

III. HEALTH AND SAFETY HAZARDS DURING THE MANUFACTURE OF PAINT
AND ALLIED COATING PRODUCTS

A. Injury and Illness Statistics

The number and severity of injuries and illnesses in the Paints, Varnishes, Lacquers, Enamels, and Allied Coating Products Industry (SIC code 285) may be estimated from information reported by the Bureau of Labor Statistics (BLS), U.S. Department of Labor [11,25-28]. Table III-1 shows the average annual employment and injury and illness incidence rates (per 100 full-time workers) from 1980 through 1982 for total cases, lost workday cases, nonfatal cases without lost workdays, and lost workdays in SIC code 285.

TABLE III-1. AVERAGE OCCUPATIONAL INJURY AND ILLNESS INCIDENCE
RATES FOR SELECTED INDUSTRIES, 1980-1982 [11,26,27]

Industry	Average Annual Employment (thousands)	Incidence Rates per 100 Full-time Workers			
		Total Cases	Lost Workdays Cases	Nonfatal Cases Without Lost Workdays	Lost Workdays
All Private Sector	74,966.0	8.2	3.8	4.5	61.9
All Manufacturing	19,775.0	11.3	5.0	6.3	81.4
Industrial Inorganic Chemicals (SIC Code 281)	160.7	4.6	2.0	2.6	37.9
Soaps, Detergents, Perfumes, and Cosmetics (SIC Code 284)	143.7	8.8	4.2	4.6	64.5
Paints, Varnishes, Lacquers, Enamels, and Allied Coating Products (SIC Code 285)	63.1	12.0	5.5	6.6	74.3
Industrial Organic Chemicals (SIC Code 286)	173.7	4.4	1.9	2.5	33.5

For comparison, average incidence rates are also shown in Table III-1 for specific industries (SIC code 281, Industrial Inorganic Chemicals; SIC code 284, Soaps, Detergents, Perfumes, and Cosmetics; and SIC code 286, Industrial Organic Chemicals) as well as for "All Private Sector" industries combined and for "All Manufacturing" industries. These data show an annual total of approximately 7,570 injuries and illnesses (employment times total case incidence rate divided by 100) in paint manufacturing facilities. Per 100 full-time workers, paint manufacturers had an average injury and illness incidence rate of 12.0 and an average lost workday incidence rate (severity rate) of 74.3, which are about the same as the average rates exhibited by "All Manufacturing" industries.

Also of interest are data included in Table III-2, which address occupational injury and illness rates by employment size in the paint and allied coating products industry. The highest incidence rates occurred in facilities with 20-249 workers.

TABLE III-2. OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES BY EMPLOYMENT SIZE FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1982 [25]

Employment Size	Incidence Rate per 100 Full-time Workers
1 to 19	9.6
20 to 49	11.9
50 to 99	13.2
100 to 249	13.5
250 to 499	8.1
500 to 999	9.0
All Sizes	11.1

Currently, workers' compensation information that is derived from initial injury forms is compiled and reported by the BLS Supplementary Data System (SDS) [28]. Table III-3 contains the number of compensation cases in the SIC code 285, reported between 1976 and 1981 by the 32 states participating in the SDS program.

TABLE III-3. DISTRIBUTION BY STATE OF SDS INJURY AND ILLNESS CASES
FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING
(SIC CODE 285) 1976-1981

State	Number	State	Number
Alaska	3	Missouri	1,371
Arizona	14	Montana	39
Arkansas	112	Nebraska	37
California	3,498	New Jersey	1,239
Colorado	111	New Mexico	9
Connecticut	17	New York	400
Idaho	52	North Carolina	242
Indiana	291	Ohio	905
Iowa	70	Oregon	133
Kentucky	547	South Carolina	8
Maine	18	Tennessee	145
Maryland	327	Utah	1
Massachusetts	210	Vermont	71
Michigan	636	Virginia	13
Minnesota	171	Washington	468
Mississippi	14	Wisconsin	196

Total Cases = 11,368

Compiled from Bureau of Labor Statistics Supplementary Data System [28]

The purpose of the SDS system is to report occupational injury and illness information in sufficient detail to alert users to the patterns and relationships of injury causal factors. Information from workers' compensation first report of injury forms includes [28]:

- o Source of injury/illness
- o Type of accident/exposure
- o Nature of injury/illness
- o Part of body affected
- o Worker's occupation
- o Worker's age
- o Worker's length of service
- o Time of accident

The SDS data for SIC code 285 are summarized in Table III-4 for the first four categories.

TABLE III-4. SUMMARY OF SDS ACCIDENT/INJURY DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

<u>Source of Injury/Illness</u>	Number of		<u>Types of Accident/Exposure</u>	Number of	
	Accidents	Percent		Accidents	Percent
Boxes, barrels, containers	3,786	33.3	Overexertion	3,557	31.3
Working surfaces	1,222	10.7	Struck by an object	1,754	15.4
Chemicals, chemical compounds	1,027	9.0	Struck against an object	1,090	9.6
Vehicles	821	7.2	Caught in, under, or between	1,011	8.9
Metal items	768	6.7	Contact with caustics	1,004	8.8
Machines	676	5.9	or toxic substances		
Bodily motion	529	4.7	Fall on same level	895	7.9
Wood items	341	3.0	Bodily reaction	567	5.0
Handtools, nonpowered	334	2.9	Fall from elevation	536	4.7
Buildings and structures	175	1.5	Rubbed or abraded	281	2.3
All other classifiable	1,335	12.0	Contact with temperature	204	1.8
Nonclassifiable	354	3.1	extremes		
TOTAL	11,368	100.0	All other classifiable	221	2.1
			Nonclassifiable	248	2.2
			TOTAL	11,368	100.0

