Flexographic Ink Options: A Cleaner Technologies Substitutes Assessment

Volume 2: Appendices

Design for the Environment
U.S. EPA

Flexographic Ink Options:

A Cleaner Technologies Substitutes Assessment

VOLUME 2

Design for the Environment Program
Economics, Exposure, and Technology Division
Office of Pollution Prevention and Toxics (7404)
U.S. Environmental Protection Agency

February 2002
EPA 744-R-02-001B

Developed in Partnership with the Following Associations:

Flexible Packaging Association

napim

fta

California Film Extruders & Converters Association

RadTech International North America

Film & Bag Federation

For More Information

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This document presents the findings and analysis of a voluntary, cooperative effort between the flexographic printing industry and the U.S. EPA. This is not an official guidance document and should not be relied on by companies in the printing industry to determine regulatory requirements. Information on cost and product usage in this document was provided by individual product vendors and has not been corroborated by EPA. Mention of specific company names or products does not constitute an endorsement by EPA.

Acknowledgments

DfE would like to thank its many partners for their participation in the Flexography Project.

- Members of the Steering and Technical Committees provided valuable guidance and feedback throughout the project. The Technical Committee included volunteer printers and suppliers, who contributed much time, expertise, materials, and the use of their facilities; their cooperation was essential to the project. (The next two pages list the participants.)
- Lori Kincaid of the University of Tennessee Center for Clean Products and Clean Technologies analyzed the data on energy and resource conservation.
- John Serafano of Western Michigan University attended the performance demonstrations, supervised the laboratory runs, and analyzed the performance data.
- Laura Rubin, formerly of Industrial Technology Institute, contributed to the cost analysis.
- Members of the EPA Workgroup contributed significantly, especially to the risk, cost, and benefit-cost analyses. The Workgroup consisted of the following individuals: Susan Dillman, Conrad Flessner, Jr., Eric Jackson, Susan Krueger, David Lai, Fred Metz, and Jerry Smrchek.
- This document was prepared by Susan Altman, Dennis Chang, Cheryl Keenan, Harry (Trey) Kellett III, and Srabani Roy of Abt Associates, Inc. under EPA Contract 68-W6-0021, Work Assignments 3-07, 4-05, and 5-08, and EPA Contract 68-W-01-039, Work Assignment 1-2. EPA work assignment managers included Stephanie Bergman, Karen Chu, and James Rea.

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* These companies voluntarily supplied materials for the CTSA or participated in the performance demonstrations.

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Appendix 3-A (Risk Chapter)
Flexographic Ink Formulations and Structures

Table 3-A.1 lists every flexographic ink chemical that was studied in this CTSA, along with its CAS number and other names by which the chemical is known.

Table 3-A.2 lists all the ink additives that were used during the performance demonstrations.

Following these tables is an alphabetical display of the chemical structures for all substances listed in Table 3-A.1. in the flexographic ink formulations that were supplied for the performance demonstrations.

Table 3-A.1 Flexographic Ink Formulation Chemicals

Chemical substance	CAS number	Synonym
Acrylated epoxy polymer	NK [a]	
Acrylated oligoamine polymer	NK	
Acrylated polyester polymer #1	NK	
Acrylated polyester polymer #2	NK	
Acrylic acid-butyl acrylate-methyl methacrylate-styrene polymer	27306-39-4	2-Propenoic acid, 2-methyl-, methyl ester, polymer with butyl 2-propenoate, ethenylbenzene and 2-propenoic acid
Acrylic acid polymer, acidic #1	NK	
Acrylic acid polymer, acidic #2	NK	
Acrylic acid polymer, insoluble	NK	
Alcohols, C11-15-secondary, ethoxylated	68131-40-8	Ethoxylated C11-15-secondary alcohols
Amides, tallow, hydrogenated	61790-31-6	Hydrogenated tallow amides
Ammonia	7664-41-7	
Ammonium hydroxide	1336-21-6	
Barium	7440-39-3	
2-Benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone	119313-12-1	1-Butanone, 2-(dimethylamino)-1-[4-(4-morpholinyl)phenyl]-2-(phenylmethyl)-
Butyl acetate	123-86-4	Acetic acid butyl ester
Butyl acrylate-methacrylic acid-methyl methacrylate polymer	25035-69-2	2-Propenoic acid, 2-methyl-, polymer with butyl 2-propenoate and methyl 2-methyl-2-propenoate
Butyl carbitol	112-34-5	2-(2-Butoxyethoxy)ethanol
C.I. Basic Violet 1, molybdatephosphate	67989-22-4	Benzenamine, 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl], N-Me derivs., molybdatephosphates
C.I. Basic Violet 1, molybdatetungstatephosphate	1325-82-2	Benzenamine, 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]-, N-Me derivs., molbdatetungstatephosphates
C.I. Pigment Blue 15	147-14-8	Copper(II) phthalocyanine
C.I. Pigment Blue 61	1324-76-1	Benzenesulfonic acid, ((4-((4-(phenylamino)phenyl)(4-(phenylamino)-2,5-cyclohexadien-1-ylidene)methyl)phenyl)amino)-
C.I. Pigment Green 7	1328-53-6	Copper phthalocyanine green derivative
C.I. Pigment Red 23	6471-49-4	2-Naphthalenecarboxamide, 3-hydroxy-4-((2-methoxy-5-nitrophenyl)azo)-N-(3-nitrophenyl)
C.I. Pigment Red 48, barium salt (1:1)	7585-41-3	2-Naphthalenecarboxylic acid, 4-((5-chloro-4-methyl-2-sulfophenyl)azo)3-hydroxy-, barium salt (1:1)
C.I. Pigment Red 48, calcium salt (1:1)	7023-61-2	2-Naphthalenecarboxylic acid, 4-((5-chloro-4-methyl-2-sulfophenyl)azo)3-hydroxy-, calcium salt (1:1)

Table 3-A.1 Flexographic Ink Formulation Chemicals (continued)

Chemical substance	CAS number	Synonym
C.I. Pigment Red 52, calcium salt (1:1)	17852-99-2	2-Naphthalenecarboxylic acid, 4-((4-chloro-5-methyl-2-sulfophenyl)azo)-3-hydroxy-, calcium salt (1:1)
C.I. Pigment Red 269	67990-05-0	2-Naphthalenecarboxamide, N-(5-chloro-2-methoxyphenyl)-3-hydroxy-4-[[2-methoxy-5-[(phenylamino)carbonyl]phenyl]azo]-
C.I. Pigment Violet 23	6358-30-1	Diindolo(3,2-b:3',2'-m)triphenodioxazine, 8,18-dichoro-5,15-diethyl-5,15-dihydro-
C.I. Pigment Violet 27	12237-62-6	Ferrate(4-), hexakis(Cyano-C)-, methylated 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]benzenamine copper (2+) salts
C.I. Pigment White 6	13463-67-7	Titanium oxide (TiO_2)
C.I. Pigment White 7	1314-98-3	Zinc sulfide
C.I. Pigment Yellow 14	5468-75-7	Butanamide, 2,2'-((3,3'-dichloro(1,1'-biphenyl)-4,4'-diyl)bis(azo))bis(N-(2-methylphenyl)-3-oxo-
C.I. Pigment Yellow 74	6358-31-2	Butanamide, 2-((2-methoxy-4-nitrophenyl)azo)-N-(2-methoxyphenyl)-3-oxo-
Citric acid	77-92-9	2-Hydroxy-1,2,3-tricarboxylic acid
D&C Red No. 7	5281-04-9	3-Hydroxy-4-((4-methyl)-2-sulfophenyl)azo)-2-naphthalenecarboxylic acid, calcium salt
Dicyclohexyl phthalate	84-61-7	1,2-Benzenedicarboxylic acid, dicyclohexyl ester
Dioctyl sulfosuccinate, sodium salt	577-11-7	Succinic acid, sulfo-, 1,4-bis(2-ethylhexyl)ester, Na salt
Diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide	75980-60-8	
Dipropylene glycol diacrylate	57472-68-1	2-Propenoic acid, oxybis(methyl-2,1-ethanediyl) ester
Dipropylene glycol methyl ether	34590-94-8	Propanol, (2-methoxymethylethoxy)-
Distillates (petroleum), hydrotreated light	64742-47-8	Kerosene (petroleum), hydrotreated
Distillates (petroleum), solvent-refined light paraffinic	64741-89-5	Petroleum distillates
Erucamide	112-84-5	cis-13-Docosenoamide
Ethanol	64-17-5	Ethyl alcohol
Ethanolamine	141-43-5	2-Aminoethanol
Ethoxylated tetramethyldecyndiol	9014-85-1	Poly(oxy-1,2-ethanediyl), .alpha.,.alpha.'-[1,4-dimethyl-1,4-bis(2-methylpropyl)-2-butyne-1,4-diyl]bis[.omega.-hydroxy-
Ethyl acetate	141-78-6	Acetic acid, ethyl ester
Ethyl carbitol	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-
Ethyl 4-dimethylaminobenzoate	10287-53-3	Benzoic acid, 4-(dimethylamino)-, ethyl ester
2-Ethylhexyl diphenyl phosphate	1241-94-7	Phosphoric acid, 2-ethylhexyl diphenyl ester

Table 3-A.1 Flexographic Ink Formulation Chemicals (continued)

Chemical substance	CAS number	Synonym
Fatty acid, dimer-based polyamide	NK	
Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid	67989-30-4	
Glycerol propoxylate triacrylate	52408-84-1	Propoxylated glycerol triacrylate
n-Heptane	142-82-5	
1,6-Hexanediol diacrylate	13048-33-4	2-Propenoic acid, 1,6-hexanediyl ester
1-Hydroxycyclohexyl phenyl ketone	947-19-3	(1-Hydroxycyclohexyl)phenylmethanone
Hydroxylamine derivative	NK	
2-Hydroxy-2-methylpropiophenone	7473-98-5	2-Hydroxy-2-methyl-1-phenyl-1-propanone
Hydroxypropyl acrylate	25584-83-2	2-Propenoic aid, monoester with 1,2-propanediol
Isobutanol	78-83-1	2-Methyl-1-propanol
Isopropanol	67-63-0	2-Propanol
Isopropoxyethoxytitanium bis(acetylacetonate)	68586-02-7	Titanium, ethoxybis(2,4-pentanedionato-O,O’)(2-propanolato)-
2-Isopropylthioxanthone	5495-84-1	9H-Thioxanthen-9-one, 2-(1-methylethyl)-
4-Isopropylthioxanthone	83846-86-0	9H-Thioxanthen-9-one, 4-(1-methylethyl)-
Kaolin	1332-58-7	Aluminum silicate hydroxide
Methylenedisalicylic acid	27496-82-8	Methylenebis[2-hydroxybenzoic acid]
2-Methyl-4'-(methylthio)-2-morpholinopropiophenone	71868-10-5	Morpholinopropiophenone, 2-methyl-4'-(methylthio)-
Mineral oil	8012-95-1	Paraffin oils
Nitrocellulose	9004-70-0	Cellulose nitrate
Paraffin wax	8002-74-2	Paraffin waxes and hydrocarbon waxes
Phosphine oxide, bis(2,6-dimethoxybenzoyl) (2,4,4-trimethylpentyl)	145052-34-2	
Polyethylene	9002-88-4	Ethene polymer
Polyethylene glycol	25322-68-3	Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy-
Polyol derivative A (generic ID) [b]		
Polytetrafluoroethylene	9002-84-0	
Propanol	71-23-8	1-Propanol
Propyl acetate	109-60-4	Acetic acid, propyl ester
Propylene glycol methyl ether	107-98-2	1-Methoxy-2-propanol
Propylene glycol propyl ether	1569-01-3	1-Propoxy-2-propanol
Resin acids, hydrogenated, methyl esters	8050-15-5	

Table 3-A.1 Flexographic Ink Formulation Chemicals (continued)

Chemical substance	CAS number	Synonym
Resin, acrylic	NK	
Resin, miscellaneous	NK	Resin, miscellaneous
Rosin, fumarated, polymer with diethylene glycol and pentaerythritol	68152-50-1	Fumarated rosin, diethylene glycol pentaerythritol polymer
Rosin, fumarated, ethylene polymer derivitized	NK	
Rosin, polymerized	65997-05-9	
Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica	68909-20-6	
Silica	7631-86-9	Silicon dioxide
Silicone oil	63148-62-9	Siloxanes and silicones, di-Me
Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, ethers with polyethylene glycol acetate	70914-12-4	
Solvent naphtha (petroleum), light aliphatic	64742-89-8	VM&P naphtha, Skellysolve
Styrene	100-42-5	Ethenylbenzene
Styrene acrylic acid polymer #1	NK	
Styrene acrylic acid polymer #2	NK	
Styrene acrylic acid resin	NK	
Tetramethyldecyndiol	126-86-3	2,4,7,9-Tetramethyl-5-decyne-4,7-diol
Thioxanthone derivative	NK	
Trimethylolpropane ethoxylate triacrylate	28961-43-5	Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-[(1-oxo-2-propenyl)oxy]-, ether with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol
Trimethylolpropane propoxylate triacrylate	53879-54-2	Poly(oxy(methyl-1,2-ethanediyl)), .alpha.-hydro-.omega.-((1-oxo-2-propenyl)oxy)-, ether with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol (3:1)
Trimethylolpropane triacrylate	15625-89-5	2-Propenoic acid, 2-ethyl-2-(((1-oxo-2-propenyl)oxy)methyl-1,3-propanediyl ester
Urea	57-13-6	

[a] Not known.
[b] Actual chemical name is confidential business information.

Table 3-A.2 Ink Additives Used in the Performance Demonstrations

Ink formulation	Site	Color	Chemical
Solvent-based Ink #S1	9B	blue	propanol
		green	none
		white	propanol
		cyan	n-propyl acetate
		magenta	propylene glycol ether
			trade secret
Solvent-based Ink #S2	5	all colors	none
	7	white	propanol
		all other colors	none
	10	blue, green	none
		white	propanol
		cyan	propylene glycol monomethyl ether
			2-methoxy-1-propanol
		magenta	propylene glycol monomethyl ether
			2-methoxy-1-propanol
Water-based Ink #W1	4	white	ethoxylated tetramethyl-decyndiol
		all other colors	none
Water-based Ink #W2	1	blue	isobutanol
			ethyl carbitol
			propanol
		green	none
		white	propanol
		cyan	isobutanol
			ethyl carbitol
			ammonia
		magenta	isobutanol
			ethyl carbitol

Table 3-A.2 Ink Additives Used in the Performance Demonstrations (continued)

Ink formulation	Site	Color	Chemical
Water-based Ink #W3	2	blue	propanol
			ammonia
			asopropanol
			polyfunctional aziridine
			other compounds
		green	propanol
			ammonia
			isopropanol
		white	propanol
			ammonia
			isopropanol
		cyan	ammonia
		magenta	ammonia
			propanol
			isopropanol
	3	blue	propanol
			ammonia
		green	ammonia
		white	extender
			propanol
			ammonia
		cyan	ammonia
		magenta	2-butoxyethanol
			ammonia
Water-based Ink #W4	9A	blue	propanol
			ammonia
		green	ammonia
		white	none
		cyan	solids
			ethyl carbitol
			petroleum distillate
			propanol
			ammonia
		magenta	ammonia
UV-cured Ink #U1	11	green	1,6-hexanediol diacrylate
		all other colors	none
UV-cured Ink #U2	6	all colors	none
UV-cured Ink #U3	8	all colors	none

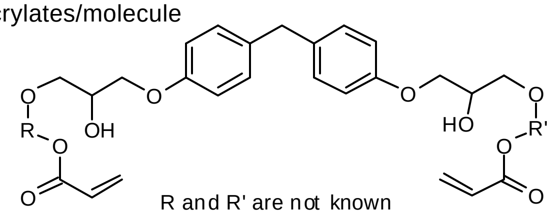
Chemical Properties Data

NK = not known
NAVG = number average molecular weight
NA = not available
E = estimated

Acrylated epoxy polymer, CAS # NK

Chemical Properties and Information

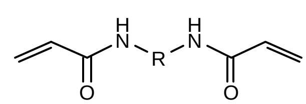
Chemical Name: NK

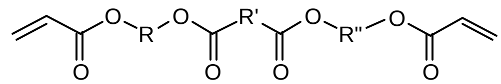
Synonyms: NK	Structure: An average of 2 acrylates/molecule
Molecular Formula: C, H, O	
Molecular Weight: NAVG 1500	
Melting Point: NA °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Curable resin	

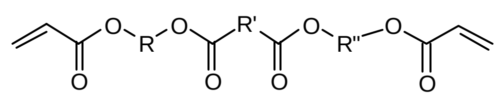
Acrylated oligoamine polymer, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK	Structure: An average of 2 acrylates/molecule
Molecular Formula: C, H, N, O	
Molecular Weight: NAVG 2000	
Melting Point: NA °C (E)	
Boiling Point: NA °C (E)	R = polymer
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Curable resin	

Acrylated polyester polymer #1, CAS # NK	
Chemical Properties and Information	
Chemical Name: NK	
Synonyms: Ebecryl 870	Structure: An average of 5-6 acrylates/ molecule
Molecular Formula: C, H, O	
Molecular Weight: NAVG 4350	
Melting Point: NA °C (E)	
Boiling Point: NA °C (E)	R, R', and R" are not known
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Curable resin	

Acrylated polyester polymer #2, CAS # NK	
Chemical Properties and Information	
Chemical Name: NK	
Synonyms: NK	Structure: An average of 4 acrylates/ molecule
Molecular Formula: C, H, O	
Molecular Weight: NAVG 1500	
Melting Point: NA °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	R, R', and R" are not known
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Curable resin	

Acrylic acid-butyl acrylate-methyl methacrylate-styrene polymer, CAS # 27306-39-4

Chemical Properties and Information

Chemical Name: 2-Propenoic acid, 2-methyl-, methyl ester, polymer with butyl 2-propenoate, ethenylbenzene and 2-propenoic acid

Synonyms: NK

Molecular Formula:

Molecular Weight: >3000 (E)

Melting Point: >100 °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

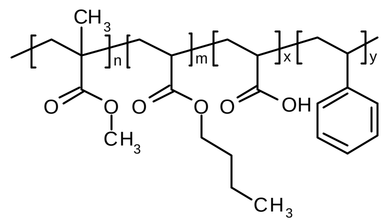
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



Henry's Law: NA $atm\text{-}m^3/mol$ (E)

Acrylic acid polymer, acidic #1, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK

Molecular Formula: $(C_3H_40_2.C,H,O)_x$

Molecular Weight: NAVG 5000 (E)

Melting Point: NA °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

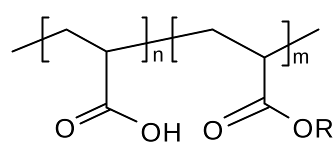
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



R not equal to H

Henry's Law: NA $atm\text{-}m^3/mol$ (E)

Acrylic acid polymer, acidic #2, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK

Molecular Formula: $(C_3H_40_2.C,H,O)_x$

Molecular Weight: NAVG 5000 (E)

Melting Point: NA °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

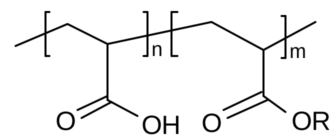
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



R not equal to H

Henry's Law: NA atm-m^3/mol (E)

Acrylic acid polymer, insoluble, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK

Molecular Formula: C, H, O

Molecular Weight: NAVG >10,000 (E)

Melting Point: NA °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

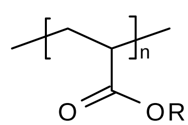
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



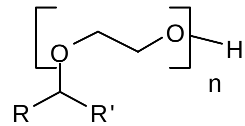
R not equal to H

Henry's Law: NA atm-m^3/mol (E)

Alcohols, C11-15-secondary, ethoxylated, CAS # 68131-40-8

Chemical Properties and Information

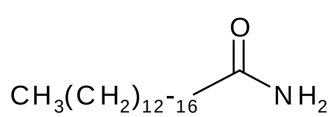
Chemical Name: Alcohols, C11-15-secondary, ethoxylated

