP4}$ 

EPA modeled the initial DIDP concentration using a uniform distribution with a lower bound of 30%
and upper bound of 60% based on information reported in the 2020 CDR by sites indicating DIDP use in
adhesives and sealants (U.S. EPA, 2020a).

Operating days (see Section E.4.16) [days/site-year]

Operating time for release points 1 and 4 [hrs/site-day]

#### 6121 E.4.8 Final DIDP Concentration

EPA modeled final DIDP concentration in adhesives and sealants using a triangular distribution with a
lower bound of 0.1%, upper bound of 60%, and mode of 1%. The upper bound is based on the upper
bound for imported DIDP concentration. The concentration of DIDP in the adhesive or sealant cannot be
higher than the concentration of neat DIDP that was imported. The lower bound and mode is based on
compiled SDS information for adhesives and sealant products containing DIDP. EPA did not have
information on the prevalence or market share of different Adhesive/ Sealant products in commerce;
therefore, EPA assumed a triangular distribution of concentrations. From the compiled data, the

- 6129 minimum concentration was 0.1% and the mode of high-end product concentrations was 1% (see
- 6130 Appendix F for EPA identified DIDP-containing products for this OES)

#### 6131 **E.4.9** Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United

6133 Kingdom (<u>Baldwin and Maynard, 1998</u>). Fifty-five work areas were surveyed across a variety of

- 6134 workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
- surveys into settings representative of industrial facilities and representative of commercial facilities.
   EPA fit separate distributions for these industrial and commercial settings and used the industrial
- 6130 EPA fit separate distributions for these industrial and commercial settings and used the indu 6137 distribution for this OES.
- 6138

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

6144

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the

following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model,

6147 the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed

6148 value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the

6149 model from sampling values that approach infinity or are otherwise unrealistically small or large,
6150 (Baldwin and Maynard, 1998).

6151

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
 individual measurements within each survey. Therefore, these distributions represent a distribution of

6154 mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.

6155 However, a mean air speed (averaged over a work area) is the required input for the model. EPA

6156 converted the units to ft/min prior to use within the model equations.

6157 E.4.10 Saturation Factor

6158 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 6159 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 6160 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 6161 6162 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 6163 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 6164 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in 6165 the ChemSTEER User Guide for the EPA/OAQPS AP-42 Loading Model (U.S. EPA, 2015).

#### E.4.11 Container Size

EPA assumed that adhesive and sealant manufacturing sites would receive DIDP in drums. According to
the *ESD for Adhesive Formulation* (OECD, 2009a), 55-gallon drums are expected to be the default
container size for adhesives and sealant components. According to the *ChemSTEER User Guide*, drums
are defined as containing between 20 and 100 gallons of liquid, and the default drum size is 55 gallons
(U.S. EPA, 2015). Therefore, EPA modeled import container size using a triangular distribution with a
lower bound of 20 gallons, an upper bound of 100 gallons, and a mode of 55 gallons.

6173

6166

6174 For packaging of adhesives and sealants after production, EPA identified products in bottles as small as

- 6175 0.1 gallons, in small containers, and in drums. According to the *ESD for Adhesive Formulation* (OECD,
- 6176 <u>2009a</u>), 55-gallon drums are expected to be the default container size for finished adhesives and
- 6177 sealants. Therefore, EPA modeled finished adhesive container size using a triangular distribution with a
- 6178 lower bound of 0.1 gallons, an upper bound of 100 gallons, and a mode of 55 gallons.

### 6179 E.4.12 Drum Residue Loss Fraction

EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data
for emptying drums by pumping was aligned with the default central tendency and high-end values from
the *EPA/OPPT Drum Residual Model*. For unloading drums by pumping in the PEI Associates Inc.
study, EPA found that the average percent residual from the pilot-scale experiments showed a range of
percent to 4.7 percent and an average of 2.6 percent. The *EPA/OPPT Drum Residual Model* from the
ChemSTEER User Guide recommends a default central tendency loss fraction of 2.5 percent and a highend loss fraction of 3.0 percent (U.S. EPA, 2015).

6187

6188 The underlying distribution of the loss fraction parameter for drums is not known; therefore, EPA

- 6189 assigned a triangular distribution, since triangular distributions require least assumptions and are
- 6190 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for
- the loss fraction probability distribution using the central tendency and high-end values, respectively,
- 6192 prescribed by the *EPA/OPPT Drum Residual Model* in the *ChemSTEER User Guide* (U.S. EPA, 2015).
- 6193 EPA assigned the minimum value for the triangular distribution using the minimum average percent
- 6194 residual measured in the PEI Associates, Inc. study (<u>Associates, 1988</u>) for emptying drums by pumping.
- 6195 E.4.13 Sampling Loss Fraction

6196 Sampling loss fractions were estimated using the *March 2023 Methodology for Estimating* 6197 *Environmental Releases from Sampling Wastes* (U.S. EPA, 2023b). In this methodology, EPA

Environmental Releases from Sampling Wastes (U.S. EPA, 2023b). In this methodology, EPA 6198 completed a search of over 300 IRERs completed in the years 2021 and 2022 for sampling release data, 6199 including a similar proportion of both PMNs and Low Volume Exemptions (LVEs). Of the searched 6200 IRERs, 60 data points for sampling release loss fractions, primarily for sampling releases from 6201 submitter-controlled sites (~75% of IRERs), were obtained. The data points were analyzed as a function 6202 of the chemical daily throughput and industry type. This analysis showed that the sampling loss fraction 6203 generally decreased as the chemical daily throughput increased. Therefore, the methodology provides 6204 guidance for selecting a loss fraction based on chemical daily throughput. Table Apx E-13 presents a 6205 summary of the chemical daily throughputs and corresponding loss fractions.

6206

# Table\_Apx E-13. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating Environmental Releases from Sampling Waste

Chemical Daily Throughput (kg/site-	Number of Data	-	Quantity nical/day)	Sampling Loss Fraction (LF <sub>sampling</sub> )		
day) (Q <sub>chem_site_day</sub> )	Points	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	
<50	13	0.03	0.20	0.002	0.02	
50 to <200	10	0.10	0.64	0.0006	0.005	
200 to <5,000	25	0.37	3.80	0.0005	0.004	
≥5,000	10	1.36	6.00	0.00008	0.0004	
All	58	0.20	5.15	0.0005	0.008	

6209

6210 For each range of daily throughputs, EPA estimated sampling loss fractions using a triangular 6211 distribution of the 50<sup>th</sup> percentile value as the lower bound, and the 95<sup>th</sup> percentile value as the upper

bound and mode. The sampling loss fraction distribution was chosen based on the calculation of daily

6213 throughput, as shown in Section E.4.3.

### 6214 E.4.14 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold
liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For
equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm
(U.S. EPA, 2015).

6219

6222

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08
cm for containers less than 5,000 gallons (<u>U.S. EPA, 2015</u>).

6223 For sampling liquid product, sampling liquid raw material, or general liquid sampling, the *ChemSTEER* User Guide indicates that the typical diameter of opening for vaporization of the liquid is 2.5 cm (U.S. 6224 6225 EPA, 2015). Additionally, the *ChemSTEER User Guide* provides ten cm as a high-end value for the 6226 diameter of opening during sampling (U.S. EPA, 2015). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the estimated lower bound, upper 6227 6228 bound, and mode of the parameter. EPA assigned the value of 2.5 cm as a lower bound for the parameter 6229 and ten cm as the upper bound based on the values provided in the *ChemSTEER User Guide* (U.S. EPA, 6230 2015). EPA also assigned 2.5 cm as the mode diameter value for sampling liquids based on the typical 6231 value described in ChemSTEER User Guide (U.S. EPA, 2015).

6232 6233 For blending operations, the ESD for Adhesive Formulation (OECD, 2009a) and GS for Formulation of 6234 Waterborne Coatings (U.S. EPA, 2014a) assumes a closed vessel with a 4-inch diameter process vent, corresponding to ten cm in diameter. In addition, EPA considered the potential for open process vessels 6235 6236 used for blending as mentioned in both the ESD for Adhesive Formulation (OECD, 2009a) and GS for 6237 Formulation of Waterborne Coatings (U.S. EPA, 2014a), with diameters of the open vessel calculated 6238 based on the batch volume for the simulation iteration and the assumption in the ESD and GS of a one-6239 to-one height to diameter ratio for the process vessel. The underlying distribution of this parameter is not 6240 known; therefore, EPA assigned a triangular distribution defined by an estimated lower bound, upper 6241 bound, and mode of the parameter. EPA assigned the value of ten cm for both the lower bound and 6242 mode of the triangular distribution as the recommended value by the ESD for Adhesive Formulation (OECD, 2009a) and GS for Formulation of Waterborne Coatings (U.S. EPA, 2014a). For the upper 6243 6244 bound value of the triangular distribution, EPA assigned an equation calculating the diameter of an open 6245 process vessel with a one-to-one height to diameter ratio and fixed batch volume of approximately 1,000 6246 gallons based on the batch size discussed in Section E.4.17:

- 6247
- 6248 **Equation E-31.**

$$D_{blending\_max} = \left[\frac{4 * V_{batch} * 3785.41 \frac{cm^3}{gal}}{\pi}\right]^{1/3}$$

#### 6250 E.4.15 Hours per Batch for Equipment Cleaning

The *ESD for Adhesive Formulation* (OECD, 2009a) cites a cleaning time per batch of one to four hours and suggests that a value of four hours per cleaning be used for model defaults. Therefore, EPA modeled

6253 this parameter via a triangular distribution with a lower bound of one hour/batch, upper bound of four

hours/batch, and mode of four hours/batch.

#### 6255 E.4.16 Operating Days

EPA was unable to identify DIDP-specific information for operating days in the production of adhesives
and sealants. Therefore, EPA assumes a constant value of 250 days/yr, which assumes the production
sites operate five days per week and 50 weeks per year, with two weeks down for turnaround.

#### 6259 **E.4.17 Batch Size**

The *ESD for Adhesive Formulation* (OECD, 2009a) cites a default batch size of 4,000 kg adhesive per
batch with an approximate batch volume of 1,000 gallons.

#### 6262 E.4.18 Container Fill Rates

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for
containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers
with less than 20 gallons of liquid.

To account for situations where operating times for container unloading and loading exceeded a 24-hour period in the simulation, EPA applied an equation to determine a corrected fill rate that would replace the deterministic values provided in the *ChemSTEER User Guide*. The equation for the corrected fill rate in cases where operating time for unloading and loading is greater than 24 hours is included below. EPA only used the corrected fill rate for loading product containers (release point 10).

#### 6273 Equation E-32.

6274

6272

6266

 $if 24 < (OH_{RP1/RP4} + OH_{RP10}), RATE_{fill\_adjusted} = \frac{N_{cont\_load\_yr}}{(24 - OH_{RP1/RP4}) * OD}$ 

6275 Where:

0215	Where.		
6276	$RATE_{fill\_adjusted}$	=	Corrected fill rate for product containers [containers/hr]
6277	$N_{cont\_load\_yr}$	=	Annual number of product containers [containers/site-year]
6278	$OH_n$	=	Operating time for release point "n" [hrs/site-day]
6279	OD	=	Operating days [days/site-year]

#### 6280 E.4.19 Equipment Cleaning Loss Fraction

EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment
cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the ChemSTEER User Guide
(U.S. EPA, 2015) provides an overall loss fraction of 2 percent from equipment cleaning.

6284 E.4.20 Off-Spec Loss Fraction

The ESD for Adhesive Formulation (OECD, 2009a) and GS for Formulation of Waterborne Coatings
(U.S. EPA, 2014a) provides a loss fraction of one percent of throughput disposed from off-specification
material during manufacturing. The one percent default loss fraction was provided as an estimate from a
Source Reduction Research Partnership (SRRP) study referenced in the ESD for Adhesive Formulation
(OECD, 2009a).

# E.5 Incorporation into Paints and Coatings Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for
 DIDP during the incorporation into paints and coatings OES. This approach utilizes the *Generic*

*Scenario for Formulation of Waterborne Coatings* (U.S. EPA, 2014a) and CDR data (U.S. EPA, 2020a)
 combined with Monte Carlo simulation (a type of stochastic simulation).

6297 Based on the ESD, EPA identified the following release sources from incorporation into paints and 6298 coatings:

- Release source 1: Transfer Operation Losses to Air from Unloading Paint Component.
- Release source 2: Dust Generation from Transfer Operations.
- Release source 3: Container Cleaning Wastes.
- Release source 4: Open Surface Losses to Air During Container Cleaning.
- Release source 5: Vented Losses to Air During Blending/Process Operations.
- Release source 6: Product Sampling Wastes.
- Release source 7: Open Surface Losses to Air During Product Sampling.
- Release source 8: Equipment Cleaning Wastes.
- Release source 9: Open Surface Losses to Air During Equipment Cleaning.
- Release source 10: Filter Waste Losses.
- Release source 11: Open Surface Losses to Air During Filter Media Replacement.
- 6310
   Release source 12: Transfer Operation Losses to Air from Packaging Paint/Coating into Transport Containers.
- Release source 13: Off-Spec and Other Waste Paint/Coatings.
- Environmental releases for DIDP during incorporation into paints and coatings are a function of DIDP's
  physical properties, container size, mass fractions, and other model parameters. While physical
  properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation
  to capture variability in the following model input parameters: production volume and rate, DIDP
  concentrations, air speed, saturation factor, container size, loss fractions, diameters of openings, and
- 6319 operating durations. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and 6320 the Latin Hypercube sampling method in @Risk to calculate release amounts for this OES.
- 6321 E.5.1 Model Equations

6322 Table Apx E-14 provides the models and associated variables used to calculate environmental releases 6323 for each release source within each iteration of the Monte Carlo simulation. EPA used these 6324 environmental releases to develop a distribution of release outputs for the incorporation into paints and 6325 coatings OES. The variables used to calculate each of the following values include deterministic or 6326 variable input parameters, known constants, physical properties, conversion factors, and other 6327 parameters. The values for these variables are provided in Appendix E.5.2. The Monte Carlo simulation 6328 calculated the total DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the 6329

- 6330 central tendency and high-end releases, respectively.
- 6331

# 6332Table\_Apx E-14. Models and Variables Applied for Release Sources in the Incorporation into6333Paints and Coatings OES

<b>Release Source</b>	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Paint Component.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP_import</sub></i> ; <i>VP</i> ; <i>f<sub>sat</sub></i> ; <i>MW</i> ; <i>R</i> ; <i>T</i> ; <i>V<sub>cont</sub></i> ; <i>RATE<sub>fill_drum_tote</sub></i>
		Operating Time: <i>Q<sub>DIDP_year</sub></i> ; <i>V<sub>cont</sub>; RATE<sub>fill_drum_tote</sub>; RHO; OD</i>
Release source 2: Dust Generation from Transfer Operations.	Not Assessed for liquid DIDP.	N/A
Release source 3: Container Cleaning Wastes.	<i>EPA/OPPT Drum Residual</i> <i>Model</i> (Appendix E.1)	$ \begin{array}{c} LF_{drum}; V_{cont}; Q_{DIDP\_year}; V_{cont}; RHO; \\ OD \end{array} $
Release source 4: Open Surface Losses to Air During Container Cleaning.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP\_import}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cont\_clean}$ ; $T$ ; P Operating Time: $Q_{DIDP\_year}$ ; $V_{cont}$ ; $RATE_{fill\_drum\_tote}$ ; $RHO$ ; $OD$
Release source 5: Vented Losses to Air During Blending/Process Operations.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; $MW$ ; $VP$ ; $RATE_{air_speed}$ ; $D_{blend}$ ; $T$ ; $P$ Operating Time: $Q_{DIDP_year}$ ; $Q_{DIDP_batch}$ ; $OD$
Release source 6: Product Sampling Wastes.	March 2023 Methodology for Estimating Environmental Releases from Sampling Waste (Appendix E.1)	$Q_{DIDP_{day}}; LF_{sampling}$
Release source 7: Open Surface Losses to Air During Product Sampling.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: <i>F</i> <sub>DIDP_final</sub> ; <i>MW</i> ; <i>VP</i> ; <i>RATE</i> <sub>air_speed</sub> ; <i>D</i> <sub>sampling</sub> ; <i>T</i> ; <i>P</i> Operating Time: <i>OH</i> <sub>sampling</sub>
Release source 8: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP\_day}; LF_{equip\_clean}$
Release source 9: Open Surface Losses to Air During Equipment Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix	Vapor Generation Rate: <i>F</i> <sub>DIDP_final</sub> ; <i>MW</i> ; <i>VP</i> ; <i>RATE</i> <sub>air_speed</sub> ; <i>D</i> <sub>equip_clean</sub> ; <i>T</i> ; <i>P</i>
	E.1)	Operating Time: $OH_{batch\_equip\_clean}$ ; $Q_{DIDP\_year}$ ; $Q_{DIDP\_batch}$ ; $OD$

Release Source	Model(s) Applied	Variables Used
Release source 10: Filter Waste Losses.	No available data or models for estimation. Estimate on a case-by-case basis.	N/A
Release source 11: Open Surface Losses to Air During Filter Media Replacement	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; $MW$ ; $VP$ ; $RATE_{air_speed}$ ; $D_{filter}$ ; $T$ ; $P$ Operating Time: $OH_{filter}$
Release source 12: Transfer Operation Losses to Air from Packaging Paint/Coating into Transport Containers.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP_final}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{cont_packaged}$ Operating Time: $Q_{DIDP_year}$ ; $V_{cont_packaged}$ ; $RATE_{fill_cont}$ ; $RHO$ ; $OD$ ; $RATE_{fill_adjusted}$
Release source 13: Off-Spec and Other Waste Paint/Coating.	See Equation E-33	$Q_{DIDP\_day}; LF_{offspec}$

6334

Release source 13 daily release (Off-Spec and Other Waste Adhesive) is calculated using the followingequation:

6337		
6338	Equation E-33.	
6339		
6340	Relea	$ase\_perDay_{RP13} = Q_{DIDP\_day} * LF_{offspec}$
6341	Where:	
6342	$Release\_perDay_{RP13} =$	DIDP released for release source 13 [kg/site-day]
6343	$Q_{DIDP\_day} =$	Facility throughput of DIDP (see Section E.5.3) [kg/site-day]
6344	$LF_{offspec} =$	Loss fraction for off-spec and waste adhesive (see Section E.5.20)
6345		[unitless]
6346	E.5.2 Model Input Para	meters
6347	Table Apx E-15 summarizes the r	nodel parameters and their values for the Incorporation into Paints and

Coatings Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for
 each parameter are provided after Table\_Apx E-15.

			Deterministic Values	Uncer	tainty Analy	sis Distribu	tion Parameters	
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Total PV of DIDP at All Sites	PV <sub>total</sub>	kg/yr	1,679,970	169,485	1,679,97 0		Uniform	See Section E.5.3
Initial DIDP Concentration	$F_{DIDP\_import}$	kg/kg	0.9	0.01	0.9		Uniform	See Section E.5.7
Final DIDP Concentration	$F_{DIDP_{final}}$	kg/kg	0.01	0.0001	0.05	0.01	Triangular	See Section E.5.8
Air Speed	RATE <sub>air_spee</sub>	ft/min	19.7	2.56	398	_	Lognormal	See Section E.5.9
Saturation Factor	f <sub>sat</sub>	dimensionl ess	0.5	0.5	1.45	0.5	Triangular	See Section E.5.10
Import Container Size	V <sub>cont</sub>	gal	55	20	100	55	Triangular	See Section E.5.11
Drum Residual Loss Fraction	LF <sub>drum</sub>	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section E.5.12
Fraction of DIDP Lost During Sampling - 1 (Q <sub>DIDP_day</sub> < 50 kg/site-day)	F <sub>sampling_1</sub>	kg/kg	0.02	0.002	0.02	0.02	Triangular	See Section E.5.13
Fraction of DIDP Lost During Sampling - 2 (Q <sub>DIDP_day</sub> 50-200 kg/site-day)	F <sub>sampling_2</sub>	kg/kg	0.005	0.0006	0.005	0.005	Triangular	See Section E.5.13
Fraction of DIDP Lost During Sampling - 3 (Q <sub>DIDP_day</sub> 200- 5000 kg/site-day)	F <sub>sampling_3</sub>	kg/kg	0.004	0.0005	0.004	0.004	Triangular	See Section E.5.13

#### 6350 Table\_Apx E-15. Summary of Parameter Values and Distributions Used in the Incorporation into Paints and Coatings Model

			Deterministic Values	Uncert	ainty Analy			
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Fraction of DIDP Lost During Sampling - 4 (Q <sub>DIDP_day</sub> > 5000 kg/site-day)	F <sub>sampling_4</sub>	kg/kg	0.0004	0.00008	0.0004	0.0004	Triangular	See Section E.5.13
Diameter of Opening- Blending	D <sub>blend</sub>	cm	10	10	168.92		Uniform	See Section E.5.14
Diameter of Opening – Sampling	D <sub>sampling</sub>	cm	2.5	2.5	10	_	Uniform	See Section E.5.14
Hours per Batch for Equipment Cleaning	OH <sub>batch_equip</sub> _clean	hours/batch	4	1	4	4	Triangular	See Section E.5.6
Packaged Container Size	$V_{cont\_packaged}$	gal	1	0.10	20	1	Triangular	See Section E.5.11
Overall Paint/Coating Production Rate	Q <sub>paint</sub>	kg/site-yr	16,000,000	1,600,00 0	16,000,0 00		Uniform	See Section E.5.15
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	-	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	_	—	Physical property
Gas Constant	R	atm- cm3/gmol- L	82.05	_	_	_	_	Universal constant
Density of DIDP	RHO	kg/L	0.9634					Physical property
Temperature	Т	К	298	_	_	_	—	Process parameter
Pressure	Р	atm	1	-	-	—	-	Process parameter
Operating Days	OD	days/yr	250	—	_	—	_	See Section E.5.16

			Deterministic Values	Uncert	ainty Analy			
Input Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Batch Size	Q <sub>batch</sub>	kg/batch	5,030	_	—	_	—	See Section E.5.17
Drum and Tote Fill Rate	RATE <sub>fill_dru</sub> m_tote	containers/ hr	20	_	_	_	_	See Section E.5.18
Small Container Fill Rate	RATE <sub>fill_con</sub>	containers/ hr	60	_	_	_	_	See Section E.5.18
Diameter of Opening – Container Cleaning	$D_{cont\_clean}$	cm	5.08	_	_	_	_	See Section E.5.14
Diameter of Opening – Equipment Cleaning	Dequip_clean	cm	92	_	_	_	_	See Section E.5.14
Diameter of Opening – Filter Media Replacement	D <sub>filter</sub>	cm	182.4	_	_	_	_	See Section E.5.14
Sampling Duration	$OH_{sampling}$	hr/day	1	_	—	_	_	See Section E.5.6
Filter Media Replacement Duration	OH <sub>filter</sub>	hr/day	1	_	_	_	_	See Section E.5.6
Equipment Cleaning Loss Fraction	$LF_{equip\_clean}$	kg/kg	0.02	_	_	_	_	See Section E.5.19
Off-Spec and Waste Loss Fraction	LF <sub>offspec</sub>	kg/kg	0.012	_	_	_	_	See Section E.5.20

6351

6352	E.5.3 Number of	of Sites						
6353		reau data for NAICS code 32551 (Paint and Coating Manufacturing), there are						
6354								
6355	not to be exceeded by the calculation. Number of sites is calculated using the following equation.:							
	not to be exceeded by the calculation. Number of sites is calculated using the following equation.							
6356 6357	Equation E 34							
0557	Equation E-34.	DI						
6358		$N_s = \frac{PV}{Q_{DIDP \ year}}$						
		$Q_{DIDP\_year}$						
6359	Where:							
6360	$N_s$	= Number of sites [sites]						
6361	PV	= Production volume (see Section E.4.4) [kg/year]						
6362	$Q_{DIDP\_year}$	= Facility annual throughput of DIDP (see Section E.4.4) [kg/site-yr]						
(2(2								
6363	E.5.4 Through							
6364		production volume for all sites using a uniform distribution with a lower bound						
6365	of 169,485 kg/yr and an $\iota$	upper bound of 1,679,970 kg/yr.						
6366								
6367		nds are based on CDR data (U.S. EPA, 2020a) and the 2003 European Union						
6368		P (ECJRC, 2003b). The 2003 EU Risk Assessment found that 1.1% of the						
6369	1 0	on-PVC, non-polymer end use categories. As this Risk Evaluation includes						
6370		PVC, non-polymer end uses, EPA assumes that each OES accounts for an equal						
6371	1 0	e ( <i>i.e.</i> , 0.37% each). CDR states that the total U.S. national PV of DIDP is a						
6372	range of 100,986,354 lbs/	/yr to 1.001 billion lbs/yr. Multiplying these figures by 0.37% results in						
6373	373,650 lb./yr (169,485 kg/yr) to 3,703,700 lbs/yr (1,679,970 kg/yr).							
6374								
6375	The annual throughput of	f DIDP is calculated using Equation E-35 by multiplying overall paint and						
6376	coating production rate b	y the concentration of DIDP in the final paint or coating product. Overall paint						
6377	and coating production ra	ate is determined according to Section E.5.15 and concentration of DIDP in the						
6378		according to Section E.5.8.						
6379								
6380	Equation E-35.							
6381	-	$Q_{DIDP\_year} = Q_{paint} * F_{DIDP_{final}}$						
6382		jinut						
6383	Where:							
6384	$Q_{DIDP\_year}$	= Facility annual throughput of DIDP [kg/site-yr]						
6385	$Q_{paint}$	= Overall paint/coating production rate (see Section E.5.15) [kg/site-						
6386	<b>Q</b> paint							
	F	yr] — Concentration of DIDD in final point/coating (acc Section E 5.8)						
6387	$F_{DIDP_{final}}$	= Concentration of DIDP in final paint/coating (see Section E.5.8)						
6388		[kg/kg]						
6389								
6390		DIDP is calculated using Equation E-36 by dividing the annual production						
6391	-	F operating days. The number of operating days is determined according to						
6392	Section E.5.16.							
6393								
6394	Equation E-36.							
6395		$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD}$						
0375		$Q_{DIDP_day} - OD$						

6396	
6397	Where:
6398	$Q_{DIDP_{day}}$ = Facility throughput of DIDP [kg/site-day]
6399	$Q_{DIDP\_year}$ = Facility annual throughput of DIDP [kg/site-yr]
6400	OD = Operating days (see Section E.5.16) [days/yr]
	OD = Operating days (see Section E.S.10) [days/y1]
6401	
6402	E.5.5 Number of Containers per Year
6403	
	The number of DIDP raw material containers received and unloaded by a site per year is calculated
6404	using the following equation:
6405	
6406	Equation E-37.
6407	$N_{cont\_unload\_yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{aal}\right) * V_{cont}}$
0407	PHO * (3.79 L) * V
	$\frac{110 + (3.75 \text{ gal}) + v_{cont}}{gal}$
6408	Where:
6409	$V_{cont}$ = Import container volume (see Section E.5.11) [gal/container]
6410	$Q_{DIDP\_year}$ = Facility annual throughput of DIDP (see Section E.5.3) [kg/site-yr]
6411	RHO = DIDP density [kg/L]
6412	$N_{cont\_unload\_yr}$ = Annual number of containers unloaded [container/site-year]
6413	
6414	The number of product containers loaded by a site per year is calculated using the following equation:
6415	The number of product containers foaded by a site per year is calculated using the following equation.
6416	Equation E-38.
0410	
6417	$N_{cont\_load\_yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{cont\_packaged}}$
	$RHO * (3.79 \frac{L}{\pi \pi^2}) * V_{cont, nackaged}$
C 4 1 0	
6418	Where:
6419	$V_{cont\_packaged}$ = Product container volume (see Section E.5.11) [gal/container]
6420	$Q_{DIDP\_year}$ = Facility annual throughput of DIDP (see Section E.5.3) [kg/site-yr]
6421	RHO = DIDP density [kg/L]
6422	$N_{cont\_load\_yr}$ = Annual number of containers loaded [container/site-year]
6122	E 5.6 Openating Hours
6423	E.5.6 Operating Hours
6424	EPA estimated operating hours or hours of duration using data provided from the GS for Formulation of
6425	Waterborne Coatings (U.S. EPA, 2014a), ESD for Adhesive Formulation (OECD, 2009a), ChemSTEER
6426	User Guide (U.S. EPA, 2015), and/or through calculation from other parameters. Release points with
6427	operating hours provided from these sources include unloading, container cleaning, blending/process
6428	operations, product sampling, equipment cleaning, filter media replacement, and loading into transport
6429	containers.
6430	
6431	For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based

For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based
on the number of containers unloaded at the site and the unloading rate using the following equation:

6434 Equation E-39.

6436

			May 2024
6437	Where:		
6438	$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 [hrs/site-day]
6439	RATE <sub>fill_drum_tote</sub>	=	Fill rate of drums and totes (see Section E.5.18) [containers/hr]
6440	N <sub>cont_unload_yr</sub>	=	Annual number of containers unloaded (see Section E.5.5)
6441	cont_uniouu_yr		[container/site-year]
6442	OD	=	Operating days (see Section E.5.16) [days/site-year]
6443			
6444	For blending/process operat	ions (re	elease point 5), the ESD for Adhesive Formulation (OECD, 2009a)
6445	recommends using the follo		
6446	-	-	-
6447	Equation E-40.		
6448			$OH_{RP5} = \left(\frac{Q_{DIDP\_year}}{Q_{batch} * OD}\right) * 8\frac{hrs}{day}$
6449			
6450	Where:		
6451	$OH_{RP5}$	=	Operating time for release point 5 [hrs/site-day]
6452	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.5.3) [kg/site-yr]
6453	$Q_{batch}$	=	Average batch size (see Section E.5.17) [kg/batch]
6454	OD	=	Operating days (see Section E.5.16) [days/site-year]
6455			
6456		se poin	t 7), the <i>ChemSTEER User Guide</i> ( <u>U.S. EPA, 2015</u> ) indicates a value
6457	of one hour/day.		
6458			
6459		-	bint 9), the ESD for Adhesive Formulation (OECD, 2009a) provides
6460	-		based on the value for cleaning multiple vessels from the $2015$ . The ESD ( $-4$ ll $-1$ $-1$ $-1$ $-1$ $-1$ $-1$ $-1$ $-1$
6461			<u>A, 2015</u> ). The <i>ESD for Adhesive Formulation</i> also states that a case
6462 6463			revention Assistance Division indicated a range of equipment ree hours per batch. The underlying distribution of this parameter is
6464	-		d a triangular distribution based on a lower bound, upper bound, and
6465		0	ating hours. EPA assigned the lower bound as one hour based on the
6466	1 1	0 1	In the case study ( $OECD$ , 2009a) and the upper bound as four hours
6467	6		<i>uide</i> default value for this worker activity. For the mode, EPA
6468			SD for Adhesive Formulation (OECD, 2009a). EPA calculated the
6469			s using the following equation:
6470		0	
6471	Equation E-41.		
6472	_	$OH_{RP}$	$_{9} = \left(\frac{Q_{DIDP\_year}}{Q_{batch} * OD}\right) * OH_{batch\_equip\_clean}$
6473			- 54001
6474	Where:		
	0.11		

6475	$OH_{RP9}$	=	Operating time for release point 9 [hrs/site-day]
6476	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.5.3) [kg/site-yr]
6477	$Q_{batch}$	=	Average batch size (see Section E.5.17) [kg/batch]
6478	OD	=	Operating days (see Section E.5.16) [days/site-year]
6479	$OH_{batch\_equip\_clean}$	=	Batch duration for equipment cleaning (see Section E.5.6)
6480			[hrs/batch]
6481			

For filter media changeout (release point 11), the *ChemSTEER User Guide* (U.S. EPA, 2015) indicates a
single value of one hour/day.