<u>Nature of Injury/Illness</u>			<u>Part of Body Affected</u>		
Sprain, strain	4,603	40.5	Back	2,777	24.4
Contusion, bruise	1,723	15.2	Finger(s)	1,309	11.5
Cut, laceration, puncture	1,180	10.4	Multiple injuries (i.e.,	682	6.0
Fracture	795	7.0	2 major parts of the body)		
Burn (chemical)	491	4.3	Hand(s)	597	5.3
Scratch, abrasion	274	2.4	Foot	578	5.1
Dermatitis	268	2.4	Eye(s)	553	4.9
Burn (hot surface)	219	1.9	Knee	514	4.5
Hernia, rupture	199	1.8	Ankle	421	3.7
Dislocation	99	0.9	Shoulder	368	3.2
All other classifiable	823	7.1	Abdomen	332	2.9
Nonclassifiable	694	6.1	All other classifiable	2,883	25.4
TOTAL	11,368	100.0	Nonclassifiable	354	3.1
			TOTAL	11,368	100.0

Compiled from Bureau of Labor Statistics Supplementary Data System [28]

The most prevalent sources of injuries and illnesses were boxes, barrels, containers, packages, etc. (33.3%), working surfaces (10.7%), and chemicals (9.0%). The most common types of accidents were overexertion (31.3%), struck by an object (15.4%), and struck against an object (9.6%). Sprains and strains (40.5%) were the most prevalent nature of injury, followed by contusions and bruises (15.2%), and cuts, lacerations, punctures, etc. (10.4%). The back (24.4%) and fingers (11.5%) were the parts of the body most frequently affected [28].

In an attempt to better elucidate accident causal factors, 38 "sources of injury" (which included 81% of the total cases) were cross-tabulated with the "type of accident," "nature of injury," and "part of body affected." These data are summarized in Table III-5. Another analysis of the SDS data is summarized in Table III-6 where 15 occupational groupings (which included 81% of the total cases) were similarly cross-indexed.

Mention needs to be made of some of the data constraints of the SDS reporting system. Although there are about 300 subcategories of "sources of injury," and 425 occupational classification codes, in many instances the subgroupings are still not useful for the purpose of quantifying accidents specific to paint manufacturing. For instance, there might not be specific SDS categories for the inclusion of equipment typically used in the paint industry which would necessitate its being grouped into a broad category such as "Machines, Not Elsewhere Classified." Similarly, although there is an occupational classification for mixing operatives, individual facilities when filling out the workers' compensation form could have coded paint mixers in a number of other categories (e.g., miscellaneous operatives, machine operatives, not specified, etc.). A further difficulty encountered in the data base, when using it for analysis of accident causal factors, is that, by definition, the "source of injury" is the object identified as most responsible for causing the injury. This may, in fact, not be directly associated with the actual cause of the accident. For example, if a worker cuts his finger while using a knife, the "source of injury" is the knife, which also is the tool most clearly associated with the cause of the accident. However, if a worker falls from a ladder and fractures his leg on the floor, the "source of injury" is the floor, which probably contributed very little to the actual cause of the accident.

However, once the constraints of the SDS data are recognized, the information included can be applied to further identify some of the hazards associated with occupations, tasks, tools, and equipment used in paint manufacturing. In Table III-5 the most frequent subcategories for each major heading are listed; all subcategories relate to the "source of injury" in the first column and are not expected to total with it. In Table III-6, the various subcategories listed (including "source of injury") relate to the occupational grouping shown above them.

TABLE III-5. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS "SOURCES OF INJURY" DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
<u>Boxes, Barrels, Containers, Packages</u>	3,786						
Containers, NEC	1,399	Overexertion in lifting objects	789	Sprain, strain	1,011	Back	680
		Struck by falling object	151	Contusion, bruise	148	Finger(s)	83
		Overexertion in pulling objects	74	Cut, laceration	62	Shoulder	80
		Overexertion in throwing objects	74	Fracture	45	Abdomen	74
		Overexertion, UNS	69	Hernia, rupture	39	Multiple parts	53
		Overexertion, NEC	64			Foot	47
		Struck against stationary object	59			Wrist	44
Barrels, kegs, drums	1,391	Overexertion in lifting objects	399	Sprain, strain	804	Back	528
		Overexertion in pulling objects	180	Contusion, bruise	224	Finger(s)	171
		Struck by falling object	177	Fracture	115	Abdomen	82
		Overexertion, NEC	122	Cut, laceration	63	Shoulder	81
		Overexertion in throwing objects	119	Hernia, rupture	47	Hand	65
		Caught in, under, or between a moving and a stationary object	81			Foot	55
		Struck by, NEC	67			Toe(s)	54
Boxes, crates, cartons	493	Overexertion in lifting objects	306	Sprain, strain	368	Back	277
		Struck by falling object	60	Contusion, bruise	50	Abdomen	22
						Wrist	22
						Finger(s)	19

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(Continued)