Synonyms: Ethoxylated C11-15-secondary alcs.	Structure:
Molecular Formula: C, H, O	
Molecular Weight: 347 (n = 3)	
Melting Point: °C (E)	
Boiling Point: >350 °C (E)	
Vapor Pressure: <0.000001 mm Hg	R+R' = C10-14 alkyl
Flash Point: NA °C (M)	
Water Solubility: Dispersible g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Dispersant	

Amides, tallow, hydrogenated, CAS # 61790-31-6

Chemical Properties and Information

Chemical Name: Amides, tallow, hydrogenated

Synonyms: Armid HT	Structure:
Molecular Formula: $C_{18}H_{37}NO$ (TYPCL)	
Molecular Weight: 283.50 (TYPCL)	
Melting Point: 152 °C (E)	
Boiling Point: >400 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: 0.00003 g/L (E)	Henry's Law: 1E-6 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 6.70 (E)	
$Log_{10}K_{oc}$: 5.01(E)	
$Log_{10}BCF$: 4.86 (E)	
Function in ink: Vehicle	

Ammonia, CAS # 7664-41-7	
Chemical Properties and Information	
Chemical Name: Ammonia	
Synonyms: None	Structure:
Molecular Formula: NH_3	NH_3
Molecular Weight: 17.03	
Melting Point: -77.7 °C (M)	
Boiling Point: -33.35 °C (M)	
Vapor Pressure: >2160 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: 310 (at 25 °C) g/L (M)	Henry's Law: NA atm-m^3/mol
Density: vapor: 0.5967 (air = 1) (M) liquid at -33 °C and 1 atm: 0.682 g/cm^3	POTW Overall Removal Rate (%):
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Buffer	

Ammonium hydroxide, CAS # 1336-21-6	
Chemical Properties and Information	
Chemical Name: Ammonium hydroxide	
Synonyms: Ammonia aqueous, Aqua ammonia	Structure:
Molecular Formula: $H_4N.HO$	NH_4OH
Molecular Weight: 35.05	
Melting Point: NA °C (M)	Approximately 28-29% NH_3 in water.
Boiling Point: NA °C (M)	
Vapor Pressure: 2160 mm Hg (M)	
Flash Point: None °C (M)	
Water Solubility: >1000 (miscible) g/L	Henry's Law: NA atm-m^3/mol (E)
Density: 0.900 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Buffer	

Barium, CAS # 7440-39-3

Chemical Properties and Information

Chemical Name: Barium

Synonyms: None

Molecular Formula: Ba

Molecular Weight: 137.34

Melting Point: about 710 °C (E)

Boiling Point: about 1600 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: Reacts

Density: 3.60 g/cm^3 (M)

$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Reactant

Structure:

Ba

Henry's Law: NA atm-m^3/mol (E)

2-Benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone, CAS # 119313-12-1

Chemical Properties and Information

Chemical Name: 1-Butanone, 2-(dimethylamino)-1-[4-(4-morpholinyl)phenyl]-2-(phenylmethyl)-

Synonyms: 2-Benzyl-2-(dimethylamino)-1-(4-morpholinophenyl)-1-butanone

Molecular Formula: $C_{23}H_{30}N_2O_2$

Molecular Weight: 366.51

Melting Point: 116-119 °C (M)

Boiling Point: 457 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 0.0061 g/L (E)

Density: 1 g/cm^3 (E)

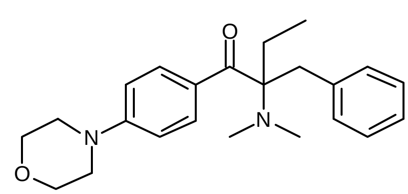
$Log_{10}K_{ow}$: 4.50 (E)

$Log_{10}K_{oc}$: 3.66 (E)

$Log_{10}BCF$: 3.19 (E)

Function in ink: NA, initiator (E)

Structure:



Henry's Law: <1E-8 atm-m^3/mol (E)

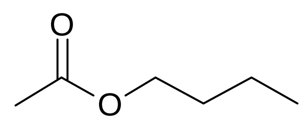
Butyl acetate, CAS # 123-86-4

Chemical Properties and Information

Chemical Name: Acetic acid, butyl ester

Synonyms: Butyl ethanoate, 1-Butyl acetate

Structure:



Molecular Formula: $C_6H_{12}O_2$

Molecular Weight: 116.16

Melting Point: -78 °C (M)

Boiling Point: 124-126 °C (M)

Vapor Pressure: 11.5 mm Hg (M)

Flash Point: 22 °C (M)

Water Solubility: 6.29 g/L (M)

Henry's Law: 0.000315 atm-m^3/mol (E)

Density: 0.882 g/cm^3 (M)

$Log_{10}K_{ow}$: 1.78 (M), 1.85 (E)

$Log_{10}K_{oc}$: 1.319 (E)

$Log_{10}BCF$: 1.123 (E)

Function in ink: Solvent

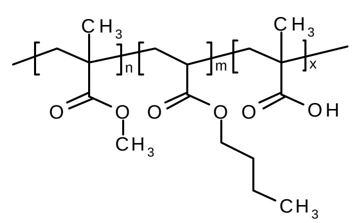
Butyl acrylate-methacrylic acid-methyl methacrylate polymer, CAS # 25035-69-2

Chemical Properties and Information

Chemical Name: 2-Propenoic acid, 2-methyl-, polymer with butyl 2-propenoate and methyl 2-methyl-2-propenoate

Synonyms: Methacrylic acid, polymer with butyl acrylate and methyl methacrylate

Structure:



Molecular Formula:

Molecular Weight: >3000 (E)

Melting Point: NA °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Henry's Law: NA atm-m^3/mol (E)

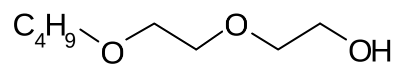
Density: 1 g/cm^3 (E)

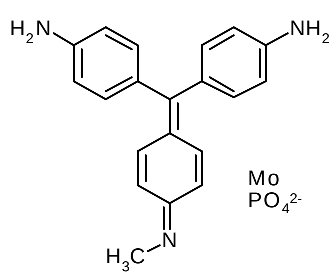
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Butyl carbitol, CAS # 112-34-5	
Chemical Properties and Information	
Chemical Name: 2-(2-Butoxyethoxy)ethanol	
Synonyms: Butoxydiethylene glycol, Diethylene glycol n-butyl ether	Structure: 
Molecular Formula: $C_8H_{18}O_3$	
Molecular Weight: 162.25	
Melting Point: -68.1 °C (M)	
Boiling Point: 230.4 °C (M)	
Vapor Pressure: 0.0219 mm Hg (M)	
Flash Point: 110 ˚C open, 78 ˚C closed cup	
Water Solubility: 1000 g/L (miscible) (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 0.967 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.56 (M), 0.29 (E)	
$Log_{10}K_{oc}$: 1.0 (E)	
$Log_{10}BCF$: 0.196 (E)	
Function in ink: Solvent	

C.I. Basic Violet 1, molybdatephosphate, CAS # 67989-22-4	
Chemical Properties and Information	
Chemical Name: Benzenamine, 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl], N-Me-derivs., molybdatephosphates	
Synonyms: None	Structure: 
Molecular Formula: $C_{20}H_{19}N_3.Mo.H_3O_4P$	
Molecular Weight: 350 (E)	
Melting Point: >250 (dec) °C(E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.0001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Basic Violet 1, molybdatetungstatephosphate, CAS # 1325-82-2

Chemical Properties and Information

Chemical Name: Benzenamine, 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]-, N-Me derivs, molybdatetungstatephosphate

Synonyms: C.I. Pigment Violet 3

Molecular Formula:

Molecular Weight: >350 (E)

Melting Point: >250 (dec) °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.001 g/L (E)

Density: 1.5 g/cm^3 (E)

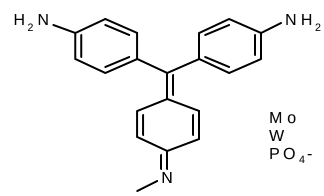
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Pigment

Structure:



Henry's Law: NA atm-m^3/mol (E)

C.I. Pigment Blue 15, CAS # 147-14-8

Chemical Properties and Information

Chemical Name: Copper(II)phthalocyanine

Synonyms: None

Molecular Formula: $C_{32}H_{16}CuN_8$

Molecular Weight: 576.08

Melting Point: NA °C (E)

Boiling Point: >450 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.001 g/L (E)

Density: 1.5 g/cm^3 (E)

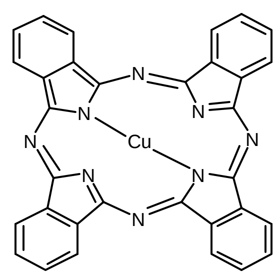
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Pigment

Structure:

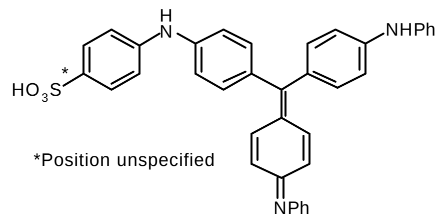


Henry's Law: NA atm-m^3/mol (E)

C.I. Pigment Blue 61, CAS # 1324-76-1

Chemical Properties and Information

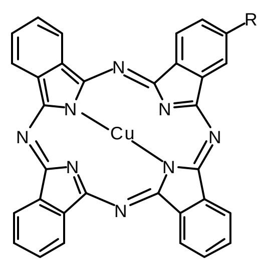
Chemical Name: Benzenesulfonic acid, ((4-((4-(phenylamino)phenyl)(4-(phenylamino)-2,5-cyclohexadien-1-ylidene)methyl)phenyl)amino)-

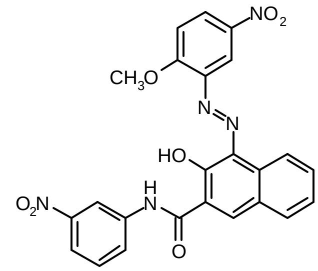
Synonyms: Reflex Blue R	Structure:  *Position unspecified
Molecular Formula: $C_{37}H_{29}N_3O_3S$	
Molecular Weight: 595.70	
Melting Point: 350 °C (E)	
Boiling Point: >450 °C (E)	
Vapor Pressure: 0.000001 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 6.514 (E)	
$Log_{10}K_{oc}$: 9.227 (E)	
$Log_{10}BCF$: 4.721 (E)	
Function in ink: Pigment	

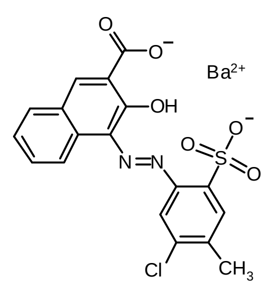
C.I. Pigment Green 7, CAS # 1328-53-6

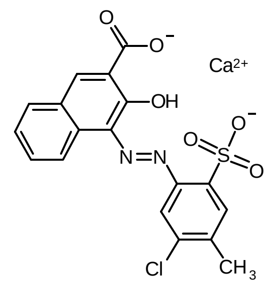
Chemical Properties and Information

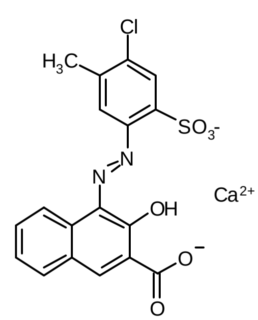
Chemical Name: C.I. Pigment Green 7

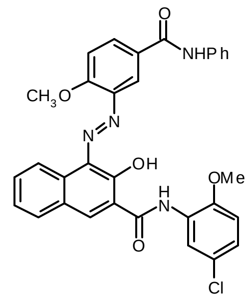
Synonyms: Copper phthalocyanine Green PG-7	Structure:  R substitution/position unspecified
Molecular Formula: Unspecified	
Molecular Weight: >550 (E)	
Melting Point: NA °C (E)	
Boiling Point: >450 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

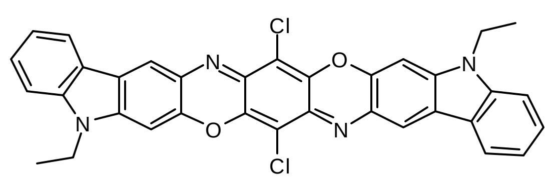
C.I. Pigment Red 23, CAS # 6471-49-4	
Chemical Properties and Information	
Chemical Name: 2-Naphthalenecarboxamide, 3-hydroxy-4-((2-methoxy-5-nitrophenyl)azo)-N-(3-nitrophenyl)	
Synonyms: Naphthol Red B	Structure: 
Molecular Formula: $C_{24}H_{17}N_5O_7$	
Molecular Weight: 487.43	
Melting Point: 322 °C (E)	
Boiling Point: >500 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: <1E-6 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 8.30 (E)	
$Log_{10}K_{oc}$: 4.9 (E)	
$Log_{10}BCF$: 6.08 (E)	
Function in ink: Pigment	

C.I. Pigment Red 48, barium salt (1:1), CAS # 7585-41-3	
Chemical Properties and Information	
Chemical Name: 2-Naphthalenecarboxylic acid, 4-[(5-chloro-4-methyl-2-sulfophenyl)azo]-3-hydroxy-, barium salt (1:1)	
Synonyms: None	Structure: 
Molecular Formula: $C_{18}H_{13}ClN_2O_6S.Ba$	
Molecular Weight: 558.14	
Melting Point: >250 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.1 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment Red 48, calcium salt (1:1), CAS # 7023-61-2	
Chemical Properties and Information	
Chemical Name: 2-Naphthalenecarboxylic acid, 4-[(5-chloro-4-methyl-2-sulfophenyl)azo]-3-hydroxy-, calcium salt (1:1)	
Synonyms: None	Structure: 
Molecular Formula: $C_{18}H_{13}ClN_2O_6S.Ca$	
Molecular Weight: 460.90	
Melting Point: >250 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.1 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment Red 52, calcium salt (1:1), CAS # 17852-99-2	
Chemical Properties and Information	
Chemical Name: 2-Naphthalenecarboxylic acid, 4-((4-chloro-5-methyl-2-sulfophenyl)azo)-3-hydroxy-, calcium salt (1:1)	
Synonyms: C.I. Pigment Red 52:1	Structure: 
Molecular Formula: $C_{18}H_{13}ClN_2O_6S.Ca$	
Molecular Weight: 460.90	
Melting Point: >250 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.0001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

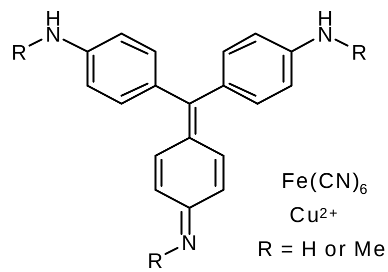
C.I. Pigment Red 269, CAS # 67990-05-0	
Chemical Properties and Information	
Chemical Name: 2-Naphthalenecarboxamide, N-(5-chloro-2-methoxyphenyl)-3-hydroxy-4-[[2-methoxy-5-[(phenylamino)carbonyl]phenyl]azo]-	
Synonyms: None	Structure: 
Molecular Formula: $C_{32}H_{25}ClN_4O_5$	
Molecular Weight: 581.03	
Melting Point: >350 °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 8.24 (E)	
$Log_{10}K_{oc}$: 5.964 (E)	
$Log_{10}BCF$: 6.033 (E)	
Function in ink: Pigment	

C.I. Pigment Violet 23, CAS # 6358-30-1	
Chemical Properties and Information	
Chemical Name: Diindolo(3,2-b:3',2'-m)triphenodioxazine, 8,18-dichloro-5,15-diethyl-5,15-dihydro-	
Synonyms: None	Structure: 
Molecular Formula: $C_{34}H_{22}Cl_2N_4O_2$	
Molecular Weight: 589.46	
Melting Point: >200 °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.0001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment Violet 27, CAS # 12237-62-6

Chemical Properties and Information

Chemical Name: Ferrate(4-), hexakis(cyano-C)-, methylated 4-[(4-aminophenyl)(4-imino-2,5-cyclohexadien-1-ylidene)methyl]benzenamine copper(2+) salts

Synonyms: None	Structure: 
Molecular Formula: C, H, N . $(CN)_6Fe$.	
Molecular Weight: >350 (E)	
Melting Point: >250 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.01 g/L	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment White 6, CAS # 13463-67-7

Chemical Properties and Information

Chemical Name: Titanium oxide

Synonyms: Titanium dioxide, Unitane	Structure:
Molecular Formula: O_2Ti	
Molecular Weight: 79.88 (based on empirical	O=Ti=O
Melting Point: 1855 °C (M)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol
Density: 4.23 (rutile); 3.9 (anatase); 4.13 (brookite)	POTW Overall Removal Rate
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment White 7, CAS # 1314-98-3

Chemical Properties and Information

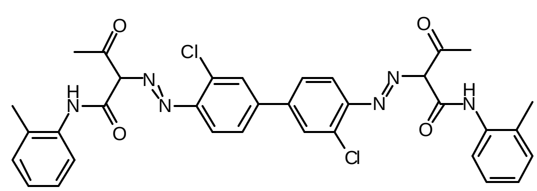
Chemical Name: Zinc sulfide

Synonyms: None	Structure:
Molecular Formula: ZnS	
Molecular Weight: 97.43	Zn=S
Melting Point: >500 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.0007 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 4.10 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

C.I. Pigment Yellow 14, CAS # 5468-75-7

Chemical Properties and Information

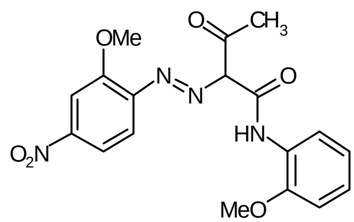
Chemical Name: Butanamide, 2,2'-((3,3'-dichloro(1,1'-biphenyl)-4,4'-diyl)bis(azo))bis(N-(2-methylphenyl)-3-oxo-

Synonyms: None	Structure:
Molecular Formula: $C_{34}H_{30}Cl_2N_6O_4$	
Molecular Weight: 657.52	
Melting Point: 350 °C (E)	
Boiling Point: >450 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 7.02 (E)	
$Log_{10}K_{oc}$: 5.338 (E)	
$Log_{10}BCF$: 5.105 (E)	
Function in ink: Pigment	

C.I. Pigment Yellow 74, CAS # 6358-31-2

Chemical Properties and Information

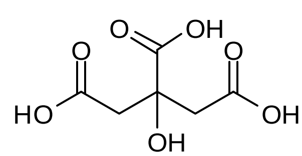
Chemical Name: Butanamide, 2-[(2-methoxy-4-nitrophenyl)azo]-N-(2-methoxyphenyl)-3-oxo-

Synonyms: 2-[(2-Methoxy-4-nitrophenyl)azo]-o-acetoacetanisidide	Structure: 
Molecular Formula: $C_{18}H_{18}N_4O_6$	
Molecular Weight: 386.34	
Melting Point: 241 °C (E)	
Boiling Point: >500 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: 0.0038 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 2.99 (E)	
$Log_{10}K_{oc}$: 1.95 (E)	
$Log_{10}BCF$: 2.04 (E)	
Function in ink: Pigment	

Citric acid, CAS # 77-92-9

Chemical Properties and Information

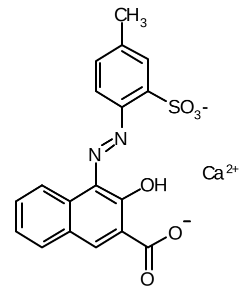
Chemical Name: 2-Hydroxy-1,2,3-propanetricarboxylic acid

Synonyms: None	Structure: 
Molecular Formula: $C_6H_8O_7$	
Molecular Weight: 192.12	
Melting Point: 152-154 °C (M)	
Boiling Point: 407 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: > 600 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1.665 g/cm^3 (M)	
$Log_{10}K_{ow}$: -1.72 (M), -1.67 (E)	
$Log_{10}K_{oc}$: 1.0 (E)	
$Log_{10}BCF$: -1.537 (E)	
Function in ink: Buffer	