6484

For loading into transport containers (release point 12), the operating hours are calculated based on
number of product containers filled per year unless the operating hours per day exceeds 24 hours. If the
total operating hours exceeds 24 hours, the duration for loading containers is estimated as the remaining
time after accounting for container unloading. The operating hours are calculated using the following
equation:

#### 6491 Equation E-42.

6492

6490

 $6493 \qquad \qquad OH_{RP12} = \begin{cases} \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * OD}, & \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * OD} \leq [24 - OH_{RP1/RP4}] \\ 24 - OH_{RP1/RP4}, & \frac{N_{cont\_load\_yr}}{RATE_{fill\_cont} * OD} > [24 - OH_{RP1/RP4}] \\ 6494 & \text{Where:} \\ 6495 & OH_n & = & \text{Operating time for release point "n" [hrs/site-day]} \\ 6496 & RATE_{fill\_cont} & = & \text{Fill rate of containers, dependent on volume (see Section E.5.18)} \end{cases}$ 

- 6497[containers/hr]6498 $N_{cont\_load\_yr}$ =6499 $Cont\_load\_yr$ =6499 $Cont\_iner/site\_year]$ 6500OD= $Operating days (see Section E.5.16) [days/site\_year]$
- 6501

6506

### 6502 E.5.7 Initial DIDP Concentration

EPA modeled the initial DIDP concentration using a uniform distribution with a lower bound of 1% and
upper bound of 90% based on information reported in the 2020 CDR by sites indicating DIDP use in
paints and coatings (U.S. EPA, 2020a).

#### E.5.8 Final DIDP Concentration

EPA modeled final DIDP concentration in paints and coatings using a triangular distribution with a
lower bound of 0.01%, upper bound of 5%, and mode of 1%. This is based on compiled SDS
information for paint and coating products containing DIDP. The lower and upper bounds represent the
minimum and maximum reported concentrations in the SDSs. The mode represents the mode of all
range endpoints reported in the SDSs. (see Appendix F for EPA identified DIDP-containing products for
this OES).

#### 6513 **E.5.9** Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
surveys into settings representative of industrial facilities and representative of commercial facilities.
EPA fit separate distributions for these industrial and commercial settings and used the industrial
distribution for this OES.

6520

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (Baldwin and Maynard, 1998). Since

lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at thelargest observed value among all of the survey mean air speeds.

6526

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the

following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model,

6529 the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed

value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the
 model from sampling values that approach infinity or are otherwise unrealistically small or large

- 6532 (Baldwin and Maynard, 1998).
- 6533

6548

6560

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
individual measurements within each survey. Therefore, these distributions represent a distribution of
mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
However, a mean air speed (averaged over a work area) is the required input for the model. EPA
converted the units to ft/min prior to use within the model equations.

#### 6539 E.5.10 Saturation Factor

6540 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 6541 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 6542 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 6543 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 6544 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 6545 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 6546 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in the ChemSTEER User Guide for the EPA/OAOPS AP-42 Loading Model (U.S. EPA, 2015). 6547

### E.5.11 Container Size

EPA assumed that paint and coating manufacturing sites would receive DIDP in drums. According to
the *ChemSTEER User Guide*, drums are defined as containing between 20 and 100 gallons of liquid, and
the default drum size is 55 gallons (U.S. EPA, 2015). Therefore, EPA modeled import container size
using a triangular distribution with a lower bound of 20 gallons, an upper bound of 100 gallons, and a
mode of 55 gallons.

For packaging of paints and coatings after production, EPA identified products in bottles as small as 0.1 gallons, and in small containers as large as 20 gallons. However, 1-gallon containers are the default packaged container size. Therefore, EPA modeled finished paint/coating container size using a triangular distribution with a lower bound of 0.1 gallons, an upper bound of 20 gallons, and a mode of one gallon.

### E.5.12 Drum Residue Loss Fraction

EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data
for emptying drums by pumping was aligned with the default central tendency and high-end values from
the *EPA/OPPT Drum Residual Model*. For unloading drums by pumping in the PEI Associates Inc.
study, EPA found that the average percent residual from the pilot-scale experiments showed a range of
1.7 percent to 4.7 percent and an average of 2.6 percent. The *EPA/OPPT Drum Residual Model* from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5 percent and a highend loss fraction of 3.0 percent (U.S. EPA, 2015).

- The underlying distribution of the loss fraction parameter for drums is not known; therefore, EPA
- assigned a triangular distribution, since triangular distributions require least assumptions and are
- 6571 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 6572 the loss fraction probability distribution using the central tendency and high-end values, respectively,
- 6573 prescribed by the *EPA/OPPT Drum Residual Model* in the *ChemSTEER User Guide* (U.S. EPA, 2015).
- 6574 EPA assigned the minimum value for the triangular distribution using the minimum average percent
- 6575 residual measured in the PEI Associates, Inc. study (<u>Associates, 1988</u>) for emptying drums by pumping.

#### E.5.13 Sampling Loss Fraction

Sampling loss fractions were estimated using the March 2023 Methodology for Estimating 6577 6578 Environmental Releases from Sampling Wastes (U.S. EPA, 2023b). In this methodology, EPA completed a search of over 300 IRERs completed in the years 2021 and 2022 for sampling release data, 6579 6580 including a similar proportion of both PMNs and Low Volume Exemptions (LVEs). Of the searched 6581 IRERs, 60 data points for sampling release loss fractions, primarily for sampling releases from submitter-controlled sites (~75% of IRERs), were obtained. The data points were analyzed as a function 6582 of the chemical daily throughput and industry type. This analysis showed that the sampling loss fraction 6583 6584 generally decreased as the chemical daily throughput increased. Therefore, the methodology provides guidance for selecting a loss fraction based on chemical daily throughput. Table\_Apx E-16 presents a 6585 summary of the chemical daily throughputs and corresponding loss fractions. 6586

6587

6576

# Table\_Apx E-16. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating Environmental Releases from Sampling Waste

Chemical Daily Throughput (kg/site-	Number of Data Points	Sampled (kg chem	Quantity nical/day)	Sampling Loss Fraction (LF <sub>sampling</sub> )	
day) (Qchem_site_day)		50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile
<50	13	0.03	0.20	0.002	0.02
50 to <200	10	0.10	0.64	0.0006	0.005
200 to <5,000	25	0.37	3.80	0.0005	0.004
≥5,000	10	1.36	6.00	0.00008	0.0004
All	58	0.20	5.15	0.0005	0.008

6590

For each range of daily throughputs, EPA estimated sampling loss fractions using a triangular
distribution of the 50<sup>th</sup> percentile value as the lower bound, and the 95<sup>th</sup> percentile value as the upper
bound and mode. The sampling loss fraction distribution was chosen based on the calculation of daily
throughput, as shown in Section E.4.3

#### 6595 E.5.14 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm (U.S. EPA, 2015). For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm for containers less than 5,000 gallons (U.S. EPA, 2015). For filter media replacement, the *ChemSTEER User Guide* indicates a single default value of 182.4 cm.

6602

For sampling liquid product, sampling liquid raw material, or general liquid sampling, the *ChemSTEER User Guide* indicates that the typical diameter of opening for vaporization of the liquid is 2.5 cm (U.S.)

EPA, 2015). Additionally, the *ChemSTEER User Guide* provides ten cm as a high-end value for the
diameter of opening during sampling (U.S. EPA, 2015). The underlying distribution of this parameter is
not known; therefore, EPA assigned a triangular distribution based on the estimated lower bound, upper
bound, and mode of the parameter. EPA assigned the value of 2.5 cm as a lower bound for the parameter
and ten cm as the upper bound based on the values provided in the *ChemSTEER User Guide* (U.S. EPA,
2015). EPA also assigned 2.5 cm as the mode diameter value for sampling liquids based on the typical

6611 value described in *ChemSTEER User Guide* (U.S. EPA, 2015).

- 6612 For blending operations, the ESD for Adhesive Formulation (OECD, 2009a) and GS for Formulation of
- 6613 *Waterborne Coatings* (U.S. EPA, 2014a) assumes a closed vessel with a 4-inch diameter process vent,
- 6614 corresponding to ten cm in diameter. In addition, EPA considered the potential for open process vessels
- 6615 used for blending as mentioned in both the *ESD for Adhesive Formulation* (OECD, 2009a) and *GS for*
- 6616 *Formulation of Waterborne Coatings* (U.S. EPA, 2014a), with diameters of the open vessel calculated 6617 based on the batch volume for the simulation iteration and the assumption in the ESD and GS of a one-
- 6618 to-one height to diameter ratio for the process vessel. The underlying distribution of this parameter is not
- 6619 known; therefore, EPA assigned a triangular distribution defined by an estimated lower bound, upper
- bound, and mode of the parameter. EPA assigned the value of ten cm for both the lower bound and
- 6621 mode of the triangular distribution as the recommended value by the ESD for Adhesive Formulation
- 6622 (OECD, 2009a) and GS for Formulation of Waterborne Coatings (U.S. EPA, 2014a). For the upper
- bound value of the triangular distribution, EPA assigned an equation calculating the diameter of an open
  process vessel with a one-to-one height to diameter ratio and fixed batch volume of approximately 1,000
  gallons based on the batch size discussed in Section E.5.17:

6626

6627 Equation E-43.

6628

$$D_{blending\_max} = \left[\frac{4 * V_{batch} * 3785.41 \frac{cm^3}{gal}}{\pi}\right]^{1/3}$$

## 6629 E.5.15 Overall Paint/Coating Production Rate

The *GS for Formulation of Waterborne Coatings* (U.S. EPA, 2014a) provides two estimates for overall
paint/coating production rates. For architectural coatings, the GS estimates 16 million kg of
coatings/site-yr. For special purpose coatings, the GS estimates 1.6 million kg of coatings/site-yr.
Therefore, EPA modeled this parameter with a uniform distribution with a lower bound of 1.6 million
kg/site-yr and an upper bound of 16 million kg/site-yr.

## 6635 E.5.16 Operating Days

- EPA was unable to identify DIDP-specific information for operating days in the production of adhesives
  and sealants. The *GS for Formulation of Waterborne Coatings* (U.S. EPA, 2014a) assumes a constant
  value of 250 days/yr, which assumes the production sites operate five days per week and 50 weeks per
  year, with two weeks down for turnaround.
- 6640 **E.5.17 Batch Size**
- The *GS for Formulation of Waterborne Coatings* (U.S. EPA, 2014a) cites a default batch size of 5,030
  kg coatings per batch with an approximate batch volume of 1,000 gallons.

## 6643E.5.18 Container Fill Rates

6644 The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for 6645 containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers 6646 with less than 20 gallons of liquid.

6647 6648 6649 6650 6651	To account for situations where operating times for container unloading and loading exceeded a 24-hour period in the simulation, EPA applied an equation to determine a corrected fill rate that would replace the deterministic values provided in the <i>ChemSTEER User Guide</i> . The equation for the corrected fill rate in cases where operating time for unloading and loading is greater than 24 hours is included below. EPA only used the corrected fill rate for loading product containers (release point 10).
6652 6653	Equation E-44.
6654	
	$if 24 < (OH_{RP1/RP4} + OH_{RP12}), RATE_{fill\_adjusted} = \frac{N_{cont\_load\_yr}}{(24 - OH_{RP1/RP4}) * OD}$
6655	Where:
6656	$RATE_{fill\_adjusted}$ = Corrected fill rate for product containers [containers/hr]
6657 6658	$N_{cont\_load\_yr}$ = Annual number of product containers [containers/site-year] $OH_n$ = Operating time for release point "n" [hrs/site-day]
6659	$OH_n$ = Operating time for release point "n" [hrs/site-day] OD = Operating days [days/site-year]
6660	E.5.19 Equipment Cleaning Loss Fraction
6661	EPA used the <i>EPA/OPPT Multiple Process Residual Model</i> to estimate the releases from equipment
6662 6663	cleaning. The <i>EPA/OPPT Multiple Process Residual Model</i> , as detailed in the <i>ChemSTEER User Guide</i> (U.S. EPA, 2015) provides an overall loss fraction of two percent from equipment cleaning.
0003	(U.S. EI A, 2015) provides an overall loss fraction of two percent from equipment cleaning.
6664	E.5.20 Off-Spec Loss Fraction
6665	The GS for Formulation of Waterborne Coatings (U.S. EPA, 2014a) provides a loss fraction of 1.2
6666	percent of throughput disposed from off-specification material during manufacturing. This 1.2 percent
6667 6668	default loss fraction was provided as an estimate from a Source Reduction Research Partnership (SRRP) study referenced in the <i>GS for Formulation of Waterborne Coatings</i> (U.S. EPA, 2014a).
0008	study referenced in the 05 jor Formulation of waterborne Countrys (0.5. Er A, 2014a).
6669	E.6 Incorporation into Other Formulations, Mixtures, and Reaction
6670	Products Not Covered Elsewhere Model Approaches and Parameters
6671	This appendix presents the modeling approach and equations used to estimate environmental releases for
6672	DIDP during the incorporation into other formulations, mixtures, and reaction products not covered
6673	elsewhere OES. This approach utilizes the same equations and assumptions presented for Incorporation
6674	into Paints and Coatings in Appendix E.5. Therefore, only the parameters that differ between
6675 6676	approaches, which includes concentration of DIDP in the raw material and final product DIDP concentrations, will be presented in this section for brevity.
0070	concentrations, will be presented in this section for brevity.
6677	E.6.1 Import DIDP Concentration
6678	EPA modeled the imported DIDP concentration using a uniform distribution with a lower bound of 30%
6679	and upper bound of 90% based on information reported in the 2020 CDR by sites indicating DIDP use in
6680	other formulations, mixtures, and reaction products (U.S. EPA, 2020a).
6681	E.6.2 Final DIDP Concentration
6682	EPA modeled final DIDP concentration in other articles using a triangular distribution with a lower
6683	bound of 0.1%, upper bound of 90%, and mode of 20%. The upper bound is based on the imported
6684	DIDP concentration. The concentration of DIDP in the adhesive or sealant cannot be higher than the
6685 6686	concentration of neat DIDP that was imported. The lower bound and mode is based on compiled SDS information for adhesives and scalart products containing DIDP. From the compiled data, the minimum
6686 6687	information for adhesives and sealant products containing DIDP. From the compiled data, the minimum concentration was 0.1% and the mode was 20%. The mode represents the mode of all high-end values of
6688	the concentration ranges found in SDSs.

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6689	E.7 Non-PVC Plastics Materials Model Approaches and Parameters
6690 6691 6692 6693 6694 6695	This appendix presents the modeling approach and equations used to estimate environmental releases for DIDP during the Non-PVC Plastics Material Compounding and Non-PVC Plastics Material Converting OESs. This approach utilizes the <i>Generic Scenario for the Use of Additives in Plastic Compounding</i> (U.S. EPA, 2021e), the 2021 <i>Use of Additives in Plastics Converting Draft Generic Scenario</i> (U.S. EPA, 2021f), <i>Emission Scenario Document on Additives in Rubber Industry</i> (OECD, 2004a), and CDR data (U.S. EPA, 2020a) combined with Monte Carlo simulation (a type of stochastic simulation).
6696 6697	Based on the GS, EPA identified the following release sources from non-PVC plastics materials compounding:
6698 6699 6700 6701 6702 6703 6704 6705 6706	<ul> <li>Release source 1: Transfer Operation Losses to Air from Unloading Plastics Additives.</li> <li>Release source 2: Container Cleaning Wastes.</li> <li>Release source 3: Open Surface Losses to Air During Compounding.</li> <li>Release source 4: Equipment Cleaning Wastes.</li> <li>Release source 5: Direct Contact Cooling Water Losses.</li> <li>Release source 6: Transfer Operations Losses to Air from Loading Compounded Plastic.</li> </ul>
6707 6708 6709 6710 6711 6712 6713 6714 6715 6716 6717	<ul> <li>Release source 1: Transfer Operation Losses to Air from Unloading Plastics Additives.</li> <li>Release source 2: Container Cleaning Wastes.</li> <li>Release source 3: Vapor Emissions from Converting.</li> <li>Release source 4: Particulate Emissions from Converting.</li> <li>Release source 5: Equipment Cleaning Wastes.</li> <li>Release source 6: Direct Contact Cooling Water Losses.</li> <li>Release source 7: Solid Wastes from Trimming Operations.</li> </ul>
6718 6719 6720 6721	to capture variability in the following model input parameters: production volume, DIDP concentrations, operating days, air speed, saturation factor, container size, loss fractions, and dust control/capture efficiencies. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts for this OES.
6722 6723 6724 6725 6726 6727 6728 6729	<b>E.7.1 Model Equations</b> Table_Apx E-17 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the non-PVC plastics materials OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Appendix E.7.2. The Monte Carlo simulation calculated the total DIDP release (by environmental media) across all release sources during each iteration of the

6730 simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency
6731 and high-end releases, respectively.

# 6733 Table\_Apx E-17. Models and Variables Applied for Release Sources in the Non-PVC Plastics 6734 Materials OES

<b>Release source</b>	Model(s) Applied	Variables Used	
	Plastics compoundin	g	
Release source 1: Transfer Operation Losses to Air from Unloading Plastics Additives.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{drum}$ ; $V_{tote}$ ; $RATE_{fill\_drum\_tote}$ Operating Time: $Q_{DIDP\_year}$ ; $V_{drum}$ ;	
		RATE <sub>fill_drum_tote</sub> ; V <sub>tote</sub> ; RHO; OD <sub>comp</sub>	
Release source 2: Container Cleaning Wastes.	<i>EPA/OPPT Drum Residual</i> <i>Model</i> or <i>EPA/OPPT Bulk</i> <i>Transport Residual Model,</i> based on container size (Appendix E.1)	$Q_{DIDP\_year}; LF_{drum}; V_{cont}; LF_{bulk}; V_{bulk}$ RHO; $OD_{comp}$	
Release source 3: Open Surface Losses to Air During Compounding.	See Equation E-45	$Q_{DIDP\_day}; F_{vapor\_emissions}$	
Release source 4: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP\_day}; LF_{equip\_clean}$	
Release source 5: Direct Contact Cooling Water Losses.	See Equation E-47	$Q_{DIDP\_day}; F_{cooling\_water}$	
Release source 6: Transfer Operations Losses to Air from Loading Compounded Plastic.	EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading Operations of Solid Powders (Appendix E.1)	Q <sub>DIDP_day</sub> ; F <sub>dust_generation</sub> ; F <sub>dust_capture</sub> ; F <sub>dust_control</sub>	
Plastics Converting			
Release source 1: Transfer Operation Losses to Air from Unloading Plastics Additives.	EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading Operations of Solid Powders (Appendix E.1)	$Q_{DIDP_day}; F_{dust\_generation}; F_{dust\_capture};$ $F_{dust\_control}$	
Release source 2: Container Cleaning Wastes.	<i>EPA/OPPT Solid Residuals</i> <i>in Transport Containers</i> <i>Model</i> (Appendix E.1)	$Q_{DIDP\_year}; LF_{cont}; V_{cont}; RHO;$ $N_{cont\_unload\_day}; OD_{conv}$	
Release source 3: Vapor Emissions from Converting.	See Equation E-45	$Q_{DIDP\_day}; F_{vapor\_emissions}$	
Release source 4: Particulate Emissions from Converting.	See Equation E-46	$Q_{DIDP\_day}; F_{particulate\_emissions}$	
Release source 5: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP_{day}}; LF_{equip_{clean}}$	

Release source	Model(s) Applied	Variables Used		
Release source 6: Direct Contact Cooling Water Losses.	See Equation E-47	$Q_{DIDP\_day}; F_{cooling\_water}$		
Release source 7: Solid Wastes from Trimming Operations.	See Equation E-48	$Q_{DIDP\_day}; F_{trimming}$		

Compounding and converting release source 3 daily release (Open Surface Losses to Air During Compounding/Converting) is calculated using the following equation: 

#### **Equation E-45.**

0710	
6741	Wł

0101	
6740	$Release\_perDay_{RP3} = Q_{DIDP\_day} * F_{vapor\_emissions}$
6741	Where:
6742	$Release\_perDay_{RP3} = DIDP$ released for release source 3 [kg/site-day]
6743	$Q_{DIDP_{day}}$ = Facility throughput of DIDP (see Section E.7.3) [kg/site-day]
6744	$F_{vapor\_emissions}$ = Fraction of DIDP lost from volatilization during
6745	compounding/converting operations (see Section E.7.21) [kg/kg]
6746	
6747	Converting release source 4 daily release (Particulate Emissions from Converting) is calculated using
6748	the following equation:
6749	
6750	Equation E-46.
6751	Release_perDay <sub>RP4</sub> = $Q_{DIDP \ day} * F_{particulate \ emissions}$

 $Release\_perDay_{RP4} = Q_{DIDP\_day} * F_{particulate\_emissions}$ 

6752	Where:	
6753	Release_perDay <sub>RP4</sub> =	DIDP released for release source 4 [kg/site-day]
6754	$Q_{DIDP_day} =$	Facility throughput of DIDP (see Section E.7.3) [kg/site-day]
6755	$F_{particulate\_emissions} =$	Fraction of DIDP lost as particulates during converting operations
6756		(see Section E.7.16) [kg/kg]
6757		

Compounding and converting release source 5 daily release (Direct Contact Cooling Water Losses) is calculated using the following equation: 

#### **Equation E-47.**

6762	Releas	$e_perDay_{RP5} = Q_{DIDP_day} * F_{cooling_water}$
6763	Where:	
6764	Release_perDay <sub>RP5</sub> =	DIDP released for release source 5 [kg/site-day]
6765	$Q_{DIDP\_day} =$	Facility throughput of DIDP (see Section E.7.3) [kg/site-day]
6766	$F_{cooling\_water} =$	Cooling water loss fraction (see Section E.7.19) [kg/kg]
6767	0-	

Converting release source 7 daily release (Solid Wastes from Trimming Operations) is calculated using the following equation: 

6770 6771	Equation E-48.
6772	$Release\_perDay_{RP7} = Q_{DIDP\_day} * F_{trimming}$
6773	Where:
6774	$Release\_perDay_{RP7} = DIDP$ released for release source 7 [kg/site-day]
6775	$Q_{DIDP_day}$ = Facility throughput of DIDP (see Section E.7.3) [kg/site-day]

## $\begin{array}{ll} 6776 \\ 6777 \end{array} \qquad \qquad = \qquad \text{Trimming loss fraction (see Section E.7.23) [kg/kg]} \\ 6777 \end{array}$

## 6778 E.7.2 Model Input Parameters

Table\_Apx E-18 and summarizes the model parameters and their values for the Non-PVC Plastics

6780 Materials Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for 6781 each parameter are provided after Table\_Apx E-18.

Input			Deterministic Values	Uncerta	ainty Analysis Di	stribution l	Parameters	Rationale / Basis
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Total PV of DIDP at all Sites	$\mathrm{PV}_{\mathrm{total}}$	kg/yr	14,529,471	1,465,812	14,529,471		Uniform	See Section E.7.3
Initial DIDP Concentration	$F_{\text{DIDP}\_import}$	kg/kg	1	0.3	1	1	Triangular	See Section E.7.9
Plastic DIDP Concentration	F <sub>DIDP</sub>	kg/kg	0.2	0.1	0.2		Uniform	See Section E.7.10
Operating Days - Compounding	OD <sub>comp</sub>	days/yr	246	147	301	246	Triangular	See Section E.7.11
Operating Days - Converting	OD <sub>conv</sub>	days/yr	253	136	255	253	Triangular	See Section E.7.11
Saturation Factor	$\mathbf{f}_{sat}$	dimensionles s	0.5	0.5	1.45	0.5	Triangular	See Section E.7.12
Drum Container Size	V <sub>drum</sub>	gal	55	20	100	55	Triangular	See Section E.7.13
Tote Container Size	V <sub>tote</sub>	gal	550	100	1,000	550	Triangular	See Section E.7.13
Solid Container Size	V <sub>cont</sub>	gal	7	7	132	7	Triangular	See Section E.7.13
Drum Residual Loss Fraction	LF <sub>drum</sub>	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section E.7.14
Bulk Container Loss Fraction	LF <sub>bulk</sub>	kg/kg	0.07	0.02	0.2	0.07	Triangular	See Section E.7.14
Fraction of chemical lost during transfer of solid powders	$F_{dust\_generation}$	kg/kg	0.0050	0.000006	0.045	0.005	Triangular	See Section E.7.15
Capture efficiency for	$F_{dust\_capture}$	kg/kg	0.9630	0.931	1	0.963	Triangular	See Section E.7.15

## 6782 Table\_Apx E-18. Summary of Parameter Values and Distributions Used in the Non-PVC Plastics Materials Model

Input			Deterministic Values	Uncerta	ainty Analysis Di	Rationale / Basis		
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	
dust capture methods								
Control efficiency for dust control methods	Fdust_control	kg/kg	Multiple distributions depending on control type. T			Triangular	See Section E.7.15	
Fraction of DIDP lost as particulates during converting processes	F <sub>particulate_emiss</sub> ions	kg/kg	0.00006	0.00002	0.0001	0.00006	Triangular	See Section E.7.16
Mass fraction of all additives in the compounded plastic resin	$F_{additives\_resin}$	kg/kg	0.49	0.49	0.87		Uniform	See Section E.7.5
Annual use rate of all plastic additives	$Q_{additives\_yr}$	kg/site-yr	198,773			_		See Section E.7.6
Vapor Pressure at 25C	VP	mmHg	5.28E-07					Physical property
Molecular Weight	MW	g/mol	446.68					Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05					Universal constant
Density of DIDP	RHO	kg/L	0.9634					Physical property
Temperature	Т	K	298					Process parameter
Pressure	Р	atm	1					Process parameter

Input			Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Drum and Tote Fill Rate	RATE <sub>fill_drum</sub>	containers/hr	20					See Section E.7.17
Small Container Fill Rate	RATE <sub>fill_cont</sub>	containers/hr	60					See Section E.7.17
Tank Truck Fill Rate	RATE <sub>fill_truck</sub>	containers/hr	2					See Section E.7.17
Rail Car Fill Rate	RATE <sub>fill_rail</sub>	containers/hr	1	_		_		See Section E.7.17
Equipment Cleaning Loss Fraction	$LF_{equip\_clean}$	kg/kg	0.02	_		_		See Section E.7.18
Cooling Water Loss Fraction	$F_{cooling\_water}$	kg/kg	0.01					See Section E.7.19
Rubber Production Rate	Q <sub>rubber</sub>	kg/day	55,000					See Section E.7.20
Fraction of the chemical of interest lost from volatilization during forming and molding processes (open process)	F <sub>vapor_emissions</sub>	kg/kg	0.00010					See Section E.7.21
Fraction of the chemical of interest lost from volatilization during forming and molding	Fvapor_emissions _closed	kg/kg	0.00002					See Section E.7.21

Input	<b>a i i</b>		Deterministic Values	Uncerta	ainty Analysis Di	Rationale / Basis		
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	
processes (closed process)								
Solid container loss fraction	LF <sub>cont</sub>	kg/kg	0.01					See Section E.7.22
Trimming loss fraction	F <sub>trimming</sub>	kg/kg	0.025	_		_		See Section E.7.23