TABLE III-5. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS "SOURCES OF INJURY" DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Tanks, bins, etc.	271	Overexertion in pulling objects	60	Sprain, strain	128	Back	70
		Struck against stationary object	42	Contusion, bruise	60	Finger(s)	22
		Overexertion in lifting objects	34			Shoulder	20
		Fall on same level	30				
Working Surfaces	1,222						
Floor	635	Fall on same level	400	Sprain, strain	233	Back	124
		Fall to lower level	68	Contusion, bruise	150	Multiple parts	82
		Fall from ladders	54	Fracture	78	Knee	81
						Ankle	59
Ground (outdoors)	189	Fall from vehicles	54	Sprain, strain	78	Ankle	27
		Fall on same level	53	Fracture	30	Back	21
		Fall to lower level, NEC	34	Contusion, bruise	30		
Stairs, steps	122	Fall on stairs	109	Sprain, strain	43	Ankle	23
				Contusion, bruise	34	Knee	19
Working surfaces, UNS	116	Fall on same level	66	Sprain, strain	52	Back	32
Chemicals, Chemical Compounds	1,027						
Chemicals and compounds, NEC	651	Skin contact (absorption)	391	Burn (chemical)	303	Eye(s)	208
		Contact, NEC	92	Contact dermatitis	103	Multiple parts	96
		Contact by inhalation	52	Other injury, NEC	49	Hand	46
		Rubbed or abraded in eyes	50	Scratch, abrasion	33	Respiratory system	36
						Foot	34
Chemicals and compounds, UNS	81	Skin contact (absorption)	63	Burn (chemical)	31	Multiple parts	17
				Dermatitis, UNS	27	Eye(s)	11

Coal and petroleum products	79	Skin contact (absorption)	44	Burn (chemical)	25	Eye(s)	27
		Contact by inhalation	10	Burn (heat)	11	Hand	9
		Contact with a hot object	7	Dermatitis, UNS	11	Respiratory system	8
						Forearm(s)	7
Acids	61	Skin contact (absorption)	40	Burn (chemical)	44	Multiple parts	12
		Contact by inhalation	13	Poisoning due to toxic materials	13	Body parts, NEC	12
<u>Vehicles</u>	821						
Forklifts, stackers, lumber carriers, and other powered carriers	316	Struck by, NEC	90	Contusion, bruise	132	Foot	70
		Caught in, under, or between a moving and a stationary object	49	Sprain, strain	53	Finger(s)	54
		Caught in, under, or between, NEC	33	Fracture	48	Back	23
		Struck against moving object	16			Toe(s)	22
Handtrucks, dollies, and other nonpowered carriers	257	Struck by, NEC	67	Sprain, strain	95	Back	61
		Overexertion in pulling objects	66	Contusion, bruise	92	Foot	26
		Caught in, under, or between a moving and a stationary object	29			Toe(s)	26
		Struck against a stationary object	25			Knee	16
						Finger(s)	16
Highway vehicles, powered	197	Collision with a vehicle moving in same direction	30	Sprain, strain	51	Multiple parts	51
		Struck against a stationary object	20	Contusion, bruise	45	Back	25
		Collision with a vehicle moving in an intersecting trafficway	19			Finger(s)	13
<u>Metal Items</u>	768						
Metal items, NEC	426	Struck by falling object	107	Cut, laceration	121	Finger(s)	81
		Struck against stationary object	82	Contusion, bruise	103	Back	53
		Struck by, NEC	58	Sprain, strain	81	Hand	40
		Overexertion in lifting objects	41	Fracture	39	Toe(s)	33
				Scratch, abrasion	30	Eye(s)	28
						Knee	27

(Continued)

TABLE III-5. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS "SOURCES OF INJURY" DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Pipe and fittings	127	Struck against stationary object	42	Sprain, strain	38	Finger(s)	25
		Struck by falling object	30	Contusion, bruise	32	Back	21
Metal items, UNS	88	Struck against stationary object	27	Cut, laceration	44	Finger(s)	25
		Struck by, NEC	11	Sprain, strain	16	Foot	12
		Overexertion in lifting objects	11			Back	11
<u>Machines</u>	676						
Machines, NEC	288	Caught in, under, or between, NEC	72	Cut, laceration	76	Finger(s)	135
		Struck against stationary object	43	Contusion, bruise	69	Hand	37
		Caught in, under, or between in-running or meshing objects	28	Sprain, strain	57	Back	30
		Caught in, under, or between a moving and a stationary object	24	Fracture	33		
		Struck by, NEC	21				
		Overexertion, NEC	21				
Packaging, wrapping machines	81	Caught in, under, or between in-running or meshing objects	19	Contusion, bruise	27	Finger(s)	34
		Struck against stationary object	12	Sprain, strain	16	Hand	11
		Caught in, under, or between a moving and a stationary object	10	Cut, laceration	11		

Agitators, mixers, tumblers, etc.	74	Struck against stationary object	12	Cut, laceration	21	Finger(s)	16
		Caught in, under, or between in-running or meshing objects	12	Fracture	14	Hand	10
		Caught in, under, or between, NEC	10	Contusion, bruise	11		
				Sprain, strain	10		
<u>Bodily Motion</u>							
	529	Bodily reaction, UNS	225	Sprain, strain	464	Back	184
		Bodily reaction by involuntary motions	183	Fracture	26	Ankle	103
		Bodily reaction by voluntary motions	109			Knee	90
<u>Wood Items</u>							
Skids, pallets	233	Struck by falling object	57	Sprain, strain	113	Back	56
		Overexertion in lifting objects	38	Contusion, bruise	50	Foot	33
		Overexertion in pulling objects	37	Fracture	23	Ankle	21
		Struck against stationary object	31	Cut, laceration	12	Toe(s)	16
		Caught in, under, or between, NEC	17				
		Struck by, NEC	13				
Wood items, NEC	80	Struck against stationary object	21	Cut, laceration	24	Finger(s)	19
		Struck by, NEC	10	Sprain, strain	22	Eye(s)	12
		Overexertion in lifting objects	9	Contusion, bruise	11		
<u>Handtools, Nonpowered</u>							
Knife	102	Struck by, NEC	72	Cut, laceration	102	Finger(s)	53
						Hand	25
Handtools, nonpowered, NEC	88	Struck by, NEC Overexertion, NEC	37	Cut, laceration	32	Finger(s)	18
			12	Sprain, strain	25	Back	17
Wrench	72	Struck by, NEC	35	Sprain, strain	20	Finger(s)	24
				Contusion, bruise	19	Wrist	8
				Cut, laceration	17		