D&C Red No. 7, CAS # 5281-04-9

Chemical Properties and Information

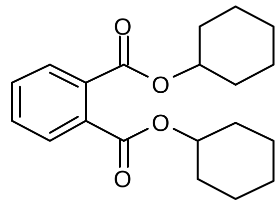
Chemical Name: 3-Hydroxy-4-((4-methyl-2-sulfophenyl)azo)-2-naphthylenecarboxylic acid, calcium salt

Synonyms: Pigment Red, CI 15850:1 (Ca salt)	Structure: 
Molecular Formula: $C_{18}H_{14}N_2O_6S.Ca$	
Molecular Weight: 426.45	
Melting Point: >250 (dec) °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Pigment	

Dicyclohexyl phthalate, CAS # 84-61-7

Chemical Properties and Information

Chemical Name: 1,2-Benzenedicarboxylic acid, dicyclohexyl ester

Synonyms: Phthalic acid, dicyclohexyl ester	Structure: 
Molecular Formula: $C_{20}H_{26}O_4$	
Molecular Weight: 330.43	
Melting Point: 64-66 °C (M)	
Boiling Point: 395 °C (E)	
Vapor Pressure: 0.0007 mm Hg (M)	
Flash Point: NA °C (M)	
Water Solubility: 0.004 g/L (M)	Henry's Law: 6.43e-6 atm-m^3/mol (E)
Density: 0.9 g/cm^3 (E)	
$Log_{10}K_{ow}$: 6.2 (E)	
$Log_{10}K_{oc}$: 4.25 (E)	
$Log_{10}BCF$: 4.48 (E)	
Function in ink: Plasticizer	

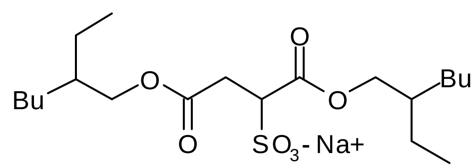
Dioctyl sulfosuccinate, sodium salt, CAS # 577-11-7

Chemical Properties and Information

Chemical Name: Sulfosuccinic acid 1,4-bis(2-ethylhexyl) ester, sodium salt

Synonyms: Sulfobutanedioic acid, 1,4-bis(2-ethylhexyl) ester, sodium salt, Docusate Na

Structure:



Molecular Formula: $C_{20}H_{38}O_7S.Na$

Molecular Weight: 444.55

Melting Point: 173-179 °C (M)

Boiling Point: >500 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 15 g/L (M)

Henry's Law: NA atm-m^3/mol (E)

Density: 1.5 g/cm^3 (E)

$Log_{10}K_{ow}$: 3.949 (E)

$Log_{10}K_{oc}$: 3.018 (E)

$Log_{10}BCF$: 2.771 (E)

Function in ink: Surfactant

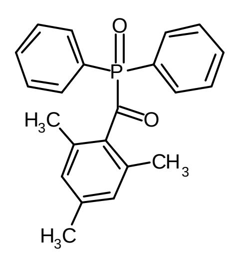
Diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide, CAS # 75980-60-8

Chemical Properties and Information

Chemical Name: Phosphine oxide, diphenyl(2,4,6-trimethylbenzoyl)-

Synonyms: None

Structure:



Molecular Formula: $C_{22}H_{21}O_2P$

Molecular Weight: 348.38

Melting Point: 88-92 °C (M)

Boiling Point: 474 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 0.00699 g/L (E)

Henry's Law: <1E-8 atm-m^3/mol (E)

Density: 1 g/cm^3 (E)

$Log_{10}K_{ow}$: 3.87 (E)

$Log_{10}K_{oc}$: 2.895 (E)

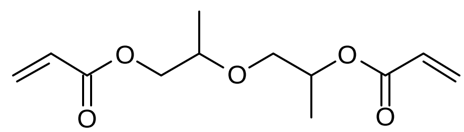
$Log_{10}BCF$: 2.713 (E)

Function in ink: Initiator

Dipropylene glycol diacrylate, CAS # 57472-68-1

Chemical Properties and Information

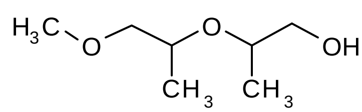
Chemical Name: 2-Propenoic acid, oxybis(methyl-2,1-ethanediyl) ester

Synonyms: None	Structure: 
Molecular Formula: $C_{12}H_{18}O_5$	
Molecular Weight: 242.30	
Melting Point: -34 °C (E)	
Boiling Point: 256 °C (E)	
Vapor Pressure: 0.0194 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: 0.968 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 1.675 (E)	
$Log_{10}K_{oc}$: 1.0 (E)	
$Log_{10}BCF$: 1.043 (E)	
Function in ink: Curing agent	

Dipropylene glycol methyl ether, CAS # 34590-94-8

Chemical Properties and Information

Chemical Name: 1,4-Dimethyl-3,6-dioxa-1-heptanol

Synonyms: 1-(2-Methoxyisopropoxy)-2-propanol, (2-Methoxymethylethoxy)propanol	Structure: 
Molecular Formula: $C_7H_{16}O_3$	
Molecular Weight: 148.20	
Melting Point: -80 °C (M)	
Boiling Point: 189 °C (M)	
Vapor Pressure: 0.41 mm Hg (M)	
Flash Point: 74 °C (M)	
Water Solubility: 370 g/L	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 0.948 g/cm^3 (M)	
$Log_{10}K_{ow}$: -1.99 (E)	
$Log_{10}K_{oc}$: 1.0 (E)	
$Log_{10}BCF$: -0.381 (E)	
Function in ink: Solvent	

Distillates (petroleum), hydrotreated light, CAS # 64742-47-8

Chemical Properties and Information

Chemical Name: Distillates (petroleum), hydrotreated light

Synonyms: Kerosene (petroleum), hydrotreated	Structure:
Molecular Formula: C_9H_{20} - $C_{16}H_{34}$	A complex combination of hydrocarbons obtained by treating a petroleum fraction with hydrogen in the presence of a catalyst. It consists of hydrocarbons having carbon numbers predominantly in the range of C9 and C16 and boiling in the range of approximately 150 °C to 290 °C.
Molecular Weight: >130	
Melting Point: -60 °C (E)	
Boiling Point: 150-290 °C (E)	
Vapor Pressure: <5 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.003 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 0.8 g/cm^3 (E)	
$Log_{10}K_{ow}$: >4.7 (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Defoamer	

Distillates (petroleum), solvent-refined light paraffinic, CAS # 64741-89-5

Chemical Properties and Information

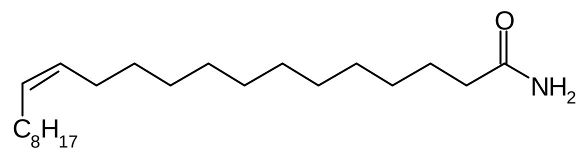
Chemical Name: Solvent refined light paraffinic distillate (petroleum)

Synonyms: None	Structure:
Molecular Formula: $C_{15}H_{32}$-$C_{30}H_{62}$	A complex combination of hydrocarbons obtained as the raffinate from a solvent extraction process. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C15-C30 and produces a finished oil with a viscosity of less than 100 SUS at 100 °F (19cSt at 40 °C).
Molecular Weight: >200 (E)	
Melting Point: <25 °C (E)	
Boiling Point: >250 °C (E)	
Vapor Pressure: <0.03 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.00001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 0.8 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Defoamer	

Erucamide, CAS # 112-84-5

Chemical Properties and Information

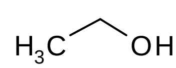
Chemical Name: cis-13-Docosenoamide

Synonyms: Erucyl amide	Structure:
Molecular Formula: $C_{22}H_{43}NO$	
Molecular Weight: 337.59	
Melting Point: 79-81 °C (M)	
Boiling Point: 461 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: 0.0002 g/L (E)	Henry's Law: 2.84E-6 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 8.445 (E)	
$Log_{10}K_{oc}$: 6.071 (E)	
$Log_{10}BCF$: 6.188 (E)	
Function in ink: Vehicle	

Ethanol, CAS # 64-17-5

Chemical Properties and Information

Chemical Name: Ethyl alcohol

Synonyms: None	Structure:
Molecular Formula: C_2H_6O	
Molecular Weight: 46.07	
Melting Point: -114 °C (M)	
Boiling Point: 78 °C (M)	
Vapor Pressure: 59.3 (M), 61.5 (E)	
Flash Point: 8 °C (M)	
Water Solubility: 1000 (miscible) g/L	Henry's Law: 5.67E-6 atm-m^3/mol (E)
Density: 0.785 g/cm^3 (M)	
$Log_{10}K_{ow}$: -0.31 (M), -0.14 (E)	
$Log_{10}K_{oc}$: 0 (E)	
$Log_{10}BCF$: -0.466 (E)	
Function in ink: Solvent	

Ethanolamine, CAS # 141-43-5

Chemical Properties and Information

Chemical Name: 2-Aminoethanol

Synonyms: Glycinol, 2-Hydroxyethylamine

Molecular Formula: C_2H_7NO

Molecular Weight: 61.08

Melting Point: 10.5 °C (M)

Boiling Point: 170 °C (M)

Vapor Pressure: 0.404 mm Hg (M)

Flash Point: 93 °C (M)

Water Solubility: Miscible g/L

Density: 1.012 g/cm^3 (M)

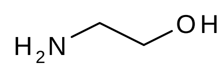
$Log_{10}K_{ow}$: -1.31 (M), -1.61 (E)

$Log_{10}K_{oc}$: 0 (E)

$Log_{10}BCF$: -1.22 (E)

Function in ink: Buffer

Structure:



Henry's Law: <1E-8 atm-m^3/mol (E)

Ethoxylated tetramethyldecyndiol, CAS # 9014-85-1

Chemical Properties and Information

Chemical Name: Poly(oxy-1,2-ethanediyl), .alpha.,.alpha'.-[1,4-dimethyl-1,4-bis(2-methylpropyl)-2-butyne-1,4-diyl]bis[.omega.-hydroxy-

Synonyms: Surfynol

Molecular Formula:

Molecular Weight: >500 (E)

Melting Point: NA °C (E)

Boiling Point: >300 °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: Dispersible g/L (E)

Density: 1 g/cm^3 (E)

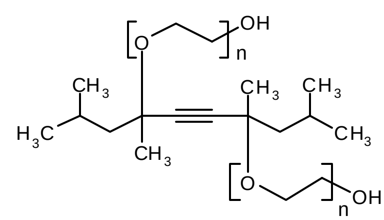
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Dispersant

Structure:



Henry's Law: NA atm-m^3/mol (E)

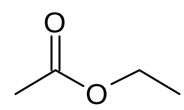
Ethyl acetate, CAS # 141-78-6

Chemical Properties and Information

Chemical Name: Acetic acid, ethyl ester

Synonyms: Acetoxyethane, Ethyl ethanoate, Ethyl acetic ester

Structure:



Molecular Formula: $C_4H_8O_2$

Molecular Weight: 88.11

Melting Point: -84 °C (M)

Boiling Point: 76.5-77.5 °C (M)

Vapor Pressure: 93.7 mm Hg (M)

Flash Point: -3 °C (M); 7.2 ˚C (open

Water Solubility: 80 g/L (M)

Henry's Law: 0.000158 atm-m^3/mol (E)

Density: 0.902 g/cm^3 (M)

$Log_{10}K_{ow}$: 0.73 (M), 0.86 (E)

$Log_{10}K_{oc}$: 0.788 (E)

$Log_{10}BCF$: 0.325 (E)

Function in ink: Solvent

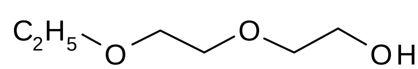
Ethyl carbitol, CAS # 111-90-0

Chemical Properties and Information

Chemical Name: 2-(2-Ethoxyethoxy)ethanol

Synonyms: Diethylene glycol ethyl ether; 3,6-Dioxa-1-octanol

Structure:



Molecular Formula: $C_6H_{14}O_3$

Molecular Weight: 134.18

Melting Point: -76 °C (E)

Boiling Point: 202 °C (M)

Vapor Pressure: 0.126 mm Hg (M)

Flash Point: 96 °C (M)

Water Solubility: 1000 (miscible) g/L

Henry's Law: <1E-8 atm-m^3/mol (E)

Density: 0.999 g/cm^3 (M)

$Log_{10}K_{ow}$: -0.54 (M), -0.69 (E)

$Log_{10}K_{oc}$: 0 (E)

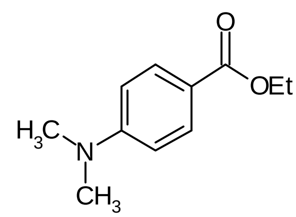
$Log_{10}BCF$: -0.64 (E)

Function in ink: Solvent

Ethyl 4-dimethylaminobenzoate, CAS # 10287-53-3

Chemical Properties and Information

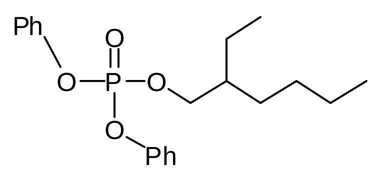
Chemical Name: Benzoic acid, 4-(dimethylamino)-, ethyl ester

Synonyms: Perbenate	Structure: 
Molecular Formula: $C_{11}H_{15}NO_2$	
Molecular Weight: 193.25	
Melting Point: 64-66 °C (M)	
Boiling Point: 269 °C (E)	
Vapor Pressure: 0.0044 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: 0.173 g/L (E)	Henry's Law: 7.33E-7 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 2.89 (E)	
$Log_{10}K_{oc}$: 1.824 (E)	
$Log_{10}BCF$: 1.97 (E)	
Function in ink: Initiator	

2-Ethylhexyl diphenyl phosphate, CAS # 1241-94-7

Chemical Properties and Information

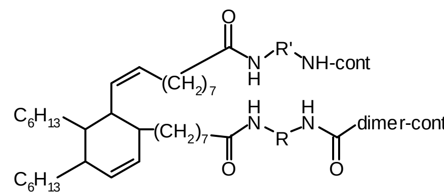
Chemical Name: Phosphoric acid, 2-ethylhexyl diphenyl ester

Synonyms: None	Structure: 
Molecular Formula: $C_{20}H_{27}O_4P$	
Molecular Weight: 362.41	
Melting Point: 87 °C (E)	
Boiling Point: 443 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: 0.0019 g/L (M)	Henry's Law: 2.7E-7 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 5.73 (M), 4.205 (E)	
$Log_{10}K_{oc}$: 4.125 (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Plasticizer	

Fatty acid, dimer-based polyamide, CAS # NK

Chemical Properties and Information

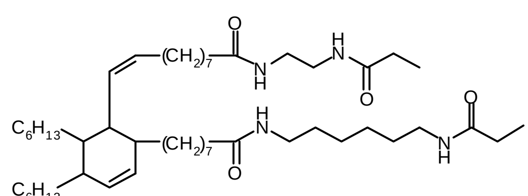
Chemical Name: NK

Synonyms: NK	Structure: 
Molecular Formula: C, H, N, O	
Molecular Weight: NAVG 2500	
Melting Point: NA °C (E)	
Boiling Point: >300 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 0.9 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid, CAS # 67989-30-4

Chemical Properties and Information

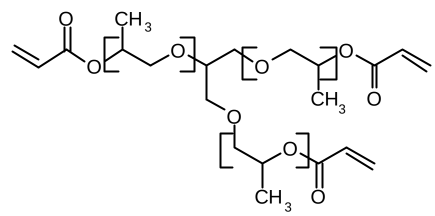
Chemical Name: Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid

Synonyms: None	Structure:  Representative structure
Molecular Formula: C, H, N, O	
Molecular Weight: >600 (E)	
Melting Point: >100 °C (E)	
Boiling Point: >250 °C (E)	
Vapor Pressure: <0.000001 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Glycerol propoxylate triacrylate, CAS # 52408-84-1

Chemical Properties and Information

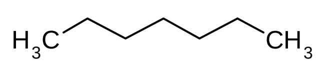
Chemical Name: Poly[oxy)methyl-1,2-ethanediyl)], .alpha.,.alpha'.,.alpha''.,-1,2,3-propanetriyltris[.omega.-[(1-oxo-2-propenyl)oxy]-

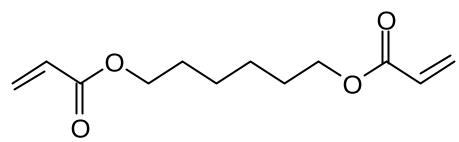
Synonyms: .alpha.,.alpha'.,.alpha''.,-1,2,3-propanetriyltris[polypropylene glycol acrylate]	Structure: 
Molecular Formula:	
Molecular Weight: >1000 (E)	
Melting Point: NA °C (M)	
Boiling Point: NA °C (M)	
Vapor Pressure: <0.000001 mm Hg (E)	
Flash Point: >110 °C (E)	
Water Solubility: dispersible g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.064 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Curing agent	

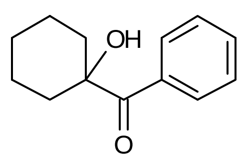
n-Heptane, CAS # 142-82-5

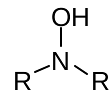
Chemical Properties and Information

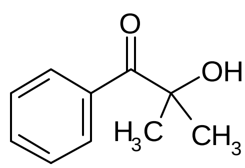
Chemical Name: Heptane

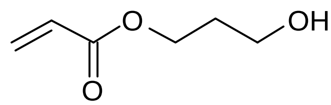
Synonyms: None	Structure:
Molecular Formula: C_7H_{16}	
Molecular Weight: 100.21	
Melting Point: -90.7 °C (M)	
Boiling Point: 98.4 °C (M)	
Vapor Pressure: 46 mm Hg (M)	
Flash Point: -1 °C open; -4 ˚C closed	
Water Solubility: 0.0034 g/L (M)	Henry's Law: 2.27 atm-m^3/mol (E)
Density: 0.684 g/cm^3 (M)	
$Log_{10}K_{ow}$: 4.66 (M), 3.78 (E)	
$Log_{10}K_{oc}$: 2.439 (E)	
$Log_{10}BCF$: 3.312 (E)	
Function in ink: Solvent	

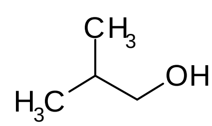
1,6-Hexanediol diacrylate, CAS # 13048-33-4	
Chemical Properties and Information	
Chemical Name: 2-Propenoic acid, 1,6-hexanediyl ester	
Synonyms: Acrylic acid, hexamethylene ester, HDODA	Structure: 
Molecular Formula: $C_{12}H_{18}O_4$	
Molecular Weight: 226.28	
Melting Point: -30 °C (E)	
Boiling Point: 259 °C (E)	
Vapor Pressure: 0.0166 mm Hg (E)	
Flash Point: >110 °C (E)	
Water Solubility: 0.0748 g/L (E)	Henry's Law: 3.7E-8 atm-m^3/mol (E)
Density: 1.01 g/cm^3 (M)	
$Log_{10}K_{ow}$: 3.079 (E)	
$Log_{10}K_{oc}$: 2.101 (E)	
$Log_{10}BCF$: 2.110 (E)	
Function in ink: Curing agent	

1-Hydroxycyclohexyl phenyl ketone, CAS # 947-19-3	
Chemical Properties and Information	
Chemical Name: (1-Hydroxycyclohexyl)phenylmethanone	
Synonyms: None	Structure: 
Molecular Formula: $C_{13}H_{16}O_2$	
Molecular Weight: 204.27	
Melting Point: 47-50 °C (M)	
Boiling Point: 290 °C (M)	
Vapor Pressure: 0.000165 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: 1.882 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 2.405 (E)	
$Log_{10}K_{oc}$: 1.731 (E)	
$Log_{10}BCF$: 1.598 (E)	
Function in ink: Vehicle	

Hydroxylamine derivative, CAS # NK	
Chemical Properties and Information	
Chemical Name: NK	
Synonyms: NK	Structure:
Molecular Formula: C, H, N, O Molecular Weight: 100-150 (E) Melting Point: NA °C (E) Boiling Point: 230-300 °C (E) Vapor Pressure: <0.01 mm Hg (E) Flash Point: NA °C (M)	 R and R' are not specified
Water Solubility: <20 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 0.9 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Inhibitor	