6784	E.7.3 Number of	of Sites									
6785	Number of sites is calculated using the following equation.:										
6785 6786	rumber of sites is calculated using the following equation.										
6780 6787	Equation E-49.										
0787	Equation E-47.	PV									
6788		$N_s = \frac{PV}{Q_{DIDP_{vear}}}$									
		$Q_{DIDP_{year}}$									
6789	Where:										
6790	N <sub>s</sub>	= Number of sites [sites]									
6791	PV	= Production volume (see Section E.7.4) [kg/year]									
6792	$Q_{DIDP\_year}$	= Facility annual throughput of DIDP (see Section E.7.4) [kg/site-yr]									
6793	E.7.4 Through	out Parameters									
6794		production volume for all sites using a uniform distribution with a lower bound									
6795		n upper bound of 14,529,471 kg/yr. This is based on CDR data (U.S. EPA,									
6796		opean Union Risk Assessment on DIDP (ECJRC, 2003b).									
6797											
6798	The upper and lower bou	nds are based on CDR data (U.S. EPA, 2020a) and the 2003 European Union									
6799		P (ECJRC, 2003b). The 2003 EU Risk Assessment found that 3.2% of the									
6800		n non-PVC polymers. CDR states that the total U.S. national PV of DIDP is in									
6801	the range of 100,986,354	lbs/yr to 1.001 billion lbs/yr. Multiplying these figures by 3.2% results in									
6802		12 kg/yr) to 32,032,000 lbs/yr (14,529,471 kg/yr). This production range is									
6803	used for both non-PVC p	lastic compounding and converting, since EPA assumes 100% of the									
6804	compounded plastic goes	to the converting process.									
6805											
6806	For compounding, the an	nual throughput of DIDP is calculated using Equation E-50 by multiplying									
6807	daily rubber production r	ate by operating days and the concentration of DIDP in the final article. Daily									
6808		determined according to Section E.7.20, operating days is determined									
6809		11, and concentration of DIDP in the final article is determined according to									
6810	Section E.7.10.										
6811											
6812	Equation E-50.										
6813		$Q_{DIDP\_year} = Q_{rubber} * F_{DIDP} * OD_{comp}$									
6814											
6815	Where:										
6816	$Q_{DIDP\_year}$	= Facility annual throughput of DIDP [kg/site-yr]									
6817	$Q_{rubber}$	= Overall non-PVC plastic material production rate (see Section									
6818		E.7.20) [kg/site-day]									
6819	$F_{DIDP}$	= Concentration of DIDP in final plastic/rubber (see Section E.7.10)									
6820		[kg/kg]									
6821	$OD_{comp}$	= Operating days for compounding (see Section E.7.11) [days/yr]									
6822	•										
6823	For converting, the annua	al throughput of DIDP is calculated using Equation E-51 by multiplying the									
6824		stics additives by the concentration of DIDP in the final article and dividing by									
6825		ditives in the compounded plastic resin. Annual use rate of all plastics									
6826		ccording to Section E.7.6, concentration of DIDP in the final article is									
6827		Section E.7.10, and mass fraction of all additives in compounded resin is									
6828	determined according to	•									
	-										

			May 2024						
6829									
6830	Equation E-51.								
6831	$Q_{DIDP\_year} = \frac{Q_{additives\_yr} * F_{DIDP}}{F_{additives\_resin}}$								
	$V_{DIDP_year} - F_{additives_resin}$								
6832									
6833	Where:								
6834	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]						
6835	$Q_{additives\_yr}$	=	Annual use rate of all plastic additives (see Section E.7.6)						
6836	_		[kg/site-yr]						
6837	$F_{DIDP}$	=	Concentration of DIDP in final plastic/rubber (see Section E.7.10)						
6838			[kg/kg]						
6839	$F_{additives\_resin}$	=	Mass fraction of all additives in the compounded plastic resin (see						
6840			Section E.7.5) [kg/kg]						
6841	For both compounding on	daannan	ting the daily throughout of DIDD is calculated using Equation E 52						
6842 6843	1 0		ting, the daily throughput of DIDP is calculated using Equation E-52 volume by the number of operating days. The number of operating						
6844	days is determined accord								
6845	days is determined accord	ing to Se							
6846	Equation E-52.								
	Equation E 52.		Q <sub>DIDP vear</sub>						
6847			$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD_{comp}/conv}$						
6848									
6849	Where:								
6850	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]						
6851	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]						
6852	$OD_{comp/conv}$	=	Operating days for either compounding or converting (based on the						
6853	comprentiv		specific OES assessed) (see Section E.7.11) [days/yr]						
6854			All Additives in Compounded Plastic Resin						
6855			additives in compounded plastic resin using a uniform distribution						
6856			upper bound of 0.87. This is based on the 2021 Use of Additives in						
6857			Scenario (U.S. EPA, 2021f). The GS provides a range of 0.49 to 0.87						
6858			ible PVC. While this OES is for non-PVC products, EPA used these						
6859	values as a surrogate for n	on-PVC	plastics.						
6860	F76 Annual Ha	se Rote e	f All Plastic Additives During Converting						
6861			tics Converting Draft Generic Scenario (U.S. EPA, 2021f) estimates						
6862	v		all plastic additives is 198,773 kg additives/site-yr. This was						
6863			J.S. demand for plastics additives by the number of sites estimated in						
6864	the GS.	umuu (	s.s. demand for plustes additives by the number of sites estimated in						
6865	E.7.7 Number o	f Contai	ners per Year						
6866	The number of DIDP raw	material	containers received and unloaded by a site per year is calculated						

The number of DIDP raw material containers received and unloaded by a site per year is calculatedusing the following equation:

(0(0	
6868 6860	Equation E 52
6869	Equation E-53.
6870	$N_{cont unload yr} = \frac{QDDP_year}{(I_y)}$
	$N_{cont\_unload\_yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{drum/tote}}$
6871	Where:
6872	$V_{drum/tote}$ = Import container volume (see Section E.7.13) [gal/container]
6873	$Q_{DIDP,year} = Facility annual throughput of DIDP (see Section E.7.10) [kg/site-$
6874	yr]
6875	RHO = DIDP density [kg/L]
6876	$N_{cont\_unload\_yr} = $ Annual number of containers unloaded [container/site-year]
0070	
6877	E.7.8 Operating Hours
6878	EPA estimated operating hours or hours of duration using data provided from the 2021 Use of Additives
6879	in Plastic Compounding Draft Generic Scenario ( <u>U.S. EPA, 2021e</u> ), 2021 Use of Additives in Plastics
6880	Converting Draft Generic Scenario (U.S. EPA, 2021f), ChemSTEER User Guide (U.S. EPA, 2015),
6881	and/or through calculation from other parameters. Release points with operating hours provided from
6882	these sources include unloading, compounding, converting, and loading into transport containers.
6883	
6884	For unloading during compounding and converting, (release point 1), the operating hours are calculated
6885	based on the number of containers unloaded at the site and the unloading rate using the following
6886	equation:
6887	Equation E 54
6888	Equation E-54.
6889	$OH_{RP1} = \frac{N_{cont\_unload\_yr}}{RATE_{fill\ drum\ tote\ *\ OD}}$
(000	$RAT E_{fill\_drum\_tote} * OD$
6890	Whorea
6891 6892	Where: $OH_{RP1}$ = Operating time for release point 1 [hrs/site-day]
6892 6893	$OH_{RP1}$ = Operating time for release point 1 [hrs/site-day] $RATE_{fill\_drum\_tote}$ = Fill rate of drums and totes (see Section E.7.17) [containers/hr]
6894	
6895	$N_{cont\_unload\_yr}$ = Annual number of containers unloaded (see Section E.7.7) [container/site-year]
6896	
6897	OD = Operating days (see Section E. /.11) [days/yr]
6898	For compounding and converting operations (release point 3 for compounding, 3 & 4 for converting),
6899	EPA assumes compounding and converting occurs for the entirety of a work-shift and assigns a duration
6900	of eight hours/day.
6901	E.7.9 Initial DIDP Concentration
6902	EPA modeled the initial DIDP concentration using a triangular distribution with a lower bound of 30%,
6903	upper bound of 100%, and mode of 100% based on information reported in the 2020 CDR by sites
6904	indicating DIDP use in non-PVC plastics (U.S. EPA, 2020a).

### 6905 E.7.10 Final DIDP Concentration

EPA modeled final DIDP concentration in non-PVC plastics using a uniform distribution with a lower
bound of 10% and upper bound of 20%. This is based on the *Emission Scenario Document on Additives in Rubber Industry* (OECD, 2004a). The ESD states that rubber additives are expected to be present at
10-20% for rubber products.

## 6910 E.7.11 Operating Days

- 6911 For compounding, EPA modeled the operating days per year using a triangular distribution with a lower 6912 bound of 148 days/yr, an upper bound of 300 days/yr, and a mode of 246 days/yr. To ensure that only 6913 integer values of this parameter were selected, EPA nested the triangular distribution probability formula 6914 within a discrete distribution that listed each integer between (and including) 148-300 days/yr. The 6915 lower bound is based on the 2014 Plastics Compounding Draft Generic Scenario (U.S. EPA, 2014c). 6916 The report states that a typical range of 148-264 days/yr are assumed. The upper bound is based on 6917 ESIG's Specific Environmental Release Category for Rubber Production and Processing (ESIG, 2020). 6918 The SpERC indicates a default of 300 days/yr for rubber manufacturing. The mode is based on the 2021 6919 Generic Scenario for the Use of Additives in Plastic Compounding (U.S. EPA, 2021e), which states that
- 6920 246 days/yr should be used as a default.
- 6921
- 6922 For converting, EPA modeled the operating days per year using a triangular distribution with a lower
- bound of 137 days/yr, an upper bound of 254 days/yr, and a mode of 253 days/yr. To ensure that only
   integer values of this parameter were selected, EPA nested the triangular distribution probability formula
- 6925 within a discrete distribution that listed each integer between (and including) 137-254 days/yr. The
- 6926 lower and upper bounds are based on the 2014 Use of Additives in the Thermoplastic Converting
- 6927 *Industry Draft GS* (U.S. EPA, 2014d), which states 137-254 days/yr should be assumed. The mode is
- based on the 2021 Use of Additives in Plastics Converting Draft Generic Scenario (U.S. EPA, 2021f),
- 6929 which states that an average value of 253 days/yr should be used as a default.
- 6930 E.7.12 Saturation Factor

6931 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 6932 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 6933 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 6934 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 6935 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 6936 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 6937 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in 6938 the ChemSTEER User Guide for the EPA/OAOPS AP-42 Loading Model (U.S. EPA, 2015).

6939E.7.13 Container Size

EPA assumed that non-PVC plastic manufacturing sites would receive DIDP in drums or totes.
According to the *ChemSTEER User Guide*, drums are defined as containing between 20 and 100 gallons
of liquid, and the default drum size is 55 gallons (U.S. EPA, 2015). Totes are defined as containing
between 100 and 1,000 gallons, and the default tote size is 550 gallons. EPA modeled triangular
distributions for each container type using these values, with the lower and upper bounds corresponding
to the range of volumes for each container type, and the mode corresponding to the default container
size for each container type.

6947

6948 For packaging of compounded plastics, EPA modeled solid containers using a triangular distribution 6949 with a lower bound and mode of 25 kg and upper bound of 500 kg. This is based on the 2021 *Use of* 

- 6950 Additives in Plastics Converting Draft Generic Scenario (U.S. EPA, 2021f), which states that
- 6951 compounded plastics in pellet form are routinely shipped in containers ranging from 25 kg bags to 500
- 6952 kg gaylords. EPA converted the mass of the container to volume assuming a compounded plastic density
- 6953 of 1 kg/L. The volumetric distribution contains a lower bound and mode of 7 gallons, and an upper
- 6954 bound of 132 gallons.

#### 6955 **E.7.14 Container Residue Loss Fractions** 6956 For drums, EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the 6957 residuals data for emptying drums by pumping was aligned with the default central tendency and high-6958 end values from the EPA/OPPT Drum Residual Model. For unloading drums by pumping in the PEI 6959 Associates Inc. study, EPA found that the average percent residual from the pilot-scale experiments 6960 showed a range of 1.7 percent to 4.7 percent and an average of 2.6 percent. The EPA/OPPT Drum 6961 Residual Model from the ChemSTEER User Guide recommends a default central tendency loss fraction 6962 of 2.5 percent and a high-end loss fraction of 3.0 percent (U.S. EPA, 2015). 6963 6964 The underlying distribution of the loss fraction parameter for drums is not known; therefore, EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 6965 6966 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for the loss fraction probability distribution using the central tendency and high-end values, respectively, 6967 6968 prescribed by the EPA/OPPT Drum Residual Model in the ChemSTEER User Guide (U.S. EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum average percent 6969 6970 residual measured in the PEI Associates, Inc. study (Associates, 1988) for emptying drums by pumping. 6971 6972 For bulk containers, EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that 6973 the residuals data for emptying tanks by gravity-draining was aligned with the default central tendency 6974 and high-end values from the EPA/OPPT Bulk Transport Residual Model. For unloading tanks by 6975 gravity-draining in the PEI Associates Inc. study, EPA found that the average percent residual from the pilot-scale experiments showed a range of 0.02 percent to 0.19 percent and an average of 0.06 percent 6976 6977 (Associates, 1988). The EPA/OPPT Bulk Transport Residual Model from the ChemSTEER User Guide 6978 (U.S. EPA, 2015) recommends a default central tendency loss fraction of 0.07 percent and a high-end 6979 loss fraction of 0.2 percent.

6980

6981 The underlying distribution of the loss fraction parameter for bulk containers is not known; therefore, 6982 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 6983 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 6984 the loss fraction probability distribution using the central tendency and high-end values, respectively, 6985 prescribed by the EPA/OPPT Bulk Transport Residual Model in the ChemSTEER User Guide (U.S. EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum 6986 6987 average percent residual measured in the PEI Associates, Inc. study for emptying tanks by gravity-6988 draining (Associates, 1988).

# 6989E.7.15 Dust Generation Loss Fraction, Dust Capture Efficiency, and Dust Control6990Efficiency

The EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading 6991 6992 Operations of Solid Powders (Dust Release Model) compiled data for loss fractions of solids from 6993 various sources in addition to the capture and removal efficiencies for control technologies in order to 6994 estimate releases of dust to the environment. Dust releases estimated from the model are based on three 6995 different parameters: the initial loss fraction, the fraction captured by the capture technology, and the 6996 fraction removed/controlled by the control technology. The underlying distributions for each of these 6997 parameters is not known; therefore, EPA assigned triangular distributions, since triangular distribution 6998 requires least assumptions and is completely defined by range and mode of a parameter. 6999

EPA assigned the range and mode for each of the three parameters using the data presented in the Dust
Release Model. For the initial loss fraction, EPA assigned a range of 6.0E-06 to 0.045 with a mode of
0.005 by mass. EPA assigned the mode based on the recommended default value for the parameter in

- the Dust Release Model. The range of initial loss fraction values comes from the range of values compiled from various sources and considered in the development of the Dust Release Model (U.S.
- 7005 EPA, 2021d).
- 7006 For the fraction captured, EPA assigned a range of 0.931 to 1.0 with a mode of 0.963 by mass. EPA
- assigned the range for the fraction captured based on the minimum and maximum estimated capture
- roos efficiencies listed in the data compiled for the Dust Release Model. EPA assigned the mode for the
- fraction captured based on the average of all lower bound estimated capture efficiency values for all
- 7010 capture technologies presented in the model (U.S. EPA, 2021d).
- 7011
- 7012 For the fraction removed/controlled, the 2021 Generic Scenario for the Use of Additives in Plastic
- 7013 Compounding (U.S. EPA, 2021e) and 2021 Use of Additives in Plastics Converting Draft Generic
- 7014 *Scenario* (U.S. EPA, 2021f) state that many facilities collect fugitive dust emissions in filters or utilize 7015 wet scrubbers. Therefore, EPA used two triangular distributions: a distribution for filter efficiency, and a
- 7016 distribution for wet scrubber efficiency. Each control technology distribution has an equal probability of
- 7017 being selected during each iteration of the simulation. The triangular distribution for filter efficiency has
- a lower bound of 0.97, upper bound of 0.99999, and mode of 0.99. The triangular distribution for wet
- scrubber efficiency has a lower bound of 0.20, upper bound of 0.995, and mode of 0.55. These
- distributions are based on the minimum, maximum, and default values presented for each control
- technology in the Dust Release Model (U.S. EPA, 2021d).

## 7022 E.7.16 Fraction of DIDP Lost as Particulates During Converting Processes

7023 EPA modeled the loss fraction of particulate DIDP during converting using a triangular distribution with 7024 a lower bound of 2.0E–05 kg/kg, upper bound of 1.0E–04 kg/kg, and mode of 6.0E–05 kg/kg. This is 7025 based on the 2021 Use of Additives in Plastics Converting Draft Generic Scenario (U.S. EPA, 2021f). 7026 The GS presents loss fractions for three types of converting: open process (1.0E–04 kg/kg), partially 7027 open process (6.0E-05 kg/kg), or closed process (2.0E-05 kg/kg). EPA used these loss fractions to build 7028 the triangular distribution based on magnitude of the values, with the loss fraction for a partially open process being the central value. The distribution does not reflect prevalence of each type of process in 7029 7030 the industry.

7031 E.7.17 Container Fill Rates

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides typical fill rates of one container per hour for containers over 10,000 gallons of liquid; two containers per hour for containers with 1,000 to 10,000 gallons of liquid; 20 containers per hour for containers with 20 to 100 gallons of liquid; and 60 containers per hour for containers with less than 20 gallons of liquid.

7036 E.7.18 Equipment Cleaning Loss Fraction

EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment
cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide*(U.S. EPA, 2015), provides an overall loss fraction of two percent from equipment cleaning.

- 7040 E.7.19 Cooling Water Loss Fraction
- The 2021 Generic Scenario for the Use of Additives in Plastic Compounding (U.S. EPA, 2021e) and 2021 Use of Additives in Plastics Converting Draft Generic Scenario (U.S. EPA, 2021f) state that the if
- direct contact cooling water is used for compounding/converting, that the *EPA/OPPT Single Vessel*
- 7045 anect contact cooling water is used for compounding/converting, that the *EPA/OPPT Single Vessel* 7044 *Residual Model* should be used to estimate releases. The *EPA/OPPT Single Vessel Residual Model*, as
- 7044 *Residual Model* should be used to estimate releases. The *EPA/OPPT Single Vessel Residual Model*, 7045 detailed in the *ChemSTEER User Guide* (U.S. EPA, 2015), provides an overall loss fraction of one
- percent residual in equipment. This model is intended for equipment; however, in the context of losses
- to contact cooling water, using this model assumes one percent of the batch size remains available on

plastic resin (*e.g.*, extruded pellets, granules) being cooled and is transferred to the cooling water, which
 is discharged from the site (U.S. EPA, 2014d).

## 7050 E.7.20 Rubber Production Rate

The *Emission Scenario Document on Additives in Rubber Industry* (OECD, 2004a) provides a point source estimate for all rubber manufacturing, with a default production rate of 55,000 kg/day, which is

## based on a 1999 German Rubber Industry study.

## E.7.21 Fraction of DIDP Lost from Volatilization During Forming and Molding Processes

The 2021 *Use of Additives in Plastics Converting Draft Generic Scenario* (U.S. EPA, 2021f) provides a breakdown of vapor emission rates during converting. The loss rates are based on plastic additive type and volatility of the chemical. DIDP is a plasticizer with a low volatility (less than 0.2 torr at 200°C). According to the GS, a loss rate of 0.01% is expected for open processes, and a loss rate of 0.002% is expected for closed processes. Within the Monte Carlo model, each loss rate has an equal probability of being selected during each iteration of the simulation.

## 7061 E.7.22 Solid Container Loss Fraction

EPA used the *EPA/OPPT Solid Residuals in Transport Containers Model* to estimate residual releases
from solid container cleaning. The *EPA/OPPT Solid Residuals in Transport Containers Model*, as
detailed in the *ChemSTEER User Guide* (U.S. EPA, 2015), provides an overall loss fraction of one
percent from container cleaning.

## 7066 E.7.23 Trimming Loss Fraction

The 2021 Use of Additives in Plastics Converting Draft Generic Scenario (U.S. EPA, 2021f)
 recommends a default trimming loss fraction of 0.025 kg/kg.

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## 7070 E.8 PVC Plastics Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for
DIDP during the PVC Plastics Compounding and PVC Plastics Converting OESs. This approach utilizes
the same equations and assumptions presented for non-PVC plastics materials in Appendix E.7.
Therefore, only the parameters that differ between approaches, including throughput parameters, DIDP
concentrations, and dust control efficiency, will be presented in this Section for brevity.

## 7076 E.8.1 Throughput Parameters

7077 EPA estimated the total production volume for all sites using a uniform distribution with a lower bound 7078 of 43,859,857 kg/yr and an upper bound of 434,749,009 kg/yr. This is based on CDR data (U.S. EPA, 7079 2020a) and the 2003 European Union Risk Assessment on DIDP (ECJRC, 2003b). The EU Risk 7080 Assessment found that 95.75% of the DIDP produced is used in PVC polymers. CDR states that the total 7081 U.S. national PV of DIDP is in the range of 100,986,354 lbs/yr to 1.001 billion lbs/yr. Multiplying these 7082 figures by 95.75% % results in 96,695,434 lb./yr (43,859,857 kg/yr) to 958,457,500 lbs/yr (434,749,009 7083 kg/yr). This production range is used for both PVC plastic compounding and converting, since EPA 7084 assumes 100% of the compounded plastic goes to the converting process. 7085

For compounding and converting, the annual throughput of DIDP is calculated using Equation E-55 by multiplying annual use rate of all plastic additives by mass fraction of DIDP in the compounded plastic resin and dividing by the mass fraction of all additives in the compounded plastic resin. Annual use rate of all plastic additives is determined according to Section E.8.5 for compounding and Section E.7.6 for converting. Mass fraction of DIDP in the compounded plastic resin is determined according to Section

7001		c 11 1 1	
7091		of all addi	tives in the compounded plastic resin is determined according to
7092	Section E.7.5.		
7093			
7094	Equation E-55.		
			$Q_{additives vr} * F_{chem resin}$
7095		$Q_D$	$_{IDP\_year} = \frac{Q_{additives\_yr} * F_{chem\_resin}}{F_{additives\ resin}}$
7006			Fadditives_resin
7096			
7097	Where:		
7098	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]
7099	$Q_{additives_yr}$	=	Annual use rate of all plastic additives (see Section E.8.5) [kg/site-
7100	-		yr]
7101	$F_{chem\_resin}$	=	Mass fraction of DIDP in the compounded plastic resin (see
7102	_		Section E.8.3) [kg/kg]
7103	$F_{additives\_resin}$	=	Mass fraction of all additives in the compounded plastic resin
7104			(see Section E.7.5) [kg/kg]
7105	E.8.2 Plastic DI	DP Conc	entration
7106	EPA modeled final DIDP	concentra	ation in PVC plastics using a uniform distribution with a lower bound
7107			This is based on a presentation by the American Chemistry Council
7108	11		t Life cycles (ACC, 2020a). The ACC indicated that DIDP is present

in PVC wire and cable at 25%, in PVC film and sheets at 20-45%, and in other PVC products at 1040%. Therefore, EPA used the lower bound and upper bound of the provided ranges to create a uniform
distribution.

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## E.8.3 Fraction of DIDP in Compounded Plastic Resin

EPA modeled the mass fraction of DIDP in compounded plastic resin using a uniform distribution with a
lower bound of 0.3 and an upper bound of 0.45. This is based on the *Generic Scenario for the Use of*

7115 Additives in Plastic Compounding (U.S. EPA, 2021e). The GS provides a range of 0.3-0.45 for the

7116 typical weight fraction of plasticizers in rigid PVC.

### E.8.4 Dust Capture and Control Efficiency

7118 The EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading

7119 *Operations of Solid Powders* (Dust Release Model) compiled data for loss fractions of solids from 7120 various sources in addition to the capture and removal efficiencies for control technologies in order to 7121 estimate releases of dust to the environment. Dust releases estimated from the model are based on three 7122 different parameters: the initial loss fraction, the fraction captured by the capture technology, and the

7123 fraction removed/controlled by the control technology. The underlying distributions for each of these

parameters is not known; therefore, EPA assigned triangular distributions, since triangular distribution

requires least assumptions and is completely defined by range and mode of a parameter. Section E.7.15
 provides the distribution for the initial loss fraction.

7127

For the fraction captured, EPA assigned a range of 0 to 1.0 with a mode of 0.321 by mass. EPA assigned the range for the fraction captured based on the minimum and maximum estimated capture efficiencies

7130 listed in the data compiled for the Dust Release Model. EPA assigned the mode for the fraction captured

7130 Instea in the data complete for the Dust Release Model. El A assigned the mode for the fraction captured 7131 based on the average of all lower bound estimated capture efficiency values for all capture technologies

7131 based on the average of an lower bound estimated capture enciency values for an capture technology 7132 presented in the model with a safety factor of three applied according to the model.

7132 presented in the model with a safety factor of three appl

7133

For the fraction removed/controlled, EPA assigned a range of 0 to 1.0 with a mode of 0.26 by mass.

EPA assigned the range for the fraction controlled based on the minimum and maximum estimated

control efficiencies listed in the data compiled for the Dust Release Model. EPA assigned the mode for

the fraction controlled based on the average of all lower bound estimated control efficiency values for all

control technologies presented in the model with a safety factor of three applied according to the model.

7139 **E.8.5** 

## E.8.5 Annual Use Rate of All Plastic Additives During Compounding

The Generic Scenario for the Use of Additives in Plastic Compounding (U.S. EPA, 2021e) estimates that

the annual facility use rate of all plastic additives at compounding sites is 4,319,048 kg additives/site-yr.

This was calculated by dividing the annual U.S. demand for plastics additives by the number of sites estimated in the GS.

# 7144 E.9 Application of Adhesives and Sealants Model Approaches and 7145 Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for
DIDP during the application of adhesives and sealants OES. This approach utilizes the *Emission Scenario Document on Use of Adhesives* (OECD, 2015b) combined with Monte Carlo simulation (a type
of stochastic simulation).

7150

Based on the ESD, EPA identified the following release sources from the application of adhesives andsealants:

- Release source 1: Container Cleaning Wastes.
- Release source 2: Open Surface Losses to Air During Container Cleaning.
- Release source 3: Transfer Operation Losses from Unloading Adhesive Formulation.
- Release source 4: Equipment Cleaning Wastes.
- Release source 5: Open Surface Losses to Air During Equipment Cleaning.
- Release source 6: Process Releases During Adhesive Application.
- Release source 7: Open Surface Losses to Air During Curing/Drying.
- Release source 8: Trimming Wastes
- 7161

Environmental releases for DIDP during use of adhesives and sealants are a function of DIDP's physical
properties, container size, mass fractions, and other model parameters. While physical properties are
fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture
variability in the following model input parameters: production volume, product throughput, DIDP
concentrations, air speed, saturation factor, container size, loss fractions, and operating days. EPA used
the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling
method in @Risk to calculate release amounts for this OES.

7169 E.9.1 Model Equations

Table\_Apx E-19 provides the models and associated variables used to calculate environmental releases 7170 7171 for each release source within each iteration of the Monte Carlo simulation. EPA used these 7172 environmental releases to develop a distribution of release outputs for the use of adhesives and sealants 7173 OES. The variables used to calculate each of the following values include deterministic or variable input 7174 parameters, known constants, physical properties, conversion factors, and other parameters. The values 7175 for these variables are provided in Appendix E.9.2. The Monte Carlo simulation calculated the total 7176 DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency 7177 7178 and high-end releases, respectively.

## Table\_Apx E-19. Models and Variables Applied for Release Sources in the Application of Adhesives and Sealants OES

Release source	Model(s) Applied	Variables Used
Release source 1: Container Cleaning Wastes.	EPA/OAQPS AP-42 Small Container Residual Model (Appendix E.1)	Q <sub>DIDP_year</sub> ; F <sub>residue</sub> ; V <sub>cont</sub> ; RHO; OD; F <sub>DIDP</sub>
Release source 2: Open Surface Losses to Air During Container Cleaning.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cont\_clean}$ ; $T$ ; $P$ Operating Time: $RATE_{fill\_cont}$ ; $RHO$ ; $V_{cont}$ ; $Q_{DIDP\_year}$
Release source 3: Transfer Operation Losses from Unloading Adhesive Formulation.	EPA/OAQPS AP-42 Loading Model (Appendix E.1))	Vapor Generation Rate: $F_{DIDP}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $RATE_{fill\_cont}$ ; $V_{cont}$ Operating Time: $RATE_{fill\_cont}$ ; $RHO$ ; $V_{cont}$ ; $Q_{DIDP\_year}$
Release source 4: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP\_day}; F_{equipment\_cleaning}$
Release source 5: Open Surface Losses to Air During Equipment Cleaning.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{equip\_clean}$ ; $T$ ; $P$ Operating Time: $OH_{equip\_clean}$
Release source 6: Process Releases During Adhesive Application.	Unable to estimate due to lack of substrate surface area data.	N/A
Release source 7: Open Surface Losses to Air During Curing/Drying.	Unable to estimate due to the required data for release estimation of volatilization during curing not being available.	N/A
Release source 8: Trimming Wastes.	See Equation E-56	$Q_{DIDP\_day}; F_{trimming}$

7182

7183 Release source 8 daily release (Trimming Wastes) is calculated using the following equation:

# 71847185 Equation E-56.

7186

$Release\_perDay_{RP8} =$	$Q_{DIDP\_day} * F_{trimming}$
---------------------------	--------------------------------

7187 Where:

where:	
$Release\_perDay_{RP8} =$	DIDP released for release source 8 [kg/site-day]
$Q_{DIDP\_day} =$	Facility throughput of DIDP (see Section E.9.3) [kg/site-day]
$F_{trimming} =$	Fraction of DIDP released as trimming waste (see Section E.9.13)
-	[kg/kg]
	$\begin{array}{l} Release\_perDay_{RP8} = \\ Q_{DIDP\_day} = \end{array}$

## 7192 E.9.2 Model Input Parameters

- 7193 Table\_Apx E-20 summarizes the model parameters and their values for the Application of Adhesives
- and Sealants Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for
   each parameter are provided after Table\_Apx E-20.