(Continued)

TABLE III-5. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS "SOURCES OF INJURY" DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
<u>Buildings and Structures</u>	175						
Doors, gates	86	Caught in, NEC	14	Sprain, strain	31	Finger(s)	20
		Struck by a falling object	11	Contusion, bruise	24	Back	19
		Caught in, under, or between a moving and a stationary object	11				
		Overexertion in pulling objects	11				
		Struck by stationary object	10				
		Struck by, NEC	10				
Buildings and structures, NEC	30	Struck against stationary object	11	Sprain, strain	10	Back	6
		Fall on same level	8	Contusion, bruise	10	Shoulder	5
						Finger(s)	4
Towers, poles, etc.	17	Struck against stationary object	15	Contusion, bruise	11	Head, NEC	7
Walls, fences	15	Struck against stationary object	9	Contusion, bruise	5	Arm	5
				Cut, laceration	5	Hand	3
<u>Furniture, Fixtures, Furnishings</u>	123	Struck against stationary object	36	Sprain, strain	45	Back	33
		Overexertion, NEC	12	Contusion, bruise	38	Finger(s)	16
		Overexertion in lifting objects	11	Cut, laceration	20		
		Overexertion in pulling objects	11				
<u>Flame, Fire, Smoke</u>	102	Contact with hot objects or substances	70	Burn (heat)	88	Multiple parts	63
		Contact by inhalation	12				

<u>Particles (Unidentified)</u>	88	Rubbed or abraded in eyes	75	Scratch, abrasion	75	Eye(s)	82
<u>Hoisting Apparatus</u>	77	Struck by, NEC	16	Sprain, strain	19	Finger(s)	20
		Caught in, under, or between, NEC	12	Fracture	17	Hand	8
		Caught in, under, or between a moving and a stationary object	11	Contusion, bruise	14		
				Cut, laceration	14		
<u>Conveyors</u>	76	Struck against stationary object	16	Contusion, bruise	27	Finger(s)	35
		Caught in, under, or between in-running or meshing objects	12	Cut, laceration	14	Hand	12
		Caught in, under, or between a moving and a stationary object	9	Fracture	12		
<u>Person</u>	74	Struck by, NEC	22	Sprain, strain	22	Circulatory system	15
				Contusion, bruise	8	Back	13
<u>Glass Items, NEC</u>	65	Struck against stationary object	17	Cut, laceration	39	Hand	16
				Contact dermatitis	11	Finger(s)	14
						Multiple parts	10

Compiled from Bureau of Labor Statistics Supplementary Data System [28]

Note: NEC = Not Elsewhere Classified

UNS = Unspecified

TABLE III-6. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS
 "OCCUPATION" DATA FOR PAINT AND ALLIED COATING PRODUCTS
 MANUFACTURING (SIC CODE 285) 1976-1981

LABORERS (MISCELLANEOUS AND NOT SPECIFIED) - 1,206 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	165	Overexertion in lifting	189	Sprain, strain	411	Back	212
Containers, NEC	121	objects		Contusion, bruise	226	Finger(s)	154
Chemicals, NEC	117	Struck against stationary	116	Cut, laceration	140	Hand	83
Floor	54	object		Burn (chemical)	82	Eye(s)	80
Bodily motion	45	Struck by, NEC	115	Fracture	69	Multiple parts	76
Boxes, crates, cartons	44	Skin contact (absorption)	109	Other injuries, NEC	41	Knee	58
Metal items, NEC	39	Struck by falling object	86	Multiple injuries	30	Foot	57
Machines, NEC	38	Caught in, under, or	72			Shoulder	45
Forklifts and other	33	between, NEC					
powered carriers		Fall on working surface	55				
		Caught in, under, or between	47				
		a moving and stationary					
		object					
		Overexertion in pulling	47				
		objects					
		Overexertion, NEC	45				

MIXING OPERATIVES - 1,106 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	266	Overexertion in lifting	228	Sprain, strain	518	Back	310
Containers, NEC	167	objects		Contusion, bruise	153	Finger(s)	91
Chemicals, NEC	89	Skin contact (absorption)	92	Fracture	87	Multiple parts	62
Floor	64	Overexertion in pulling	82	Burn (chemical)	75	Eye(s)	61
Tanks, bins, etc.	59	objects		Cut, laceration	72	Foot	61
Bodily motion	54	Struck by falling object	82	Contact dermatitis	20	Knee	58
Metal items, NEC	35	Struck against stationary	81			Ankle	48
Forklifts and other	24	object				Elbow	29
powered carriers		Struck by, NEC	79			Wrist	26
		Overexertion in throwing	60				
		objects					
		Fall on working surface	54				
		Overexertion, NEC	50				

MACHINE OPERATIVES, MISCELLANEOUS SPECIFIED - 1,095 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	151	Overexertion in lifting objects	184	Sprain, strain	448	Back	255
Barrels, kegs, drums	108	Struck against stationary object	99	Contusion, bruise	180	Finger(s)	151
Floor	72	Struck by, NEC	81	Cut, laceration	130	Hand	83
Chemicals, NEC	70	Fall on working surface	73	Fracture	72	Eye(s)	51
Bodily motion	70	Overexertion in pulling objects	73	Burn (chemical)	46	Multiple parts	51
Machines, NEC	63	Struck by falling object	66			Foot	45
Metal items, NEC	45	Skin contact (absorption)	60			Ankle	39
		Caught in, under or between, NEC	52			Knee	37