2-Hydroxy-2-methylpropiophenone, CAS # 7473-98-5	
Chemical Properties and Information	
Chemical Name: 2-Hydroxy-2-methyl-1-phenyl-1-propanone	
Synonyms: None	Structure:
Molecular Formula: $C_{10}H_{12}O_2$ Molecular Weight: 164.20 Melting Point: 54.5 °C (E) Boiling Point: 235 °C (M) Vapor Pressure: 0.00429 mm Hg (E) Flash Point: >110 °C (E)	
Water Solubility: 25.3 g/L (E)	Henry's Law: 2.7E-6 atm-m^3/mol (E)
Density: 1.077 g/cm^3 (M)	
$Log_{10}K_{ow}$: 1.08 (E)	
$Log_{10}K_{oc}$: 1.0 (E)	
$Log_{10}BCF$: 0.591 (E)	
Function in ink: Solvent	

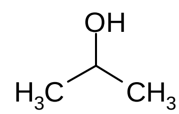
Hydroxypropyl acrylate, CAS # 25584-83-2	
Chemical Properties and Information	
Chemical Name: 2-Propenoic acid, monoester with 1,2-propanediol	
Synonyms: Propyleneglycol acrylate, Acrylic acid, hydroxypropyl ester	Structure: 
Molecular Formula: $C_6H_{10}O_3$	
Molecular Weight: 130.14	
Melting Point: -4.4 °C (E)	
Boiling Point: 191 °C (M)	
Vapor Pressure: 0.124 mm Hg (E)	
Flash Point: 89 °C (M)	
Water Solubility: 183.5 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1.044 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.245 (E)	
$Log_{10}K_{oc}$: -0.044 (E)	
$Log_{10}BCF$: 0.904 (E)	
Function in ink: Reactive diluent	

Isobutanol, CAS # 78-83-1	
Chemical Properties and Information	
Chemical Name: 2-Methyl-1-propanol	
Synonyms: 1-Hydroxymethylpropane, Isobutyl alcohol	Structure: 
Molecular Formula: $C_4H_{10}O$	
Molecular Weight: 74.12	
Melting Point: -108 °C (M)	
Boiling Point: 107.89 °C (M)	
Vapor Pressure: 10.4 mm Hg (M)	
Flash Point: 27 °C closed cup (M)	
Water Solubility: 1000 (miscible) g/L	Henry's Law: 9.99E-6 atm-m^3/mol (E)
Density: 0.803 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.76 (M), 0.77 (E)	
$Log_{10}K_{oc}$: 0.311 (E)	
$Log_{10}BCF$: 0.348 (E)	
Function in ink: Solvent	

Isopropanol, CAS # 67-63-0

Chemical Properties and Information

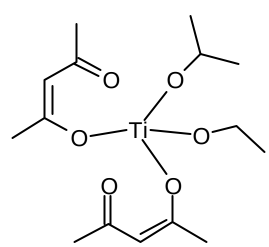
Chemical Name: 2-Propanol

Synonyms: Isopropyl alcohol, 2-propyl alcohol	Structure: 
Molecular Formula: C_3H_8O	
Molecular Weight: 6.10	
Melting Point: -88.5 °C (M)	
Boiling Point: 82.5 °C (M)	
Vapor Pressure: 45.4 mm Hg (M)	
Flash Point: 11.7 °C closed cup (M)	
Water Solubility: 1000 (miscible) g/L	Henry's Law: 7.52E-6 atm-m^3/mol (E)
Density: 0.785 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.05 (M), 0.28 (E)	
$Log_{10}K_{oc}$: 0.025 (E)	
$Log_{10}BCF$: -0.192 (E)	
Function in ink: Solvent	

Isopropoxyethoxytitanium bis(acetylacetonate), CAS # 68586-02-7

Chemical Properties and Information

Chemical Name: Titanium, ethoxybis(2,4-pentanedionato-O,O')(2-propanolato)-

Synonyms: 2-Propanol, titanium complex	Structure: 
Molecular Formula: $C_{15}H_{26}O_6Ti$	
Molecular Weight: 350.25	
Melting Point: NA °C (E)	
Boiling Point: >250 °C (E)	
Vapor Pressure: <0.01 mm Hg (E)	
Flash Point: 30 °C (E)	
Water Solubility: Reacts	Henry's Law: NA atm-m^3/mol (E)
Density: 1.1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Adhesion promoter	

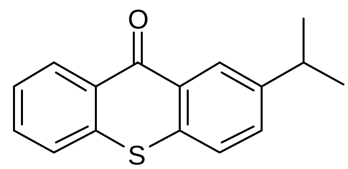
2-Isopropylthioxanthone, CAS # 5495-84-1

Chemical Properties and Information

Chemical Name: 9H-Thioxanthen-9-one, 2-(1-methylethyl)-

Synonyms: None

Structure:



Molecular Formula: $C_{16}H_{14}OS$
Molecular Weight: 254.35
Melting Point: 141.7 °C (E)
Boiling Point: 379 °C (E)
Vapor Pressure: 0.00002 mm Hg (E)
Flash Point: NA °C (M)
Water Solubility: 0.000032 g/L (E)
Henry's Law: 9.99E-8 atm-m^3/mol (E)
Density: 0.9 g/cm^3 (E)
$Log_{10}K_{ow}$: 5.54 (E)
$Log_{10}K_{oc}$: 3.983 (E)
$Log_{10}BCF$: 3.980 (E)
Function in ink: Photoinitiator

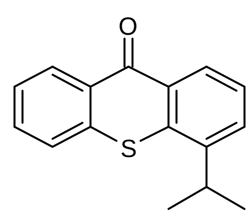
4-Isopropylthioxanthone, CAS # 83846-86-0

Chemical Properties and Information

Chemical Name: 9H-Thioxanthen-9-one, 4-(1-methylethyl)-

Synonyms: None

Structure:



Molecular Formula: $C_{16}H_{14}OS$
Molecular Weight: 254.35
Melting Point: 141.7 °C (E)
Boiling Point: 379 °C (E)
Vapor Pressure: 0.000002 mm Hg (E)
Flash Point: NA °C (M)
Water Solubility: 0.000032 g/L (E)
Henry's Law: 9.99E-8 atm-m^3/mol (E)
Density: 0.9 g/cm^3 (E)
$Log_{10}K_{ow}$: 5.54 (E)
$Log_{10}K_{oc}$: 3.983 (E)
$Log_{10}BCF$: 3.980 (E)
Function in ink: Photoinitiator

Kaolin, CAS # 1332-58-7

Chemical Properties and Information

Chemical Name: Kaolin

Synonyms: Clays, white, Aluminum silicate hydroxide

Molecular Formula: $Al_2Si_2O_5(OH)_4$

Molecular Weight: 258.16 (from Emp.

Melting Point: >500 °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 2.75 g/cm^3 (E)

$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Pigment

Structure:

A clay that is essentially kaolinite, a hydrated aluminum silicate. It has a high fusion point and is the most refractory of all clays.

Henry's Law: NA atm-m^3/mol (E)

Methylenedisalicylic acid, CAS # 27496-82-8

Chemical Properties and Information

Chemical Name: Benzoic acid, methylenebis[2-hydroxy-

Synonyms: Methylenedisalicylic acid

Molecular Formula: $C_{15}H_{12}O_6$

Molecular Weight: 288.26

Melting Point: 220 °C (E)

Boiling Point: 517 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 0.0076 g/L (E)

Density: 0.9 g/cm^3 (E)

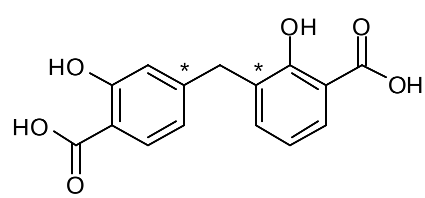
$Log_{10}K_{ow}$: 4.52 (E)

$Log_{10}K_{oc}$: 4.13 (E)

$Log_{10}BCF$: 3.2 (E)

Function in ink: NA, crosslinker (E)

Structure:



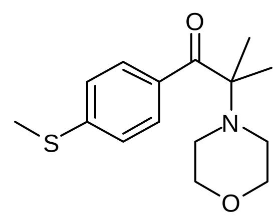
*Positions not specified

Henry's Law: <1E-6 atm-m^3/mol (E)

2-Methyl-4'-(methylthio)-2-morpholinopropiophenone, CAS # 71868-10-5

Chemical Properties and Information

Chemical Name: 2-Methyl-4'-(methylthio)-2-morpholinopropiophenone

Synonyms: None	Structure: 
Molecular Formula: $C_{15}H_{21}NO_2S$	
Molecular Weight: 279.40	
Melting Point: 74-76 °C (M)	
Boiling Point: 372°C (E)	
Vapor Pressure: 0.0000135 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: 1.077 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 2.726 (E)	
$Log_{10}K_{oc}$: 2.552 (E)	
$Log_{10}BCF$: 1.842 (E)	
Function in ink: Antioxidant, photinitiator	

Mineral oil, CAS # 8012-95-1

Chemical Properties and Information

Chemical Name: Mineral oil

Synonyms: Paraffin oils	Structure:
Molecular Formula: C, H	Liquid hydrocarbons from petroleum.
Molecular Weight: >100 (E)	
Melting Point: <25 °C (E)	
Boiling Point: >200 °C (E)	
Vapor Pressure: <0.01 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.0001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 0.85 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Vehicle	

Nitrocellulose, CAS # 9004-70-0

Chemical Properties and Information

Chemical Name: Cellulose nitrate

Synonyms: None

Molecular Formula: C, H, N, O

Molecular Weight: >1000 (E)

Melting Point: NA °C (M)

Boiling Point: >350 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 1000 (miscible) g/L

Density: 1 g/cm^3 (E)

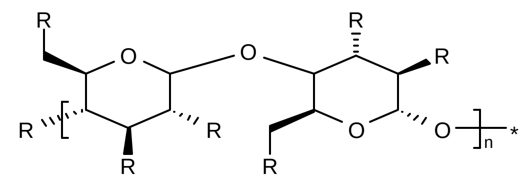
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



R = OH or NO2

Henry's Law: NA atm-m^3/mol (E)

Paraffin wax, CAS # 8002-74-2

Chemical Properties and Information

Chemical Name: Paraffin waxes and hydrocarbon waxes

Synonyms: Paraffin

Molecular Formula: C_nH_{2n+2} (n>20,

Molecular Weight: >280 (TYPCL)

Melting Point: 50-57 °C (M)

Boiling Point: >250 °C (E)

Vapor Pressure: <0.0004 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: about 0.9 g/cm^3 (E)

$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Wax

Structure:

A complex combination of hydrocarbons obtained from petroleum fractions (by solvent crystallization or the sweating process) or from the catalytic hydrogenation of carbon monoxide. It consists predominantly of straight chain hydrocarbons having carbon numbers predominantly greater than C20.

Henry's Law: NA atm-m^3/mol (E)

Phosphine oxide, bis(2,6-dimethoxybenzoyl)(2,4,4-trimethylpentyl)-, CAS # 145052-34-2

Chemical Properties and Information

Chemical Name: Phosphine oxide, bis(2,6-dimethoxybenzoyl)(2,4,4-trimethylpentyl)-

Synonyms: None

Molecular Formula: $C_{26}H_{35}O_7P$

Molecular Weight: 490.54

Melting Point: 90 °C (E)

Boiling Point: 480 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 0.00054 g/L (E)

Density: 1 g/cm^3 (E)

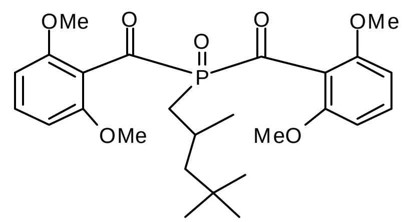
$Log_{10}K_{ow}$: 3.724 (E)

$Log_{10}K_{oc}$: 2.528 (E)

Log_{10}BCF: 2.60 (E)

Function in ink: Plasticizer

Structure:



Henry's Law: <1E-8 atm-m^3/mol (E)

Polyethylene, CAS # 9002-88-4

Chemical Properties and Information

Chemical Name: Polyethylene

Synonyms: Ethylene polymer

Molecular Formula: $(C_2H_4)_n$

Molecular Weight: 1500 -100,000

Melting Point: 85-110 °C (M)

Boiling Point: NA °C (M)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 0.92 g/cm^3 (M)

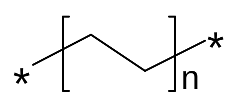
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

Log_{10}BCF: NA (E)

Function in ink: Wax

Structure:



Henry's Law: NA atm-m^3/mol (E)

Polyethylene glycol, CAS # 25322-68-3

Chemical Properties and Information

Chemical Name: Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-hydroxy-

Synonyms: PEG, Polyglycol, Polyoxyethylene

Molecular Formula: $(C_2H_4O)_n$

Molecular Weight: 200 - 9000

Melting Point: -65 °C (M)

Boiling Point: >250 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: 1000 (miscible) g/L

Density: 1.1 g/cm^3 (E)

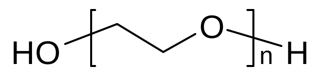
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Dispersant

Structure:



Henry's Law: NA atm-m^3/mol (E)

Polyol derivative A, CAS # NK

Chemical Properties and Information

Chemical Name: Polyol derivative A

Synonyms: None

Molecular Formula: C, H, O

Molecular Weight: >400

Melting Point: >280 °C (E)

Boiling Point: >600 °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: >300 g/L (E)

Density: 1 g/cm^3 (E)

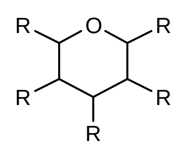
$Log_{10}K_{ow}$: -2.76 (E)

$Log_{10}K_{oc}$: 1.0 (E)

$Log_{10}BCF$: -2.33 (E)

Function in ink: Resin

Structure:



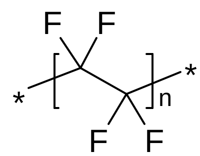
R = OH or other

Henry's Law: <1E-8 atm-m^3/mol (E)

Polytetrafluoroethylene, CAS # 9002-84-0

Chemical Properties and Information

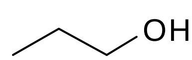
Chemical Name: Polytetrafluoroethylene

Synonyms: PTFE, Polytef, Teflon	Structure: 
Molecular Formula: $(C_2F_4)_n$	
Molecular Weight: >1000 (E)	
Melting Point: 321 (gels) °C (M)	
Boiling Point: monomer gas formed at 400	
Vapor Pressure: <0.000001 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 2.25 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Wax	

Propanol, CAS # 71-23-8

Chemical Properties and Information

Chemical Name: 1-Propanol

Synonyms: n-Propyl alcohol, 1-hydroxypropane	Structure: 
Molecular Formula: C_3H_8O	
Molecular Weight: 60.10	
Melting Point: -127 °C (M)	
Boiling Point: 97.2 °C (M)	
Vapor Pressure: 21 (M), 23.4 (E) mm	
Flash Point: 15 °C (M)	
Water Solubility: 1000 (miscible) g/L	Henry's Law: 7.52E-6 atm-m^3/mol (E)
Density: 0.804 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.25 (M), 0.35 (E)	
$Log_{10}K_{oc}$: 0.122 (E)	
$Log_{10}BCF$: -0.04 (E)	
Function in ink: Solvent	

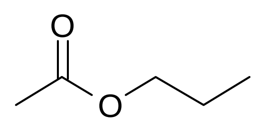
Propyl acetate, CAS # 109-60-4

Chemical Properties and Information

Chemical Name: Acetic acid, propyl ester

Synonyms: 1-Acetoxypropane

Structure:



Molecular Formula: $C_5H_{10}O_2$
Molecular Weight: 102.13
Melting Point: -92 °C (M)
Boiling Point: 101.6 °C (M)
Vapor Pressure: 33.7 (M), 34.4 (E)
Flash Point: 14 °C closed cup (M)
Water Solubility: 18.9 (M), 15.5 (E)
Henry's Law: 0.000223 atm-m^3/mol (E)
Density: 0.888 g/cm^3
$Log_{10}K_{ow}$: 1.24 (M), 1.36 (E)
$Log_{10}K_{oc}$: 1.053 (E)
$Log_{10}BCF$: 0.712 (E)
Function in ink: Solvent

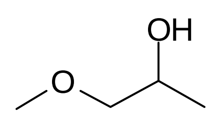
Propylene glycol methyl ether, CAS # 107-98-2

Chemical Properties and Information

Chemical Name: 1-Methoxy-2-propanol

Synonyms: None

Structure:

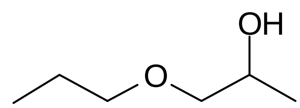


Molecular Formula: $C_4H_{10}O_2$
Molecular Weight: 90.12
Melting Point: -142 °C (M)
Boiling Point: 118-119 °C (M)
Vapor Pressure: 12.5 mm Hg (M)
Flash Point: 33 °C (M)
Water Solubility: 1000 g/L (miscible)
Henry's Law: 1.81E-8 atm-m^3/mol (E)
Density: 0.922 g/cm^3 (M)
$Log_{10}K_{ow}$: -0.489 (E)
$Log_{10}K_{oc}$: 0 (E)
$Log_{10}BCF$: -0.602 (E)
Function in ink: Solvent

Propylene glycol propyl ether, CAS # 1569-01-3

Chemical Properties and Information

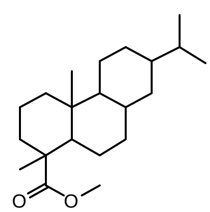
Chemical Name: 1-Propoxy-2-propanol

Synonyms: None	Structure: 
Molecular Formula: $C_6H_{14}O_2$	
Molecular Weight: 118.18	
Melting Point: -80 °C (M)	
Boiling Point: 140-160 °C (M)	
Vapor Pressure: 1.7 mm Hg (M)	
Flash Point: 48 °C (M)	
Water Solubility: 125 g/L (E)	Henry's Law: 3.46E-8 atm-m^3/mol (E)
Density: 0.885 g/cm^3 (M)	
$Log_{10}K_{ow}$: 0.49 (E)	
$Log_{10}K_{oc}$: 0 (E)	
Log_{10}BCF: 0.145 (E)	
Function in ink: Solvent	

Resin acids, hydrogenated, methyl esters, CAS # 8050-15-5

Chemical Properties and Information

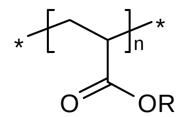
Chemical Name: Resin acids and rosin acids, hydrogenated, Me esters

Synonyms: Hydrogenated resin acid Me esters	Structure:  Representative structure
Molecular Formula: $C_{21}H_{36}O_2$ (TYPCL)	
Molecular Weight: 320.5	
Melting Point: 113 °C (E)	
Boiling Point: >350 °C (E)	
Vapor Pressure: <0.00002 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.00001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: 6.918 (E)	
$Log_{10}K_{oc}$: 5.07 (E)	
Log_{10}BCF: 5.028 (E)	
Function in ink: Resin	

Resin, acrylic, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK	Structure: 
Molecular Formula: C, H, O	R = H and/or other
Molecular Weight: NAVG >30,000 (E)	
Melting Point: NA °C (E)	
Boiling Point: >350 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: >500 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Resin, miscellaneous, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: NK	Structure: Unknown
Molecular Formula: C, H, O	
Molecular Weight: NAVG 30,000 (E)	
Melting Point: NA °C (E)	
Boiling Point: >350 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Rosin, fumarated, polymer with diethylene glycol and pentaerythritol, CAS # 68152-50-1

Chemical Properties and Information

Chemical Name: Rosin, fumerates, polymer with diethylene glycol and pentaerythritol

Synonyms: None

Molecular Formula:

Molecular Weight: >1000 (E)

Melting Point: NA °C (E)

Boiling Point: >300 °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: <0.001 g/L (E)

Density: 1 g/cm^3 (E)

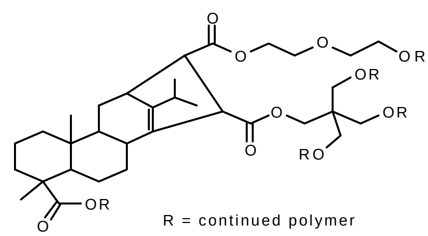
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin, vehicle

Structure:



Henry's Law: NA atm-m^3/mol (E)

Rosin, fumarated, polymer with pentaerythritol, 2-propenoic acid, ethenylbenzene, and (1-methylethylenyl)benzene, CAS # NK

Chemical Properties and Information

Chemical Name: Rosin, fumarated, polymer with pentaerythritol, 2-propenoic acid, ethenylbenzene, and (1-methylethylenyl)benzene

Synonyms: None

Molecular Formula: $(C_5H_{12}O_4.unspecified)_x$

Molecular Weight: NAVG 2290

Melting Point: >100 °C (E)

Boiling Point: NA °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

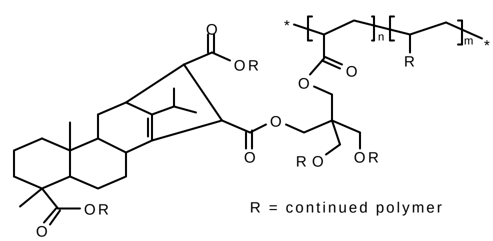
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:

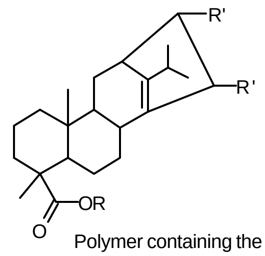


Henry's Law: NA atm-m^3/mol (E)

Rosin, polymerized, CAS # 65997-05-9

Chemical Properties and Information

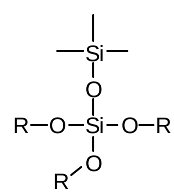
Chemical Name: Rosin, polymd.