	Symbol	Unit	Determinist ic Values	Uncertai	nty Analysis	s Distributio	on Parameters	
Input Parameter			Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Annual Facility Throughput of Adhesive/ Sealant	Qproduct_yr	kg/yr	13,500	2,300	141,498	13,500	Triangular	See Section E.9.3
Adhesive/ Sealant DIDP Concentration	F <sub>DIDP</sub>	kg/kg	0.01	0.001	0.6	0.01	Triangular	See Section E.9.7
Operating Days	OD	days/yr	250	49	366	260	Triangular	See Section E.9.8
Air Speed	RATE <sub>air_spee</sub>	ft/min	19.7	2.56	398	_	Lognormal	See Section E.9.9
Saturation Factor	f <sub>sat</sub>	dimensionless	0.5	0.5	1.45	0.5	Triangular	See Section E.9.10
Small Container Volume	V <sub>cont</sub>	gal	1	1	5	1	Triangular	See Section E.9.11
Small Container Residual Loss Fraction	Fresidue	kg/kg	0.003	0.0003	0.006	0.003	Triangular	See Section E.9.12
Fraction of DIDP Released as Trimming Waste	F <sub>trimming</sub>	kg/kg	0.04	0	0.04	0.04	Triangular	See Section E.9.13
Vapor Pressure at 25C	VP	mmHg	5.28E-07	-	-	-	-	Physical property
Molecular Weight	MW	g/mol	446.68	_	-	-	-	Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05	-	-	-	-	Universal constant
Density of DIDP	RHO	kg/L	0.9634	_	-	_	-	Physical property
Temperature	Т	К	298	_	-	_	_	Process parameter
Pressure	Р	atm	1	-	-	-	-	Process parameter
Small Container Fill Rate	RATE <sub>fill_con</sub>	containers/hr	60	-	-	-	-	See Section E.9.14

## 7196 **Table\_Apx E-20. Summary of Parameter Values and Distributions Used in the Application of Adhesives and Sealants Model**

Input Parameter	Symbol	Unit	Determinist ic Values	Uncertair	nty Analysis	n Parameters		
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	- Rationale / Basis
Diameter of Opening – Container Cleaning	D <sub>cont_clean</sub>	cm	5.08	_	_	_	_	See Section E.9.15
Diameter of Opening – Equipment Cleaning	$D_{equip\_clean}$	cm	92	-	-	_	_	See Section E.9.15
Operating Hours for Equipment Cleaning	$OH_{equip\_clean}$	hr/day	1	-	_	-	-	See Section E.9.6
Equipment Cleaning Loss Fraction	Fequipment_clea	kg/kg	0.02	-	-	-	_	See Section E.9.16

7198	E.9.3 Number of Sites									
7199	Per 2020 U.S. Census Bureau data for the NAICS codes identified in the Emission Scenario Document									
7200	on Use of Adhesives (OECD, 2015b), there are 10,144 adhesive and sealant use sites (U.S. BLS, 2016).									
7201	Therefore, this value is used as a bounding limit, not to be exceeded by the calculation. Number of sites									
7202	is calculated using the following equation.:									
7203 7204	Equation E 57									
7204	Equation E-57.									
7205	$N_s = \frac{PV}{Q_{DIDP_{vear}}}$									
7206	Where:									
7207	$N_s = $ Number of sites [sites]									
7208	PV = Production volume (see Section E.9.4) [kg/year]									
7209	$Q_{DIDP\_year}$ = Facility annual throughput of DIDP (see Section E.9.4) [kg/site-yr]									
7210	E.9.4 Throughput Parameters									
7211	The annual throughput of adhesive and sealant product is modeled using a triangular distribution with a									
7212	lower bound of 2,300 kg/yr, an upper bound of 141,498 kg/yr, and mode of 13,500 kg/yr. This is based									
7213	on the Emission Scenario Document on Use of Adhesives (OECD, 2015b). The ESD provides default									
7214	adhesive use rates based on end-use category. EPA compiled the end-use categories that were relevant to									
7215	downstream uses for adhesives and sealants. The relevant end-use categories included general assembly,									
7216	motor and non-motor vehicle, vehicle parts, and tire manufacturing (except retreading), and									
7217	computer/electronic and electrical product manufacturing. The lower and upper bound adhesive use									
7218	rates for these categories was 2,300 to 141,498 kg/yr. The mode is based on the ESD default for									
7219	unknown end-use markets.									
7220										
7221	The annual throughput of DIDP in adhesives/sealants is calculated using Equation E-58 by multiplying									
7222 7223	the annual throughput of all adhesives and sealants by the concentration of DIDP in the adhesives/sealants.									
7223	autiestves/seatants.									
7225	Equation E-58.									
7226	$Q_{DIDP\_year} = Q_{product\_yr} * F_{DIDP}$									
7227	<i><i><b>WOIDF_year</b> Cproduct_yr DIDP</i></i>									
7228	Where:									
7229	$Q_{DIDP\_year}$ = Facility annual throughput of DIDP [kg/site-yr]									
7230	$Q_{product_yr}$ = Facility annual throughput of all Adhesive/ Sealant [kg/batch]									
7231	$F_{DIDP}$ = Concentration of DIDP in Adhesive/ Sealant (see Section E.9.8)									
7232	[kg/kg]									
7233										
7234	The daily throughput of DIDP is calculated using Equation E-59 by dividing the annual production									
7235	volume by the number of operating days. The number of operating days is determined according to									
7236	Section E.9.8.									
7237										
7238	Equation E-59.									
7239	$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD}$									
7240										
7241	Where:									

7242	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
7243	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]
7244	OD	=	Operating days (see Section E.9.8) [days/yr]

7245

7246

## E.9.5 Number of Containers per Year

## The number of DIDP raw material containers received and unloaded by a site per year is calculated using the following equation:

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#### 7250 **Equation E-60.**

7251

$$N_{cont\_unload\_yr} = \frac{Q_{DIDP\_year}}{RHO * \left(3.79 \frac{L}{gal}\right) * V_{cont}}$$

~

7252 Where:

7253	$V_{cont}$	=	Import container volume (see Section E.9.11) [gal/container]
7254	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.9.3) [kg/site-yr]
7255	RHO	=	DIDP density [kg/L]
7256	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year]
7257			

7258 E.9.6 Operating Hours

EPA estimated operating hours or hours of duration using data provided from the *Emission Scenario Document on Use of Adhesives* (OECD, 2015b), *ChemSTEER User Guide* (U.S. EPA, 2015), and/or
 through calculation from other parameters. Release points with operating hours provided from these
 sources include container cleaning and equipment cleaning.

#### For container cleaning and unloading (release points 2 and 3), the operating hours are calculated based on the number of containers unloaded at the site and the unloading rate using the following equation: 7266

## 7267 **Equation E-61**.

$$OH_{RP2/RP3} = \frac{N_{cont\_unload\_yr}}{RATE_{fill\_cont} * OD}$$

7269 7270 Where:

7263

7268

7271	$OH_{RP2/RP3}$	=	Operating time for release points 2 and 3 [hrs/site-day]
7272	RATE <sub>fill_cont</sub>	=	Container fill rate (see Section E.9.14) [containers/hr]
7273	N <sub>cont_unload_yr</sub>	=	Annual number of containers unloaded (see Section E.9.5)
7274			[container/site-year]
7275	OD	=	Operating days (see Section E.9.8) [days/site-year]
7276			

For equipment cleaning (release point 5), the *ChemSTEER User Guide* (U.S. EPA, 2015) states that the default operating hours for equipment cleaning is one hour/batch multiplied by the number of batches per day. Per the *Emission Scenario Document on Use of Adhesives* (OECD, 2015b), the default number of batches per day is one Therefore, EPA assumes that equipment cleaning occurre for one hour/day.

## of batches per day is one. Therefore, EPA assumes that equipment cleaning occurs for one hour/day.

## 7281 E.9.7 Adhesive/ Sealant DIDP Concentration

EPA modeled DIDP concentration in adhesives and sealants using a triangular distribution with a lower
bound of 0.1%, upper bound of 60%, and mode of 1%. The upper bound is based on the upper bound for

imported DIDP concentration. The concentration of DIDP in the adhesive or sealant cannot be higher
than the concentration of DIDP in the final formulation. The lower bound and mode is based on
compiled SDS information for adhesives and sealant products containing DIDP. EPA did not have
information on the prevalence or market share of different Adhesive/ Sealant products in commerce;
therefore, EPA assumed a triangular distribution of concentrations. From the compiled data, the
minimum concentration was 0.1% and the mode of high-end product concentrations was 1% (see

7290 Appendix F for EPA identified DIDP-containing products for this OES).

## E.9.8 Operating Days

7292 EPA modeled the operating days per year using a triangular distribution with a lower bound of 50 7293 days/yr, an upper bound of 365 days/yr, and a mode of 260 days/yr. To ensure that only integer values of 7294 this parameter were selected, EPA nested the triangular distribution probability formula within a discrete 7295 distribution that listed each integer between (and including) 50-365 days/yr. This is based on the 7296 *Emission Scenario Document on Use of Adhesives* (OECD, 2015b). The ESD provides operating days 7297 for several end-use categories, as listed in Section E.9.3. The range of operating days for the end-use 7298 categories is 50-365 days/yr. The mode of the distribution is based on the ESD's default of 260 days/yr 7299 for unknown or general use cases.

7300 **E.9.9** Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
surveys into settings representative of industrial facilities and representative of commercial facilities.
EPA fit separate distributions for these industrial and commercial settings and used the industrial
distribution for this OES.

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7291

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air
speed measurements within a surveyed location were lognormally distributed and the population of the
mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since
lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the
largest observed value among all of the survey mean air speeds.

7313

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

7320

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
individual measurements within each survey. Therefore, these distributions represent a distribution of
mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
However, a mean air speed (averaged over a work area) is the required input for the model. EPA
converted the units to ft/min prior to use within the model equations.

## 7326E.9.10 Saturation Factor

The CEB Manual indicates that during splash filling, the saturation concentration was reached or

exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA,

1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular
distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was
not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling
minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in
the *ChemSTEER User Guide* for the *EPA/OAQPS AP-42 Loading Model* (U.S. EPA, 2015).

## 7335 E.9.11 Container Size

EPA assumed that use sites would receive adhesives and sealants in bottles. According to the *ChemSTEER User Guide*, bottles are defined as containing between one and five gallons of liquid, and
the default bottle size is one gallon (U.S. EPA, 2015). Therefore, EPA modeled container size using a
triangular distribution with a lower bound and mode of one gallon, an upper bound of five gallons.

## 7340 E.9.12 Small Container Residue Loss Fraction

7341 EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data 7342 for emptying drums by pouring was aligned with the default central tendency and high-end values from 7343 the EPA/OPPT Small Container Residual Model. For unloading drums by pouring in the PEI Associates 7344 Inc. study (Associates, 1988), EPA found that the average percent residual from the pilot-scale 7345 experiments showed a range of 0.03 percent to 0.79 percent and an average of 0.32 percent. The 7346 EPA/OPPT Small Container Residual Model from the ChemSTEER User Guide (U.S. EPA, 2015) 7347 recommends a default central tendency loss fraction of 0.3 percent and a high-end loss fraction of 0.6 7348 percent. 7349

7350 The underlying distribution of the loss fraction parameter for small containers is not known; therefore, 7351 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 7352 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 7353 the loss fraction probability distribution using the central tendency and high-end values, respectively, 7354 prescribed by the EPA/OPPT Small Container Residual Model in the ChemSTEER User Guide (U.S. 7355 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum 7356 average percent residual measured in the PEI Associates, Inc. study (Associates, 1988) for emptying 7357 drums by pouring.

## 7358 E.9.13 Fraction of DIDP Released as Trimming Waste

EPA modeled the fraction of DIDP released as trimming waste using a uniform distribution with a lower
bound of 0 and upper bound of 0.04. This is based on the *Emission Scenario Document on Use of Adhesives* (OECD, 2015b). The ESD states that trimming losses should only be assessed if trimming
losses are expected for the end-use being assessed. Since not all adhesive and sealant end uses will result
in trimming losses, EPA assigned a lower bound of 0. The upper bound is based on the ESD's default
waste fraction of 0.04 kg chemical in trimmings/kg chemical applied.

## E.9.14 Container Unloading Rates

- The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.
- 7369 E.9.15 Diameters of Opening

- 7370 The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold
- 1371 liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For
- equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm
   (U.S. EPA, 2015).

7374

- For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm for containers less than 5,000 gallons (U.S. EPA, 2015).
- 7377 E.9.16 Equipment Cleaning Loss Fraction

EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment
cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide*(U.S. EPA, 2015) provides an overall loss fraction of two percent from equipment cleaning.

## E.10 Application of Paints and Coatings Model Approaches and Parameters

7383 This appendix presents the modeling approach and equations used to estimate environmental releases for 7384 DIDP during the application of paints and coatings OES. This approach utilizes the *Emission Scenario* 7385 Document on Coating Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 7386 2011a), Emission Scenario Document on the Coating Industry (Paints, Lacquers, and Varnishes) 7387 (OECD, 2009c), and Emission Scenario Document on the Application of Radiation Curable Coatings, 7388 Inks, and Adhesives via Spray, Vacuum, Roll, and Curtain Coating (OECD, 2011b) combined with 7389 Monte Carlo simulation (a type of stochastic simulation). 7390 7391 Based on the ESD, EPA identified the following release sources from the application of paints and

7392 coatings:

- Release source 1: Transfer Operation Losses to Air from Unloading Paint.
- Release source 2: Open Surface Losses to Air During Raw Material Sampling.
- Release source 3: Container Cleaning Wastes.
- Release source 4: Open Surface Losses to Air During Container Cleaning.
- Release source 5: Process Releases During Operations.
- Release source 6: Equipment Cleaning Wastes.
- Release source 7: Open Surface Losses to Air During Equipment Cleaning.
- Release source 8: Raw Material Sampling Wastes.
- Finishing the sequence of the sequenc
  - E.10.1 Model Equations
- 7410 Table\_Apx E-21 provides the models and associated variables used to calculate environmental releases
- 7411 for each release source within each iteration of the Monte Carlo simulation. EPA used these
- environmental releases to develop a distribution of release outputs for the application of paints and
- 7413 coatings OES. The variables used to calculate each of the following values include deterministic or
- variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Appendix E.10.2. The Monte Carlo
- parameters. The values for these variables are provided in Appendix E.10.2. The Monte Carlo
   simulation calculated the total DIDP release (by environmental media) across all release sources during
- reach iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate
- 7418 the central tendency and high-end releases, respectively.

7419

# Table\_Apx E-21. Models and Variables Applied for Release Sources in the Application of Paints and Coatings OES

<b>Release source</b>	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Paint.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: <i>F<sub>DIDP</sub></i> ; <i>VP</i> ; <i>f<sub>sat</sub></i> ; <i>MW</i> ; <i>R</i> ; <i>T</i> ; <i>V<sub>cont</sub></i> ; <i>RATE<sub>fill_cont</sub></i>
		Operating Time: $Q_{DIDP\_year}$ ; $RATE_{fill\_cont}$ ; $V_{cont}$ ; $RHO$ ; $F_{DIDP}$ ; $OD$
Release source 2: Open Surface Losses to Air During Raw Material Sampling.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model,	Vapor Generation Rate: <i>F</i> <sub>DIDP</sub> ; <i>MW</i> ; <i>VP</i> ; <i>RATE</i> <sub>air_speed</sub> ; <i>D</i> <sub>sampling</sub> ; <i>T</i> ; <i>P</i>
	based on air speed (Appendix E.1)	Operating Time: <i>OH</i> <sub>sampling</sub>
Release source 3: Container Cleaning Wastes.	EPA/OAQPS AP-42 Small Container Residual Model (Appendix E.1)	$Q_{DIDP\_day}; F_{residue}$
Release source 4: Open Surface Losses to Air During Container Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model, based on air speed (Appendix	Vapor Generation Rate: <i>F<sub>DIDP</sub></i> ; <i>MW</i> ; <i>VP</i> ; <i>RATE<sub>air_speed</sub></i> ; <i>D<sub>cont_clean</sub></i> ; <i>T</i> ; <i>P</i> Operating Time:
	E.1)	$Q_{DIDP\_year}$ ; $RATE_{fill\_cont}$ ; $V_{cont}$ ; $RHO$ ; $F_{DIDP}$ ; $OD$
Release source 5: Process Releases During Operations.	See Equation E-62 through Equation E-66	$Q_{DIDP\_day}; F_{transfer\_eff}; F_{capture\_eff};$ $F_{solidrem\_eff}; OD$
Release source 6: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP_{day}}; LF_{equip_{clean}}$
Release source 7: Open Surface Losses to Air During Equipment Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model,	Vapor Generation Rate: <i>F</i> <sub>DIDP</sub> ; <i>MW</i> ; <i>VP</i> ; <i>RATE</i> <sub>air_speed</sub> ; <i>D</i> <sub>equip_clean</sub> ; <i>T</i> ; <i>P</i>
	based on air speed (Appendix E.1)	Operating Time: <i>OH<sub>equip_clean</sub></i>
Release source 8: Raw Material Sampling Wastes.	March 2023 Methodology for Estimating Environmental Releases from Sampling Waste (Appendix E.1)	$Q_{DIDP\_day}; LF_{sampling}$

7422

7425

7427

Release source 5 (Process Releases During Operations) is partitioned out by release media. In order to calculate the releases to each media, the total release is calculated first using the following equation:

=

7426 Equation E-62.

$$Release\_perDay_{RP5\_total} = Q_{DIDP\_day} * (1 - F_{transfer\_eff})$$

7428 Where:

7429 Rele

*Release\_perDay*<sub>RP5\_total</sub>

DIDP released for release source 5 to all release media

				Way 2024
7430				[kg/site-day]
7431	$Q_{DIDP\_day}$		=	Facility throughput of DIDP (see Section E.10.3) [kg/site-
7432	obibi _uuy			day]
7433	$F_{transfer\_eff}$		=	Paint/coating transfer efficiency fraction (see Section
7434	- transjer_ej j			E.10.15) [unitless]
7435				L.10.157 [unitess]
7436	Transfer efficiency is detern	nined ac	cording	to Section E.10.15. The percent of release 5 that is released
7437	to water is calculated using			
7438	to water is calculated using	ine tono		Juuron.
7439	Equation E-63.			
7440	Equation E 05.	0/6	— F	$apture_{eff} * (1 - F_{solidrem_{eff}})$
7441	Whore	<sup>70</sup> wate	$er - r_{co}$	apture_eff * (1 I solidrem_eff)
	Where:	_	Damaan	at of volcases 5 that is volcased to water [writless]
7442	‰ <sub>water</sub>	=		nt of release 5 that is released to water [unitless]
7443	$F_{capture\_eff}$	=		capture efficiency for spray-applied Paints/ Coatings (see
7444				on E.10.18) [kg/kg]
7445	$F_{solidrem\_eff}$	=		on of solid removed in the spray mist of sprayed
7446			Paints	/ Coatings (see Section E.10.19) [kg/kg]
7447				
7448	· ·			ording to Section E.10.18 and solid removal efficiency is
7449	0		l0.19. T	he percent of release 5 that is released to air is calculated
7450	using the following equation	1:		
7451				
7452	Equation E-64.			
7453			% <sub>air</sub>	$L = \left(1 - F_{capture\_eff}\right)$
7454	Where:			
7455	$\%_{air}$	=	Percer	nt of release 5 that is released to air [unitless]
7456	$F_{capture\_eff}$	=	Booth	capture efficiency for spray-applied Paints/ Coatings (see
7457			Sectio	n E.10.18) [kg/kg]
7458				
7459	The percent of release 5 that	t is relea	sed to l	and is calculated using the following equation:
7460				
7461	Equation E-65.			
7462		%	$n_{land} =$	$F_{capture\_eff} * F_{solidrem\_eff}$
7463	Where:		-	// _ //
7464	% <sub>land</sub>	=	Percei	nt of release 5 that is released to land [unitless]
7465	$F_{capture\_eff}$	=		capture efficiency for spray-applied Paints/ Coatings (see
7466	cupture_cy y			on E.10.18) [kg/kg]
7467	F <sub>solidrem_eff</sub>	=		on of solid removed in the spray mist of sprayed
7468	- sollarem_ej j			/ Coatings (see Section E.10.19) [kg/kg]
7469			1 anns	· County (see section 1.10.17) [Kg/Kg]
7470	Finally, the release amounts	to each	media	are calculated using the following equation:
7471	i many, the release amounts	to caell	mouta a	are careatated using the following equation.
7472	Equation E-66.			
7472	-	norDa	V	Rologso nor Davis
7473	Teleuse_		YRP5_me	$_{dia} = Release\_perDay_{RP5\_total} * \%_{media}$
7474 7475	Where:			
7475 7476			_	Amount of release 5 that is released to water, air, or land
/+/0	Release_perDay <sub>RP</sub>	5_media	=	Amount of release 5 that is released to water, all, of falle

7477 7478	Release_perDay <sub>RP5_total</sub>	=	[kg/site-day] DIDP released for release source 5 to all release media
7479			[kg/site-day]
7480	% <sub>media</sub>	=	Percent of release 5 that is released to water, air, or land
7481			[unitless]

### 7482 E.10.2 Model Input Parameters

- 7483 Table\_Apx E-22 summarizes the model parameters and their values for the Application of Paints and
- Coatings Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for
   each parameter are provided after Table\_Apx E-22.

Input			Deterministic Values	Uncert	ainty Analys	is Distributio	on Parameters	
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	- Rationale / Basis
Annual Facility Throughput of Paint/Coating	Q <sub>coat_yr</sub>	kg/site-yr	225,000	2,694	446,600	225,000	Triangular	See Section E.10.3
Paint/Coating DIDP Concentration	F <sub>DIDP</sub>	kg/kg	0.01	0.001	0.05	0.01	Triangular	See Section E.10.7
Operating Days	OD	days/yr	250	225	300	250	Triangular	See Section E.10.8
Air Speed	RATE <sub>air_spee</sub>	ft/min	19.7	2.56	398	_	Lognormal	See Section E.10.9
Saturation Factor	f <sub>sat</sub>	dimensionless	0.5	0.5	1.45	0.5	Triangular	See Section E.10.10
Container Size	V <sub>cont</sub>	gal	5	5	20	5	Triangular	See Section E.10.11
Small Container Loss Fraction	Fresidue	kg/kg	0.003	0.003	0.006	0.003	Triangular	See Section E.10.12
Fraction of DIDP Lost During Sampling – 1 (Q <sub>DIDP_day</sub> < 50 kg/site-day)	$F_{sampling_1}$	kg/kg	0.02	0.002	0.02	0.02	Triangular	See Section E.10.13
Fraction of DIDP Lost During Sampling – 2 (Q <sub>DIDP_day</sub> 50-200 kg/site-day)	F <sub>sampling_2</sub>	kg/kg	0.005	0.0006	0.005	0.005	Triangular	See Section E.10.13
Fraction of DIDP Lost During Sampling – 3 (Q <sub>DIDP_day</sub> 200- 5000 kg/site-day)	F <sub>sampling_3</sub>	kg/kg	0.004	0.0005	0.004	0.004	Triangular	See Section E.10.13

### 7486 Table\_Apx E-22. Summary of Parameter Values and Distributions Used in the Application of Paints and Coatings Model

Input			Deterministic Values	Uncert	ainty Analys	is Distributio	on Parameters	
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
$\begin{tabular}{lllllllllllllllllllllllllllllllllll$	F <sub>sampling_4</sub>	kg/kg	0.0004	0.00008	0.0004	0.0004	Triangular	See Section E.10.13
Diameter of Opening – Sampling	D <sub>sampling</sub>	cm	2.5	2.5	10	_	Uniform	See Section E.10.14
Transfer Efficiency Fraction	F <sub>transfer_eff</sub>	unitless	0.65	0.2	0.8	0.65	Triangular	See Section E.10.15
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	-	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	_	-	Physical property
Gas Constant	R	atm-cm3/gmol- L	82.05	—	_	-	_	Universal constant
Density of DIDP	RHO	kg/L	0.9634				_	Physical property
Temperature	Т	K	298	_	_	_	_	Process parameter
Pressure	Р	atm	1	_	_	_	_	Process parameter
Small Container Fill Rate	RATE <sub>fill_con</sub>	containers/hr	60	_	-	_	_	See Section E.10.16
Diameter of Opening – Container Cleaning	$D_{cont\_clean}$	cm	5.08	_	_	_	_	See Section E.10.14
Diameter of Opening – Equipment Cleaning	D <sub>equip_clean</sub>	cm	92	_	-	-	-	See Section E.10.14

Input		<b>.</b>	Deterministic Values	Uncerta	ainty Analysi	s Distribution	<b>Parameters</b>	
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Sampling Duration	OH <sub>sampling</sub>	hr/day	1	_	_	_	_	See Section E.10.6
Equipment Cleaning Duration	OH <sub>equip_clean</sub>	hr/day	4	_	_	_	_	See Section E.10.6
Equipment Cleaning Loss Fraction	$LF_{equip\_clean}$	kg/kg	0.02	_	_	_	_	See Section E.10.17
Capture Efficiency for Spray Booth	$F_{capture_eff}$	kg/kg	0.9	_	_	_	_	See Section E.10.18
Fraction of Solid Removed in Spray Mist	F <sub>solidrem_eff</sub>	kg/kg	1	_	_	_	_	See Section E.10.19

#### 7488 E.10.3 Number of Sites

7489	Per 2020 U.S. Census Bureau data for the NAICS codes identified in the Emission Scenario Document
7490	on Coating Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a),
7491	Emission Scenario Document on the Coating Industry (Paints, Lacquers, and Varnishes) (OECD,
7492	2009c), and Emission Scenario Document on the Application of Radiation Curable Coatings, Inks, and
7493	Adhesives via Spray, Vacuum, Roll, and Curtain Coating (OECD, 2011b), there are 83,456 paints and
7494	coatings use sites (U.S. BLS, 2016). Therefore, this value is used as a bounding limit, not to be exceeded
7495	by the calculation. Number of sites is calculated using the following equation.:
7496	

#### 7497 **Equation E-67.**

7498

7503

$$N_s = \frac{PV}{Q_{DIDP_{year}}}$$

7499 Where:

- 7500 $N_s$ =Number of sites [sites]7501PV=Production volume (see Section E.9.4) [kg/year]7502 $Q_{DIDP_year}$ =Facility annual throughput of DIDP (see Section E.9.4) [kg/site-yr]
  - E.10.4 Throughput Parameters

7504 The annual throughput of paint and coating product is modeled using a triangular distribution with a lower bound of 2,694 kg/yr, an upper bound of 446,600 kg/yr, and mode of 225,000 kg/yr. The lower 7505 bound is based on the Emission Scenario Document on the Application of Radiation Curable Coatings, 7506 7507 Inks, and Adhesives via Spray, Vacuum, Roll, and Curtain Coating (OECD, 2011b). The ESD provides a 7508 range of 2,694-265,000 kg of radiation curable coatings produced per site, per year. The lower bound 7509 was taken from this range. The upper bound is based on the Generic Scenario for Spray Coatings in the 7510 Furniture Industry (U.S. EPA, 2004d). The GS provides a range of 5,000 to 446,000 liters of furniture 7511 coatings used per year based on plant size, with an assumption of 1 kg/L as the density of the coating. 7512 The upper bound was taken from this range and using the assumed coating density. The mode is based on CEPE's SpERC Industrial application of coatings by spraying (CEPE, 2020). The factsheet provides 7513 a production rate of 1,000 kg/day for 225 days/yr, for a total of 225,000 kg/yr. 7514

The annual throughput of DIDP in the Paints and Coatings OES is calculated using Equation E-68 by
multiplying the annual throughput of all paints and coatings by the concentration of DIDP found in the
paints and coatings.

7518 7519 7520 7521	Equation E-68.		$Q_{DIDP\_year} = Q_{coat\_yr} * F_{DIDP}$
7522	Where:		
7523	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]
7524	$Q_{coat\_yr}$	=	Facility annual throughput of all Paints/ Coatings [kg/site-yr]
7525	$F_{DIDP}$	=	Concentration of DIDP in Paints/ Coatings (see Section E.10.7)
7526			[kg/kg]
7527			
7528	The daily throughput of	DIDP is ca	Ilculated using Equation E-69 by dividing the annual production
7529	volume by the number o	f operating	days. The number of operating days is determined according to
7530	Section E.10.8.		
7531			

7532 **Equation E-69.** 

$$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD}$$

7534 7535 Where:

1555	vincio.		
7536	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
7537	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]
7538	OD	=	Operating days (see Section E.10.8) [days/yr]

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E.10.5 Number of Containers per Year

7541 The number of DIDP raw material containers received and unloaded by a site per year is calculated 7542 using the following equation:

7544 **Equation E-70.** 

7545

7543

N —	$Q_{DIDP\_year}$
$N_{cont\_unload\_yr} =$	$\overline{RHO * \left(3.79 \ \frac{L}{gal}\right) * V_{cont}}$

7546	Where:		
7547	$V_{cont}$	=	Container volume (see Section E.10.11) [gal/container]
7548	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.10.3) [kg/site-
7549			yr]
7550	RHO	=	DIDP density [kg/L]
7551	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year]

#### 7552 **E.10.6 Operating Hours**

EPA estimated operating hours or hours of duration using data provided from the ChemSTEER User 7553 7554 Guide (U.S. EPA, 2015) and/or through calculation from other parameters. Release points with operating hours provided from these sources include unloading, product sampling, and equipment 7555 7556 cleaning. 7557

7558 For unloading (release point 1), the operating hours are calculated based on the number of containers 7559 unloaded at the site and the unloading rate using the following equation:

#### **Equation E-71.** 7561

$$OH_{RP1/RP4} = \frac{N_{cont\_unload\_yr}}{RATE_{fill\_cont} * OD}$$

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7563			
7564	Where:		
7565	$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 [hrs/site-day]
7566	RATE <sub>fill_cont</sub>	=	Container fill rate (see Section E.10.16) [containers/hr]
7567	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded (see Section E.10.5)
7568			[container/site-year]
7569	OD	=	Operating days (see Section E.10.8) [days/site-year]
7570			

7571 For product sampling (release point 2), the ChemSTEER User Guide (U.S. EPA, 2015) indicates a single 7572 value of one hour/day.

For equipment cleaning (release point 7), the *ChemSTEER User Guide* provides an estimate of four

hours per day for cleaning multiple vessels (U.S. EPA, 2015).