FREIGHT AND MATERIAL HANDLERS, STOCK HANDLERS, WAREHOUSEMEN (NEC) - 742 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	131	Overexertion in lifting objects	216	Sprain, strain	380	Back	210
Boxes, crates, cartons	110	Struck by falling object	84	Contusion, bruise	129	Finger(s)	71
Barrels, kegs, drums	82	Struck by, NEC	62	Cut, laceration	61	Foot	42
Floor	36	Struck against stationary object	46	Fracture	31	Knee	40
Handtrucks, dollies	35	Overexertion in pulling objects	46			Shoulder	39
Forklifts and other powered carriers	35	Fall on working surface	39			Abdomen	33
Skids, pallets	34	Overexertion in throwing objects	32				

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(Continued)

TABLE III-6. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS
 "OCCUPATION" DATA FOR PAINT AND ALLIED COATING PRODUCTS
 MANUFACTURING (SIC CODE 285) 1976-1981

MISCELLANEOUS OPERATIVES - 741 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	101	Overexertion in lifting	125	Sprain, strain	269	Back	171
Barrels, kegs, drums	93	objects		Contusion, bruise	117	Finger(s)	100
Chemicals, NEC	59	Skin contact (absorption)	61	Cut, laceration	80	Hand	52
Floor	40	Struck against stationary	55	Fracture	44	Multiple parts	45
Tanks, bins, etc.	32	object		Burn (chemical)	35	Foot	38
Machines, NEC	26	Struck by falling object	54			Eye(s)	37
		Struck by, NEC	52				
		Overexertion in pulling	44				
		objects					
		Fall on working surface	42				

TRUCK DRIVERS, DELIVERYMEN, AND ROUTEMEN - 431 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	80	Overexertion in lifting	98	Sprain, strain	204	Back	128
Containers, NEC	65	objects		Contusion, bruise	70	Multiple parts	34
Highway vehicles, powered	57	Struck by falling object	31	Cut, laceration	30	Knee	29
Ground (outdoors)	28	Struck by, NEC	30	Fracture	25	Finger(s)	26
						Ankle	25

FOREMEN, NEC - 307 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	39	Overexertion in lifting	48	Sprain, strain	128	Back	73
Containers, NEC	34	objects		Cut, laceration	35	Eye(s)	26
Chemicals, NEC	22	Struck against stationary	29	Contusion, bruise	31	Finger(s)	21
Floor	17	object		Fracture	16		
Bodily motion	15	Overexertion in pulling	28				
		objects					

MECHANICS AND REPAIRMEN - 276 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Floor	23	Struck by, NEC	33	Sprain, strain	100	Back	53
Metal items, NEC	21	Overexertion in lifting	28	Cut, laceration	50	Finger(s)	44
Bodily motion	16	objects	16	Contusion, bruise	29	Hand	23
Machines, NEC	15	Struck against stationary object	16	Fracture	24	Eye(s)	22
		Struck by falling object	16			Multiple parts	19
		Fall on working surface	16				

PACKERS AND WRAPPERS - 226 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	41	Overexertion in lifting	44	Sprain, strain	97	Back	58
Boxes, crates, cartons	23	objects	24	Contusion, bruise	51	Finger(s)	38
Barrels, kegs, drums	17	Struck against stationary object	24	Cut, laceration	27	Foot	20
Skids, pallets	14	Struck by falling object	24	Fracture	14		
Chemicals, NEC	12	Struck by, NEC	14				
Packaging, wrapping machines	11						
Floor	11						

MACHINE OPERATIVES, NOT SPECIFIED - 224 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Packaging, wrapping machines	24	Overexertion in lifting	36	Sprain, strain	85	Back	53
Barrels, kegs, drums	23	objects	21	Contusion, bruise	30	Finger(s)	37
Chemicals, NEC	18	Skin contact (absorption)	19	Cut, laceration	26	Eye(s)	21
Metal items, NEC	14	Overexertion in pulling	19	Burn (chemical)	21	Shoulder	13
Floor	14	objects	18	Fracture	15	Ankle	13
Machines, NEC	13	Struck against stationary object	18				
		Struck by, NEC	18				
		Fall on working surface	15				

(Continued)

TABLE III-6. SUMMARY OF CROSS-TABULATION ANALYSIS OF SDS
 "OCCUPATION" DATA FOR PAINT AND ALLIED COATING PRODUCTS
 MANUFACTURING (SIC CODE 285) 1976-1981

FORKLIFT AND TOWMOTOR OPERATIVES - 203 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	37	Struck against stationary object	26	Sprain, strain	79	Back	40
Forklifts and other powered carriers	29	Overexertion in lifting objects	26	Contusion, bruise	39	Finger(s)	29
Skids, pallets	15	Fall on working surface	21	Cut, laceration	19	Ankle	14
Floor	14	Struck by falling object	17	Fracture	16	Multiple parts	14
Ground (outdoors)	14	Struck by, NEC	17				

NOT SPECIFIED OPERATIVES - 169 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Barrels, kegs, drums	29	Overexertion in lifting objects	33	Sprain, strain	64	Back	46
Chemicals, NEC	11	Skin contact (absorption)	19	Contusion, bruise	17	Finger(s)	19
Metal items, NEC	10	Overexertion in throwing objects	13	Burn (chemical)	16	Hand	16
		Struck by falling object	11	Cut, laceration	15	Multiple parts	12
				Fracture	13	Eye(s)	10

SERVICE WORKERS (CLEANERS, JANITORS, COOKS, GUARDS, ETC.) - 151 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	18	Skin contact (absorption)	19	Sprain, strain	63	Back	39
Bodily motion	14	Struck against stationary object	17	Contusion, bruise	22	Finger(s)	16
Barrels, kegs, drums	13	Struck by falling object	15	Fracture	16	Foot	15
Chemicals, NEC	10	Overexertion in lifting objects	13	Burn (chemical)	15		
Floor	10			Cut, laceration	12		

BOTTLING AND CANNING OPERATIVES - 120 CASES

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	30	Overexertion in lifting	30	Sprain, strain	61	Back	50
Barrels, kegs, drums	18	objects		Contusion, bruise	21	Finger(s)	16
		Struck by falling object	11	Cut, laceration	13		
		Struck by, NEC	11				

NONPRODUCTION WORKERS - 1,306 CASES

(SHIPPING AND RECEIVING CLERKS, SALESMEN, MANAGERS, ADMINISTRATORS, STOCK CLERKS, CHEMISTS, SECRETARIES, ETC.)