Synonyms: Gum rosin WW, polymers; Wood rosin, Poly-pale resin	Structure: 
Molecular Formula: C, H, O	
Molecular Weight: NAVG >1000 (E)	
Melting Point: NA °C (E)	
Boiling Point: >250 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica, CAS # 68909-20-6

Chemical Properties and Information

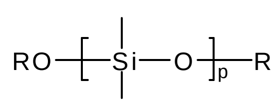
Chemical Name: Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica

Synonyms: None	Structure:  R = H or continued polymer
Molecular Formula: C, H, O, Si	
Molecular Weight: >10000 (E)	
Melting Point: >500 °C (E)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1.5 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Defoamer	

Silica, CAS # 7631-86-9

Chemical Properties and Information	
Chemical Name: Silicon dioxide	
Synonyms: Silicic anhydride	Structure:
Molecular Formula: $SiO2$	
Molecular Weight: >10,000 (60.09 from Emp.	O=Si=O
Melting Point: 1550 °C (M)	
Boiling Point: NA °C (E)	
Vapor Pressure: <0.000001 mm Hg (E)	
Flash Point: NA °C (M)	
Water Solubility: <0.0001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 2.2 (amorphous) g/cm^3 (M); 2.65	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: NA, defoamer (E)	

Silicone oil, CAS # 63148-62-9

Chemical Properties and Information	
Chemical Name: Siloxanes and silicones, di-Me	
Synonyms: .alpha.-Methyl-.omega.-methoxypolydimethyl siloxane, Poly(dimethylsiloxane)	Structure:
Molecular Formula: $(Si(CH_3)_2O)_n$	
Molecular Weight: >1000 (E)	
Melting Point: <-40 °C (E)	
Boiling Point: >450 °C (E)	R = H or continued polymer
Vapor Pressure: <0.000001 mm Hg	
Flash Point: 315 °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: atm-m^3/mol (E)
Density: 0.963 g/cm^3	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: NA, defoamer (E)	

Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, ethers with polyethylene glycol acetate, CAS # 70914-12-4

Chemical Properties and Information

Chemical Name: Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, esters with polyethylene glycol acetate

Synonyms: None

Molecular Formula: C, H, O, Si

Molecular Weight: >1000 (E)

Melting Point: >100 °C (E)

Boiling Point: >350 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: Dispersible g/L (E)

Density: 1 g/cm^3 (E)

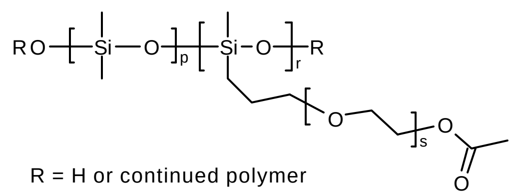
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: wetting agent,

Structure:



Henry's Law: NA atm-m^3/mol (E)

Solvent naphtha (petroleum), light aliphatic, CAS # 64742-89-8

Chemical Properties and Information

Chemical Name: Solvent naphtha(petroleum), light aromatic

Synonyms: Skellysolve

Molecular Formula: C_5H_{10}-$C_{10}H_{22}$

Molecular Weight: 100 (E)

Melting Point: <-80 °C (E)

Boiling Point: 35-160 °C (E)

Vapor Pressure: <355 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: <0.2 g/L (E)

Density: 0.8 g/cm^3 (E)

$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Solvent

Structure:

Complex combination of hydrocarbons obtained from the distillation of crude oil or natural gas. It consists predominantly of saturated hydrocarbons having carbon numbers predominantly in the range of C5 through C10 and boiling in the range of approximately 35 °C to 160 °C.

Henry's Law: NA atm-m^3/mol (E)

Styrene, CAS # 100-42-5

Chemical Properties and Information

Chemical Name: Ethenylbenzene

Synonyms: Vinylbenzene

Molecular Formula: C_8H_8

Molecular Weight: 104.15

Melting Point: -31 °C (M)

Boiling Point: 145-146 °C (M)

Vapor Pressure: 6.4 mm Hg (M)

Flash Point: 31 °C (M)

Water Solubility: 0.31 g/L (M)

Density: 0.909 g/cm^3 (M)

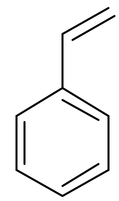
$Log_{10}K_{ow}$: 2.95 (M), 2.89 (E)

$Log_{10}K_{oc}$: 2.714 (E)

$Log_{10}BCF$: 2.102 (E)

Function in ink: Curing agent

Structure:



Henry's Law: 0.00281 atm-m^3/mol (E)

Styrene acrylic acid polymer #1, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: Styrene acrylic acid polymer

Molecular Formula: C, H, O

Molecular Weight: NAVG > 30,000

Melting Point: NA °C (E)

Boiling Point: >300 °C (E)

Vapor Pressure: <0.000001 mm Hg

Flash Point: NA °C (M)

Water Solubility: <0.000001 g/L (E)

Density: 1 g/cm^3 (E)

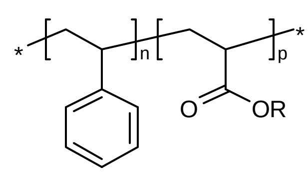
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Resin

Structure:



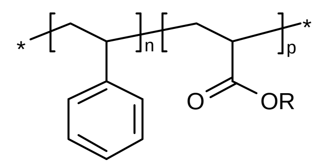
R = H and/or other

Henry's Law: NA atm-m^3/mol (E)

Styrene acrylic acid polymer #2, CAS # NK

Chemical Properties and Information

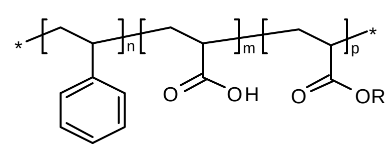
Chemical Name: NK

Synonyms: Styrene acrylic adic polymer	Structure:
Molecular Formula: C, H, O	
Molecular Weight: NAVG >10,000	
Melting Point: NA °C (E)	
Boiling Point: >300 °C (E)	
Vapor Pressure: <0.000001 mm Hg	R = H and/or other
Flash Point: NA °C (M)	
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Styrene acrylic acid resin, CAS # NK

Chemical Properties and Information

Chemical Name: NK

Synonyms: Styrene acrylic acid resin	Structure:
Molecular Formula: C, H, O	
Molecular Weight: >10000	
Melting Point: NA °C (E)	
Boiling Point: >300 °C (E)	
Vapor Pressure: <0.000001 mm Hg	
Flash Point: NA °C (M)	R = H or other
Water Solubility: <0.000001 g/L (E)	Henry's Law: NA atm-m^3/mol (E)
Density: 1 g/cm^3 (E)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Resin	

Tetramethyldecyndiol, CAS # 126-86-3

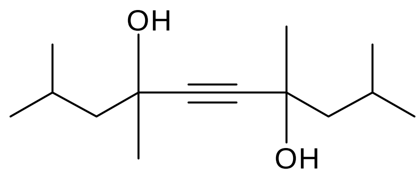
Chemical Properties and Information

Chemical Name: 2,4,7,9-Tetramethyl-5-decyne-4,7-diol

Synonyms: Surfynol 104

Molecular Formula: $C_{14}H_{26}O_2$
Molecular Weight: 226.36
Melting Point: 42-44 °C (M)
Boiling Point: 255 °C (M)
Vapor Pressure: 0.00099 mm Hg (E)
Flash Point: >110 °C (E)
Water Solubility: 0.052 g/L (E)
Density: 1 g/cm^3 (E)
$Log_{10}K_{ow}$: 3.609 (E)
$Log_{10}K_{oc}$: 1.328 (E)
$Log_{10}BCF$: 2.513 (E)
Function in ink: Solvent

Structure:



Henry's Law: 2.44E-7 atm-m^3/mol (E)

Thioxanthone derivative, CAS # NK

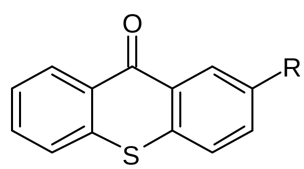
Chemical Properties and Information

Chemical Name: NK

Synonyms: NK

Molecular Formula: C, H, O, S
Molecular Weight: 260 (E) (for R = iPr)
Melting Point: 150 °C (E)
Boiling Point: >350 °C (E)
Vapor Pressure: <0.00001 mm Hg (E)
Flash Point: NA °C (M)
Water Solubility: <0.00005 g/L (E)
Density: 0.9 g/cm^3 (E)
$Log_{10}K_{ow}$: NA (E)
$Log_{10}K_{oc}$: NA (E)
$Log_{10}BCF$: NA (E)
Function in ink: Photoinitiator

Structure:



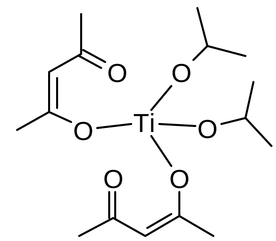
R position and content unspecified

Henry's Law: NA atm-m^3/mol (E)

Titanium diisopropoxide bis(2,4-pentanedionate) CAS# 17927-72-9

Chemical Properties and Information

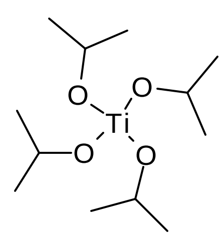
Chemical Name: Titanium, bis(2,4-pentanedionato-.kappa.O,.kappa.O')bis(2-propanolato)-

Synonyms: 2-Propanol, titanium complex; diiospropoxytitanium bis(acetylacetonate)	Structure: 
Molecular Formula: $C_{16}H_{28}O_6Ti$	
Molecular Weight: 364.30	
Melting Point: NA °C (E)	
Boiling Point: >250 °C (E)	
Vapor Pressure: <0.01 mm Hg (E)	
Flash Point: 12 °C (M)	
Water Solubility: Reacts	Henry's Law: NA atm-m^3/mol (E)
Density: 0.995 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Adhesion promoter	

Titanium isopropoxide, CAS# 546-68-9

Chemical Properties and Information

Chemical Name: 2-Propanol, titanium(4+) salt

Synonyms: Tetraisopropyl titanate	Structure: 
Molecular Formula: $C_{12}H_{32}O_4Ti$	
Molecular Weight: 284.26	
Melting Point: 18-20 °C (M)	
Boiling Point: 232 °C (M)	
Vapor Pressure: 0.11 mm Hg (E)	
Flash Point: 22 °C (M)	
Water Solubility: Reacts	Henry's Law: NA atm-m^3/mol (E)
Density: 0.963 g/cm^3 (M)	
$Log_{10}K_{ow}$: NA (E)	
$Log_{10}K_{oc}$: NA (E)	
$Log_{10}BCF$: NA (E)	
Function in ink: Adhesion promoter	

Trimethylolpropane ethoxylate triacrylate, CAS # 28961-43-5

Chemical Properties and Information

Chemical Name: Poly(oxy-1,2-ethanediyl), .alpha.-hydro-.omega.-[(1-oxo-2-propenyl)oxy]-, ether with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol (3:1)

Synonyms: Ethoxylated trimethylolpropane, triacrylate

Molecular Formula: $(C_2H_4O)_n(C_2H_4O)_nC_2H_4O)_nC_{15}H_{20}O_6$

Molecular Weight: >500 (E)

Melting Point: NA °C (E)

Boiling Point: >250 °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: NA °C (M)

Water Solubility: Dispersible g/L

Density: 1 g/cm^3 (E)

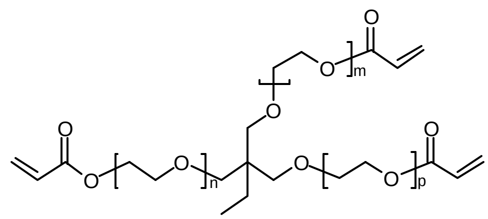
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Curable resin

Structure:



Henry's Law: NA atm-m^3/mol (E)

Trimethylolpropane propoxylate triacrylate, CAS # 53879-54-2

Chemical Properties and Information

Chemical Name: Poly(oxy-(methyl-1,2-ethanediyl)), .alpha.-hydro-.omega.-((1-oxo-2-propenyl)oxy)-, ether with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol (3:1)

Synonyms: None

Molecular Formula:

Molecular Weight: >500 (E)

Melting Point: NA °C (M)

Boiling Point: >250 °C (E)

Vapor Pressure: <0.000001 mm Hg (E)

Flash Point: >110 °C (E)

Water Solubility: Dispersible g/L (E)

Density: 1 g/cm^3 (E)

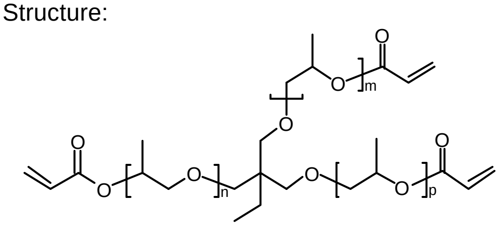
$Log_{10}K_{ow}$: NA (E)

$Log_{10}K_{oc}$: NA (E)

$Log_{10}BCF$: NA (E)

Function in ink: Curable resin

Structure:

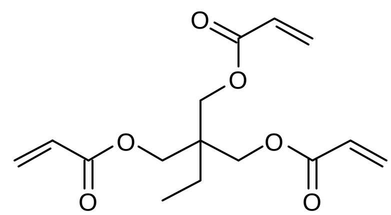


Henry's Law: NA atm-m^3/mol (E)

Trimethylolpropane triacrylate, CAS # 15625-89-5

Chemical Properties and Information

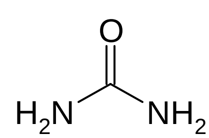
Chemical Name: 2-Propenoic acid, 2-ethyl-2-(((1-oxo-2-propenyl)oxy)methyl)-1,3-propanediol

Synonyms: TMPT, acrylic acid, triester with 2-ethyl-2-(hydroxymethyl)-1,3-propanediol	Structure: 
Molecular Formula: $C_{15}H_{20}O_6$	
Molecular Weight: 296.32	
Melting Point: 27 °C (E)	
Boiling Point: 322 °C (E)	
Vapor Pressure: 0.000563 mm Hg (E)	
Flash Point: >110 °C (E)	
Water Solubility: 0.0463 g/L (E)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1.10 g/cm^3 (M)	
$Log_{10}K_{ow}$: 2.863 (E)	
$Log_{10}K_{oc}$: 3.282 (E)	
$Log_{10}BCF$: 1.946 (E)	
Function in ink: Curing agent	

Urea, CAS # 57-13-6

Chemical Properties and Information

Chemical Name: Urea

Synonyms: Carbamide, Carbonyldiamine, Carbonyl diamide	Structure: 
Molecular Formula: CH_4N_2O	
Molecular Weight: 60.06	
Melting Point: 133-135 °C (M)	
Boiling Point: 158 °C (dec) (E)	
Vapor Pressure: 0.207 mm Hg (E)	
Flash Point: °C (M)	
Water Solubility: 1000 g/L (miscible)	Henry's Law: <1E-8 atm-m^3/mol (E)
Density: 1.335 g/cm^3 (M)	
$Log_{10}K_{ow}$: -2.11 (M), -1.56 (E)	
$Log_{10}K_{oc}$: 0.632 (E)	
$Log_{10}BCF$: -1.834 (E)	
Function in ink: Slip additive	

Appendix 3-B (Risk Chapter)
Human Health and Ecological Hazard Results

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Chemicals for which quantitative hazard data are available.							
Ammonia 7664-41-7	1, 2	dermal	ND	ND	74 mg/kg/day - L (bone effects)[b]	ND	The LOAEL is based on a study conducted on ammonia chloride.
		inhalation	sys: corneal, liver, respiratory, and spleen effects	0.1 mg/m^3 (skin and eye irritation, respiratory effects)	ND	ND	ND
		oral	sys: decreases in bone density, bone softening	ND	74 mg/kg/day - L (bone effects)	ND	The LOAEL is based on a study conducted on ammonia chloride.
Ammonium hydroxide 1336-21-6	2	dermal	ND	ND	1.8 mg/kg/day (W), 1.2 mg/kg/day (G) - N[c] (skin and eye irritation, respiratory effects)	ND	The NOAEL is based on an inhalation NOAEL of 6.4 mg/m^3 from a study conducted on ammonia.
		inhalation	sys: eye effects, nasal irritation, respiratory effects	0.1 mg/m^3 (skin and eye irritation, respiratory effects)	ND	ND	The RfC is based on a study conducted on ammonia.
		oral	ND	ND	1.8 mg/kg/day (W), 1.2 mg/kg/day (G) - ppm (skin and eye irritation, respiratory effects)	ND	The NOAEL is based on an inhalation NOAEL of 6.4 mg/m^3 from a study conducted on ammonia.
Barium 7440-39-3	2, 3	dermal	ND	0.007 mg/kg/day (increased blood pressure)[b]	ND	18 mg/kg/day - L (increased mortality, impaired liver function)[b]	ND
		inhalation	sys: decreased body weight, reproductive and respiratory effects, increased arterial blood pressure; dev: decreased survival and weight gain, changes in hematology parameters	ND	1.15 mg/m^3 - N (decreased body weight, increased arterial blood pressure, respiratory effects)	2.2 mg/m^3 - L (reduced survival, decreased weight gain, blood effects)	ND
		oral	sys: cardiovascular, kidney and reproductive effects, increased kidney weight, decreased survival; dev: increased mortality, impaired liver function	0.007 mg/kg/day (increased blood pressure)	ND	18 mg/kg/day - L (increased mortality, impaired liver function)	ND