## E.10.7 Paint/Coating DIDP Concentration

EPA modeled final DIDP concentration in paints and coatings using a triangular distribution with a
lower bound of 0.01%, upper bound of 5%, and mode of 1%. This is based on compiled SDS
information for paint and coating products containing DIDP. The lower and upper bounds represent the
minimum and maximum reported concentrations in the SDSs. The mode represents the mode of all
range endpoints reported in the SDSs (see Appendix F for EPA identified DIDP-containing products for
this OES).

7583 E.10.8 Operating Days

7584 EPA modeled the operating days per year using a triangular distribution with a lower bound of 225 7585 days/yr, an upper bound of 300 days/yr, and a mode of 250 days/yr. To ensure that only integer values of 7586 this parameter were selected, EPA nested the triangular distribution probability formula within a discrete 7587 distribution that listed each integer between (and including) 225-300 days/yr. The lower bound is based 7588 on ESIG's Specific Environmental Release Category Factsheet for Industrial Application of Coatings by 7589 Spraving (CEPE, 2020). The factsheet estimates 225 days/yr as the number of emission days. The upper 7590 bound is based on the European Risk Report for DIDP (ECJRC, 2003a) which provided a default of 300 7591 days/yr. The mode is based on the Generic Scenario for Automobile Spray Coating (U.S. EPA, 1996)

which estimates 250 days/yr, based on five days/week operation that takes place 50 weeks/yr.

## E.10.9 Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
surveys into settings representative of industrial facilities and representative of commercial facilities.
EPA fit separate distributions for these industrial and commercial settings and used the industrial
distribution for this OES.

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EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

7613

7614 Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the

individual measurements within each survey. Therefore, these distributions represent a distribution of

7616 mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.

- 7617 However, a mean air speed (averaged over a work area) is the required input for the model. EPA
- converted the units to ft/min prior to use within the model equations.

## 7619 E.10.10 Saturation Factor

7620 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 7621 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 7622 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 7623 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 7624 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 7625 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 7626 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in 7627 the ChemSTEER User Guide for the EPA/OAOPS AP-42 Loading Model (U.S. EPA, 2015).

## 7628 E.10.11 Container Size

EPA assumed that paint and coating use sites would receive DIDP in small containers. According to the *ChemSTEER User Guide*, small containers are defined as containing between 5 and 20 gallons of liquid,
and the default drum size is 5 gallons (U.S. EPA, 2015). Therefore, EPA modeled import container size
using a triangular distribution with a lower bound of 5 gallons, an upper bound of 20 gallons, and a
mode of 5 gallons.

## 7634 E.10.12 Small Container Loss Fraction

EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such that the residuals data 7635 7636 for emptying drums by pouring was aligned with the default central tendency and high-end values from 7637 the EPA/OPPT Small Container Residual Model. For unloading drums by pouring in the PEI Associates 7638 Inc. study (Associates, 1988), EPA found that the average percent residual from the pilot-scale experiments showed a range of 0.03 percent to 0.79 percent and an average of 0.32 percent. The 7639 7640 EPA/OPPT Small Container Residual Model from the ChemSTEER User Guide (U.S. EPA, 2015) 7641 recommends a default central tendency loss fraction of 0.3 percent and a high-end loss fraction of 0.6 7642 percent.

7643

7644 The underlying distribution of the loss fraction parameter for small containers is not known; therefore, 7645 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 7646 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 7647 the loss fraction probability distribution using the central tendency and high-end values, respectively, 7648 prescribed by the EPA/OPPT Small Container Residual Model in the ChemSTEER User Guide (U.S. 7649 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum 7650 average percent residual measured in the PEI Associates, Inc. study (Associates, 1988) for emptying 7651 drums by pouring.

## 7652 E.10.13 Sampling Loss Fraction

Sampling loss fractions were estimated using the March 2023 Methodology for Estimating 7653 7654 Environmental Releases from Sampling Wastes (U.S. EPA, 2023b). In this methodology, EPA 7655 completed a search of over 300 IRERs completed in the years 2021 and 2022 for sampling release data, 7656 including a similar proportion of both PMNs and Low Volume Exemptions (LVEs). Of the searched 7657 IRERs, 60 data points for sampling release loss fractions, primarily for sampling releases from 7658 submitter-controlled sites (~75% of IRERs), were obtained. The data points were analyzed as a function of the chemical daily throughput and industry type. This analysis showed that the sampling loss fraction 7659 generally decreased as the chemical daily throughput increased. Therefore, the methodology provides 7660 7661 guidance for selecting a loss fraction based on chemical daily throughput. Table Apx E-23 presents a 7662 summary of the chemical daily throughputs and corresponding loss fractions. 7663

Chemical Daily	NumberSampled Quantity (kg chemical/day)			Sampling Loss Fraction (LF <sub>sampling</sub> )		
Throughput (kg/site- day) (Q <sub>chem_site_day</sub> )	of Data Points	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	95 <sup>th</sup> Percentile	
<50	13	0.03	0.20	0.002	0.02	
50 to <200	10	0.10	0.64	0.0006	0.005	
200 to <5,000	25	0.37	3.80	0.0005	0.004	
≥5,000	10	1.36	6.00	0.00008	0.0004	
All	58	0.20	5.15	0.0005	0.008	

# Table\_Apx E-23. Sampling Loss Fraction Data from the March 2023 Methodology for Estimating Environmental Releases from Sampling Waste

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For each range of daily throughputs, EPA estimated sampling loss fractions using a triangular
distribution of the 50<sup>th</sup> percentile value as the lower bound, and the 95<sup>th</sup> percentile value as the upper
bound and mode. The sampling loss fraction distribution was chosen based on the calculation of daily
throughput, as shown in Section E.10.3.

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## E.10.14 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold
liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For
equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm
(U.S. EPA, 2015). For container cleaning activities, the *ChemSTEER User Guide* indicates a single
default value of 5.08 cm for containers less than 5,000 gallons (U.S. EPA, 2015).

7678 For sampling liquid product, sampling liquid raw material, or general liquid sampling, the *ChemSTEER* 7679 User Guide indicates that the typical diameter of opening for vaporization of the liquid is 2.5 cm (U.S. 7680 EPA, 2015). Additionally, the ChemSTEER User Guide provides ten cm as a high-end value for the 7681 diameter of opening during sampling (U.S. EPA, 2015). The underlying distribution of this parameter is 7682 not known; therefore, EPA assigned a triangular distribution based on the estimated lower bound, upper 7683 bound, and mode of the parameter. EPA assigned the value of 2.5 cm as a lower bound for the parameter 7684 and ten cm as the upper bound based on the values provided in the ChemSTEER User Guide (U.S. EPA, 7685 2015). EPA also assigned 2.5 cm as the mode diameter value for sampling liquids based on the typical 7686 value described in ChemSTEER User Guide (U.S. EPA, 2015).

## 7687E.10.15Transfer Efficiency Fraction

EPA modeled transfer efficiency fraction using a triangular distribution with a lower bound of 0.2, an
upper bound of 0.8, and a mode of 0.65. The lower bound and mode are based on the *EPA/OPPT Automobile OEM Overspray Loss Model*. Per the model, the transfer efficiency varies based on the type
of spray gun used. For high volume, low pressure (HVLP) spray guns, the default transfer efficiency is
0.65. For conventional spray guns, the default transfer efficiency is 0.2 by mass. Across all spray
technologies, the *ESD on Coating Industry* (OECD, 2009c) estimates a transfer efficiency of 30-80
percent. Therefore, EPA used 0.8 as the upper bound.

 7695 E.10.16 Small Container Unloading Rate
 7696 The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical unloading rate of 60 containers per hour for containers with less than 20 gallons of liquid.

7698 E.10.17 Equipment Cleaning Loss Fraction
 7699 EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment
 7700 cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide* 7701 (U.S. EPA, 2015), provides an overall loss fraction of two percent from equipment cleaning.

## 7702 E.10.18 Capture Efficiency for Spray Booth

- The Emission Scenario Document on the Application of Radiation Curable Coatings, Inks, and
- Adhesives via Spray, Vacuum, Roll, and Curtain Coating (OECD, 2011b) uses the EPA/OPPT
- Automobile Refinish Coating Overspray Loss Model to estimate releases from spray coating. This model
   assumes a spray booth capture efficiency of 90%.

## 7707 E.10.19 Fraction of Solid Removed in Spray Mist

The Emission Scenario Document on the Application of Radiation Curable Coatings, Inks, and
Adhesives via Spray, Vacuum, Roll, and Curtain Coating (OECD, 2011b) uses the EPA/OPPT
Automobile Refinish Coating Overspray Loss Model to estimate releases from spray coating. This model
assumes a solid removal efficiency of 100%.

## 7712 E.11 Use of Laboratory Chemicals Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for
DIDP during the use of laboratory chemicals OES. This approach utilizes the *Generic Scenario on Use of Laboratory Chemicals* (U.S. EPA, 2023c) and CDR data (U.S. EPA, 2020a) combined with Monte
Carlo simulation (a type of stochastic simulation).

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7718 Based on the GS, EPA identified the following release sources from use of laboratory chemicals:

- Release source 1: Transfer Operation Losses to Air from Unloading Laboratory Chemicals.
- Release source 2: Dust Emissions from Transferring Powders.
- Release source 3: Container Cleaning Wastes.
- Release source 4: Open Surface Losses to Air During Container Cleaning.
- Release source 5: Equipment Cleaning Wastes.
- Release source 6: Open Surface Losses to Air During Equipment Cleaning.
- Release source 7: Releases During Laboratory Analysis.
  - Release source 8: Laboratory Waste Disposal.
- 7726 7727

Environmental releases for DIDP during the use of laboratory chemicals are a function of DIDP's
physical properties, container size, mass fractions, and other model parameters. While physical
properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation
to capture variability in the following model input parameters: facility throughput, operating days, DIDP
concentrations, air speed, saturation factor, container size, loss fractions, and diameters of openings.
EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube
sampling method in @Risk to calculate release amounts for this OES.

## 7735 E.11.1 Model Equations

Table\_Apx E-24 provides the models and associated variables used to calculate environmental releases
for each release source within each iteration of the Monte Carlo simulation. EPA used these
environmental releases to develop a distribution of release outputs for the use of laboratory chemicals
OES. The variables used to calculate each of the following values include deterministic or variable input
parameters, known constants, physical properties, conversion factors, and other parameters. The values
for these variables are provided in Appendix E.11.2. The Monte Carlo simulation calculated the total

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DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected  $50^{\text{th}}$  percentile and  $95^{\text{th}}$  percentile values to estimate the central tendency 7743 and high-end releases, respectively. 7744

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#### 7746 Table\_Apx E-24. Models and Variables Applied for Release Sources in the Use of Laboratory 7747 **Chemicals OES**

Release source	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Laboratory Chemicals.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP-L}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{cont}$ ; $RATE_{fill}$ Operating Time: $Q_{DIDP\_day}$ ; $V_{cont}$ ; $RATE_{fill}$ ; $RHO$ ; $OD$ ; $F_{DIDP-L}$
Release source 2: Dust Emissions from Transferring Powders.	EPA/OPPT Generic Model to Estimate Dust Releases from Transfer/Unloading/Loading Operations of Solid Powders (Appendix E.1)	<i>Q<sub>DIDP_day</sub>; F<sub>dust_generation</sub></i>
Release source 3: Container Cleaning Wastes.	EPA/OAQPS AP-42 Small Container Residual Model or EPA/OPPT Solid Residuals in Transport Containers Model, based on physical form (Appendix E.1)	$Q_{DIDP\_day}; F_{residue}; V_{cont}; RHO;$ $F_{DIDP\_S}; F_{DIDP\_L}; LF_{cont}; OD;$ $Q_{cont\_solid}$
Release source 4: Open Surface Losses to Air During Container Cleaning.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP-L}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cleaning}$ ; $T$ ; $P$ Operating Time: $Q_{DIDP\_day}$ ; $V_{cont}$ ; $RATE_{fill}$ ; $RHO$ ; $OD$ ; $F_{DIDP-L}$
Release source 5: Equipment Cleaning Wastes.	<i>EPA/OPPT Multiple Process</i> <i>Vessel Residual Model</i> or <i>EPA/OPPT Solids Residuals in</i> <i>Transport Container Model</i> , based on physical form (Appendix E.1)	Q <sub>DIDP_day</sub> ; F <sub>lab_residue_L</sub> ; F <sub>lab_residue_S</sub>
Release source 6: Open Surface Losses to Air During Equipment Cleaning.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP-L}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cleaning}$ ; $T$ ; $P$ Operating Time: $OH_{cleaning}$
Release source 7: Releases During Laboratory Analysis.	<i>EPA/OPPT Penetration Model</i> or <i>EPA/OPPT Mass Transfer</i> <i>Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP-L}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{testing}$ ; $T$ ; $P$ Operating Time: $OH_{testing}$
Release source 8: Laboratory Waste Disposal.	See Equation E-72 and Equation E-73	$Q_{DIDP\_day}; F_{residue}; LF_{cont}; F_{lab\_residue\_L}; F_{lab\_residue\_S};$

<b>Release source</b>		Model(s) Applied	Variables Used
			<i>F<sub>dust_generation</sub></i> ; Release Points 1,3,6,and 7
-	ource 8 (L	aboratory Waste Disposal)	) is calculated via a mass-balance, via
following equation:			
Equation E-72.			
Release_perDay <sub>RP8-L</sub>			
$= (Q_{DIDP\_da})$	<sub>ay</sub> – Releas	e <sub>perDay<sub>RP1</sub></sub> – Release <sub>perDay<sub>RP</sub></sub>	$P_{23} - Release_{perDay_{RP6}} - Release_perDay_R$
$*(1 - F_{resid})$			
Where:			
Release_perDay <sub>RI</sub>	$P8-L^{\pm}$	Liquid DIDP released for	release source 8 [kg/site-day]
$Q_{DIDP\_day}$	=	Facility throughput of DI	DP (see Section E.11.3) [kg/site-day]
Release_perDay <sub>RI</sub>	<sub>P1</sub> =	Liquid DIDP released for	release source 1 [kg/site-day]
Release_perDay <sub>RI</sub>	<sub>P3</sub> =	Liquid DIDP released for	release source 3 [kg/site-day]
Release_perDay <sub>RI</sub>	<sub>P6</sub> =	Liquid DIDP released for	release source 6 [kg/site-day]
Release_perDay <sub>RI</sub>	<sub>P7</sub> =	1	release source 7 [kg/site-day]
$F_{residue}$	=		ing in transport containers (see Sectio
		E.11.11) [kg/kg]	
$F_{lab\_residue\_L}$	=		ing in lab equipment (see Section
		E.11.15) [kg/kg]	
For solids containing DIDF	P, release	source 8 (Laboratory Wast	te Disposal) is calculated via a mass-
balance, via the following e		· · ·	
Equation E-73.			
	rDay <sub>RP8-S</sub>	$= Q_{DIDP\_day} * (1 - F_{dust\_gener})$	$_{ation} - LF_{cont} - F_{lab\_residue\_S}$ )
Where: <i>Release_perDay<sub>RI</sub></i>	_	Solid DIDP released for a	elease source 8 [kg/site-day]
• • •	P8-S- =		DP (see Section E.11.3) [kg/site-day]
Q <sub>DIDP_day</sub> F	=		ring unloading of solid powder (see
$F_{dust\_generation}$	_	Section E.11.12) [kg/kg]	ing unbading of solid powder (see
<i>LF<sub>cont</sub></i>	=		ing in transport containers (see Section
L' cont	_	E.11.11) $[kg/kg]$	ing in transport containers (see Section
F <sub>lab</sub> residue s	=		ing in lab equipment (see Section
- iup_i esiuue_s		E.11.15) [kg/kg]	(500 Socrash
E.11.2 Model Inpu	ıt Paramı	eters	
			alues for the Use of Laboratory

Table\_Apx E-25 summarizes the model parameters and their values for the Use of Laboratory
Chemicals Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for
each parameter are provided after Table\_Apx E-25.

Input	Input Samehol Unit		Deterministic Values					
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Facility Throughput of Solid DIDP	Qstock_site_day_S	g/site-day	330	_	_	_	_	See Section E.11.3
Facility Throughput of Liquid DIDP	Qstock_site_day_L	mL/site-day	4,000	17.05	4000	_	Uniform	See Section E.11.3
Liquid DIDP Concentration	F <sub>DIDP-L</sub>	kg/kg	0.95	0.9	1	0.95	Triangular	See Section E.11.6
Solid DIDP Concentration	F <sub>DIDP-S</sub>	kg/kg	0.03	-	-	-	_	See Section E.11.6
Operating Days	OD	days/yr	260	174	260	260	Triangular	See Section E.11.7
Air Speed	RATE <sub>air_speed</sub>	ft/min	19.7	2.56	398	_	Lognormal	See Section E.11.8
Saturation Factor	$\mathbf{f}_{sat}$	dimensionless	0.5	0.5	1.45	0.5	Triangular	See Section E.11.9
Liquid Container Size	V <sub>cont</sub>	gal	1	0.5	1	1	Triangular	See Section E.11.10
Solid Container Mass	$Q_{cont\_solid}$	kg	1	0.5	1	1	Triangular	See Section E.11.10
Small Container Loss Fraction	Fresidue	kg/kg	0.003	0.003	0.006	0.003	Triangular	See Section E.11.11
Solid Container Loss Fraction	LF <sub>cont</sub>	kg/kg	0.01	_	_	_	_	See Section E.11.11
Fraction of chemical lost during transfer of solid powders	$F_{dust\_generation}$	kg/kg	0.005	_	_	_	_	See Section E.11.12
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	_	Physical property

### 7786 Table\_Apx E-25. Summary of Parameter Values and Distributions Used in the Use of Laboratory Chemicals Model

Input	~		Deterministic Values	Uncertai	nty Analysis	Distributio	on Parameters	
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Molecular Weight	MW	g/mol	446.68	_	_	_	_	Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05	_	_	_	-	Universal constant
Density of DIDP	RHO	kg/L	0.9634	_	_	_	-	Physical property
Temperature	Т	K	298	_	_	_	-	Process parameter
Pressure	Р	atm	1	_	_	_	-	Process parameter
Small Container Fill Rate	RATE <sub>fill</sub>	containers/hr	60	_	_	_	-	See Section E.11.13
Diameter of Opening – Container Cleaning	D <sub>cleaning</sub>	cm	5.08	-	-	-	-	See Section E.11.14
Lab Testing Duration	OH <sub>testing</sub>	hr/day	1	_	_	_	-	See Section E.11.5
Equipment Cleaning Duration	OH <sub>cleaning</sub>	hr/day	4	-	-	-	-	See Section E.11.5
Equipment Cleaning Loss Fraction Liquid	F <sub>lab_residue_L</sub>	kg/kg	0.02	-	-	-	_	See Section E.11.15
Equipment Cleaning Loss Fraction Solid	F <sub>lab_residue_S</sub>	kg/kg	0.01	-	-	-	_	See Section E.11.15

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## 7788 E.11.3 Throughput Parameters

7789 The Use of Laboratory Chemicals – Generic Scenario for Estimating Occupational Exposures and 7790 Environmental Releases (U.S. EPA, 2023c) provides daily throughput of DIDP required for laboratory 7791 stock solutions. According to the GS, laboratory liquid use rates range from 0.5 mL up to four liters per day, and laboratory solid use rates range from 0.003 grams to 510 grams per day. Laboratory stock 7792 7793 solutions are used for multiple analyses and eventually need to be replaced. The expiration or 7794 replacement times range from daily to six months (U.S. EPA, 2023c). For this scenario, EPA assumes stock solutions are prepared daily. EPA initially assigned a uniform distribution for the daily throughput 7795 7796 of laboratory stock solutions with upper and lower bounds corresponding to the high and low use rates, 7797 respectively. 7798

However, the proposed distributions resulted in an unreasonably high result for the calculated number of
sites. Therefore, for liquid stock solutions, EPA modified the lower bound to 17.05 mL. This lower
bound was calculated using the minimum operating days of 174 days/yr and the lowest known weight
fraction of liquid laboratory chemicals (0.9 kg/kg). For solids, EPA used a deterministic value of 330
g/site-day. This deterministic value was calculated using the maximum operating days of 260 days/yr
and the highest known weight fraction of solid laboratory chemicals (0.03 kg/kg).

The daily throughput of DIDP in liquid laboratory chemicals is calculated using Equation E-74 by
multiplying the daily throughput of all laboratory solutions by the concentration of DIDP in the
solutions and converting volume to mass.

7810 Equation E-74.

 $Q_{DIDP\_day} = Q_{stock\_site\_day\_L} * F_{DIDP\_L} * RHO * \frac{0.001L}{mL}$ 

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7813	Where:		
7814	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
7815	$Q_{stock\_site\_day\_L}$	=	Facility annual throughput of liquid laboratory chemicals [mL/site-
7816			day]
7817	$F_{DIDP-L}$	=	Concentration of DIDP in liquid laboratory chemicals (see Section
7818			E.11.6) [kg/kg]
7819	RHO	=	Density of DIDP [kg/L]
7820			

The daily throughput of DIDP in solid laboratory chemicals is calculated using Equation E-75 by
multiplying the daily throughput of all laboratory solids by the concentration of DIDP in the solids.

## 7824 **Equation E-75.**

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$$Q_{DIDP\_day} = Q_{stock\_site\_day\_S} * F_{DIDP\_S} * \frac{0.001kg}{g}$$

7827 Where:

, •=,			
7828	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
7829	$Q_{stock\_site\_day\_S}$	=	Facility annual throughput of solid laboratory chemicals [g/site-
7830			day]
7831	$F_{DIDP-S}$	=	Concentration of DIDP in solid laboratory chemicals (see Section
7832			E.11.6) [kg/kg]

E.11.7.		
Equation E-76.		
		$Q_{DIDP\_year} = Q_{DIDP\_day} * OD$
Where:		
0	=	Facility annual throughput of DIDP [kg/site-yr]
$Q_{DIDP\_year} \ Q_{DIDP\_day}$	=	Facility throughput of DIDP (see Section E.11.3) [kg/site-d
QDDP_day OD	=	Operating days (see Section E.11.7) [days/yr]
		operating days (see beealon 2.11.7) [days, y1]
E.11.4 Number o	f Contai	ners per Year
The number of liquid DID	P labora	tory containers unloaded by a site per year is calculated using
following equation:		
Equation E-77.		0
Λ	l <sub>cont_</sub> unlo	$_{ad\_yr} = \frac{Q_{DIDP\_year}}{F_{DIDP\_L} * RHO * \left(3.79 \frac{L}{aal}\right) * V_{cont}}$
		$F_{DIDP-L} * RHO * \left(3.79 \frac{d}{gal}\right) * V_{cont}$
Where:		
$V_{cont}$	=	Container volume (see Section E.11.10) [gal/container]
$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.11.3) [k
DUIO		yr]
RHO	=	DIDP density [kg/L]
F <sub>DIDP-L</sub> N	=	Mass fraction of DIDP in liquid (see Section E.11.6) [kg/kg Annual number of containers unloaded [container/site-year
$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year
The number of laboratory	containe	rs containing solids with DIDP unloaded by a site per year is
calculated using the follow		
Equation E-78.		$Q_{DIDP_year}$
	IN	$_{cont\_unload\_yr} = \frac{Q_{DIDP\_year}}{F_{DIDP-S} * Q_{cont\_solid}}$
Where:		
$Q_{cont\_solid}$	=	Mass in container of solids (see Section E.11.10) [kg/conta
$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.11.3) [k
		yr]
$F_{DIDP-S}$	=	Mass fraction of DIDP in solid (see Section E.11.6) [kg/kg]
$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year
E.11.5 Operating	TT	

7876 (U.S. EPA, 2023c), ChemSTEER User Guide (U.S. EPA, 2015), and/or through calculation from other 7877 parameters. Release points with operating hours provided from these sources include unloading, 7878 container cleaning, equipment cleaning, and product sampling.

7880 For unloading and container cleaning (release points 1 and 4), the operating hours are calculated based 7881 on the number of containers unloaded at the site and the unloading rate using the following equation: 7882

#### 7883 **Equation E-79.**

7884

7879

$$OH_{RP1/RP4} = \frac{N_{cont\_unload\_yr}}{RATE_{fill} * OD}$$

7885

7886	Where:		
7887	$OH_{RP1/RP4}$	=	Operating time for release points 1 and 4 [hrs/site-day]
7888	RATE <sub>fill</sub>	=	Container fill rate (see Section E.11.13) [containers/hr]
7889	N <sub>cont_unload_yr</sub>	=	Annual number of containers unloaded (see Section E.11.4)
7890			[container/site-year]
7891	OD	=	Operating days (see Section E.11.7) [days/site-year]
7892			

- 7893 For equipment cleaning (release point 6), the ChemSTEER User Guide provides an estimate of four 7894 hours per day for cleaning multiple vessels (U.S. EPA, 2015).
- 7895
- 7896 For product sampling (release point 7), the ChemSTEER User Guide (U.S. EPA, 2015) indicates a single 7897 value of one hour/day.

## 7898

## **E.11.6 DIDP Concentration in Laboratory Chemicals**

7899 EPA modeled DIDP concentration in liquid laboratory chemicals using a triangular distribution with a 7900 lower bound of 90%, upper bound of 100%, and mode of 95%. The Use of Laboratory Chemicals -7901 Generic Scenario for Estimating Occupational Exposures and Environmental Releases (U.S. EPA, 7902 2023c) states that most laboratory chemicals are sold as reagent grade equal to or higher than 95% 7903 purity. EPA built the triangular distribution by using this value as the mode and including concentrations 7904 5% lower and higher than the mode to be the lower and upper bounds. For solid laboratory chemicals, 7905 EPA used the maximum weight fraction out of four identified SDSs (3% DIDP by mass) as a 7906 deterministic value (see Appendix F for EPA identified DIDP-containing products for this OES).

#### 7907 **E.11.7 Operating Days**

7908 EPA modeled the operating days per year using a discrete distribution with a low end of 174 days/yr and 7909 a high end of 260 days/yr. These values were based on U.S. BLS Occupational Employment Statistics 7910 (U.S. BLS, 2016). Per the U.S. BLS website, operating duration for each NAICS code is assumed as a 7911 'year-round, full-time' hours figure of 2,080 hours (U.S. BLS, 2016). Therefore, dividing this time by an 7912 assumed working duration of eight or 12 hours/day yields 174 or 260 days/year. EPA assumed an equal 7913 probability that the number of operating days would be either 174 or 260 days/year.

#### 7914 E.11.8 Air Speed

7915 Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United

- 7916 Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of
- 7917 workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed
- 7918 surveys into settings representative of industrial facilities and representative of commercial facilities.

EPA fit separate distributions for these industrial and commercial settings and used the industrialdistribution for this OES.

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EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

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EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

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Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
individual measurements within each survey. Therefore, these distributions represent a distribution of
mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
However, a mean air speed (averaged over a work area) is the required input for the model. EPA
converted the units to ft/min prior to use within the model equations.

## E.11.9 Saturation Factor

7941 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 7942 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 7943 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 7944 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 7945 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 7946 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 7947 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in 7948 the ChemSTEER User Guide for the EPA/OAQPS AP-42 Loading Model (U.S. EPA, 2015).

## 7949E.11.10Container Size

7950 EPA identified laboratory chemicals packaged in small containers no larger than one gallon in size 7951 (liquids) or one kg in quantity (solids). The Use of Laboratory Chemicals – Generic Scenario for 7952 Estimating Occupational Exposures and Environmental Releases (U.S. EPA, 2023c) states that, in the 7953 absence of site-specific information, a default liquid volume of one gal and a default solid quantity of 7954 one kg may be used. Laboratory products containing DIDP showed container sizes less than one gallon 7955 or one kg. Based on model assumptions of site daily throughput, EPA decided to allow for a lower 7956 bound of 0.5 gallons or 0.5 kg to account for smaller container sizes while maintaining the daily number 7957 of containers unloaded per site at a reasonable value. Therefore, EPA built a triangular distribution for 7958 liquid volumes with a lower bound of 0.5 gallons, and an upper bound and mode of one gallon. EPA 7959 similarly built a triangular distribution for solid quantities with a lower bound of 0.5 kg, and an upper 7960 bound and mode of one kg.

## 7961E.11.11Container Loss Fractions

For small liquid containers, EPA paired the data from the PEI Associates Inc. study (<u>Associates, 1988</u>)
such that the residuals data for emptying drums by pouring was aligned with the default central tendency
and high-end values from the *EPA/OPPT Small Container Residual Model*. For unloading drums by

pouring in the PEI Associates Inc. study (<u>Associates, 1988</u>), EPA found that the average percent residual
from the pilot-scale experiments showed a range of 0.03 percent to 0.79 percent and an average of 0.32
percent. The *EPA/OPPT Small Container Residual Model* from the *ChemSTEER User Guide* (<u>U.S.</u>
<u>EPA, 2015</u>) recommends a default central tendency loss fraction of 0.3 percent and a high-end loss
fraction of 0.6 percent.

7971 The underlying distribution of the loss fraction parameter for small containers is not known; therefore, 7972 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 7973 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for 7974 the loss fraction probability distribution using the central tendency and high-end values, respectively, 7975 prescribed by the EPA/OPPT Small Container Residual Model in the ChemSTEER User Guide (U.S. 7976 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum 7977 average percent residual measured in the PEI Associates, Inc. study (Associates, 1988) for emptying 7978 drums by pouring.

7979

7970

For solid containers, EPA used the *EPA/OPPT Solid Residuals in Transport Containers Model* to
estimate residual releases from solid container cleaning. The *EPA/OPPT Solid Residuals in Transport Containers Model*, as detailed in the *ChemSTEER User Guide* (U.S. EPA, 2015) provides an overall loss
fraction of one percent from container cleaning.

# 7984E.11.12Dust Generation Loss Fraction, Dust Capture Efficiency, and Dust Control7985Efficiency

The *EPA/OPPT Solids Transfer Dust Loss Model* from the *ChemSTEER User Guide* (U.S. EPA, 2015)
recommends a default loss fraction of 0.5 percent. This model may estimate releases to different media
based on the presence of control technologies and removal efficiencies. EPA does not expect control
technologies for solids transfer during laboratory uses; therefore, EPA did not apply any additional
parameters besides the overall loss fraction from the *EPA/OPPT Solids Transfer Dust Loss Model*.