Source of Injury	Number	Type of Accident/Exposure	Number	Nature of Injury	Number	Body Part Injured	Number
Containers, NEC	210	Overexertion in lifting	276	Sprain, strain	549	Back	313
Boxes, crates, cartons	95	objects		Contusion, bruise	179	Finger(s)	135
Barrels, kegs, drums	84	Struck against stationary	110	Cut, laceration	130	Multiple parts	98
Floor	77	object		Fracture	99	Foot	85
Bodily motion	69	Struck by falling object	104	Multiple injuries	36	Knee	75
Chemicals, NEC	58	Fall on working surface	104			Eye(s)	58
Highway vehicles, powered	55	Struck by, NEC	87			Ankle	57
		Skin contact (absorption)	50			Hand	50

Compiled from Bureau of Labor Statistics Supplementary Data System [28]

Note: NEC = Not Elsewhere Classified

As would be expected, Table III-5 indicates that injuries related to materials handling (i.e., containers, handtrucks, dollies, skids, pallets, etc.) were most often caused by overexertion and by being struck by falling objects. Sprains, strains, contusions, bruises, cuts, and lacerations were the most common injuries; the back and fingers were the parts of the body most frequently affected. An interesting finding was that 60% of the injuries caused by chemicals (i.e., 615 of 1,027) were from skin contact (absorption); 47% of these injuries were chemical burns of the skin.

Analysis of the SDS data by "occupation" yielded similar results. As Table III-6 indicates, various types of containers (i.e., barrels, boxes, crates, etc.) were the most common sources of injury (20-30%) in almost every occupational grouping. As before, overexertion and "struck by or against" type accidents were the most prevalent, with the most common injuries also being sprains, contusions, and cuts. Exposure to chemicals again accounted for a significant proportion of injuries in many of the occupational groups, usually resulting in chemical burns of the skin. Nonproduction workers (clerks, salesmen, managers, chemists, secretaries, etc.), who make up about 51% of the workforce in SIC code 285 [29], accounted for 13% of the cases in the SDS file [28]. Conversely, production workers were involved in 87% of the injuries and illnesses in paint and allied coating products manufacturing although comprising only about 49% of the total workforce.

Further analysis of the SDS data [28] showed that workers under 26 years of age accounted for about one-third of the injuries and illnesses and that workers under 31 years of age accounted for over half (51.6%). Although only about one-third of the SDS cases had length of service data, 36.9% of those injuries occurred within the first year with the company, 50.4% within the first 2 years, and 69.9% within the first 5 years [28]. The types and numbers of illnesses in the SDS data base are shown in Table III-7. Dermatitis was the most common illness noted (41.2%). The SDS data show that only 5.7% of the total number of injuries and illnesses were due to illnesses [28]. However, occupational illness data from the SDS suffer from the same degree of identification as that experienced in the BLS annual survey of occupational injuries and illnesses. Recognition of occupational illness depends on the "state of the art." Nevertheless, despite the underestimate of the incidence of occupational illnesses, it is evident that reducing injuries should be a high priority of the paint and allied coating products industry.

TABLE III-7. SUMMARY OF SDS ILLNESS DATA FOR PAINT AND ALLIED COATING PRODUCTS MANUFACTURING (SIC CODE 285) 1976-1981

Nature of Illness	Number	Percent
Dermatitis -- includes rash, skin or tissue inflammation, etc., from direct contact with irritants or sensitizing chemicals	268	41.2
Poisoning, systemic -- includes chemical or drug poisoning, metal poisoning, organic diseases, etc.	153	23.5
Inflammation or irritation of the joints, tendons, or muscles occurring over time as a result of repetitive activity -- includes bursitis, synovitis, tenosynovitis, etc., but does not include strains and sprains, or their aftereffects	73	11.2
Disease of the eye	34	5.2
Effects from physical agents -- includes sunburn, welder's flash, hearing loss, heat stroke, heat exhaustion, frostbite, etc.	25	3.8
Respiratory system effects -- includes influenza, pneumonia, bronchitis, asthma, etc.	23	3.5
All other illnesses	75	11.6
Total Illness Cases	651	100.0

B. Hazards

Workers in paint and allied coating products facilities may be exposed to a wide variety of hazardous conditions during the performance of their jobs. The majority of these hazards exist, to some extent, throughout industry, although certain characteristics in the paint industry may magnify the degree of risk. The hazards associated with the manufacture of paint and allied coating products involve materials handling; toxic, flammable, or explosive substances; and physical agents such as electrical shock, noise, heat, and cold. These hazards can be present at various stages of production. In this section, there will be a discussion of the hazards involved with the storage and handling of raw materials and finished products for the industry in general, followed by other hazards associated with specific types of paint and allied coating products manufacture.

1. Materials Handling

Materials handling hazards in the manufacture of paint and allied coating products are similar to those in most other processing industries. Handling of raw materials is estimated by the National Safety Council to account for 20-25% of all reported occupational injuries in the U.S. [30]. The SDS data finding that "boxes, barrels, containers, packages, etc." were the source of injury in 33.3% of the cases [28] would confirm this. These injuries are caused primarily by overexertion due to improper lifting, failure to wear appropriate protective equipment, slipping, and falling. Workers may be exposed to toxic substances during materials handling when containers leak, rupture, or are opened and when materials are transferred to weighing or processing containers. Inhalation is a primary route of exposure for materials handlers, but skin exposure and ingestion are also possible.