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
2-Benzyl-2-(dimethylamino)-4'-morpholino-butyrophenone 119313-12-1	4	dermal	ND	ND	3000 mg/kg/day - L (neurotoxic effects)[b]	ND	ND
		inhalation	ND	ND	3000 mg/kg/day (10,500 mg/m^3 (W), 15,909 mg/m^3 (G)) - L (neurotoxic effects)[b]	ND	ND
		oral	sys: neurotoxic effects	ND	3000 mg/kg/day - L (neurotoxic effects)	ND	The systemic LOAEL is based upon a subacute study.
2-Butoxyethanol (glycol ether EB) 111-76-2	102-106	dermal	ND	ND	150 mg/kg/day - N	2160 mg/kg/day - N	ND
		inhalation	sys: decreased growth and hematological effects, dev: decreased maternal body, uterine, and liver weight; embryotoxicity; increased non-viable implantations; cardiac defects; skeletal malformations	ND	25 ppm (approximately 121 mg/m^3) - N	50 ppm (approximately 242 mg/m^3) -N (decreased body and uterine weight, embryotoxicity, hematological effects, skeletal malformations)	ND
		oral	sys: testicular atrophy, decreased body weight gain, increased kidney and liver weights; dev: maternal mortality, increased number of resorbed litters	ND	30 mg/kg/day - N (testicular atrophy)	1180 mg/kg/day -L (maternal mortality, increased number of resorbed litters)	ND
Butyl acetate 123-86-4	5, 6	dermal	ND	ND	60 mg/kg/day (W), 40 mg/kg/day (G) - L (serum chemistry)[c]	2031 mg/kg/day (W), 1341 mg/kg/day (G) - L (fetotoxicity and musculoskeletal abnormalities)[c]	ND
		inhalation	sys: changes in serum chemistry, fluctuations in blood pressure; dev: fetotoxicity, musculoskeletal abnormalities	ND	210 mg/m^3 - L (serum chemistry)[d]	7110 mg/m^3 - L (fetotoxicity and musculoskeletal abnormalities)[d]	ND
		oral	ND	ND	60 mg/kg/day (W), 40 mg/kg/day (G) - L (serum chemistry)[c]	2031 mg/kg/day (W), 1341 mg/kg/day (G) - L (fetotoxicity and musculoskeletal abnormalities)[c]	ND
Butyl carbitol 112-34-5	7-11	dermal	sys: blood and skin effects	ND	30 mg/kg/day - L (blood effects)[d]	2000 mg/kg/day - N[d]	ND
		inhalation	sys: liver effects	ND	2 ppm (approximately 13.3 mg/m^3) - N (liver effects)[e]	500 mg/kg/day (1750 mg/m^3 (W), 2652 mg/m^3 (G)) - N (decreased pup body weight)[b]	ND
		oral	sys: blood, kidney, liver, and reproductive effects, increased liver weight, changes in	ND	57 mg/kg/day - L (blood and clinical chemistry effects)	500 mg/kg/day - N (decreased pup body weight)	ND

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
C.I. Pigment Blue 15 147-14-8	12	dermal	ND	ND	6000 mg/kg/day - N[b]	ND	ND
		inhalation	ND	ND	6000 mg/kg/day (21,000 mg/m^3 (W), 31,818 mg/m^3 (G)) - N[b]	ND	ND
		oral	ND	ND	6000 mg/kg/day - N[f]	ND	No effects were seen at the highest dose tested.
C.I. Pigment Green 7 1328-53-6	13	dermal	ND	ND	2750 mg/kg/day - L (decreased body weight)[b]	ND	Not reported to be a dermal sensitizer in guinea pigs.
		inhalation	ND	ND	2750 mg/kg/day (9625 mg/m^3 (W), 14,583 (G)) - L (decreased body weight)[b]	ND	ND
		oral	sys: decreased body weight	ND	2750 mg/kg/day - L (decreased body weight)	ND	ND
C.I. Pigment Red 23 6471-49-4	14	dermal	ND	ND	425 mg/kg/day - L (nephropathy, renal tubule hyperplasia)[b]	ND	ND
		inhalation	ND	ND	425 mg/kg/day (1488 mg/m^3 (W), 2254 mg/m^3 (G)) - L (nephropathy, renal tubule hyperplasia)[b]	ND	ND
		oral	sys: blood effects, nephropathy, renal tubule hyperplasia, forestomach epithelial hyperplasia	ND	425 mg/kg/day - L (nephropathy, renal tubule hyperplasia)	ND	ND
C.I. Pigment White 6 13463-67-7	2, 16	dermal	ND	6 mg/kg/day (premature aging)[b]	ND	ND	Not reported to be a dermal sensitizer in humans.
		inhalation	sys: respiratory effects, lung carcinogenicity (rat)	0.04 mg/m^3 (respiratory effects)	ND	ND	ND
		oral	sys: bile duct, lymphatic, and respiratory effects	6 mg/kg/day (bile duct, lymphatic, respiratory effects)	ND	ND	ND

Chemical name/ CAS number	Reference*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Citric acid 77-92-9	18	dermal	ND	ND	645 mg/kg/day - N[b]	6000 mg/kg/day - N[b]	ND
		inhalation	ND	ND	645 mg/kg/day (2258 mg/m^3 (W), 3420 mg/m^3 (G)) - N[b]	6000 mg/kg/day (21,000 mg/m^3 (W), 31,818 mg/m^3 (G)) - N[b]	ND
		oral	sys: decreased body weight gain, decreased survival	ND	645 mg/kg/day - N[d]	6000 mg/kg/day - N[d]	No effects were seen at the only doses tested in the systemic and developmental studies.
D&C Red No. 7 5281-04-9	19	dermal	ND	ND	100 mg/kg/day - L (decreased thymus weight, kidney lesions)[b]	1000 mg/kg/day - N[b]	ND
		inhalation	ND	ND	100 mg/kg/day (350 mg/m^3 (W), 530 mg/m^3 (G)) - L (decreased thymus weight, kidney lesions)[b]	1000 mg/kg/day (3500 mg/m^3 (W), 5303 mg/m^3 (G)) - N[b]	ND
		oral	sys: thymus and reproductive effects, changes in clinical chemistry, kidney effects, decreased thymus weight	ND	100 mg/kg/day - L (decreased thymus weight, kidney lesions)	1000 mg/kg/day - N[f]	No effects were seen at the highest dose tested in the developmental study.
Dicyclohexyl phthalate 84-61-7	20	dermal	ND	ND	240 mg/kg/day - N[b]	290 mg/kg/day - N[b]	ND
		inhalation	ND	ND	240 mg/kg/day (840 mg/m^3 (W), 1273 mg/m^3 (G)) - N[b]	290 mg/kg/day (1015 mg/m^3 (W), 1538 mg/m^3 (G)) - N[b]	ND
		oral	sys: increased liver weight, increased liver enzyme activity, liver effects, testicular atrophy	ND	240 mg/kg/day - N[f]	290 mg/kg/day - N[f]	No effects were seen at the highest doses tested in the systemic and developmental studies.
Dioctyl sulfosuccinate, sodium salt 577-11-7	21, 22	dermal	ND	ND	ND	60 mg/kg/day - N (decreased pup body weight)[b]	Reported to be a dermal sensitizer to humans. SAT: Low to Moderate
		inhalation	ND	ND	ND	60 mg/kg/day (210 mg/m^3 (W), 318 mg/m^3 (G)) - N (decreased pup body weight)[b]	ND
		oral	sys: death, gastrointestinal and neurotoxic effects (dose unclear); dev: decreased pup body weight and weight gain	ND	ND	60 mg/kg/day - N (decreased pup body weight)	ND

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide 75980-60-8	23, 24	dermal	ND	ND	100 mg/kg/day - N (decreased body weight and testes size, blood effects)[b]	ND	ND
		inhalation	ND	ND	100 mg/kg/day (350 mg/m^3 (W), 530 mg/m^3 (G)) - N (decreased body weight and testes size, blood effects)[b]	ND	ND
		oral	sys: decreased body weight, increased food consumption, blood and reproductive effects, reduced testes size, scale formation	ND	100 mg/kg/day - N (decreased body weight and testes size, blood effects)	ND	ND
Dipropylene glycol methyl ether 34590-94-8	25-27	dermal	sys: neurotoxic effects	ND	5 ml/kg/day (approximately 4750 mg/kg/day) - N (neurotoxic effects)[g]	ND	Not reported to be a dermal sensitizer in humans.
		inhalation	sys: decreased growth, liver, and neurotoxic effects, increased kidney weight	ND	200 ppm (approximately 1213 mg/m^3) - L (increased kidney weight)[e]	ND	ND
		oral	ND	ND	1000 mg/kg/day - N[d]	ND	No effects were seen at the only dose tested.
Distillates (petroleum), hydrotreated light 64742-47-8	15	dermal	sys: skin carcinogenicity (mice)	ND	ND	ND	Oral LD_{50} in rats = 8532 mg/kg[h]; dermal LD_{50} in rabbits > 5000 mg/kg. SAT report indicates Low to Moderate concern for skin, eye, and mucous membrane irritation, inhalation.
		oral	ND	ND	ND	ND	
Distillates (petroleum), solvent-refined light paraffinic 64741-89-5	28, 29	dermal	sys: skin effects, benign skin tumors (mice)	ND	0.05 ml 2x/week (approximately 400 mg/kg/day) - L (skin irritation)[i]	ND	Reported to be a dermal sensitizer in guinea pigs.
		inhalation	ND	ND	400 mg/kg/day (1400 mg/m^3 (W), 2121 mg/m^3 (G)) - L (skin irritation)[j]	ND	ND
		oral	ND	ND	400 mg/kg/day - L (skin irritation)[j]	ND	ND

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Ethanol 64-17-5	30, 31	dermal	ND	ND	8000 mg/kg/day - L (liver effects)[b]	171 mg/kg/day - N (increased spontaneous abortions)[b]	ND
		inhalation	sys: blood, liver, neurotoxic, and reproductive effects, decreased cellularity of the spleen, thymus, and bone marrow; dev: fetal malformations	ND	5653 mg/m^3 - N	30,148 mg/m^3 - N (increased incidence of malformations)	ND
		oral	sys: endocrine, gastro-intestinal, liver, reproductive, CNS, pancreatic, and rectal effects, disrupted hormone metabolism and immune response, altered left ventricular function; stomach, lymph, lung, pituitary, adrenal, pancreatic, mammary and testes carcinogenicity (mice), oral, pharyngeal, laryngeal, esophageal, rectal, and breast carcinogenicity (humans), liver carcinogenicity (mice and humans); dev: spontaneous abortions, decreased pre- and post-natal survival, increased fetal malformations, inhibited fetal growth and development, altered brain weight, retarded skeletal and muscle development and muscle growth, CNS structural defects, altered gonad growth and development, disturbances in sexual behavior and performance, hormone disruptions, decreased ovarian function, behavioral and neuromotor alterations, Fetal Alcohol Syndrome (FAS)	ND	8000 mg/kg/day - L (liver effects)	1200 mg/kg once/week (171 mg/kg/day) - N (increased spontaneous abortions)[k]	IARC (1988) has concluded that there is inadequate evidence for carcinogenicity of ethanol and of alcoholic beverages in experimental animals, but there is sufficient evidence for carcinogenicity of alcoholic beverages in humans. Ethanol is classified by IARC as a Group 1 carcinogen based on the occurrence of malignant tumors of the oral cavity, pharynx, larynx, esophagus, and liver that have been causally related to the consumption of alcoholic beverages.
Ethanolamine 141-43-5	32-35	dermal	ND	ND	500 mg/kg/day - N[b]	50 mg/kg/day - L (growth retardation, malformations)[b]	Reported to be a moderate skin sensitizer in guinea pigs.
		inhalation	sys: respiratory irritation, kidney, liver, neurotoxic, and respiratory effects	ND	5 ppm (approximately 12.5 mg/m^3) - L (skin irritation, decreased body weight, neurotoxic effects)[e]	50 mg/kg/day (175 mg/m^3 (W), 265 mg/m^3 (G)) - L (growth retardations, malformations)[b]	ND
		oral	sys: neurotoxic and reproductive effects, altered liver and kidney weights; dev: intrauterine deaths, malformations, decreased fetal weight, growth retardation	ND	500 mg/kg/day) - N[d]	50 mg/kg/day - L (growth retardation, malformations)	No effects were seen at the only dose tested in the systemic study.

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer- ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Ethyl acetate 141-78-6	2, 36	dermal	ND	0.9 mg/kg/day (mortality and body weight loss)[b]	ND	ND	ND
		inhalation	sys: blood, cardiovascular, gastrointestinal, kidney, liver, neurotoxic, and respiratory effects, decreased spleen and liver weight, increased adrenal, lung, and kidney weight	ND	1261 mg/m^3 - L (degeneration of nasal mucosa)	ND	ND
		oral	sys: excess salivation, decreased food consumption, neurotoxic and respiratory effects, mortality, decreased body and organ weights	0.9 mg/kg/day (mortality and body weight loss)	ND	ND	ND
Ethyl carbitol 111-90-0	37-40	dermal	ND	ND	5 mg/kg/day - L (blood effects, increased kidney weight)[b]	6000 mg/kg/day - N	Not reported to be a dermal sensitizer in humans.
		inhalation	ND	ND	5 mg/kg/day (17.5 mg/m^3 (W), 26.5 mg/m^3 (G) - L (blood effects, increased kidney weight)[b]	1500 mg/kg/day (5250 mg/m^3 (W), 7955 mg/m^3 (G) - N (decreased motile sperm, increased liver weight, decreased brain weight in offspring)[b]	ND
		oral	sys: decreased food consumption, bladder, blood, kidney, liver, neurotoxic, reproductive and spleen effects, altered blood chemistry, increased kidney weight; dev: decreased motile sperm, increased liver weight, decreased brain weight and birth weight in offspring	ND	5 mg/kg/day - L (blood effects, increased kidney weight)	1.25% in diet (approximately 1500 mg/kg/ day) - N (decreased motile sperm, increased liver weight, decreased brain weight in offspring)[l]	Length of dosing period for systemic study was not specified.

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
2-Ethylhexyl diphenyl phosphate 1241-94-7	41, 42	dermal	ND	ND	136 mg/kg/day - L (increased liver weight, increased serum triglycerides)[b]	144 mg/kg/day - L (increased liver weight in pups)[b]	ND
		inhalation	ND	ND	136 mg/kg/day (476 mg/m^3 (W), 721 mg/m^3 (G)) - L (increased liver weight, increased serum triglycerides)[b]	144 mg/kg/day (504 mg/m^3 (W), 764 mg/m^3 (G) - L (increased liver weight in pups)[b]	ND
		oral	sys: decreased body weight gain, liver, reproductive, and spleen effects, increased adrenal weight, altered liver weight, changes in serum chemistry; dev: decreased pup survival, malformations, unossified sternebrae, extra ribs, increased adrenal and liver weight, decreased spleen weight	ND	136 mg/kg/day - L (increased liver weight, increased serum triglycerides)	144 mg/kg/day - L (increased liver weight in pups)	The systemic LOAEL is based upon a subacute study.
Glycerol propoxylate triacrylate 52408-84-1	43	dermal	sys: tissue necrosis at application site, decreased body weight, neurotoxic and respiratory effects	ND	0.1 ml/animal/day (426 mg/kg/day) - L (dermal irritation and necrosis, decreased body weight gain)[m]	ND	ND
		inhalation	ND	ND	426 mg/kg/day (1491 mg/m^3 (W), 2259 mg/m^3 (G)) - L (dermal irritation and necrosis, decreased body weight gain)[j]	ND	ND
		oral	ND	ND	426 mg/kg/day - L (dermal irritation and necrosis, decreased body weight gain)[j]	ND	ND
n-Heptane 142-82-5	44, 45	dermal	ND	ND	1000 mg/kg/day - N (enzyme and gastrointestinal effects)[b]	ND	ND
		inhalation	sys: auditory and neurotoxic effects, altered serum chemistry	ND	1635 mg/m^3 - L (neurotoxic effects)	ND	ND
		oral	sys: gastrointestinal effects, altered enzyme levels, increased liver weight	ND	1000 mg/kg/day - N (enzyme and gastrointestinal effects)	ND	ND

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
1,6-Hexanediol diacrylate 13048-33-4	46-48	dermal	ND	ND	ND	750 mg/kg/day - L (increased incidence of skeletal variations)[b]	Reported to be dermal sensitizer in animal studies. SAT: Moderate
		inhalation	ND	ND	ND	750 mg/kg/day (2625 mg/m^3 (W), 3977 mg/m^3 (G)) - L (increased incidence of skeletal variations)[b]	Rats exposed to 90 mg/m^3 for 6 hours exhibited no significant changes in clinical signs or gross necropsy.
		oral	dev: increase in skeletal variations	ND	ND	750 mg/kg/day - L (increased incidence of skeletal variations)[d]	ND
2-Hydroxy-2-methylpropioph e-none 7473-98-5	49, 50	dermal	ND	ND	100 mg/kg/day - N (increased liver weight)[b]	ND	Reported to be a dermal sensitizer in guinea pigs.
		inhalation	ND	ND	100 mg/kg/day (350 mg/m^3 (W), 530 mg/m^3 (G)) - N (increased liver weight)[b]	ND	ND
		oral	sys: liver effects, increased liver and kidney weights	ND	100 mg/kg/day - N (increased liver weight)	ND	The systemic NOAEL is based upon a subacute study.
Hydroxypropyl acrylate 25584-83-2	51	dermal	ND	ND	7.7 mg/kg/day (W), 5.1 mg/kg/day (G) - L (respiratory lesions)[c]	ND	ND
		inhalation	sys: respiratory effects	ND	27 mg/m^3 - L (respiratory lesions)	ND	ND
		oral	ND	ND	7.7 mg/kg/day (W), 5.1 mg/kg/day (G) - L (respiratory lesions)[c]	ND	ND
Isobutanol 78-83-1	2, 52, 53	dermal	ND	0.3 mg/kg/day (neurotoxic effects)[b]	ND	ND	ND
		inhalation	sys: blood and neurotoxic effects, changes in enzyme levels; dev: cardiac septal defects	ND	0.1 mg/m^3 - N (blood effects, neurotoxic effects)	ND	ND

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
		oral	ND	0.3 mg/kg/day (neurotoxic effects)	ND	ND	ND
Isopropanol 67-63-0	54-59	dermal	sys: blood and skin effects, tissue necrosis at application site, increased kidney and liver weight	ND	157 mg/kg/day - L (blood and skin effects, increased kidney and liver weight)	0.015 mg/kg/day - N (decreased embryo survival, developmental anomalies of the CNS)[b]	Reported to be a dermal sensitizer to humans. IARC (1987) has classified isopropanol as a Group 3 compound, not classifiable as to its carcinogenicity to humans based on inadequate evidence in humans and experimental animals.
		inhalation	sys: liver, neurotoxic, reproductive, respiratory, and spleen effects, changes in enzyme levels and clinical and urine chemistry; dev: fetal death, musculoskeletal abnormalities, fetotoxicity	ND	0.66 mg/m^3 - N (neurotoxic effects, enzyme, urine, blood, respiratory, liver, and spleen effects)	3500 ppm (approximately 8601 mg/m^3) - L (fetotoxicity)[e]	
		oral	sys: decreased body weight gain, kidney, liver, and reproductive effects; dev: reduced pup growth	ND	0.015 mg/kg/day - N (liver and kidney effects)	0.015 mg/kg/day - N (decreased embryo survival, developmental anomalies of the CNS)[b]	
Kaolin 1332-58-7	60, 61	dermal	ND	ND	10,000 mg/kg/day - L (blood effects)[b]	10,000 mg/kg/day - L (decreased pup body weight)[b]	ND
		inhalation	sys: respiratory effects, increased lung weight, lung carcinogenicity (rat)	ND	3 mg/m^3 - L (lung lesions)	10,000 mg/kg/day (35,000 mg/m^3 (W), 53,030 mg/m^3(G)) - L (decreased pup body weight)[b]	ND
		oral	sys: blood effects; dev: decreased pup body weight	ND	10,000 mg/kg/day - L (blood effects)[d]	10,000 mg/kg/day - L (decreased pup body weight)[d]	Hematology was the only non-reproductive parameter evaluated.
2-Methyl-4'-(methylthio)-2-morpholino-propiophenone 71868-10-5	62	dermal	ND	ND	75 mg/kg/day - N (neurotoxic effects, cataracts)[b]	ND	ND
		inhalation	ND	ND	75 mg/kg/day (263 mg/m^3 (W), 398 mg/m^3 (G)) - N (neurotoxic effects, cataracts)[b]	ND	ND
		oral	sys: decreased body weight and food consumption, blood, liver, and neurotoxic effects, nerve fiber degeneration, cataracts	ND	75 mg/kg/day - N (neurotoxic effects, cataracts)[d]	ND	ND

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Mineral oil 8012-95-1	63	dermal	ND	ND	1676 mg/kg/day - N[b]	ND	ND
		inhalation	ND	ND	1676 mg/kg/day (5866 mg/m^3 (W), 8888 mg/m^3 (G)) - N[b]	ND	ND
		oral	sys: respiratory effects	ND	1676 mg/kg/day - N[d]	ND	No effects were seen at the only dose tested.
Phosphine oxide, bis(2,6-dimethoxy benzoyl)(2,4,4-trimethylpentyl)- 145052-34-2	64, 65	dermal	ND	ND	10 mg/kg/day - N (neurotoxic effects, increased liver weight, decreased thymus weight, squamous skin on feet)[b]	ND	Reported to be an extreme skin sensitizer in guinea pigs.
		inhalation	ND	ND	10 mg/kg/day (35 mg/m^3 (W), 53 mg/m^3 (G)) - N (neurotoxic effects, increased liver weight, decreased thymus weight, squamous skin on feet)[b]	ND	ND
		oral	sys: neurotoxic, decreased food consumption and body weight, adrenal, blood, and liver effects, changes in enzyme levels and serum chemistry, increased liver and adrenal weight, decreased thymus weight, squamous skin on feet, tail, and scrotum	ND	10 mg/kg/day - N (neurotoxic effects, increased liver weight, decreased thymus weight, squamous skin on feet)	ND	The systemic NOAEL is based upon a subacute study.
Polyethylene glycol 25322-68-3	66, 67	dermal	ND	ND	1580 mg/kg/day - N (decreased body weight, liver and kidney lesions)[b]	ND	Not reported to be a dermal sensitizer based on studies with several materials.
		inhalation	ND	ND	1580 mg/kg/day (5530 mg/m^3 (W), 8379 mg/m^3 (G)) - N (decreased body weight, liver and kidney lesions)[b]	ND	ND
		oral	sys: decreased body weight, kidney and liver effects	ND	1580 mg/kg/day - N (decreased body weight, liver and kidney lesions)	ND	NOAEL is based upon a study with polyethylene glycol with a MW of 400.