7991E.11.13Small Container Fill Rate

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

## 7994E.11.14Diameters of Opening

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08
cm for containers less than 5,000 gallons (<u>U.S. EPA, 2015</u>).

## 7997E.11.15Equipment Cleaning Loss Fraction

For liquids, EPA used the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from
equipment cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide* (U.S. EPA, 2015) provides an overall loss fraction of two percent from equipment cleaning.

8001

8002 For solids, used the *EPA/OPPT Solid Residuals in Transport Containers Model* to estimate the releases

8003 from equipment cleaning. The EPA/OPPT Solid Residuals in Transport Containers Model, as detailed in

the *ChemSTEER User Guide* (U.S. EPA, 2015) provides an overall loss fraction of one percent from equipment cleaning.

# 8006 E.12 Use of Lubricants and Functional Fluids Model Approaches and 8007 Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for
DIDP during the use of lubricants and functional fluids OES. This approach utilizes the *Emission Scenario Document on Lubricants and Lubricant Additives* (OECD, 2004b) combined with Monte Carlo
simulation (a type of stochastic simulation).

- 8013 Based on the ESD, EPA identified the following release sources from the use of lubricants and 8014 functional fluids:
  - Release source 1: Release During the Use of Equipment.
  - Release source 2: Release During Changeout.
- 8017 Environmental releases for DIDP during the use of lubricants and fluids are a function of DIDP's
- 8018 physical properties, container size, mass fractions, and other model parameters. While physical
- 8019 properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation
- to capture variability in the following model input parameters: production volume, DIDP concentrations,
- 8021 product density, container size, loss fractions, and operating days. EPA used the outputs from a Monte
- 8022 Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to 8023 calculate release amounts for this OES.
- E 12 1 Model Equations
- 8024 E.12.1 Model Equations
- Table\_Apx E-26 provides the models and associated variables used to calculate environmental releases
  for each release source within each iteration of the Monte Carlo simulation. EPA used these
  environmental releases to develop a distribution of release outputs for the use of lubricants and fluids
  OES. The variables used to calculate each of the following values include deterministic or variable input
  parameters, known constants, physical properties, conversion factors, and other parameters. The values
  for these variables are provided in Appendix E.12.2. The Monte Carlo simulation calculated the total
  DIDP release (by environmental media) across all release sources during each iteration of the
- simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency and high-end releases, respectively.
- 8034

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# 8035 Table\_Apx E-26. Models and Variables Applied for Release Sources in the Use of Lubricants and 8036 Functional Fluids OES

Release Source	Model(s) Applied	Variables Used
Release source 1: Release During the Use of Equipment.	See Equation E-80 through Equation E-84	$Q_{DIDP\_day}; LF_{land\_use}; LF_{water\_use}$
Release source 2: Release During Changeout.		$Q_{DIDP\_day}; LF_{land\_disposal}; LF_{water\_disposal}$

8037

Release source 1 (Release During the Use of Equipment) and 2 (Release During Changeout) are

8039 partitioned out by release media. Loss fractions are described in the model parameter sections below.

8040 For both water and land media, release 1 is then calculated using the following equation: 8041

## 8042 **Equation E-80.**

 $Release\_perDay_{RP1\_land/water} = Q_{DIDP\_day} * (LF_{land\_use} + LF_{water\_use})$ 

8045 Where:

8046	Release_perDay <sub>RP2</sub>	1_land/water <sup>=</sup>	DIDP loss to land/water for release source 1 [kg/site-day]
8047	$Q_{DIDP\_day}$		Facility throughput of DIDP (see Section E.12.3) [kg/site-
8048			day]
8049	$LF_{land\_use}$	=	Loss fraction to land during the use of equipment (see
8050	tunu_use		Section E.12.7) [unitless]
8051	$LF_{water\_use}$	=	Loss fraction to water during the use of equipment (see
8052	water_ase		Section E.12.7) [unitless]
8053			
8054	A similar equation is used to	o calculate rele	ase 2 to water and land:
8055	1		
8056	Equation E-81.		
8057		RP2 land/water	$= Q_{DIDP_day} * (LF_{land_disposal} + LF_{water_disposal})$
8058			·DIDI_aay ( lana_aaposal water_asposal)
8059	Where:		
8060	Release_perDay <sub>RP2</sub>	land/water=	DIDP loss to land/water for release source 2 [kg/site-day]
8061	$Q_{DIDP\_day}$	=	Facility throughput of DIDP (see Section E.12.3) [kg/site-
8062	<i>CDIDP_uuy</i>		day]
8063	LF <sub>land_disposal</sub>	=	Loss fraction to land during lubricant disposal (see
8064	ana_aisposai		Section E.12.7) [unitless]
8065	$LF_{water\_disposal}$	=	Loss fraction to water during lubricant disposal (see
8066	"water_disposal	—	Section E.12.7) [unitless]
8000 8067			Section E.12.7) [unitless]
8067	If the sum of <i>LE</i> , <i>LE</i>	I.F.	$d_{disposal}$ , and $LF_{water_{disposal}}$ is over 100%, EPA creates
8069			contributions to equal exactly 100% release. The releases per
8009			ed loss fractions. For example, the adjusted land use loss
8070	fraction would be calculated		
8072	indential would be calculated	using the follo	Swing equation.
8073	Equation E-82.		
			LF <sub>land</sub> use
8074	$LF_{land\_use\_adjusted}$	$=\frac{1}{(LF_{low} + LF_{low})}$	$\frac{LF_{land\_use}}{LF_{water\_use} + LF_{land\_disposal} + LF_{water\_disposal})}$
8075	Where:	( <sup>III</sup> lana_use	( ) Water_use ( ) It tana_atsposat ( ) Water_atsposat (
8076	<i>LF<sub>land_use_adjusted</sub></i>	= Adju	sted loss fraction to land during the use of equipment
8077	Li lana_use_aajusted	/ Iuju	
8077	I F.	-	fraction to land during the use of equipment (see
8078 8079	$LF_{land\_use}$		on E.12.7) [unitless]
8079	IF		fraction to water during the use of equipment (see
8080	$LF_{water\_use}$		on E.12.7) [unitless]
8081	IF		fraction to land during lubricant disposal (see
	$LF_{land\_disposal}$		
8083			on E.12.7) [unitless]
8084	$LF_{water\_disposal}$		fraction to water during lubricant disposal (see
8085		Secti	on E.12.7) [unitless]
8086			
8087			eased to the environment after accounting for release sources
8088			ding (incineration). If all DIDP is released during release
8089 8000		•	ng and fuel blending won't be calculated. The following
8090	equations are used to calcula	me me amount	of remaining DIDP sent for recycling and fuel blending:
8091			

8092 8093 8094 8095 8096 8097 8098	– Release_perL <b>Equation E-84.</b> Release_perDay <sub>RP2_fuel_blend</sub>	Day <sub>RP2_w</sub>	$perDay_{RP1\_land} - Release_{perDay_{RP1\_water\_}}Release_{perDay_{RP2\_land}}$ $ater) * F_{waste\_recycle}$
8099	$= (Q_{\text{DDP} day} -$	Release,	$_{perDay_{RP1}_{land}} - Release_{perDay_{RP1}_{water}} Release_{perDay_{RP2}_{land}}$
8100 8101 8102 8103 8104 8105 8106 8107 8108 8109 8110 8111 8112 8113			<ul> <li>DIDP recycled [kg/site-day]</li> <li>DIDP sent for fuel blending [kg/site-day]</li> <li>Facility throughput of DIDP (see Section E.12.3) [kg/site-day]</li> <li>DIDP released for release source 1 to land [kg/site-day]</li> <li>DIDP released for release source 2 to land [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> <li>DIDP released for release source 2 to water [kg/site-day]</li> </ul>
8114 8115			E.12.9) [kg/kg]

8116 E.12.2 Model Input Parameters

8117 Table\_Apx E-27 summarizes the model parameters and their values for the Use of Lubricants and Fluids
8118 Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each

8119 parameter are provided after Table\_Apx E-27.

Input		Unit	Deterministic Values	Uncerta	inty Analysis			
Parameter	Symbol		Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Total Production Volume of DIDP at All Sites	PV <sub>total</sub>	kg/yr	1,679,970	169,485	1,679,970		Uniform	See Section E.12.3
Mass Fraction of DIDP in Product	F <sub>DIDP</sub>	kg/kg	0.2	0.01	0.99	0.2	Triangular	See Section E.12.4
Density of DIDP-based Products	RHO <sub>product</sub>	kg/m3	900	840	1000	900	Triangular	See Section E.12.4
Operating Days	OD	days/yr	4	1	4		Uniform	See Section E.12.5
Container Size	V <sub>cont</sub>	gal	55	20	330	55	Triangular	See Section E.12.6
Loss Fraction to Land During Use	LF <sub>land_use</sub>	kg/kg	0.16	0.014	0.16		Uniform	See Section E.12.7
Loss Fraction to Water During Use	LF <sub>water_use</sub>	kg/kg	0.45	0.003	0.45		Uniform	See Section E.12.7
Loss Fraction to Land During Disposal	LF <sub>land_disposal</sub>	kg/kg	0.30	0.010	0.3	_	Uniform	See Section E.12.7
Loss Fraction to Water During Disposal	LF <sub>water_disposal</sub>	kg/kg	0.37	0.230	0.37	_	Uniform	See Section E.12.7
Percentage of Waste to Recycling	F <sub>waste_recycle</sub>	kg/kg	0.043	-	-	_	-	See Section E.12.8
Percentage of Waste to Fuel Blending	F <sub>waste_incineration</sub>	kg/kg	0.957	-	_	_	-	See Section E.12.9

### 8120 Table\_Apx E-27. Summary of Parameter Values and Distributions Used in the Use of Lubricants and Functional Fluids Model

8121

8122	E.12.3 Throughp	out Parameters						
8123		roduction volume for all sites using a uniform distribution with a lower bound						
8124	of 169,485 kg/yr and an upper bound of 1,679,970 kg/yr. This is based on CDR data (U.S. EPA, 2020a)							
8125	and the 2003 European Union Risk Assessment on DIDP (ECJRC, 2003b). The EU Risk Assessment							
8126	found that only 1.1% of the	found that only 1.1% of the DIDP produced goes to non-PVC, non-polymer end use categories. As this						
8127	Risk Evaluation includes	three OESs that fall under this category, EPA assumes that each category						
8128	contributes 0.37% of the	DIDP produced. CDR states that the total U.S. national production volume of						
8129	DIDP is a range of 100,98	86,354 lbs/yr to 1.001 billion lbs/yr. Multiplying these figures by 0.37% results						
8130	in 373,650 lb./yr (169,485	5 kg/yr) to 3,703,700 lbs/yr (1,679,970 kg/yr).						
8131								
8132	01	culated by converting container volume to mass using the product density and						
8133		days. This equation assumes that each site uses one container of product each						
8134		ermined according to Section E.12.6. Product density is determined according						
8135	to Section E.12.4. Operation	ing days are determined according to Section E.12.5.						
8136	E E. 95							
8137	Equation E-85.	m3						
8138	$Q_{i}$	$_{product\_year} = V_{cont} * 0.00379 \frac{m3}{gal} * RHO_{product} * OD$						
8139								
8140	Where:							
8141	$Q_{product\_year}$	= Facility annual throughput of lubricant/fluid [kg/site-yr]						
8142	$V_{cont}$	= Container size (see Section E.12.6) [gal]						
8143	$RHO_{product}$	= Product density (see Section E.12.4) [kg/m3]						
8144	OD	= Operating days (see Section E.12.5) [days/yr]						
8145								
8146		DIDP is calculated using Equation E-86 by multiplying product annual						
8147	<b>U</b> 1 <b>I</b>	tration of DIDP in the product. Concentration of DIDP in the product is						
8148	determined according to S	Section E.12.4.						
8149 8150	Equation E-86.							
8150	Equation E-80.	O = O * F						
8151		$Q_{DIDP\_year} = Q_{product\_year} * F_{DIDP}$						
81 <i>52</i> 8153	Where:							
8153 8154	$Q_{DIDP\_year}$	= Facility annual throughput of DIDP [kg/site-yr]						
8155	$Q_{product_year}$	= Facility annual throughput of lubricant/fluid						
8156	&proauct_year	[kg/site-yr]						
8157	F <sub>DIDP</sub>	= Concentration of DIDP in lubricant/fluid (see Section E.12.4)						
8158	<sup>1</sup> DIDP	[kg/kg]						
8159								
8160	The daily throughput of I	DIDP is calculated using Equation E-87 by dividing the annual production						
8161		operating days. The number of operating days is determined according to						
8162	Section E.12.5.							
8163								
8164	Equation E-87.							
8165		$Q_{DIDP\_day} = \frac{Q_{DIDP\_year}}{OD}$						
8166		$QDIDP_{aay} = OD$						

8167	Where:		
8168	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]
8169	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]
8170	OD	=	Operating days (see Section E.12.5) [days/yr]

8171 E.12.4 Mass Fraction of DIDP in Lubricant/Fluid and Product Density

8172 EPA modeled DIDP concentration in lubricants and fluids using a triangular distribution with a lower 8173 bound of 1%, upper bound of 99%, and mode of 20%. EPA modeled product density using a triangular

8174 distribution with a lower bound of 840 kg/m<sup>3</sup>, an upper bound of 1,000 kg/m<sup>3</sup>, and a mode of 900 kg/m<sup>3</sup>.

8175 This is based on compiled SDS information for lubricants and fluids containing DIDP (see Appendix F

8176 for EPA identified DIDP-containing products for this OES).

## 8177 E.12.5 Operating Days

8178 EPA modeled operating days per year using a uniform distribution with a lower bound of one day/yr and 8179 an upper bound of four days/yr. To ensure that only integer values of this parameter were selected, EPA 8180 nested the uniform distribution probability formula within a discrete distribution that listed each integer 8181 between (and including) one to four days/yr. Both bounds are based on the Emission Scenario Document 8182 on Lubricants and Lubricant Additives (OECD, 2004b). The ESD states that changeout rates for 8183 hydraulic fluids range from three to 60 months. This corresponds to one to four changeouts per year, 8184 which EPA assumes is equal to operating days. Where changeout frequency occurs over 12 months, EPA used a value one container per 12 months as a representative value. 8185

## E.12.6 Container Size

EPA modeled container size using a triangular distribution with a lower bound of 20 gallons, an upper
bound of 330 gallons, and a mode of 55 gallons. This was based on SDS and technical data sheets for
DIDP-containing lubricants. In this data, EPA identified lubricants in containers from less than one
gallon to 330 gallons. The mode of the reported container sizes was 55 gallons. However, when running
the model, smaller use rates produced an unreasonable number of use sites. Therefore, EPA assumed
this to be an indication that it is unlikely that sites only have one small piece of equipment. Based on this
and the remaining technical data, EPA selected 20 gallons as the lower bound.

8194 E.12.7 Loss Fractions

8186

The loss fractions to each release media for the use and disposal of lubricants are based on the *Emission Scenario Document on Lubricants and Lubricant Additives* (OECD, 2004b). The ESD provides multiple values for loss fractions to land and water. EPA used these values to build the uniform distributions for each loss fraction. For the use of lubricants, the ESD provided a range of 0.014 to 0.16 for loss fractions to land, and 0.003 to 0.45 for loss fractions to water. For the disposal of lubricants, the ESD provided a range of 0.01 to 0.3 for loss fractions to land, and 0.23 to 0.37 for loss fractions to water.

## 8201 E.12.8 Percentage of Waste to Recycling

The *Emission Scenario Document on Lubricants and Lubricant Additives* (OECD, 2004b) estimates that
4.3% of all hydraulic fluids are recycled.

## 8204 E.12.9 Percentage of Waste to Fuel Blending

8205 The *Emission Scenario Document on Lubricants and Lubricant Additives* (OECD, 2004b) estimates that 8206 95.7% of all hydraulic fluids are reused for fuel oil or other general incineration releases.

# E.13 Use of Penetrants and Inspection Fluids Release Model Approaches and Parameters

- 8209 This appendix presents the modeling approach and equations used to estimate environmental releases for
- 8210 DIDP during the use of penetrants and inspection fluids OES. This approach utilizes the *Emission*
- 8211 Scenario Document on the Use of Metalworking Fluids (OECD, 2011d) combined with Monte Carlo
- simulation (a type of stochastic simulation). EPA assessed the environmental releases for this OES
- separately for non-aerosol penetrants and for aerosol-applied penetrants.
- 8214
- Based on the ESD, EPA identified the following release sources from the use of non-aerosol penetrants:
  Release source 1: Transfer Operation Losses to Air from Unloading Penetrant.
- Release source 2: Container Cleaning Wastes.
- Release source 3: Open Surface Losses to Air During Container Cleaning.
- Release source 4: Equipment Cleaning Wastes.
- Release source 5: Open Surface Losses to Air During Equipment Cleaning.
- Release source 7: Disposal of Used Penetrant.
- Based on the ESD, EPA identified the following release sources from the use of aerosol-appliedpenetrants:
- Release source 2: Container Cleaning Wastes.
- Release source 6: Aerosol Application of Penetrant.
- Environmental releases for DIDP during the use of penetrants are a function of DIDP's physical
  properties, container size, mass fractions, and other model parameters. While physical properties are
  fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture
  variability in the following model input parameters: DIDP concentrations, air speed, saturation factor,
  container size, loss fractions, and operating days. EPA used the outputs from a Monte Carlo simulation
  with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release
  amounts for this OES.
- 8233 E.13.1 Model Equations

Table Apx E-28 provides the models and associated variables used to calculate environmental releases 8234 8235 for each release source within each iteration of the Monte Carlo simulation. EPA used these 8236 environmental releases to develop a distribution of release outputs for the use of penetrants OES. The 8237 variables used to calculate each of the following values include deterministic or variable input 8238 parameters, known constants, physical properties, conversion factors, and other parameters. The values 8239 for these variables are provided in Appendix E.13.2. The Monte Carlo simulation calculated the total 8240 DIDP release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50<sup>th</sup> percentile and 95<sup>th</sup> percentile values to estimate the central tendency 8241 8242 and high-end releases, respectively. 8243

# Table\_Apx E-28. Models and Variables Applied for Release Sources in the Use of Penetrants and Inspection Fluids OES

Release source	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Unloading Penetrant.	EPA/OAQPS AP-42 Loading Model (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $VP$ ; $f_{sat}$ ; $MW$ ; $R$ ; $T$ ; $V_{cont}$ ; $RATE_{fill\_cont}$ ; $RATE_{fill\_drum}$
		Operating Time: $Q_{DIDP\_year}$ ; $V_{cont}$ ; $OD$ ; $RATE_{fill\_cont}$ ; $RATE_{fill\_drum}$ ; $RHO$ ; $F_{DIDP}$
Release source 2: Container Cleaning Wastes.	<i>EPA/OPPT Drum Residual</i> <i>Model</i> or <i>EPA/OPPT Bulk</i> <i>Transport Residual Model</i> , based on container size (Appendix E.1)	$Q_{DIDP_day}; LF_{drum}; LF_{cont}; V_{cont}; RHO; OD; F_{DIDP}$
Release source 3: Open Surface Losses to Air During Container Cleaning.	<i>EPA/OPPT Penetration</i> <i>Model</i> or <i>EPA/OPPT Mass</i> <i>Transfer Coefficient Model</i> , based on air speed (Appendix E.1)	Vapor Generation Rate: $F_{DIDP}$ ; $MW$ ; $VP$ ; $RATE_{air\_speed}$ ; $D_{cont\_clean}$ ; $T$ ; $P$ Operating Time: $Q_{DIDP\_year}$ ; $V_{cont}$ ; $OD$ ;
		RATE <sub>fill_cont</sub> ; RATE <sub>fill_drum</sub> ; RHO; F <sub>DIDP</sub>
Release source 4: Equipment Cleaning Wastes.	EPA/OPPT Multiple Process Vessel Residual Model (Appendix E.1)	$Q_{DIDP_{day}}; LF_{equip}$
Release source 5: Open Surface Losses to Air During Equipment Cleaning.	EPA/OPPT Penetration Model or EPA/OPPT Mass Transfer Coefficient Model,	Vapor Generation Rate: <i>F</i> <sub>DIDP</sub> ; <i>MW</i> ; <i>VP</i> ; <i>RATE</i> <sub>air_speed</sub> ; <i>D</i> <sub>equip_clean</sub> ; <i>T</i> ; <i>P</i>
	based on air speed (Appendix E.1)	Operating Time: <i>OH<sub>equip_clean</sub></i>
Release source 6: Aerosol Application of Penetrant.	See Equation E-88 and Equation E-89	$Q_{DIDP_{day}}$ ; % <sub>air</sub> ; % <sub>uncertain</sub> ; Release Point 2
Release source 7: Disposal of Used Penetrant.	See Equation E-90	$Q_{DIDP\_day}$ ; Release Points 1 through 5

8246

Release source 6 (Aerosol Application of Penetrant) is partitioned out by release media. In order to calculate the releases to each media, the total release is calculated first using the following equation:

# 82498250 Equation E-88.

 $Release\_perDay_{RP6} = Q_{DIDP\_day} - Release\_perDay_{RP2}$ 8251 8252 Where:  $Release\_perDay_{RP6} =$ DIDP released for release source 6 to all release media 8253 8254 [kg/site-day] Facility throughput of DIDP (see Section E.13.3) [kg/site-day] 8255  $Q_{DIDP \ dav}$ =DIDP released for release source 2 [kg/site-day] 8256  $Release\_perDay_{RP2} =$ 8257

8258 Then, the release amounts to each media are calculated using the following equation:

8259			
8260	Equation E-89.		
8261	Equation E 05.		
8262	Release pert	$av_{nnc}$	$_{media} = Release\_perDay_{RP6} * \%_{media}$
8263	Where:	, «J RP6_	meala Robolico_por Day RP6 Vomeala
8264	Release_perDay <sub>RP6_media</sub>	=	Amount of release 6 that is released to selected media
8265	Release_per Day <sub>RP6_</sub> media	—	[kg/site-day]
8265 8266	$Release\_perDay_{RP6}$	=	DIDP released for release source 6 to all release media
8200 8267	Release_per Duy <sub>RP6</sub>	_	[kg/site-day]
8207 8268	06	=	Percent of release 6 that is released to selected media
8208 8269	$\%_{media}$	_	[unitless]
8209 8270			[unitiess]
8270 8271	Palassa source 7 (Disposal of Used	Donatre	ant) is calculated via a mass-balance, via the following
8271	equation:	I eneu a	int) is calculated via a mass-balance, via the following
8272	equation.		
8273 8274	Equation E-90.		
0274			5
8275	Release_p	erDay <sub>RF</sub>	$Q_{DT} = Q_{DIDP\_day} - \sum_{i=1}^{5} Release\_perDay_{RPi}$
		<i>p</i>	i=1
8276	Where:		
8277	Release_perDay <sub>RP7</sub>	=	DIDP released for release source 7 [kg/site-day]
8278	$Q_{DIDP\_day}$	=	Facility throughput of DIDP (see Section E.13.3) [kg/site-
8279			day]
8280	$\sum_{i=1}^{5} Release_perDay_{RPi}$	=	The sum of release points 1-5 emissions [kg/site-day]
	• -		
8281	E.13.2 Model Input Param	ieters	
8282	Table_Apx E-29 summarizes the me	odel par	rameters and their values for the Use of Penetrants Monte
8283	Carlo simulation. Additional explan	ations of	of EPA's selection of the distributions for each parameter are
0004			

8284 provided after Table\_Apx E-29.

 8285
 Table\_Apx E-29. Summary of Parameter Values and Distributions Used in the Release Estimation of Penetrants and Inspection

 8286
 Fluids

Input			Deterministic Values	Uncertair	nty Analysis			
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Penetrant DIDP Concentration	F <sub>DIDP</sub>	kg/kg	0.2	0.1	0.2		Uniform	See Section E.13.6
Operating Days	OD	days/yr	247	246	249	247	Triangular	See Section E.13.7
Air Speed	RATE <sub>air_spee</sub>	ft/min	19.7	2.56	398		Lognormal	See Section E.13.8
Saturation Factor	$\mathbf{f}_{sat}$	dimensionles s	0.5	0.5	1.45	0.5	Triangular	See Section E.13.9
Container Size	V <sub>cont</sub>	gal	0.082	0.082	55	0.082	Triangular	See Section E.13.10
Small Container Loss Fraction	LF <sub>cont</sub>	kg/kg	0.003	0.003	0.006	0.003	Triangular	See Section E.13.11
Drum Residual Loss Fraction	LF <sub>drum</sub>	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section E.13.11
Equipment Cleaning Loss Fraction	$LF_{equip}$	kg/kg	0.002	0.0007	0.01	0.002	Triangular	See Section E.13.12
Vapor Pressure at 25C	VP	mmHg	5.28E-07	_	_	_	_	Physical property
Molecular Weight	MW	g/mol	446.68	_	_	—	_	Physical property
Gas Constant	R	atm- cm3/gmol-L	82.05	_	_	—	—	Universal constant
Density of DIDP	RHO	kg/L	0.9634					Physical property
Temperature	Т	K	298	_	_		_	Process parameter
Pressure	Р	atm	1	_	_	_	_	Process parameter

Input	~		Deterministic Values	Uncertair	nty Analysis	Distributio	on Parameters	
Parameter	Symbol	Unit	Value	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale / Basis
Small Container Fill Rate	RATE <sub>fill_con</sub>	containers/hr	60	_	_	_	_	See Section E.13.13
Drum Fill Rate	RATE <sub>fill_dru</sub>	containers/hr	20	—	_	_	_	See Section E.13.13
Diameter of Opening – Container Cleaning	$D_{\text{cont\_clean}}$	cm	5.08	_	_	_	_	See Section E.13.14
Diameter of Opening – Equipment Cleaning	$D_{equip\_clean}$	cm	92	_	_	_	_	See Section E.13.14
Equipment Cleaning Duration	OH <sub>equip_clean</sub>	hr/day	0.5	_	_	_	_	See Section E.13.5
Penetrant User per Job	Qpenetrant_job	oz/job	10.5	_	_	_	_	See Section E.13.15
Application Jobs per Day	$N_{jobs\_day}$	jobs/day	8	_	_	_	_	See Section E.13.16
Percentage of Aerosol Released to Fugitive Air	% <sub>air</sub>	unitless	0.15	_	_	_	_	See Section E.13.17
Percentage of Aerosol Released to Uncertain Media	% uncertain	unitless	0.85	_	_	_	_	See Section E.13.17

8287

		_					
8288	E.13.3 Throughput Parameters						
8289	The daily throughput of DIDP in penetrants is calculated using Equation E-91 by multiplying the						
8290	amount of penetrant per job by the number of jobs per day, density, and concentration of DIDP. The						
8291 8292	amount of penetrant used per job is determined according to Section E.13.15. The number of jobs per day is determined according to Section E.13.16.						
8292 8293	day is determined according	, to sect	1011 E.15.10.				
8293 8294	Equation E-91.						
			0.00781 all L				
8295	$Q_{DIDP\_day} = Q_{pe}$	enetrant <sub>.</sub>	$_{job} * N_{jobs\_day} * \frac{0.00781gal}{oz} * 0.264 \frac{L}{gal} * RHO * F_{DIDP}$				
8296 8297	Whore						
8297 8298	Where:	_	Eacility throughout of DIDB [kg/site day]				
	$Q_{DIDP\_day}$	=	Facility throughput of DIDP [kg/site-day]				
8299	$Q_{penetrant_job}$	=	Amount of penetrant used per job (see Section E.13.15) [oz/job]				
8300	N <sub>jobs_day</sub>	=	Application jobs of penetrant per day (see Section E.13.16)				
8301	DHO		[jobs/day]				
8302	RHO	=	Density of DIDP [kg/m3]				
8303	$F_{DIDP}$	=	Concentration of DIDP in penetrants (see Section E.13.6) [kg/kg]				
8304 8305	The appual throughout of D		valeulated using Equation E 02 by multiplying the daily production				
8305	01		calculated using Equation E-92 by multiplying the daily production days. The number of operating days is determined according to				
8300 8307	Section E.13.7.	berating	days. The number of operating days is determined according to				
8308	Section E.15.7.						
8309	Equation E-92.						
8310			$Q_{DIDP\_year} = Q_{DIDP\_day} * OD$				
8311			Color_year Color_aay				
8312	Where:						
8313	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP [kg/site-yr]				
8314	$Q_{DIDP_{day}}$	=	Facility throughput of DIDP [kg/site-day]				
8315	OD	=	Operating days (see Section E.13.7) [days/yr]				
8316		—					
8317	E.13.4 Number of (		•				
8318	The number of containers un	nloaded	by a site per year is calculated using the following equation:				
8319							
8320	Equation E-93.						
8321	N	omt umle	$Q_{DIDP_year} = $				
		cont_unic	$P_{ad\_yr} = \frac{Q_{DIDP\_year}}{F_{DIDP} * RHO * \left(3.79 \frac{L}{gal}\right) * V_{cont}}$				
8322	Where:						
8323	$V_{cont}$	=	Container volume (see Section E.13.10) [gal/container]				
8324	$Q_{DIDP\_year}$	=	Facility annual throughput of DIDP (see Section E.13.3) [kg/site-				
8325			yr]				
8326	RHO	=	DIDP density [kg/L]				
8327	F <sub>DIDP</sub>	=	Mass fraction of DIDP in product (see Section E.13.6) [kg/kg]				
8328	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded [container/site-year]				

## 8329 E.13.5 Operating Hours

EPA estimated operating hours or hours of duration using data provided from *the Emission Scenario Document on the Use of Metalworking Fluids* (OECD, 2011d), *ChemSTEER User Guide* (U.S. EPA,
2015), and/or through calculation from other parameters. Release points with operating hours provided
from these sources include unloading, container cleaning, equipment cleaning, filter media replacement,
and aerosol application.