Dry materials such as pigments and additives can become airborne when containers leak or are ruptured and when materials are transferred. Loading pigments into grinding equipment and discarding empty bags can cause the surrounding plant areas to become contaminated with dust. Solvents are volatile and their vapors can escape when transferred in the open or if containers develop minor leaks or are accidentally ruptured. Because of both toxicity and danger of fire, solvent spills present a serious hazard to workers.

Many substances used in paint and allied coating products are highly volatile and flammable or are explosive. The fire and explosion risk is high wherever organic solvents are present. Combustible material can be ignited by a spark or by high temperatures. Sources of sparks or fires include faulty electrical equipment, smoking, friction, open flames, static electricity from moving vehicles or materials, spontaneous combustion, highly reactive chemical combinations, and the use of hand tools made of ferrous materials [30,31]. Leaks, spills, and escape of volatile materials from open containers and equipment can provide fuel for explosions and fires.

Preventing the accumulation of static electricity in the handling of liquid raw materials requires special techniques and precautions. Static electricity may be produced when nonconducting liquids flow through pipes or hoses; when liquids fall through the air in droplets or as a spray; when liquids are splashed around in tanks -- in the mixing, pouring, pumping, filtering, and agitation of liquids; or when air or other gases bubble through liquids [31,32].

In addition to potential exposures to the many raw materials handled, carbon monoxide emitted from engine exhausts may be a hazard on loading and shipping docks. Exposures may be greater in the winter when loading areas are often enclosed to minimize heat loss.

2. Manufacture of Paints and Lacquers

There are a number of potential hazards that confront workers in the various processes involved in the manufacture of paints and lacquers.

a. Dispersion

Pigment and resin particles may enter the breathing zones of workers when mixer and mill hoppers are filled. Airborne particles may also result when the mixers and the mills are operated. Workers may also be exposed to solvents during the loading, operation, and cleaning of mills.

A noise hazard may be associated with the use of ball and pebble mills, especially when the mills are improperly adjusted, as well as with the use of high-speed dispersers. The noise levels at dispersion equipment such as Kady® mills have been found to range from 109-114 dBA [33]. Several mills operating simultaneously will have a combined sound pressure level greater than any individual mill. Ball mills that do not have vibration isolators can be the source of structure-borne vibrations that could be reradiated by other objects in the building [34].

Cleaning the dispersion equipment involves the use of solvents and may result in potential exposure by inhalation or skin absorption. Cleaning may be performed manually or by automatic solvent wash. Since roller mills are often cleaned manually, there is also the potential hazard of catching and crushing arms and fingers between rollers. To clean sand mills or high-speed dispersion mills, automatic solvent washes are used. However, it is sometimes necessary to enter and manually scrape the insides of the equipment. Maintenance operations involve many of the same hazards associated with cleaning operations.

Nitrocellulose, which is used in lacquer production, is one of the most flammable materials used in the coatings industry; it will not burn when wet with water but becomes flammable when water is extracted and replaced with alcohol [2]. When nitrocellulose is dry, it burns very rapidly and can be ignited by friction or impact [2].

b. Thinning, Tinting, and Shading

Although exposure to additives either as dusts or vapors can also occur, solvent exposure is the primary hazard associated with these adjustment procedures. Since quality control checks are often made during these operations, exposures can also occur during sampling and transport of samples to the laboratory.

c. Filling

Solvent exposure is also the primary hazard of filling operations. Such exposures may result from direct evaporation of the solvent as the coatings flow into containers or from the cleaning and maintenance of the filling apparatus, particularly the filters used in the first step of the operation.

Extensive noise can be generated by the vibrating screens used for filtering. Packaging the products usually involves automated equipment with moving parts that may catch on clothing. Burns or vapor exposure may also result from the use of hot, melted glues to secure packaging and labels.

d. Handling Finished Products

Safety hazards involved in handling finished coating products are similar to those involved in handling raw materials (e.g., lifting, slippery working surfaces, poor clearance, reduced visibility, etc.). Finished products are usually in sealed metal containers and present little respiratory hazard. Automatic depalletizers are a potential source of excessive noise.

3. Manufacture of Varnishes

Varnish production requires an external source of heat and, therefore, differs from paint and lacquer production. Temperatures associated with the manufacture of varnish are often 200°-600°F (93°-316°C) and cause the formation of gaseous substances during varnish cooking [19].

a. Kettle and Reactor Operation Hazards

The major hazards associated with the cooking stage in varnish production involve airborne exposures while loading the vessels or emissions while processing. Loading or charging the reactor vessel is usually done by pumping in the liquid reactants such as oils, glycols, or acid anhydrides. When dry materials are added, they can release irritant dusts or vapors of maleic, phthalic, or fumaric anhydride. Splattered molten anhydride can harm eyes and skin. Moreover, temperature changes at vents and orifices must be avoided so that vapors of these materials will not condense and form pressure plugs.

Since these reaction vessels are mostly closed systems, only inadvertent or fugitive emissions present a hazard to workers during the reaction phase. In a few cases, however, open kettles may still be used in the manufacture of varnishes. Some of the emissions given off during the cooking of varnishes include acrolein, phenol, aldehydes, ketones, glycerin, fatty acids, and carbon dioxide [35].