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Polytetrafluoro-ethylene 9002-84-0	54, 74, 75	dermal	ND	ND	6000 mg/kg/day - N[b]	ND	Not reported to be a skin sensitizer (species not indicated).
		inhalation	sys: blood, neurotoxic, and respiratory effects, changes in urine chemistry	ND	6000 mg/kg/day (21,000 mg/m^3 (W), 31,818 mg/m^3 (G)) - N[b]	ND	IARC (1987) has classified polytetrafluoroethylene as a Group 3 compound, not classifiable as to its carcinogenicity, based on no adequate evidence in humans and inadequate evidence in experimental animals.
		oral	ND	ND	6000 mg/kg/day - N[d]	ND	The systemic NOAEL is based upon a subacute study. No effects were seen at the only dose tested.
Propanol 71-23-8	76-79	dermal	ND	ND	57.1 mg/kg/ day) - L (reduced survival, liver and bone marrow effects)[b]	2458 mg/kg/day (W), 1622 mg/kg/day (G) - N (decreased fetal body weight, increased litters with malformations)[c]	ND
		inhalation	sys: liver and reproductive effects; dev: decreased fetal body weight, malformations	ND	165 mg/m^3 - L (liver lesions)	3500 ppm (approximately 8603 mg/m^3) - N (decreased fetal body weight, increased litters with malformations)[e]	The systemic LOAEL is based upon a subacute study.
		oral	sys: liver, bone marrow, and neurotoxic effects, increased liver weight, decreased survival	ND	200 mg/kg twice/week (approximately 57.1 mg/kg/day) - L (reduced survival, liver and bone marrow effects)[k]	2458 mg/kg/day (W), 1622 mg/kg/day (G) - N (decreased fetal body weight, increased litters with malformations)[c]	The U.S. EPA (1987) has proposed that propanol be given a Group C classification, possible human carcinogen, based on no evidence of carcinogenicity in humans and limited evidence of carcinogenicity in experimental animals.

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Propyl acetate 109-60-4	80, 81	dermal	ND	ND	ND	ND	Dermal LD_{50} > 20 mL/kg (species not indicated). SAT: Low to Moderate
		inhalation	ND	ND	ND	ND	ND
		oral	ND	ND	ND	ND	Oral LD_{50}'s range from 6.64 to 9.37 g/kg for rats, mice, and rabbits.
Propylene glycol methyl ether 107-98-2	68-70	dermal	sys: increased mortality, blood, neurotoxic, and skin effects, altered kidney weight	0.7 mg/kg/day (liver and kidney effects, increased liver and kidney weights)[b]	ND	1580 mg/kg/day (W), 1043 mg/kg/day (G) - N (delayed ossification)[c]	Not reported to be a dermal sensitizer in guinea pigs.
		inhalation	sys: decreased growth, liver, neurotoxic, reproductive, and respiratory effects, increased liver and kidney weights; dev: delayed ossification of vertebrae, musculoskeletal abnormalities	2 mg/m^3 (neurotoxic effects)	ND	1500 ppm (approximately 5530 mg/m^3) - N (delayed ossification)[e]	ND
		oral	sys: decreased body weight and body weight gain, decreased food consumption, blood, neurotoxic, kidney, liver, and reproductive effects, and increased liver and kidney weight, spermiophages in the epididymus	0.7 mg/kg/day (liver and kidney effects, increased liver and kidney weights)	ND	1580 mg/kg/day (W), 1043 mg/kg/day (G) - N (delayed ossification)[c]	ND
Propylene glycol propyl ether 1569-01-3	71-73	dermal	ND	ND	41 mg/kg/day (W), 27 mg/kg/day (G) - N[c]	1034 mg/kg/day (W), 683 mg/kg/day (G) - N (poorly ossified hind-limb phalanges)[c]	ND
		inhalation	sys: decreased body weight and body weight gain, corneal opacity and injury, neurotoxic effects, increased kidney and liver weight; dev: poorly ossified hind-limb phalanges	ND	145 mg/m^3 - N	3620 mg/m^3 - N (poorly ossified hind-limb phalanges)	483 mg/m^3 caused irreversible eye lesions in F344 rats, and potentially reversible eye lesions in SD rats and rabbits.
		oral	ND	ND	41 mg/kg/day (W), 27 mg/kg/day (G) - N[c]	1034 mg/kg/day (W), 683 mg/kg/day (G) - N (poorly ossified hind-limb phalanges)[c]	ND

Chemical name/ CAS number	Refer- ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Resin, acrylic NK	82-85	dermal	ND	ND	1500 mg/kg/day - N[f]	4000 mg/kg/day - N[b]	NOAELs and toxicity endpoints are based on studies conducted on acrylic acid homopolymer, CAS# 9003-01-4.
		inhalation	sys: respiratory effects, lung carcinogenicity (rats)	ND	0.05 mg/m^3 - N (respiratory effects)	10 mg/m^3 - N[f]	
		oral	sys: decreased body weight gain, kidney effects, changes in urine chemistry	ND	3000 mg/kg/day - N[f]	4000 mg/kg/day - N[f]	
Silica 7631-86-9	86, 101	dermal	ND	ND	ND	ND	Dose was not extrapolated from inhalation to oral or dermal because treatment-related effects were confined to the lungs. IARC (1997) has classified amorphous silica as a Group 3 compound, not classifiable as to its carcinogenicity to humans, based on inadequate evidence in humans and experimental animals.
		inhalation	sys: death, lymphatic and respiratory effects, lung carcinogenicity (rats and humans)	ND	0.1 mg/m^3 crystalline silica - N (silicosis)	ND	
		oral	ND	ND	ND	ND	
Silicone oil 63148-62-9	87-90	dermal	sys: decreased testes weight and size, spermatogenic depression, tubular atrophy; dev: increased resorptions, malformations	ND	200 mg/kg/day - L (death, decreased testes weight, spermatogenic depression)	200 mg/kg/day - L (increased incidence of resorptions)	ND
		inhalation	ND	ND	200 mg/kg/day (700 mg/m^3 (W), 1061 mg/m^3 (G)) - N[b]	200 mg/kg/day (700 mg/m^3 (W), 1061 mg/m^3 (G)) - L (increased incidence of resorptions)[j]	Exposure of rats, dogs, and guinea pigs to 2,120 mg/m^3 for 6 hours resulted in neurotoxic and respiratory effects.
		oral	sys: increased food consumption, gastrointestinal effects, increased spleen weight, decreased seminal vesicle weight	ND	1% in the diet (approximately 200 mg/kg/day) - N[l]	200 mg/kg/day - L (increased incidence of resorptions)[j]	ND

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Styrene 100-42-5	2, 91, 92	dermal	ND	0.2 mg/kg/day (blood effects)[b]	ND	300 mg/kg/day - N[b]	ND
		inhalation	sys: nasal and lung irritation, blood, liver, neurotoxic, and respiratory effects, increased liver weight, mammary carcinogenicity (rats); dev: increased resorptions, fetal deaths, decreased pup body weight, decreased levels of fetal cerebral serotonin and S-hydroxyindoleacetic acid	1.0 mg/m^3 (neurotoxic effects in humans)	ND	50 ppm (approximately 213 mg/m^3) - L (decreased pup body weight)[e]	ND
		oral	sys: blood, liver, neurotoxic, and respiratory effects, lung and liver carcinogenicity (mice)	0.2 mg/kg/day (blood effects)	ND	300 mg/kg/day - N	ND
Trimethylol-propane ethoxylate triacrylate 28961-43-5	93	dermal	ND	ND	ND	1000 mg/kg/day - N[b]	SAT: Low to Moderate
		inhalation	sys: liver and spleen effects; dose unclear	ND	ND	1000 mg/kg/day (3500 mg/m^3 (W), 5303 mg/m^3 (G)) - N[b]	ND
		oral	ND	ND	ND	1000 mg/kg/day - N[d]	No effects were seen at the only dose tested.
Trimethylol-propane triacrylate 15625-89-5	94-97	dermal	sys: decreased body weight, skin and neurotoxic effects, changes in clinical chemistry, altered organ weights	ND	0.75 mg/kg/day - N (dermal lesions)	500 mg/kg/day - N[b]	Reported to be a mild dermal sensitizer in guinea pigs.
		inhalation	sys: decreased body weight, respiratory effects	ND	5.7 mg/m^3 - L (respiratory effects, body weight loss)	500 mg/kg/day (1750 mg/m^3 (W), 2652 mg/m^3 (G)) - N[b]	ND
		oral	ND	ND	1.6 mg/kg/day (W), 1.1 mg/kg/day (G) - L (respiratory effects, body weight loss)[c]	500 mg/kg/day - N	ND

Chemical name/ CAS number	Refer-ence*	Exposure route	Toxicity endpoints [a]	RfD/RfC	Critical toxicity value**		Comment
					Systemic	Developmental	
Urea 57-13-6	98-100	dermal	ND	ND	6750 mg/kg/day - N[b]	50,000 mg/kg/day - N[b]	Not reported to be a dermal sensitizer (species not indicated).
		inhalation	ND	ND	6750 mg/kg/day (23,625 mg/m^3 (W), 35,795 mg/m^3 (G)) - N[b]	50,000 mg/kg/day (175,000 mg/m^3 (W), 265,152 mg/m^3 (G)) - N[b]	ND
		oral	ND	ND	6750 mg/kg/day - N	50,000 mg/kg/day - N	No effects were seen at any doses tested in the systemic and developmental studies.

Table 3-B.1 Health Hazard Results for Flexographic Ink Chemicals (continued)

TABLE 3-B.1 FOOTNOTES

ABBREVIATIONS: NK, not known; CTV, critical toxicity value; N, NOAEL or NOAEC; L, LOAEL or LOAEC; sys, systemic effects; dev, developmental effects; W, worker; G, general population
*Most of the references were developed from online database searches conducted during July and August 1997. In most cases, the primary references were not reviewed.
**The critical toxicity value (CTV) is the NOAEL, NOAEC, LOAEL, or LOAEC. The CTV is used with exposure data for quantitative evaluation of risk.
[a] Provides a complete listing for all endpoints/toxic effects found within the hazard profiles. Does not indicate severity of effects.
[b] Inhalation or dermal CTV or RfD is based on oral data. Worker inhalation values (W) have been converted from mg/kg/day to mg/m^3 using the following conversion, based upon default human body weight (70 kg) and respiratory rate (20 m^3/day):

mg/m^3 = mg/kg/day x 1 day/20 m^3 x 70 kg

General population inhalation values (G) have been converted from mg/kg/day using the following conversions, based upon default human body weight (70 kg) and respiratory rate (13.2 m^3/day):

mg/m^3 = mg/kg/day x 1 day/13.2m^3 x 70 kg

[c] Oral or dermal CTV is based upon inhalation data. Worker oral or dermal values (W) have been converted from mg/m^3 to mg/kg/day using the following conversion, based upon default human body weight (70 kg) and respiratory rate (20 m^3/day):

mg/kg/day = mg/m^3 x 20m^3/1 day x 1/70 kg

General population oral or dermal values (G) have been converted from mg/m^3 to mg/kg/day using the following conversion, based upon default human body weight (70 kg) and respiratory rate (13.2 m^3/day):

mg/kg/day = mg/m^3 x 13.2 m^3/1 day x 1/70 kg

[d] Only dose tested.
[e] Original data given in ppm, converted to mg/m^3 using the following conversion:

mg/m^3 = [ppm x molecular weight (grams)] ÷ 24.45

[f] Highest dose tested
[g] Original dose was given in ml/kg/day and was converted to mg/kg/day using the following conversion:

mg/kg/day = ml/kg/day x density (grams/ml) x 1000 mg/gram

[h] Available LD_{50}s given only for those chemicals for which no other toxicity information was found.
[i] Original value for petroleum distillates was given as 0.05 ml 2x/week and has been converted to mg/kg/day using the following conversion, using a default mouse body weight of 25 grams, a dose of 0.01 ml/day, and assuming a density of 1 gram/ml:

mg/kg/day = 0.01 ml/.025 kg x 1/day x 1 gram/ml x 1000 mg/gram = 400 mg/kg/day

[j] Oral or inhalation CTV or RfD is based upon dermal data. Worker inhalation values (W) have been converted from mg/kg/day to mg/m^3 using the following conversion, based upon default human body weight (70 kg) and respiratory rate (20 m^3/day):

mg/m^3 = mg/kg/day x 1 day/20m^3 x 70 kg

General population inhalation values (G) have been converted from mg/kg/day to mg/m^3 using the following conversion, based upon default human body weight (70 kg) and respiratory rate (13.2 m^3/day):

mg/m^3 = mg/kg/day x 1 day/13.2 m^3 x 70 kg

[k] Original dose was given as 1x or 2x/week and has been converted to mg/kg/day by dividing the total weekly dose by 7 days/week.
[l] Original exposure was given as % in diet. For studies with humans, conversions were done by the performing laboratory. For mice, values were converted using a default body weight of 25 grams and average food intake of 3 grams/day:

mg/kg/day = % in diet/100 x 3 grams/day ÷ 0.025 kg x 1000 mg/gram

[m] Original value was given as ml/animal/day and has been converted to mg/kg/day using the following conversion, based upon default rat body weight (250 g) and density of 1.064 grams/ml:

mg/kg/day = 0.1 ml/.25 kg x 1/day x 1.064 grams/ml x 1000 mg/gram

Table 3-B.2 SAT Reports and Available Acute Data for Chemicals with No or Inadequate Hazard Data

Chemical name and CAS number	Summary of SAT report and available acute data	Refer-ence
SAT reports [a] for chemicals with no or inadequate toxicity data.		
Acrylated epoxy polymer NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. If the polymer is terminated with acrylates, there is concern for mutagenicity, oncogenicity, developmental toxicity, and dermal and respiratory sensitization. Low concern for other effects.	
Acrylated oligoamine polymer NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. If the polymer is terminated with acrylates, there is concern for mutagenicity, oncogenicity, developmental toxicity, and dermal and respiratory sensitization. Low concern for other effects.	
Acrylated polyester polymer #1 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. If the polymer is terminated with acrylates, there is concern for mutagenicity, oncogenicity, developmental toxicity, and dermal and respiratory sensitization. Low concern for other effects.	
Acrylated polyester polymer #2 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. If the polymer is terminated with acrylates, there is concern for mutagenicity, oncogenicity, developmental toxicity, and dermal and respiratory sensitization. Low concern for other effects.	
Acrylic acid-butyl acrylate-methyl methacrylate-styrene polymer 27306-39-4	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Acrylic acid polymer, acidic #1 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Acrylic acid polymer, acidic #2 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Acrylic acid polymer, insoluble NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Alcohols, C11-C15-secondary, ethoxylated 68131-40-8	Moderate concern overall. This material is reported to be a severe skin irritant. The surfactant activity of this chemical may result in eye irritation and lung effects.	
Amides, tallow, hydrogenated 61790-31-6	Low concern overall.	
Butyl acrylate-methacrylic acid-methyl methacrylate polymer 25035-69-2	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
C.I. Basic Violet 1, molybdatephosphate 67989-22-4	Low to Moderate concern for oncogenicity, mutagenicity, and developmental toxicity.	
C.I. Basic Violet 1, molybdatetungstate-phosphate 1325-82-2	Low to Moderate concern for oncogenicity, genotoxicity, developmental toxicity, immunosuppression, methemoglobinemia, and liver effects.	

Chemical name and CAS number	Summary of SAT report and available acute data	Refer-ence
C.I. Pigment Blue 61 1324-76-1	Low concern overall.	
C.I. Pigment Red 48, barium salt (1:1) 7585-41-3	4 hour LC_{50} in rats = 5420 mg/m^3[h]. Low to Moderate concern for oncogenicity, neurotoxicity and developmental toxicity.	15
C.I. Pigment Red 48, calcium salt (1:1) 7023-61-2	Low to Moderate concern for oncogenicity.	
C.I. Pigment Red 52, calcium salt (1:1) 17852-99-2	Low to Moderate concern for mutagenicity, developmental toxicity, and oncogenicity.	
C.I. Pigment Red 269 67990-05-0	Low concern overall.	
C.I. Pigment Violet 23 6358-30-1	Low concern overall.	
C.I. Pigment Violet 27 12237-62-6	Low to Moderate concern for oncogenicity, mutagenicity, developmental toxicity, and neurotoxicity.	
C.I. Pigment White 7 1314-98-3	Low to Moderate concern for mutagenicity, developmental toxicity, and immunotoxicity.	
C.I. Pigment Yellow 14 5468-75-7	No clinical signs of toxicity were seen in rats exposed orally to 11,000 mg/kg. Low concern overall unless exposed to temperatures greater than 200C. There is Low to Moderate concern for oncogenicity, mutagenicity, neurotoxicity, and liver effects.	17
C.I. Pigment Yellow 74 6358-31-2	Low concern overall.	
Dipropylene glycol diacrylate 57472-68-1	Oral LD_{50} in rats = 4.6 g/kg. Moderate concern for genotoxicity, neurotoxicity, oncogenicity, developmental and reproductive effects, dermal and respiratory sensitization, and skin and eye irritation.	
Erucamide 112-84-5	Low concern overall.	
Ethoxylated tetramethyldecyndiol 9014-85-1	Low to Moderate concern for eye, skin, lung and mucous membrane irritation, and neurotoxic, liver, and kidney effects. The surfactant nature of this material may cause lung effects if inhaled.	
Ethyl 4-dimethyl-aminobenzoate 10287-53-3	Low to Moderate concern for genotoxicity, oncogenicity, neurotoxicity, cardiac sensitization, and developmental toxicity.	
Fatty acid, dimer-based polyamide NK	Low concern overall.	
Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid 67989-30-4	Low concern overall.	