For unloading and container cleaning (release points 1 and 3), the operating hours are calculated based
on the number of containers unloaded at the site and the unloading rate using the following equation:

## 8339 Equation E-94.

$$OH_{RP1/RP3} = \frac{N_{cont\_unload\_yr}}{RATE_{fill\_drum/cont} * OD}$$

8341

8352

8340

8335

8342	Where:		
8343	$OH_{RP1/RP3}$	=	Operating time for release points 1 and 3 [hrs/site-day]
8344	RATE <sub>fill_drum/cont</sub>	=	Container fill rate, depending on container size (see Section
8345	, <u> </u>		E.13.13) [containers/hr]
8346	$N_{cont\_unload\_yr}$	=	Annual number of containers unloaded (see Section E.13.4)
8347	-		[container/site-year]
8348	OD	=	Operating days (see Section E.13.7) [days/site-year]
8349			

For equipment cleaning (release point 5), the *ChemSTEER User Guide* (U.S. EPA, 2015) provides a
typical equipment cleaning duration of 0.5 hours/day for cleaning a single, small vessel.

For aerosol application (release point 6), EPA treats this activity as container unloading. Therefore, EPA
calculates the operating duration for this release using Equation E-94.

## 8355 E.13.6 Penetrant DIDP Concentration

EPA modeled DIDP concentration in paints and coatings using a uniform distribution with a lower
bound of 10% and upper bound of 20%. This is based on compiled SDS information for penetrants
containing DIDP. EPA identified one product in the DINP Use Report which is being used as a
surrogate for DIDP concentration, since no penetrants containing DIDP were readily found (see
Appendix F for EPA identified DIDP-containing products for this OES).

## 8361 E.13.7 Operating Days

EPA modeled the operating days per year using a triangular distribution with a lower bound of 246 days/yr, an upper bound of 249 days/yr, and a mode of 247 days/yr. To ensure that only integer values of this parameter were selected, EPA nested the triangular distribution probability formula within a discrete distribution that listed each integer between (and including) 246-249 days/yr. This is based on the *Emission Scenario Document on the Use of Metalworking Fluids* (OECD, 2011d). The ESD cites a general average for metal shaping operations to be 246-249 days/yr, and it recommends a default value of 247 days/yr.

## 8369 **E.13.8 Air Speed**

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of

8372 workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed

- 8373 surveys into settings representative of industrial facilities and representative of commercial facilities.
- 8374 EPA fit separate distributions for these industrial and commercial settings and used the industrial 8375 distribution for this OES.
- 8376

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air
speed measurements within a surveyed location were lognormally distributed and the population of the
mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since
lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the
largest observed value among all of the survey mean air speeds.

8382

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

8389

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
individual measurements within each survey. Therefore, these distributions represent a distribution of

mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
However, a mean air speed (averaged over a work area) is the required input for the model. EPA

- 8394 converted the units to ft/min prior to use within the model equations.
- 8395 E.13.9 Saturation Factor

8396 The CEB Manual indicates that during splash filling, the saturation concentration was reached or 8397 exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991b). The CEB Manual 8398 indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 8399 1991b). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular 8400 distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was 8401 not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling 8402 minimizes volatilization (U.S. EPA, 1991b). This value also corresponds to the typical value provided in the ChemSTEER User Guide for the EPA/OAQPS AP-42 Loading Model (U.S. EPA, 2015). 8403

## 8404 **E.13.10 Container Size**

EPA modeled container size using a triangular distribution with a lower bound of 0.082 gallons, an
upper bound of 55 gallons, and a mode of 0.082 gallons. EPA identified penetrants in 10.5 oz (0.082
gallon) aerosol cans, and one gallon, five gallon, and 55-gallon containers. EPA used 10.5 oz cans as the
mode because most products indicated using 10.5 oz cans.

## 8409 E.13.11 Container Loss Fractions

8410 For small containers, EPA paired the data from the PEI Associates Inc. study (Associates, 1988) such 8411 that the residuals data for emptying drums by pouring was aligned with the default central tendency and 8412 high-end values from the EPA/OPPT Small Container Residual Model. For unloading drums by pouring 8413 in the PEI Associates Inc. study (Associates, 1988), EPA found that the average percent residual from 8414 the pilot-scale experiments showed a range of 0.03 percent to 0.79 percent and an average of 0.32 8415 percent. The EPA/OPPT Small Container Residual Model from the ChemSTEER User Guide (U.S. 8416 EPA, 2015) recommends a default central tendency loss fraction of 0.3 percent and a high-end loss 8417 fraction of 0.6 percent.

8418 The underlying distribution of the loss fraction parameter for small containers is not known; therefore,

- 8419 EPA assigned a triangular distribution, since triangular distributions require least assumptions and are 8420 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for
- the loss fraction probability distribution using the central tendency and high-end values, respectively,
- prescribed by the *EPA/OPPT Small Container Residual Model* in the *ChemSTEER User Guide* (U.S.
- 8423 EPA, 2015). EPA assigned the minimum value for the triangular distribution using the minimum
- average percent residual measured in the PEI Associates, Inc. study (<u>Associates, 1988</u>) for emptying
  drums by pouring.
- 8426

For drums, EPA paired the data from the PEI Associates Inc. study (<u>Associates, 1988</u>) such that the residuals data for emptying drums by pumping was aligned with the default central tendency and highend values from the *EPA/OPPT Drum Residual Model*. For unloading drums by pumping in the PEI Associates Inc. study, EPA found that the average percent residual from the pilot-scale experiments showed a range of 1.7 percent to 4.7 percent and an average of 2.6 percent. The *EPA/OPPT Drum Residual Model* from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5 percent and a high-end loss fraction of 3.0 percent (U.S. EPA, 2015).

8434

8435 The underlying distribution of the loss fraction parameter for drums is not known; therefore, EPA

8436 assigned a triangular distribution, since triangular distributions require least assumptions and are

8437 completely defined by range and mode of a parameter. EPA assigned the mode and maximum values for

the loss fraction probability distribution using the central tendency and high-end values, respectively,

8439 prescribed by the *EPA/OPPT Drum Residual Model* in the *ChemSTEER User Guide* (U.S. EPA, 2015).

8440 EPA assigned the minimum value for the triangular distribution using the minimum average percent 8441 residual measured in the PEL Acceptions. Inc. study (Acceptions, 1088) for exercising derive here are been average by the second study (Acception and States, 1088) for exercising derive here are been average by the second study (Acception and States, 1088) for exercising derive here are been average by the second study (Acception average

residual measured in the PEI Associates, Inc. study (<u>Associates, 1988</u>) for emptying drums by pumping.

## 8442E.13.12Equipment Cleaning Loss Fraction

EPA used the *EPA/OPPT Single Vessel Residual Model* to estimate the releases from equipment
cleaning. The *EPA/OPPT Single Vessel Residual Model*, as detailed in the *ChemSTEER User Guide*(U.S. EPA, 2015) provides a default loss fraction of 0.002 for equipment cleaning. In addition, the
model provides non-default loss fractions of 0.01 and 0.0007. Therefore, developed a triangular
distribution for equipment cleaning, with a lower bound of 0.0007, an upper bound of 0.01, and a mode
of 0.002, based on the *ChemSTEER User Guide* (U.S. EPA, 2015).

## 8449E.13.13Container Fill Rates

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

## 8453E.13.14Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold
liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). For
equipment cleaning operations, the *ChemSTEER User Guide* indicates a single default value of 92 cm
(U.S. EPA, 2015).

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm for containers less than 5,000 gallons (U.S. EPA, 2015).

## 8461 E.13.15 Penetrant Used per Job

EPA identified 10.5 oz as a standard size for aerosol cans. EPA assumed that one container is used per job, so the amount of penetrant used per job is 10.5 oz.

## 8464 **E.13.16 Jobs per Day**

EPA assumes eight penetrant jobs occur per day. As there was no available usage data, EPA assumed a
duration of one hour per job, and eight jobs/day due to a typical shift being eight hours long. Therefore,
EPA could not develop a distribution of values for this parameter and used the single value of eight
jobs/day.

## 8469 E.13.17 Percentage of Aerosol Released to Fugitive Air and Uncertain Media

According to the *Generic Scenario on Chemicals Used in Furnishing Cleaning Products* (U.S. EPA,
2022b), 15% of spray application releases are to fugitive air, and 85% are to water, incineration, or
landfill.

## 8473 E.14 Spray Exposure Model Approach and Parameters

8474 This section presents the modeling approach and equations used to estimate occupational exposures for 8475 DIDP during the use in paints and coatings and use in adhesives and sealants OESs. This approach 8476 utilizes the Automotive Refinishing Spray Coating Mist Inhalation Model from the ESD on Coating 8477 Application via Spray-Painting in the Automotive Refinishing Industry (OECD, 2011a). The model 8478 estimates worker inhalation exposure based on the concentration of the chemical of interest in the 8479 nonvolatile portion of the sprayed product and the concentration of over sprayed mist/particles. The 8480 model is based on PBZ monitoring data for mists during automotive refinishing. EPA used the 50<sup>th</sup> and 8481 95<sup>th</sup> percentile mist concentration along with the concentration of DIDP in the paint to estimate the 8482 central tendency and high-end inhalation exposures, respectively.

## 8483 E.14.1 Model Design Equations

The Automotive Refinishing Spray Coating Mist Inhalation Model calculates the 8-hour TWA exposure
to DIDP present in mist and particulates using the following equation:

## 8487 Equation E-95.

8488

$$C_{DIDP,8hr-TWA} = \frac{C_{mist} \times F_{DIDP\_solids} \times ED}{8 \, hrs}$$

8489 8490 WI

8490	Where:		
8491	$C_{DIDP,8hr-TWA}$	=	8-hr TWA inhalation exposure to DIDP (mg/m <sup>3</sup> )
8492	$C_{mist}$	=	Over sprayed product mist concentration in the air within worker's
8493			breathing zone (mg/m <sup>3</sup> )
8494	$F_{DIDP\_solids}$	=	Mass fraction of DIDP in the non-volatile portion of the spray
8495			$(mg_{DIDP}/mg_{nonvolatile components})$
8496	ED	=	Exposure Duration (hr)

8497 E.14.2 Model Parameters

8498

Table\_Apx E-30 summarizes the input model parameters and their values for the *Automotive Refinishing Spray Coating Mist Inhalation Model*. Additional explanations of EPA's selection of the values for each
 parameter are provided after Table\_Apx E-30.

8502

Innut				Paramet		
Input Parameter	Symbol	Unit	OES	Central Tendency	High End	Rationale/ Basis
Concentration	C	mg/m <sup>3</sup>	Use of Paints and Coatings	3.38	22.1	See Section
of Mist	C <sub>mist</sub>	mg/m	Use of Adhesives and Sealants	5.58	22.1	E.14.2.1
DIDP	DIDP Concentration F <sub>DIDP_prod</sub> in Product	kg/kg	Use of Paints and Coatings	0.01	0.05	See Section
			Use of Adhesives and Sealants	0.01	0.78	E.14.2.2
Concentration of Nonvolatile	$F_{solids\_prod}$	kg/kg	Use of Paints and Coatings	0.25	0.5	See Section E.14.2.3
Solids in the Spray Product			Use of Adhesives and Sealants			
DIDP Concentration	F	malma	Use of Paints and Coatings	0.04	0.10	See Section
of Nonvolatile <sup>F</sup> <sub>I</sub> Components	$F_{\text{DIDP}_{solids}}$	mg/mg	Use of Adhesives and Sealants	0.04	1.00	E.14.2.4
Exposure Duration	ED		Use of Paints and Coatings	8		See Section
	ED	hr	Use of Adhesives and Sealants	6	)	E.14.2.5

#### 8503 Table\_Apx E-30. Summary of Parameter Values Used in the Spray Inhalation Model

8504

8505

## E.14.2.1 Concentration of Mist

EPA utilized coating mist concentrations within spray booths obtained through a search of available 8506 OSHA In-Depth Surveys of the Automotive Refinishing Shop Industry and other relevant studies, as 8507 published in the ESD on Coating Application via Spray-Painting in the Automotive Refinishing Industry 8508 (OECD, 2011a). The data is divided into various combinations of spray booth types (e.g., downdraft and 8509 8510 cross draft) and spray gun types (e.g., conventional, high-volume low-pressure). EPA expects there to be 8511 a variety of facility types and substrates being coated such that a variety of spray booth and spray gun combinations may be used to apply the products. Due to this, EPA used mist concentrations from all 8512 scenarios for this parameter. Central tendency and high-end scenario parameters represent the 50<sup>th</sup> and 8513 95<sup>th</sup> percentile mist concentrations, respectively. The central tendency mist concentration was 3.38 8514  $mg/m^3$  and the high-end concentration was 22.1 mg/m<sup>3</sup>. 8515

# 8516 E.14.2.2 DIDP Product Concentration

8516 E.14.2.2 DIDP Product Concentration
 8517 EPA compiled DIDP concentration information from various paint, coating, adhesive, and sealant

8518 products containing DIDP (see Appendix F). EPA used material safety data sheets and technical data

8519 sheets to develop DIDP concentration distributions in each of these product categories. These

distributions were implemented in the modeled Monte Carlo release assessments for each scenario outlined in Sections E.9.7 and E.10.7. For the exposure assessment, EPA used the 50<sup>th</sup> and 95<sup>th</sup>

percentile results as the central tendency and high-end product concentration input parameters,

- respectively. For paints and coatings, the central tendency value was 0.01, and the high-end value was
- 8524 0.05. For adhesives and sealants, the central tendency value was 0.01, and the high-end value was 0.78.

8525	E.14.2.3 Cond	centratio	on of Nonvolatile Solids in the Spray Product			
8526 8527 8528 8529 8530 8531	The ESD on Coating Application via Spray-Painting in the Automotive Refinishing Industry cites data from Volume 6 of the Kirk-Othmer Encyclopedia of Chemical Technology stating that nonvolatile solids in a spray paint or coating product can range from 0.15-0.50 mg/mg (OECD, 2011a; Kirk-Othmer, 1993). EPA used the ESD recommended value of 0.25 mg/mg and the upper bound of the underlying					
8532	E.14.2.4 DID	P Conce	ntration in Nonvolatile Components			
8533 8534 8535	The mass fraction of DID following equation:	P in the r	nonvolatile portion of the sprayed product is calculated using the			
8536	Equation E-96.					
8537			$F_{DIDP\_solids} = \frac{F_{DIDP\_prod}}{F_{solids\ prod}}$			
8538	Where:					
8539 8540	$F_{DIDP\_solids}$	=	Mass fraction of DIDP in the nonvolatile portion of the sprayed product (mg <sub>DIDP</sub> /mg <sub>nonvolatile components</sub> )			
8541 8542	$F_{DIDP\_prod}$	=	Mass fraction of DIDP in the paint, coating, adhesive, or sealant product, spray-applied (mg <sub>DIDP</sub> /mg <sub>s prayed product</sub> )			
8543 8544	$F_{solids\_prod}$	=	Mass fraction of nonvolatile components within the sprayed product (mg <sub>nonvolatile components</sub> /mg <sub>sprayed product</sub> )			
8545 8546 8547 8548 8549	results of this equation we	re a cent	$F_{s} > 1$ , then the value of $F_{DIDP\_solids}$ is assessed at a value of 1. The ral tendency DIDP concentration of 0.04 for both scenarios, a highs and coatings, and a high-end concentration of 1.00 for adhesives			

8550

## **E.14.2.5 Exposure Duration**

8551 EPA did not identify DIDP-specific data on spray application duration. Due to this, and the expected 8552 variety in substrates and facility types for these scenarios, the exposure duration was assessed at a full eight-hour shift. The full-shift assumption may overestimate the application duration as workers likely 8553 8554 have other activities (e.g., container unloading and cleaning) during their shift; however, those activities 8555 may also result in exposures to vapors that volatilize during those activities. Since EPA is not factoring 8556 in those vapor exposures, an eight-hour duration for spraying is used and assumed to be protective of 8557 any contribution to exposures from vapors.

#### E.15 Inhalation Exposure Modeling for Penetrants and Inspection Fluids 8558

This appendix presents the modeling approach and model equations used in the near-field/far-field 8559 8560 exposure modeling of the use of penetrants and inspection fluids. EPA developed the model through 8561 review of the literature and consideration of existing EPA/OPPT exposure models. This model is based 8562 on a near-field/far-field approach (AIHA, 2009), where an aerosol application located inside the near-8563 field generates a mist of droplets, and indoor air movements lead to the convection of the droplets 8564 between the near-field and far-field. The model assumes workers are exposed to DIDP droplets in the 8565 near-field, while occupational non-users are exposed in the far-field. 8566

8567 The model uses the following parameters to estimate exposure concentrations in the near-field and farfield: 8568

- Far-field size;
- Near-field size;
- Air exchange rate;
- Indoor air speed;
- Concentration of DIDP in the aerosol formulation;
- Amount of product used per job;
- Number of applications per job;
- Time duration of job;
- Operating hours per week; and
  - Number of jobs per work shift.

8579 An individual model parameter could be either a discrete value or a distribution of values. EPA assigned statistical distributions based on available literature data. EPA used a Monte Carlo simulation (a type of 8580 8581 stochastic simulation) to capture variability in the model parameters. EPA conducted the simulation 8582 using the Latin hypercube sampling method in @Risk Industrial Edition, Version 8.0.0. The Latin hypercube sampling method generates parameter values from a multi-dimensional distribution and is a 8583 8584 stratified method, where the generated samples are representative of the probability density function 8585 (variability) defined in the model. EPA selected 100,000 model iterations to capture a broad range of possible input values, including values with low probability of occurrence. 8586

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Model results from the Monte Carlo simulation are presented as 95<sup>th</sup> and 50<sup>th</sup> percentile values in
Section 3.14.4.3. The statistics were calculated directly in @Risk. EPA selected the 95<sup>th</sup> percentile value
to represent high-end exposure level and the 50<sup>th</sup> percentile value to represent the central tendency
exposure level. The following subsections detail the model design equations and parameters for the
near-field/far-field model.

## 8593 E.15.1 Model Design Equations

Penetrant/inspection fluid application generates a mist of droplets in the near-field, resulting in worker 8594 8595 exposures at a DIDP concentration  $C_{NF}$ . This concentration is directly proportional to the amount of 8596 penetrant applied by the worker standing in the near-field-zone (*i.e.*, the working zone). The near-field-8597 zone volume is denoted as V<sub>NF</sub>. The ventilation rate for the near-field-zone (Q<sub>NF</sub>) determines the rate of 8598 DIDP dissipation into the far-field (*i.e.*, the facility space surrounding the near-field), resulting in occupational bystander exposures to DIDP at a concentration C<sub>FF</sub>. V<sub>FF</sub> denotes the volume of the far-8599 8600 field space into which the DIDP dissipates from the near-field. The ventilation rate of the surroundings, denoted as Q<sub>FF</sub>, determines the rate of DIDP dissipation from the surrounding space into the outside air. 8601 8602

EPA denoted the top of each five-minute period for each hour of the day (*e.g.*, 8:00 am, 8:05 am, 8:10 am, etc.) as  $t_{m,n}$ . Here, m has the values of 0, 1, 2, 3, 4, 5, 6, and 7 to indicate the top of each hour of the day (*e.g.*, 8 am, 9 am, etc.) and n has the values of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, and 11 to indicate the top of each five-minute period within the hour. The worker begins the first penetrant application job during the first hour,  $t_{0,0}$  to  $t_{1,0}$  (*e.g.*, 8 am to 9 am). The worker applies the penetrant at the top of the second 5minute period  $t_{m,1}$  (*e.g.*, 8:05 am, 9:05 am, etc.).

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8610 The model design equations are presented below in Equation E-97 through Equation E-117.

- 8611
- 8612 <u>Near-Field Mass Balance:</u>
- 8613 **Equation E-97.**

$$V_{NF}\frac{dC_{NF}}{dt} = C_{FF}Q_{NF} - C_{NF}Q_{NF}$$

- 8616 **Equation E-98.**
- 8617

8626

0010	Equation E >	••	
8617			$V_{FF}\frac{dC_{FF}}{dt} = C_{NF}Q_{NF} - C_{FF}Q_{NF} - C_{FF}Q_{FF}$
8618	Where:		
8619	$V_{NF}$	=	near-field volume [m <sup>3</sup> ]
8620	$V_{FF}$	=	far-field volume [m <sup>3</sup> ]
8621	$Q_{NF}$	=	near-field ventilation rate [m <sup>3</sup> /hr]
8622	$Q_{FF}$	=	far-field ventilation rate [m <sup>3</sup> /hr]
8623	$C_{NF}$	=	average near-field concentration [mg/m <sup>3</sup> ]
8624	$C_{FF}$	=	average far-field concentration [mg/m <sup>3</sup> ]
8625	t	=	elapsed time [hr]
8625	t	=	elapsed time [hr]

Solving Equation E-97 and Equation E-98 in terms of the time-varying concentrations in the near-field 8627 and far-field yields Equation E-99 and Equation E-100. EPA assessed Equation E-99 and Equation 8628 E-100 for all values of t<sub>m.n</sub>. For each five-minute increment, EPA calculated the initial near-field 8629 concentration at the top of each period  $(t_{m,n})$ , accounting for the burst of DIDP from the penetrant 8630 application (if the five-minute increment is during an application) and the residual near-field 8631 8632 concentration remaining after the previous five-minute increment  $(t_{m,n-1}; except during the first hour and$  $t_{m,0}$  of the first penetrant application job, in which case there would be no residual DIDP from a previous 8633 8634 application). The initial far-field concentration is equal to the residual far-field concentration remaining 8635 after the previous five-minute increment. EPA then calculated the decayed concentration in the near-8636 field and far-field at the end of the five-minute period, just before the penetrant application at the top of 8637 the next period  $(t_{m,n+1})$ . EPA then calculated 5-minute TWA exposures for the near-field and far-field, 8638 representative of the worker's and ONU's exposures to the airborne concentrations during each fiveminute increment using Equation E-109 and Equation E-110. k coefficients (Equation E-101 through 8639 Equation E-104) are a function of initial near-field and far-field concentrations and are re-calculated at 8640 8641 the top of each five-minute period.

8642 8643 In the equations below, if n-1 is less than zero, the value at "m-1, 11" is used instead. Additionally, if n+1 is greater than 11, the value at "m+1, 0" is used instead. 8644

8646 **Equation E-99.** 

$$C_{NF,t_{m,n+1}} = \left(k_{1,t_{m,n}}e^{\lambda_1 t} + k_{2,t_{m,n}}e^{\lambda_2 t}\right)$$

8649 **Equation E-100.** 

$$C_{FF,t_{m,n+1}} = \left(k_{3,t_{m,n}}e^{\lambda_1 t} - k_{4,t_{m,n}}e^{\lambda_2 t}\right)$$

8652 **Equation E-101.** 

$$k_{1,t_{m,n}} = \frac{Q_{NF} \left( C_{FF,0}(t_{m,n}) - C_{NF,0}(t_{m,n}) \right) - \lambda_2 V_{NF} C_{NF,0}(t_{m,n})}{V_{NF} (\lambda_1 - \lambda_2)}$$

8655 **Equation E-102.** 

8656 
$$k_{2,t_{m,n}} = \frac{Q_{NF} \left( C_{NF,0}(t_{m,n}) - C_{FF,0}(t_{m,n}) \right) + \lambda_1 V_{NF} C_{NF,0}(t_{m,n})}{V_{NF} (\lambda_1 - \lambda_2)}$$

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## Page 321 of 335

**Equation E-103.** 

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$$k_{3,t_{m,n}} = \frac{(Q_{NF} + \lambda_1 V_{NF})(Q_{NF} \left(C_{FF,0}(t_{m,n}) - C_{NF,0}(t_{m,n})\right) - \lambda_2 V_{NF} C_{NF,0}(t_{m,n}))}{Q_{NF} V_{NF} (\lambda_1 - \lambda_2)}$$

**Equation E-104.** 

8662 
$$k_{4,t_{m,n}} = \frac{(Q_{NF} + \lambda_2 V_{NF})(Q_{NF} (C_{NF,0}(t_{m,n}) - C_{FF,0}(t_{m,n})) + \lambda_1 V_{NF} C_{NF,0}(t_{m,n}))}{Q_{NF} V_{NF} (\lambda_1 - \lambda_2)}$$

## **Equation E-105.**

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$$\lambda_{1} = 0.5 \left[ -\left( \frac{Q_{NF}V_{FF} + V_{NF}(Q_{NF} + Q_{FF})}{V_{NF}V_{FF}} \right) + \sqrt{\left( \frac{Q_{NF}V_{FF} + V_{NF}(Q_{NF} + Q_{FF})}{V_{NF}V_{FF}} \right)^{2} - 4\left( \frac{Q_{NF}Q_{FF}}{V_{NF}V_{FF}} \right)} \right]$$

8667 Equation E-106.  
8668 
$$\lambda_2 = 0.5 \left[ -\left(\frac{Q_{NF}V_{FF} + V_{NF}(Q_{NF} + Q_{FF})}{V_{NF}V_{FF}}\right) - \sqrt{\left(\frac{Q_{NF}V_{FF} + V_{NF}(Q_{NF} + Q_{FF})}{V_{NF}V_{FF}}\right)^2 - 4\left(\frac{Q_{NF}Q_{FF}}{V_{NF}V_{FF}}\right)} \right]$$

8670 Equation E-107.

8671  

$$C_{NF,o}(t_{m,n}) = \begin{cases} Amt \\ V_{NF} \\ (1,000 \frac{mg}{g}) + C_{NF}(t_{m,n-1}), & n > 0 \text{ for all } m \text{ where penetrant job occurs} \end{cases}$$
8672

8673 Equation E-108.

8674 
$$C_{FF,o}(t_{m,n}) = \begin{cases} 0, & m = 0\\ C_{FF}(t_{m,n-1}), & \text{for all } n \text{ where } m > 0 \end{cases}$$

**Equation E-109**.

8677 
$$C_{NF, 5-\min TWA, t_{m,n}} = \frac{\left(\frac{k_{1,t_{m,n-1}}}{\lambda_1}e^{\lambda_1 t_2} + \frac{k_{2,t_{m,n-1}}}{\lambda_2}e^{\lambda_2 t_2}\right) - \left(\frac{k_{1,t_{m,n-1}}}{\lambda_1}e^{\lambda_1 t_1} + \frac{k_{2,t_{m,n-1}}}{\lambda_2}e^{\lambda_2 t_1}\right)}{t_2 - t_1}$$

## **Equation E-110.**

8680 
$$C_{FF, 5-\min TWA, t_{m,n}} = \frac{\left(\frac{k_{3,t_{m,n-1}}}{\lambda_1}e^{\lambda_1 t_2} + \frac{k_{4,t_{m,n-1}}}{\lambda_2}e^{\lambda_2 t_2}\right) - \left(\frac{k_{3,t_{m,n-1}}}{\lambda_1}e^{\lambda_1 t_1} + \frac{k_{4,t_{m,n-1}}}{\lambda_2}e^{\lambda_2 t_1}\right)}{t_2 - t_1}$$

After calculating all near-field/far-field 5-minute TWA exposures (*i.e.*,  $C_{NF,5-\min TWA,t_{m,n}}$  and  $C_{FF,5-\min TWA,t_{m,n}}$ ), EPA calculated the near-field/far-field 1-hour and 8-hour TWA concentrations according to the following equations: 

## **Equation E-111.**

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$$C_{NF, 8-hr TWA} = \frac{\sum_{m=0}^{7} \sum_{n=0}^{11} \left[ C_{NF, 5-\min TWA, t_{m,n}} \times 0.0833 hr \right]}{8 hr}$$

### Page 322 of 335

8688 8689 **Equation E-112.** 

8690  
8691
$$C_{NF, 8-hr TWA} = \frac{\sum_{m=0}^{7} \sum_{n=0}^{11} \left[ C_{FF, 5-\min TWA, t_{m,n}} \times 0.0833 hr \right]}{8 hr}$$

8692 Equation E-113.

$$C_{NF,1-\text{hr }TWA} = \frac{\sum_{n=0}^{11} \left[ C_{NF,5-\min TWA,t_{m,n}} \times 0.0833 \ hr \right]}{1 \ hr}$$

8694 8695 **Equation E-114.** 

$$C_{FF,1-\text{hr }TWA} = \frac{\sum_{n=0}^{11} \left[ C_{FF,5-\min TWA,t_{m,n}} \times 0.0833 \ hr \right]}{1 \ hr}$$

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EPA calculated rolling 1-hour TWAs throughout the workday, while the model reported the maximum
calculated 1-hour TWA.

To calculate the mass transfer to and from the near field, the free surface area (FSA) is defined as the surface area through which mass transfer can occur. The FSA is not equal to the surface area of the entire near field. EPA defined the near-field zone to be a hemisphere with its major axis oriented vertically, against the application surface. The top half of the circular cross-section rests against, and is blocked by, the surface and is not available for mass transfer. The FSA is calculated as the entire surface area of the hemisphere's curved surface and half of the hemisphere's circular surface per Equation E-115:

8709 Equation E-115.

$$FSA = \left(\frac{1}{2} \times 4\pi R_{NF}^2\right) + \left(\frac{1}{2} \times \pi R_{NF}^2\right)$$

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Where:  $R_{NF}$  is the radius of the near-field [m]

The near-field ventilation rate,  $Q_{NF}$ , is calculated from the indoor wind speed,  $v_{NF}$ , and FSA, assuming half of the FSA is available for mass transfer into the near-field and half is available for mass transfer out of the near-field:

8718 **Equation E-116.** 

$$Q_{NF} = \frac{1}{2} v_{NF} FSA$$

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8721 The far-field volume,  $V_{FF}$ , and the air exchange rate (AER) are used to calculate the far-field ventilation 8722 rate,  $Q_{FF}$ :

8724 **Equation E-117.** 

8725  $Q_{FF} = V_{FF} \times AER$ 8726 Using the model inputs described in Section E.15.2, EPA estimated DIDP worker inhalation exposures 8727 in the near-field and ONU inhalation exposures in the far-field. EPA then conducted Monte Carlo 8728 simulations using @Risk Version 8.0.0 to calculate exposure results shown in Section 3.14.4.3. The

simulations applied the Latin Hypercube sampling method using 100,000 iterations.