Maximum reactor vessel emissions occur during "sparging," when an inert gas is blown through the reactor to remove the water of reaction. Emissions from solvent cooking operations do not vary significantly with the size of the reactor, but are more a result of the volatility of the solvent being used and the size and efficiency of the condenser. Startup, process upset, shutdown, and, particularly, emergencies offer further potential for worker exposure. [18].

Ambient temperatures around reactors generally are not hazardous. However, when insulation or climate controls are inadequate, ambient temperatures may rise and workers may be subject to heat stress. In direct-fired kettles or reaction vessels, the constant heating and cooling can cause metal fatigue and subsequent cracks in the vessel. These cracks can be sources of vapor leaks and fire hazards. Also, open kettles, especially portable ones, pose the hazard of burns from contact with hot surfaces or from splattering material.

b. Thinning and Filtering

Exposure to solvents may occur during the thinning stage of varnish production. Thinning is usually done in separate tanks but may be performed in the varnish or resin kettle itself. Solvent exposure may also occur during filtering but is more likely during the subsequent cleaning of the filters.

c. Equipment Cleaning

The cleaning of equipment (e.g., reactors, kettles, thinning tanks, filters, etc.) is another source of worker exposure to toxic substances. Cleaning operations in confined spaces are especially hazardous. Workers may be exposed by skin contact or inhalation. Equipment is also sometimes cleaned with hot caustic solutions that may affect the skin, eyes, and respiratory tract. The cleaning of filters may be performed manually or by automatic washing with solvents. Respiratory exposure to diatomaceous earths and dusts from other finely ground materials used as filter aids is possible.

4. Manufacture of Powder Coatings

Many of the same types of hazards found during the manufacture of paints or varnishes also exist in the production of powder coatings. Dust exposure can occur during the charging of hoppers, mixers, and grinders and in packaging. The fine particle sizes associated with powder coatings increase the possibility of dust explosions [22]. Inhalation of resin powders, pigments, curing agents, and other additives is the primary health hazard associated with the production of powder coatings.

5. Manufacture of Radiation-Curable Coatings

Since the manufacture of radiation-curable coatings, which dry or cure as a result of radiation such as infrared, ultraviolet, and electron beam, is similar to that of other paints, so are most of its hazards. Radiation-curable coatings, however, contain reactive monomers in place of solvents. In addition, ultraviolet-curable coatings also contain photoinitiators. Both reactive monomers and photoinitiators may have acute or delayed effects on the skin, eyes, and respiratory tract causing skin sensitization and other effects [36]. Because of the likelihood of acute effects resulting from skin or eye contact with some components of radiation-curable coatings, this type of coating is manufactured in enclosed equipment. Enclosed equipment is also necessary to prevent vaporization of some components that have relatively high vapor pressures.

Various types of hazards are associated with acrylate monomers used in radiation-curable coatings. Acrylates cause irritation of the eyes, nose, throat, lungs, and skin. In addition, it is important to avoid contamination during the handling of acrylate monomers because contaminants may act as polymerization catalysts and result in uncontrolled reactions accompanied by heat and pressure, increasing the risk of fire or explosion [37]. Ethyl acrylate is one of the most volatile acrylate compounds. A flammable air-vapor mixture exists at normal storage temperatures unless air is excluded [37].

6. Laboratory Functions

In addition to the hazards associated with the manufacture of coatings, the operations associated with laboratory functions may also expose workers to other chemical substances (e.g., reagents) and physical agents such as ultraviolet or infrared radiation, heat, cold, and ionizing radiation used in curing processes and in exposure tests. A potentially hazardous practice in laboratories involves spraying a coating to match colors. Often no exposure controls are used, and exposure to airborne coatings is likely. This situation is easily remedied by providing a spray booth with negative pressure to remove the overspray and thus protect the worker.

C. Adverse Health Effects

OSHA has promulgated occupational exposure standards for many of the chemicals used in the manufacture of paint and allied coating products. NIOSH has also evaluated many of these materials and has published Criteria Documents and other reports which have recommended occupational safety and health standards for them, including occupational exposure limits. The current OSHA standards and the NIOSH-recommended exposure limits, as well as pertinent health effects, are listed in Appendix B. The materials used in coatings vary greatly in their toxicity. Some have been shown to be biologically inert, and others are proven or potential occupational carcinogens.

Pigments are usually handled as finely divided solids that can readily become airborne; adhere to skin, hair, and clothing; and generally coat the work area with dust. The primary routes of exposure to pigments are inhalation, skin contact, and eye exposure. Ingestion of pigments can result from eating, smoking, or drinking in the work areas as well as from swallowing material gathered by the mucociliary clearance mechanism in the respiratory tract. The volatility of many organic solvents and resins at room temperature accounts for the likelihood that workers will be exposed to them by inhalation. Exposure to solvents and resins by skin contact and skin absorption is also common.

An epidemiological study [38] was conducted on a cohort of 16,243 men from 32 plants who were employed in the manufacture of paint or varnish for at least one year after January 1, 1946. The total mortality data of these workers compared favorably with that of the United States white male population (i.e., 2,633 deaths observed, standardized mortality ratio [SMR] of 86). However, a statistically significant increased mortality risk from colon and rectal cancer (65 and 26 deaths observed, SMR's of 138 and 139, respectively) were found. The workers were also divided into seven subgroups on the basis of the type of exposure. In one of these subgroups (the pigment workers) there was a significant increase of liver cancer (7 deaths observed, SMR of 273, $p < 0.05$). Lacquer workers had increased, although not significant, liver cancer and leukemia (SMR's of 255 and 212, respectively). The investigators [38] concluded that work in this industry presented no major health hazard. However, there were no analyses performed which took into account either exposure or latency. Without such analyses, positive findings would likely be obscured by the dilution of the study population with persons with inadequate exposure and latency for chronic disease to manifest. There is no basis for the author's conclusions.