## 8730 E.15.2 Model Parameters

- 8731 Table\_Apx E-31 summarizes the model parameters for the near-field/far-field modeling of the use
- penetrants and inspection fluids. Each parameter is discussed in further detail in the followingsubsections.

8734 Table\_Apx E-31. Summary of Parameter Values Used in the Near-Field/Far-Field Inhalation Exposure Modeling of Penetrants and
 8735 Inspection Fluids

•				Variable				
Input Parameter	Symbol	Unit	Constant Value <sup>11</sup>	Lower Bound	Upper Bound	Mode	Distribution Type	Rationale
Far-field Volume	$V_{FF}$	m <sup>3</sup>	_	206	70,679	3,769	Triangular	See Section E.15.2.1
Air Exchange Rate	AER	m³/hr		1	20	3.5	Triangular	See Section E.15.2.2
Near-field Indoor		cm/s		1.3	202.2		Lognormal	See Section
Air Speed	VNF	ft/min	_	2.56	398.05		Lognormal	E.15.2.3
Near-field Radius	$R_{\rm NF}$	m <sup>3</sup>	1.5		_	_	_	See Section E.15.2.4
Application Time	$t_2$	hr	0.0833			_	—	See Section E.15.2.5
Averaging Time	t <sub>avg</sub>	hr	8				—	See Section E.15.2.6
DIDP Product Concentration	Fdidp	kg/kg	_	0.1	0.2		Uniform	See Section E.15.2.7
Volume of Penetrant Used per Job	$Q_{penetrant_job}$	oz/job		1.05	2.63		Uniform	See Section E.15.2.8
Number of Applications per Job	$\mathbf{N}_{app\_job}$	applications/job	1				_	See Section E.15.2.9
Number of Jobs per Work Shift	$N_{jobs\_day}$	jobs/day	8					See Section E.15.2.11

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<sup>&</sup>lt;sup>11</sup> Each parameter is represented either by a constant value or a distribution.

## 8737 E.15.2.1 Far-Field Volume

- 8738 Since EPA was not able to identify any penetrant- or DIDP-specific use or exposure data, EPA utilized a 8739 near-field/far-field approach (AIHA, 2009). The far-field volume is based on site visits of 137 8740 automotive maintenance and repair shops in California (CARB, 2000). The California Air Resources Board indicated that shop volumes ranged from 200 to 70,679 m<sup>3</sup> with an average shop volume of 3,769 8741 8742 m<sup>3</sup>. EPA assumed that the range of facility volumes in this data set would also be representative of other 8743 facility types which use DIDP-based penetrants and inspection fluids Based on this data EPA assumed a triangular distribution bound from 200 m<sup>3</sup> to 70,679 m<sup>3</sup> with a mode of 3,769 m<sup>3</sup> (the average of the data 8744 8745 from CARB).
- 8746

8747 CARB measured the physical dimensions of the brake service work area within each automotive

8748 maintenance and repair shop. CARB did not consider other areas of the facility, such as customer

8749 waiting areas and adjacent storage rooms if they were separated by a normally closed door. If the door 8750 was normally open, CARB considered these areas as part of the area in which brake servicing emission

was normally open, CARB considered these areas as part of the area in which brake servicing emissions
 could occur (CARB, 2000). CARB's methodology for measuring the physical dimensions of the visited

8752 facilities provides the appropriate physical dimensions needed to represent the far-field volume in EPA's

8753 model. Therefore, CARB's reported facility volume data are appropriate for EPA's modeling purposes.

## 8754 E.15.2.2 Air Exchange Rate

The AER is based on data from Demou et al., Hellweg et al., Golsteijn, et al., and information received 8755 8756 from a peer reviewer during the development of the 2014 TSCA Work Plan Chemical Risk Assessment 8757 Trichloroethylene: Degreasing, Spot Cleaning and Arts & Crafts Uses (Golsteijn et al., 2014; U.S. EPA, 2013; Demou et al., 2009; Hellweg et al., 2009). Demou et al. identified typical AERs of 1 hr<sup>-1</sup> and 3 to 8758 8759 20 hr<sup>-1</sup> for occupational settings with and without mechanical ventilation systems, respectively. 8760 Similarly, Hellweg et al. identified average AERs for occupational settings using mechanical ventilation 8761 systems to vary from 3 to 20 hr<sup>-1</sup>. Golsteijn, *et al.* indicated a characteristic AER of 4 hr<sup>-1</sup>. The risk assessment peer reviewer comments from TCE indicated that values around 2 to 5  $hr^{-1}$  are likely (U.S. 8762 8763 EPA, 2013), in agreement with Golsteijn, et al. and at the low end of the range reported by Demou *et al.* 8764 and Hellweg et al. Therefore, EPA used a triangular distribution with a mode of 3.5 hr<sup>-1</sup>. EPA used the 8765 midpoint of the range provided by the risk assessment peer reviewer (3.5 is the midpoint of the range 2 8766 to 5 hr<sup>-1</sup>), a minimum of 1 hr<sup>-1</sup> per Demou *et al.*, and a maximum of 20 hr<sup>-1</sup> per Demou *et al.* and 8767 Hellweg et al.

## E.15.2.3 Near-Field Indoor Air Speed

Baldwin and Maynard measured indoor air speeds within 55 occupational settings in the United
Kingdom (Baldwin and Maynard, 1998). EPA analyzed the air speed data from Baldwin and Maynard
and categorized the air speed surveys into data representative of industrial facilities and data
representative of commercial facilities. EPA fit separate distributions for these industrial and
commercial settings and used the industrial distribution for this model.

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EPA fit a lognormal distribution for the data set, consistent with the authors' observations that the air
speed measurements within a surveyed location were lognormally distributed, and the population of the
mean air speeds among all surveys were lognormally distributed (<u>Baldwin and Maynard, 1998</u>). Since
lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the
largest mean air speed value observed among the surveys.

8781 EPA resulting lognormal distribution had a mean of  $22.414 \pm 19.958$  cm/s, a minimum allowed value of 8782 1.3 cm/s, and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in

Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are
otherwise unrealistically small or large (<u>Baldwin and Maynard, 1998</u>).

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  - 85
- 8786 Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the
- individual measurements within each survey. Therefore, these distributions represent a distribution of
  mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting.
- 8789 However, a mean air speed (averaged over a work area) is the required input for the model.
- 8790 E.15.2.4 Near-Field Volume

8791 EPA defined the near-field zone as a hemisphere with its major axis oriented vertically against the 8792 application surface. EPA also defined a near-field radius ( $R_{NF}$ ) of 1.5 meters, approximately 4.9 feet, as 8793 an estimate of the working height of the application surface, as measured from the floor to the center of 8794 the surface.

 $V_{NF} = \frac{1}{2} \times \frac{4}{3} \pi R_{NF}^3$ 

- 8796 **Equation E-118.**
- 8797

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- 8799 E.15.2.5 Application Time

EPA modeled the application time at 5-minute intervals, as it is expected that the penetrant will be
sprayed onto the surface, allowed to sit on the surface, and finally wiped away after the surface has been
examined for defects. For this process, it is expected that the application step will only take 5 minutes.

8803 E.15.2.6 Averaging Time

EPA uses 8-hr TWAs for its risk calculations; therefore, EPA used a constant averaging time of eighthours.

8806 E.15.2.7 DIDP Product Concentration

EPA was not able to identify DIDP-specific penetrant product information; however, EPA assessed the
DIDP penetrant concentration using surrogate DINP concentration information from a penetrant and
inspection fluid product, Spotcheck ® SKL-SP2. EPA used the safety data sheet to develop a range of
concentrations for the product (<u>ITW Inc, 2018</u>). EPA assessed the DIDP product concentration using a
uniform distribution ranging from 0.1 to 0.2.

8812 E.15.2.8 Volume of Penetrant Used per Job

EPA utilized a penetrant and inspection fluid containing DINP as surrogate and assessed the product
information using the safety data sheet (<u>ITW Inc, 2018</u>). Based on this information, EPA estimated that
the amount of penetrant per aerosol container was 10.5 oz. EPA then assumed the quantity of penetrant
used per job as a uniform distribution ranging from 10-25% of can per job or 1.05 to 2.63 oz.

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- 8818 This throughput range differs from the throughput used to assess the releases for this OES as outlined in 8819 Section E.13.3. The discrepancy reflects the expected discrepancy in number of workers applying the
- 8819 Section E.13.3. The discrepancy reflects the expected discrepancy in number of workers applying the 8820 product and working the job at a given site. EPA expects that these tasks will be performed by multiple
- workers per day, and that no one worker would regularly apply these products for a full shift. Thus, the
- 8822 10-25% range results in less penetrant per job and is expected be more representative of aerosol
- 8823 exposures for a single worker.

#### 8824 E.15.2.9 Number of Applications per Job

EPA modeled the penetrant scenario with one application per job, as it is expected that the penetrant will 8825 8826 be sprayed onto the surface, allowed to sit on the surface, and finally wiped away after the surface has 8827 been examined for defects.

#### E.15.2.10 Amount of DIDP Used per Application 8828

EPA calculated the amount of DIDP used per application using Equation E-119. The calculated mass of 8829 DIDP per application ranges from  $2.09 \times 10^{-3}$  to  $4.17 \times 10^{-3}$  grams. 8830

8832 **Equation E-119.** 

$$Amt = \frac{Q_{penetrant_job} \times F_{DIDP} \times 28.3495 \frac{g}{oz}}{N_{app_job}}$$

8831

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8834	Where:	
8835	Amt =	Amount of DIDP used per application [g/application]
8836	$Q_{penetrant_job} =$	Amount of penetrant used per job [oz/job]
8837	$F_{DIDP} =$	Product concentration [kg/kg]
8838	$N_{app_job} =$	Number of applications per job [applications/job]

8839 E.15.2.11 Number of Jobs per Work Shift EPA did not identify DIDP-specific data on penetrant and inspection fluid application frequency. 8840 8841 Therefore, EPA assessed exposures assuming 8 jobs per work shift, which is equivalent to one job per 8842 hour for a full 8-hour shift. The full-shift assumption may overestimate the application duration, as 8843 workers likely have other activities during their shift; however, those activities may also result in 8844 exposures to vapors that volatilize during those activities. Since EPA is not factoring in those vapor 8845 exposures, a full-shift exposure assessment is assumed to be protective of any contribution to exposures 8846 from vapors.

#### **E.16 Inhalation Exposure to Respirable Particulates Model Approach and** 8847 **Parameters** 8848

8849 The Generic Model for Central Tendency and High-End Inhalation Exposure to Total and Respirable 8850 Particulates Not Otherwise Regulated (PNOR) (U.S. EPA, 2021d) estimates worker inhalation exposure 8851 to respirable solid particulates using personal breathing zone Particulate, Not Otherwise Regulated (PNOR) monitoring data from OSHA's Chemical Exposure Health Data (CEHD) data set. The CEHD 8852 8853 data provides PNOR exposures as 8-hour TWAs by assuming exposures outside the sampling time are zero, and the data also include facility NAICS code information for each data point. To estimate 8854 particulate exposures for relevant OESs, EPA used the 50<sup>th</sup> and 95<sup>th</sup> percentiles of respirable PNOR 8855 values for applicable NAICS codes as the central tendency and high-end exposure estimates, 8856 respectively. 8857 8858

8859 EPA assumed DIDP is present in particulates at the same mass fraction as in the bulk solid material, whether that is a plastic product or another solid article. Therefore, EPA calculates the 8-hour TWA 8860 8861 exposure to DIDP present in dust and particulates using the following equation:

8862 8863 **Equation E-120.** 

 $C_{DIDP,8hr-TWA} = C_{PNOR,8hr-TWA} \times F_{DIDP}$ 

8865

8864

Where: 8866

8867	$C_{DIDP,8hr-TWA}$	=	8-hour TWA exposure to DIDP [mg/m <sup>3</sup> ]
8868	C <sub>PNOR,8hr-TWA</sub>	=	8-hour TWA exposure to PNOR [mg/m <sup>3</sup> ]
8869	F <sub>DIDP</sub>	=	Mass fraction of DIDP in PNOR [mg/mg]

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Table\_Apx E-32 provides a summary of the OESs assessed using the *Generic Model for Central* 

8872 Tendency and High-End Inhalation Exposure to Total and Respirable Particulates Not Otherwise

8873 Regulated (PNOR) (U.S. EPA, 2021d) along with the associated NAICS code, PNOR 8-hour TWA

8874 exposures, DIDP mass fraction, and DIDP 8-hour TWA exposures assessed for each OES.

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# Table\_Apx E-32. Summary of DIDP Exposure Estimates for OESs Using the Generic Model for Exposure to PNOR

Occupational Exposure	NAICS Code Assessed	Respirable P hr TWA fron (mg/m	n Model	DIDP Mass Fraction	DIDP 8-hr TWA (mg/m <sup>3</sup> )		
Scenario		Central Tendency	High- End	Assessed	Central Tendency	High- End	
Non-PVC Materials Compounding	326 – Plastics and Rubber Manufacturing	0.23	4.7	0.20	4.6E-02	0.94	
PVC Plastics Compounding	326 – Plastics and Rubber Manufacturing	0.23	4.7	0.20	4.6E-02	0.94	
Non-PVC Materials Converting	326 – Plastics and Rubber Manufacturing	0.23	4.7	0.45	0.10	2.1	
PVC Plastics Converting	326 – Plastics and Rubber Manufacturing	0.23	4.7	0.45	0.10	2.1	
Recycling and Disposal	56 – Administrative and Support and Waste Management and Remediation Services	0.24	3.5	0.45	0.11	1.6	
Fabrication and Final Use of Products or Articles	337 – Furniture and Related Product Manufacturing	0.20	1.8	0.45	9.0E-02	0.81	

8878

HERO ID

6984628

6984634

6984636

6984631

6984632

6984633

6984645

## 8879 Appendix F Products Containing DIDP

This section includes a sample of products containing DIDP. This is not a comprehensive list of
products containing DIDP. In addition, some manufacturers may appear over-represented in Table\_Apx
F-1. This may mean that they are more likely to disclose product ingredients online than other
manufacturers but does not imply anything about use of the chemical compared to other manufacturers
in this sector.

8885

#### DIDP OES Product Manufacturer Source Concentration 5 - 10%, by Adhesive/ M-3180 Part A **BJB** Enterprises **BJB** Enterprises, weight Inc. (2013) Sealant Inc. WC-766 Part B **BJB** Enterprises, 1 - 5%, by **BJB** Enterprises Adhesive/ weight Inc. (2017e) Sealant Inc. **BJB** Enterprises, 10 - 30%, by **BJB** Enterprises Adhesive/ BR-90 Brushable Sealant Part B Inc. weight Inc. (2018) Adhesive/ TC-808 Part A **BJB** Enterprises, 10 - 30%, by **BJB** Enterprises Sealant Inc. weight Inc. (2017b) 15 - 40%, by Adhesive/ **BJB** Enterprises, **BJB** Enterprises TC-885 FR Rev 1 Sealant Part A Inc. weight Inc. (2017c; 2017d) 15 - 40%, by **BJB** Enterprises Adhesive/ TC-886 FR Rev 1 **BJB** Enterprises, Sealant weight Inc. (2017c; Part A Inc. 2017d) 50-<75%. Adhesive/ Carboseal Flex Carboline Carboline

## 8886 Table\_Apx F-1. Products Containing DIDP

Tunesive/	Carboscar r lex	Carbonne	50 <7570,	Carbonne	0704043
Sealant	Joint Part B	Company	unspecified	Company	
				(2019)	
Adhesive/	Fast Cast <sup>TM</sup>	Environmental	10 - 40%,	Environmental	6984665
Sealant		Technology,	unspecified	Technology Inc.	
		Inc.,		(2016)	
Adhesive/	Quikjoint UVR	Euclid Chemical	0.01 - < 1%,	Euclid	6984667
Sealant	Standard Gray 1:1	Company	unspecified	Chemical	
	Part B			Company	
				(2017)	
Adhesive/	Euco Qwikjoint	Euclid Chemical	50-<100%,	Euclid	6984669
Sealant	200 Part B - 50	Company	unspecified	Chemical	
	Gallon			Company	
				(2019)	
Adhesive/	Part #3475	Fibre Glast	<30%,	Fibre Glast	6984678
Sealant	Urethane Casting	Developments	unspecified	Developments	
	Resin, 75 Shore D,	Corp.		Corp.	
	Part B			(2019)	
Adhesive/	Floor 2-Glk Epoxy	Rust-Oleum	0.1%, by weight	Rust-Oleum	6984580
Sealant	Floor Patching	Corporation		Corporation	
	Comp Part B			(2018a)	
Adhesive/	InstaPatch Part B	Rust-Oleum	24%, by weight	Rust-Oleum	6984579
Sealant	Tile Red	Corporation		Corporation	
		_		(2018b, 2017)	
Adhesive/	InstaPatch Part B	Rust-Oleum			6984581
Sealant	Gray	Corporation			

OES	Product	Manufacturer	DIDP Concentration	Source	HERO ID
Adhesive/ Sealant	Heavy Duty Construction Adhesive	Gorilla Glue Company	Unknown	Home Depot (2019a)	6984539
Adhesive/ Sealant	3M(TM) Marine Adhesive Sealant Fast Cure 4000 UV, White	3M	10-20%, by weight	3M Company (2019)	6984622
Adhesive/ Sealant	3.0 Gutter & Flashing Sealant Crystal Clear	DAP Products Inc.	Unknown	DAP Products Inc. (2015)	6984655
Adhesive/ Sealant	3.0 Window, Door, Trim & Siding Sealant -Crystal Clear	DAP Products Inc.	Unknown	DAP Products Inc. (2019)	6836835
Adhesive/ Sealant	Genova Products Vinyl Adhesive/Filler - Clear	Genova Products	<30%, by weight	Genova Products (2013)	6984680
Adhesive/ Sealant	Marldon MXA 200 600ml	Havwoods Accessories	1 – <5%, unspecified	Havwoods Accessories (2017)	6984536
Adhesive/ Sealant	Red Devil King Kaul All In One Adhesive, Caulk, Sealant	Red Devil, Inc.	1%, unspecified	Walmart (2019)	6984555
Adhesive/ Sealant	King Kaulk Adhesive & Sealant-White & colors	Red Devil, Inc.		Red Devil (2016)	6984577
Adhesive/ Sealant	Soudaseal SL	Soudal	Unknown	Soudal (2019a; 2019b)	6984584
Adhesive/ Sealant	Soudaseal MB	Soudal	Unknown	Soudal (2019a; 2019b)	6984583
Adhesive/ Sealant	Bird Barrier Bond	SOUDAL Accumetric	1%, unspecified	SOUDAL Accumetric (2015a)	6984586
Adhesive/ Sealant	Soudaseal AP	SOUDAL Accumetric	20 – 30%, unspecified	SOUDAL Accumetric (2015b)	6984588
Adhesive/ Sealant	Soudaseal FC	SOUDAL Accumetric	1%, unspecified	SOUDAL Accumetric (2015c)	6984589
Adhesive/ Sealant	3M <sup>™</sup> MSP Seam Sealer – White, PN 08369	3M	1-5%, by weight	3M Company (2018)	5353143
Adhesive/ Sealant	Childers CP-70	H.B. Fuller Construction Products Inc.	1-5%, unspecified	H.B. Fuller Construction Products Inc. (2017)	6984517

OES	Product	Manufacturer	DIDP Concentration	Source	HERO ID
Adhesive/ Sealant	Protecto Sealant 25XL	Protecto Wrap Company	3 – 7%, by weight	Protecto Wrap Company (2008)	6302503
Adhesive/ Sealant	Joint and Termination Sealant	R.M. Lucas Company	10 – 20%, by weight	R.M. Lucas Company (2015a)	6984563
Adhesive/ Sealant	Semi-Selfleveling Sealer	R.M. Lucas Company	10 – 20%, by weight	R.M. Lucas Company (2015b)	6984576
Adhesive/ Sealant	Watertite 10.1-Oz 12 Pk Polyurethan SLR	Rust-Oleum Corporation	0.1 – <1%, by weight	Rust-Oleum Corporation (2015)	6984578
Adhesive/ Sealant	Zinsser 10 oz. Watertite Waterproofing Poly Seal Tube	Rust-Oleum Corporation	0.1 – 1%, by weight	Home Depot (2019b) <u>ENRE</u> <u>F_78</u>	6984543
Adhesive/ Sealant	Sakrete Polyurethane Self Leveling Sealant	Sakrete of North America	20-40%, by weight	Sakrete of North America (2018)	6984582
Adhesive/ Sealant	TremGrip Gray Adh. 12 X 300 ML CTG	Tremco Canadian Sealants	1 – <5%, unspecified	Tremco Canadian Sealants (2018)	6984637
Adhesive/ Sealant	Dymonic 100 White - 30 CTG	Tremco Canadian Sealants	0.1 – 1%, unspecified	Tremco Canadian Sealants (2019a)	6984640
Adhesive/ Sealant	Vulkem 116 Limestone	Tremco Incorporated	15 – 40%, by weight	Tremco Incorporated (2010)	6984648
Adhesive/ Sealant	Vulkem 116 Gray	Tremco Incorporated		Tremco Incorporated (2010)	6984646
Adhesive/ Sealant	Vulkem 116 LV Buff 30 CTG/CS	Tremco Incorporated		Tremco Incorporated (2010)	6984650
Adhesive/ Sealant	Vulkem 116 White	Tremco Incorporated		Tremco Incorporated (2010)	6984654
Adhesive/ Sealant	TremSeal Pro Limestone- 30 CTG CS	Tremco U.S. Roofing	0.1 – 1%, unspecified	Tremco U.S. Roofing (2019)	6984522
Adhesive/ Sealant	Spectrem® 4	Tremco U.S. Sealants	1-<5%, unspecified	Tremco U.S. Sealants (2018)	6302529
Adhesive/ Sealant	Dymonic 100 Redwood Tan - 30 CG CS	Tremco U.S. Sealants	0.1 – <1%, unspecified	Tremco U.S. Sealants (2017a)	6984532
Adhesive/ Sealant	Vulkem 116 LV Off White 30 CTG/CS	Tremco U.S. Sealants	10-<25%, unspecified	Tremco U.S. Sealants (2017b)	6984533
Functional Fluid	Duratherm G-LV	Duratherm	10-30%, unspecified	Duratherm (2019)	6984663

			DIDP		
OES	Product	Manufacturer	Concentration	Source	HERO ID
Functional Fluid	Duratherm G	Duratherm	10-30%,	Duratherm	6984662
			unspecified	(2019)	
Functional Fluid	U-Clean	Duratherm	10 - 20%,	Duratherm	6984660
			unspecified	(2018c)	
Functional Fluid	Duraclean Ultra	Duratherm	20 - 75%,	Duratherm	6984661
			unspecified	(2019)	
Functional Fluid	Duraclean	Duratherm	20 - 75%,	Duratherm	6984658
			unspecified	(2019)	
Functional Fluid	Duraclean LSC	Duratherm	20 - 75%,	Duratherm	6984659
			unspecified	(2019)	
Functional Fluid	DELF Clean Ultra	Mokon	20 - 75%,	Mokon (2018b)	6984550
			unspecified		
Functional Fluid	DELF Clean	Mokon	10 - 20%,	Mokon (2018a)	6836818
			unspecified		
Functional Fluid	BG ATC Plus	BG Products	3 - 7%,	BG Products	6984626
		Inc.	unspecified	Inc. (2016)	
Functional Fluid	ANDEROL 497	Chemtura	$\geq 10 - <20\%$ ,	Chemtura	6984647
		Corporation	unspecified	Corporation	
				(2015)	
Functional Fluid	ANDEROL 3046	Chemtura	$\geq 10 - <20\%$ ,	Chemtura	6984649
		Corporation	unspecified	Corporation	
			-	(2015)	
Functional Fluid	XL 700	Ingersoll Rand	10 - 40%, by	Ingersoll Rand	6984520
		Industrial	weight	(2015)	
		Technologies	_		
Functional Fluid	PS-200	Klüber	5 - 10%, by	Klüber	6984525
		Lubrication NA	weight	Lubrication NA	
		LP		LP (2018b)	
Functional Fluid	DSL- 125	Klüber	10 - 30%, by	Klüber	6984523
		Lubrication NA	weight	Lubrication NA	
		LP		LP (2018)	
Functional Fluid	ULTIMA- 68	Klüber	10 - 30%, by	Klüber	6984527
		Lubrication NA	weight	Lubrication NA	
		LP		LP (2018)	
Functional Fluid	QuinSyn Flush	Quincy	99%,	Quincy	6836826
	Fluid	Compressor	unspecified	Compressor	
				(2012)	
Functional Fluid	DACNIS SB 68	TOTAL	1 - 10%, by	TOTAL	6984599
		Specialties USA	weight	Specialties USA	
		Inc.		Inc. (2015a)	
Functional Fluid	SYNOLAN DE	TOTAL	10 - 40%, by	TOTAL	6984635
	100	Specialties USA	weight	Specialties USA	
		Inc.		Inc. (2015b)	
Lab Use	Phthalates in	SPEX CertiPrep,	3%, unspecified	SPEX CertiPrep	6301562
	Poly(vinyl	LLC		LLC (2017a)	
	chloride)				
Lab Use	Phthalates in	SPEX CertiPrep,	3%, unspecified	SPEX CertiPrep	6301560
	Polyethylene	LLC		LLC (2017c)	
	Standard				
Lab Use	Diisodecyl	SPEX CertiPrep,	0.1%,	SPEX CertiPrep	6984594
	phthalate in PE	LLC	unspecified	LLC (2017b)	

OES	Product	Manufacturer	DIDP Concentration	Source	HERO ID
Lab Use	Phthalates in Polyethylene Standard w/BPA	SPEX CertiPrep, LLC	3%, unspecified	SPEX CertiPrep LLC (2017d)	6301542
Lab Use	Diisodecyl Phthalate	Toronto Research Chemicals	Unknown	Toronto Research Chemicals (2017)	6984598
Paints/ Coatings	Super Diamond Clear 350 - 5 Gal Pail	Euclid Admixture Canada Inc.	1 – <5%, unspecified	Euclid Admixture Canada Inc. (2017)	6984666
Paints/ Coatings	Crystal Shine	SpecChem	<2%, by weight	SpecChem (2018)	6984591
Paints/ Coatings	AlphaGuard® MTS	Tremco U.S. Roofing	0.01 – <1%, unspecified	Tremco U.S. Roofing (2018)	6984521
Paints/ Coatings	6823 Orange	BJB Enterprises, Inc.	60 – 100%, by weight	BJB Enterprises Inc. (2019a)	6984639
Paints/ Coatings	6827 Burnt Sienna	BJB Enterprises, Inc.	30 – 60%, by weight	BJB Enterprises Inc. (2019b)	6984641
Paints/ Coatings	6800 Pigment Thinner	BJB Enterprises, Inc.	60 – 100%, by weight	BJB Enterprises Inc. (2017a)	6984630
Paints/ Coatings	Universal C/P Amarillo White	Tremco Canadian Sealants	25 – <50%, unspecified	Tremco Canadian Sealants (2019b)	6984643
Paints/ Coatings	Universal C/P Dark Gray	Tremco Canadian Sealants	50 – <100%, unspecified	Tremco Canadian Sealants (2019c)	6984644
Paints/ Coatings	Universal C/P Baptist Brick	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2019 or 2016)	11373489
Paints/ Coatings	Universal C/P Toast Tan	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2019)	6984540
Paints/ Coatings	Universal C/P Sunset Yellow	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6302292
Paints/ Coatings	Universal C/P River Rouge Red	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6984530
Paints/ Coatings	Universal C/P Navy Blue	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6984529
Paints/ Coatings	Universal C/P Limestone	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2019)	6984535
Paints/ Coatings	Universal C/P Kelly Pink	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6984528
Paints/ Coatings	Universal C/P Hartford Green	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6984526
Paints/ Coatings	Universal C/P Dover Sky	Tremco U.S. Sealants	25 - <50%, unspecified	Tremco U.S. Sealants (2019)	6984534
Paints/ Coatings	Universal C/P Antique Pink	Tremco U.S. Sealants	25 – <50%, unspecified	Tremco U.S. Sealants (2016)	6984524

OES	Product	Manufacturer	DIDP Concentration	Source	HERO ID
Formulation	Tracer Tech P-	Evident Crime	Unknown	Evident Crime	6984674
Other	133D	Scene Products		Scene Products	
				(n.d.)	
Plastic	SC-22	BJB Enterprises,	60 - 100%, by	<b>BJB</b> Enterprises	6984629
Compounding		Inc.	weight	Inc. (2014)	
Plastic	SKINFLEX III Part	BJB Enterprises,	90 – 100%, by	<b>BJB</b> Enterprises	6984627
Compounding	C Castable	Inc.	weight	Inc. (2012)	
Plastic	DIDP DLD	HB Chemical	65 – 73%,	HB Chemical	6984519
Compounding			unspecified	(2014c)	
Plastic	DIDP	HB Chemical	99%, by weight	HB Chemical	6836813
Compounding				(2014a)	
Plastic	DIDP-E	HB Chemical	99%, by weight	HB Chemical	6984518
Compounding				(2014b)	
Plastic	Diisodecyl	Megaloid	100%	Megaloid	6984546
Compounding	Phthalate	Laboratories		Laboratories	
				(2013)	
Plastic	Plasthall® DIDP	The HallStar	100%	The HallStar	6984597
Compounding		Company		Company	
				(2015)	
Plastics	Vinyl Barrier	Acoustical	0.23%,	Acoustical	6984624
Converting		Surfaces, Inc.	unspecified	Surfaces Inc.	
-			-	(2014)	
Other	Spotcheck ® SKL-	ITW Ltd.		ITW Ltd.	6984562
Formulation	SP2			(2018)	

8887