Chemical name and CAS number	Summary of SAT report and available acute data	Reference
1-Hydroxycyclohexyl phenyl ketone 947-19-3	Low concern overall.	
Hydroxylamine derivative NK	Moderate concern for genotoxicity, dermal sensitization, and developmental toxicity.	
Isopropoxyethoxytitanium bis(acetylacetonate) 68586-02-7	Moderate concern for neurotoxicity, genotoxicity, oncogenicity, and developmental/reproductive toxicity. This material is expected to be reactive, which may result in irritation of the eyes, skin, and mucous membranes.	
2-Isopropylthioxanthone 5495-84-1	Low concern overall.	
4-Isopropylthioxanthone 83846-86-0	Low concern overall.	
2-Methoxy-1-propanol	Low to Moderate concern for developmental toxicity, neurotoxicity, and immunosuppresion.	
Methylenedisalicylic acid 27496-82-8	Low to Moderate concern for effects on blood clotting, sensitization, immunosuppresion, irritation of mucous membranes, developmental toxicity, endocrine disruption, and genotoxicity.	
Nitrocellulose 9004-70-0	Oral LD_{50} in rats and mice > 5 grams/kg. Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	15
Paraffin wax 8002-74-2	Low to Moderate concern for respiratory effects.	
Polyethylene 9002-88-4	IARC (1987) has classified polyethylene as a Group 3 compound, not classifiable as to its carcinogenicity to humans, based on no adequate evidence in humans and inadequate evidence in experimental animals. Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	57
Polyol derivative A —	Low concern overall.	
Resin acids, hydrogenated, methyl esters 8050-15-5	Low concern overall. There is uncertain concern for respiratory sensitization.	
Rosin, fumarated, polymer with diethylene glycol and pentaerythritol 68152-50-1	Low concern overall unless respirable particles of high molecular weight species (>10,000) are inhaled. There is uncertain concern for respiratory sensitization. Low concern for other effects.	
Rosin, fumarated NK	Low concern overall.	
Rosin, polymerized 65997-05-9	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. There is uncertain concern for respiratory sensitization. Low concern for other effects.	
Silanamine, 1,1,1-trimethyl-N-(trimethyl-silyl)-, hydrolysis products with silica 68909-20-6	Low to Moderate concern for lung effects (silicosis) if crystalline material is inhaled. Low concern for other effects.	

Table 3-B.2 SAT Reports and Available Acute Data for Chemicals with No or Inadequate Hazard Data (continued)

Chemical name and CAS number	Summary of SAT report and available acute data	Reference
Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, ethers with polyethylene glycol acetate 70914-12-4	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Solvent naphtha (petroleum), light aliphatic 64742-89-8	Low to Moderate concern for neurotoxicity and lung irritation. The material may also cause defatting of the skin through prolonged exposure.	
Styrene acrylic acid polymer #1 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Styrene acrylic acid polymer #2 NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Styrene acrylic acid resin NK	Low to Moderate concern for lung effects if respirable particles of high molecular weight species (>10,000) are inhaled. Low concern for other effects.	
Tetramethyldecyndiol 126-86-3	Low concern for eye, skin, lung, and mucous membrane irritation, and neurotoxic, liver, and kidney effects.	
Thioxanthone derivative NK	Low to Moderate concern for neurotoxicity.	
Titanium diisopropoxide bis(2,4-pentanedionate) 17927-72-9	This material is expected to be reactive, which may result in irritation of the eyes, skin, and mucous membranes. Moderate concern based on release of hydrolysis products: 2,4 pentanedione, inorganic titanium, and isopropanol. 2,4 pentanedione: concern for neurotoxicity, mutagenicity, oncogenicity, and developmental/reproductive toxicity. Inorganic titanium: concern for mutagenicity and oncogenicity. Isopropanol: concern for liver, neurotoxic, reproductive, respiratory, and spleen effects; changes in enzyme levels and clinical and urine chemistry; fetal death, musculoskeletal abnormalities, fetotoxicity, blood and skin effects, tissue necrosis at application site, increased kidney and liver weight.	
Titanium isopropoxide 546-68-9	This material is expected to be reactive, which results in moderate concern for irritation of the eyes, skin, and mucous membranes. Moderate concern based on release of the hydrolysis products, inorganic titanium and isopropanol. Inorganic titanium: concern for mutagenicity and oncogenicity. Isopropanol: concern for liver, neurotoxic, reproductive, respiratory, and spleen effects; changes in enzyme levels and clinical and urine chemistry; fetal death, musculoskeletal abnormalities, fetotoxicity, blood and skin effects, tissue necrosis at application site, increased kidney and liver weight.	
Trimethylolpropane propoxylate triacrylate 53879-54-2	Low to Moderate concern for oncogenicity, mutagenicity, developmental and reproductive effects, sensitization, and irritation.	

[a] SAT reports are generated by the OPPT Structure-Activity Team to predict toxicity based on analog data and/or structure-activity considerations.

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ENVIRONMENTAL HAZARD ASSESSMENT METHODOLOGY

Hazard Profile

The environmental hazard assessment of chemicals consists of the identification of the effects that a chemical may have on organisms in the environment. An overview of this assessment process has been reported, for example, by Smrchek and Zeeman (1998)[1] and by Zeeman and Gilford (1993a)[2]. The effects are expressed in terms of the acute and chronic toxicity of a chemical on the exposed organisms. There are generally given as either the lethal concentration (LC) or as the effective concentration (EC), which describe the type and seriousness of the effect for a known concentration of a chemical. When the effective concentrations for a range of species for a chemical are tabulated, the tabulation is called a Hazard Profile or Toxicity Profile. A more detailed discussion of a comprehensive Hazard Profile has been presented by Nabholz, 1991.[3] The most frequently used Hazard Profile for the aquatic environment consists of a set of six effective concentrations as reported by Nabholz, et al., (1993a).[4] These are:

- Fish acute value (usually a fish 96-hour LC_{50} value)
- Aquatic invertebrate acute value (usually a daphnid 48-hour LC_{50} value)
- Green algal toxicity value (usually an algal 96-hour EC_{50} value)
- Fish chronic value [usually a fish 28-day chronic value (ChV)]
- Aquatic invertebrate chronic value (usually a daphnid 21-day ChV)
- Algal chronic value [usually an algal 96-hour no effect concentration (NEC) or geometric mean maximum acceptable toxicant concentration (GMATC) value for biomass]

For the acute values, the LC_{50} (lethality or mortality) or EC_{50} (non-lethal effects) refers to the concentration that results in 50 percent of the test organisms affected at the end of the specified exposure period in a toxicity test. The chronic values represent the concentration of the chemical that results in no statistically significant sublethal effects on the test organism following an extended or chronic exposure.

The Hazard Profile can be constructed using effective concentrations based on toxicity test data (with measured test chemical concentrations) or estimated toxicity values based on Structure Activity Relationships (SARs). The measured values are preferred because they are based on actual test data, but SAR estimates, if available for the chemical class, can be used in the absence of test data. Thus the Hazard Profile may consist of only measured data, only predicted values, or a combination of both. Also, the amount of data in the hazard profile may range from a minimum of one acute or chronic value to the full compliment of three acute values and three chronic values.

In the absence of measured toxicity values, estimates of these values can be made using Structure Activity Relationships (SARs). SAR methods include Quantitative Structure Activity Relationships (QSARs), qualitative SARs or the use of the chemical analogs. The use of SARs by OPPT has been described in other texts.[5] The use and application of QSARs specifically for the hazard assessment of new TSCA chemicals has been presented in other information sources as well.[6] The development, validation and application of SARs in OPPT have been presented by OPPT staff.[7,8,9,10,11,12]

The predictive equations (QSARs) are used in lieu of actual test data to estimate a toxicity value for aquatic organisms within a specific chemical class. The chemical classes and subclasses with available QSARs, numbering a total of 140, have been listed.[13,14] Although the equations are derived from correlation and linear regression analysis based on measured data, the confidence intervals associated with the equation are not used to provide a range of toxicity values. Even with measured test data, the use of the confidence limits to determine the range of values is not used.

Determination of Concern Concentration

Upon completion of a hazard profile, a concern concentration (CC) is determined. A concern concentration is that concentration of a chemical in the aquatic environment which, if exceeded, may cause a significant risk to aquatic organisms. Conversely, if the CC is not exceeded, the assumption is made that probability of a significant risk occurring is low and no regulatory action is required. The CC for each chemical is determined by applying Assessment Factors (AsF)[15] or Uncertainty Factors (UF)[16] to the effect concentrations in the hazard profile.

These factors incorporate the concept of the uncertainty associated with (1) toxicity data; laboratory tests versus field test and measured versus estimated data and (2) species sensitivity. For example, if only a single LC_{50} value for a single species, is available, there are several uncertainties to consider. First, how reliable is the value itself? If the test were to be done again by the same laboratory or a different laboratory, would the value differ, and if so, by how much? Second, there are differences in sensitivity (toxicity) among and between species that have to be considered. Is the species tested the most or the least sensitive? In general, if only a single toxicity value is available, there is a large uncertainty about the applicability of this value to other organisms in the environment and large assessment factor, i.e., 1000, is applied to cover the breadth of sensitivity known to exist among and between organisms in the environment. Conversely, the more information that is available results in more certainty concerning the toxicity values and requires the use of smaller factors. For example, if toxicity values are derived from field tests, then an assessment factor on 1 is used, because these tools measure chemical effects on field organisms.

Four factors are used by OPPT to set a CC for chronic risk: 1, 10, 100, and 1000. The factor used is dependent on the amount and type of toxicity data contained in the hazard profile and reflects the amount of uncertainty about the potential effects associated with a toxicity value. In general, the more complete the hazard profile and the higher the quality of the generated toxicity data, the smaller the factor that is used. The following discussion describes the use and application of the uncertainty or assessment factors:

- If the hazard profile only contains one or two acute toxicity values, the concern concentration is set at 1/1000 of the acute value.

- If the hazard profile contains three acute values (called the base set), the concern concentration is set at 1/100 of the lowest acute value.

- If the hazard profile contains one chronic value, the concern concentration is set at 1/10 of the chronic value if the value is for the most sensitive species. Otherwise, it is 1/100 of the acute value for the most sensitive species.

- If the hazard profile contains three chronic values, the concern concentration is set at 1/10 of the lowest chronic value.

- If the hazard profile contains a measured chronic value from a field study, then an assessment factor of 1 is used.

Hazard Ranking

Chemicals can be also be ranked by their hazard concern levels for the aquatic environment. This ranking can be based upon the acute toxicity values expressed in milligrams per liter (mg/L). The generally accepted scoring used by OPPT is as follows:[17,18]

High Concern (H)	≤ 1
Moderate (or Medium) Concern (M)	> 1 and ≤ 100
Low Concern (L)	> 100

This ranking can also be expressed in terms of chronic values as follows:

High Concern (H)	≤ 0.1
Moderate (or Medium) Concern (M)	> 0.1 and ≤ 10.0
Low Concern (L)	> 10.0

Chronic toxicity ranking takes precedent over the acute ranking.

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Table 3-B.3 Estimated Lowest Aquatic Toxicity Values of Flexographic Ink Chemicals Based on SAR Analysis or on Actual Measured Test Data

Chemical	Acute toxicity (mg/L)			Chronic toxicity (mg/L)			Concern concen-tration
	Fish	Invert.	Algal	Fish	Invert.	Algal	
Acrylated epoxy polymer	a						
Acrylated oligoamine polymer	a						
Acrylated polyester polymer #1	a						
Acrylated polyester polymer #2	a						
Acrylic acid-butyl acrylate-methyl methacrylate-styrene polymer	a						
Acrylic acid polymer, acidic #1	≥300	≥400	9	≥30	≥40	1	>1
Acrylic acid polymer, acidic #2	≥300	≥400	9	≥30	≥40	1	>1
Acrylic acid polymer, insoluble	a						
Alcohols, C11-15-secondary, ethoxylated	1	1	1	0.2	0.2	0.3	0.02
Amides, tallow, hydrogenated	b	b	b	0.002	0.005	0.01	0.001
Ammonia fresh water salt water	0.93 1.1	1.91 1.0	2.4	0.07 0.06	0.6 0.14	0.6	0.01-0.006
Ammonium hydroxide	12	32	>30	1	3	>3	0.3
Barium	580	24	31	23	13	7.7	0.8
2-Benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone	2.0	1	1.5	0.3	0.2	0.6	0.02
Butyl acetate	25	170	2	3	7.8	1.5	0.2
Butyl acrylate-methacrylic acid-methyl methacrylate polymer	a						
Butyl carbitol fresh water salt water	1300 170	1300 821	760	140	41	40	2-4
C.I. Basic Violet 1, molybdatephosphate	0.05 or [a]	0.05 or [a]	0.05 or [a]	0.05 or [a]	0.005 or [a]	0.01 or [a]	0.001
C.I. Basic Violet 1, molybdatetungstatephosphate	0.08 or [a]	0.05 or [a]	0.04 or [a]	0.008 or [a]	0.005 or [a]	0.01 or [a]	0.001 for solub.≥0.005
C.I. Pigment Blue 15	a						
C.I. Pigment Blue 61	≤70	≤70	≤10	≤7	≤7	≤1	0.1
C.I. Pigment Green 7	a						
C.I. Pigment Red 23	a						
C.I. Pigment Red 48, barium salt (1:1)	≥30	≥30	20	≥3	≥3	2	0.3
C.I. Pigment Red 48, calcium salt (1:1)	≥30	≥30	20	≥3	≥3	2	0.3
C.I. Pigment Red 52, calcium salt (1:1)	30	40	170	3	3	≥20	0.3
C.I. Pigment Red 269	a						
C.I. Pigment Violet 23	a						
C.I. Pigment Violet 27	0.05 or [a]	0.05 or [a]	0.05 or [a]	0.005 or [a]	0.005 or [a]	0.005 or [a]	0.001
C.I. Pigment White 6	a						
C.I. Pigment White 7	a						

Chemical	Acute toxicity (mg/L)			Chronic toxicity (mg/L)			Concern concen-tration
	Fish	Invert.	Algal	Fish	Invert.	Algal	
C.I. Pigment Yellow 14	a						
C.I. Pigment Yellow 74	a						
Citric acid in hard water	>100	>100	5 100	10	10	1 30	0.1 3.0

Table 3-B.3 Estimated Lowest Aquatic Toxicity Values of Flexographic Ink Chemicals Based on SAR Analysis or on Actual Measured Test Data (continued)

Chemical	Acute toxicity (mg/L)			Chronic toxicity (mg/L)			Concern concen-tration
	Fish	Invert.	Algal	Fish	Invert.	Algal	
D&C Red No. 7	29	37	20	>3	2.6	2	0.2-0.3
Dicyclohexyl phthalate	b	b	0.05	0.03	0.03	0.04	0.003
Dioctyl sulfosuccinate, sodium salt	3	3	30	0.5	.05	3	0.05
Diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide	3	5.2	0.43	0.4	0.61	0.35	0.04
Dipropylene glycol diacrylate	3.8	26	2.7	0.25	3	6	0.03
Dipropylene glycol methyl ether	5000	4600	2600	500	110	95	10
Distillates (petroleum), hydrotreated light	0.23	0.3	0.22	0.05	0.05	0.1	0.005
Distillates (petroleum), solvent-refined light paraffinic	a						
Erucamide	a						
Ethanol	4300	4000	6100	390	76	60	6
Ethanolamine	1035	100	63	200	10	0.85	0.09
Ethoxylated tetramethyldecynidiol	>50	>50	>50	>10	>10	>10	1
Ethyl acetate	66	>1000	5	7	>100	3.7	0.4
Ethyl carbitol	>1000	>1000	>1000	900	190	150	20
Ethyl 4-dimethylaminobenzoate	13	15	10	2	1.3	1.9	0.1
2-Ethylhexyl diphenyl phosphate	b	b	0.05	0.03	0.03	0.04	0.003
Fatty acid, dimer-based polyamide	a						
Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid	a						
Glycerol propoxylate triacrylate	4.5	14	1.6	0.13	0.1	0.4	0.01
n-Heptane	0.41	0.52	0.37	0.08	0.08	0.15	0.008
1,6-Hexanediol diacrylate	2.4	7.6	0.82	0.2	0.8	0.07	0.007
1-Hydroxylcyclohexyl phenyl ketone	33	37	24	4.8	2.6	3.6	0.3
Hydroxylamine derivative	54	3.9	6.8	5	0.4	1.4	0.04
2-Hydroxy-2-methylpropiophenone	450	460	280	52	18	20	2
Hydroxypropyl acrylate	4.9	160	15	1.7	20	4	0.2
Isobutanol	930	910	530	97	26	25	2.5
Isopropanol	2700	2600	1400	260	57	48	5
Isopropoxyethoxytitanium bis(acetylacetonate)	13	15	10	2	1.4	2.3	0.1, 1.0 [c]
2-Isopropylthioxanthone	b	b	b	0.004	0.004	0.004	0.001

Table 3-B.3 Estimated Lowest Aquatic Toxicity Values of Flexographic Ink Chemicals Based on SAR Analysis or on Actual Measured Test Data (continued)

Chemical	Acute toxicity (mg/L)			Chronic toxicity (mg/L)			Concern concen-tration
	Fish	Invert.	Algal	Fish	Invert.	Algal	
4-Isopropylthioxanthone	b	b	b	0.03 or a	0.03 or a	0.03 or a	0.003
Kaolin	>1000	>1000	>1000	>100	50	>100	5.0
Methylenedisalicylic acid	>100	>100	30	>10	>10	3	0.3
2-Methyl-4'(methylthio)-2-morpholinopropiophoenone	45	51	33	6.6	3.6	5	0.4
Mineral oil	b	b	b	0.002 or a	0.004 or a	0.010 or a	0.001
Nitrocellulose	>100	>100	>100	>10	>10	>10	1
Paraffin wax	a						
Phosphine oxide, bis(2,6-dimethoxybenzoyl) (2,4,4-trimethylpentyl)-	5.1 or a	5.1 or a	0.78 or a	0.9 or a	1.2 or a	0.62 or a	0.06
Polyethylene glycol	>100	>100	>100	>10	>10	>10	1
Polyol derivative A	>1000	>1000	>1000	>100	>100	>100	10
Polytetrafluoroethylene	a						
Propanol	1800	1700	970	180	42	36	4
Propyl acetate	41	430	3.2	4	16	2.4	0.2
Propylene glycol methyl ether	>1000	>1000	>1000	>1000	210	160	20
Propylene glycol propyl ether	1000	1000	980	180	47	44	4
Resin acids, hydrogenated, methyl esters	b	b	b	0.001 or a	0.001 or a	0.005 or a	0.001
Resin, acrylic	300	400	9	30	40	1	>1
Rosin, fumarated, polymer with diethylene glycol and pentaerythritol	a						
Rosin, fumarated, polymer with pentaerythritol, 2-propenoic acid, ethenylbenzene, and (1-methylethylenyl)benzene	a						
Rosin, polymerized	a						
Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica	>100 or a	>100 or a	>100 or a	>10 or a	>10 or a	>10 or a	>1 or a
Silica	a						
Silicone oil	>100 or a	>100 or a	>100 or a	>10 or a	>10 or a	>10 or a	1.0 or a
Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, ethers with polyethylene glycol acetate	>100	>100	>100	>10	>10	>10	>1
Solvent naphtha (petroleum), light aliphatic	1.8	2.2	1.5	0.31	0.23	0.38	0.02
Styrene	4	13	0.72	1.6	0.95	0.06	0.006
Styrene acrylic acid polymer #1	300	400	9	30	40	1	>1
Styrene acrylic acid polymer #2	300	400	9	30	40	1	>1
Styrene acrylic acid resin	300	400	9	30	40	1	>1
Tetramethyldecyndiol	31	30	30	3	3	3	0.3
Thioxanthone derivative	b	b	b	0.05 or a	0.05 or a	0.05 or a	0.005

Table 3-B.3 Estimated Lowest Aquatic Toxicity Values of Flexographic Ink Chemicals Based on SAR Analysis or on Actual Measured Test Data (continued)

Chemical	Acute toxicity (mg/L)			Chronic toxicity (mg/L)			Concern concen-tration
	Fish	Invert.	Algal	Fish	Invert.	Algal	
Titanium diisopropoxide bis (2,4-pentanedionate)	220	110	19	20	10	5	0.5
Titanium isopropoxide	2900	2700	1500	270	60	50	5
Trimethylolpropane ethoxylate triacrylate	8	70	7	0.6	7	2	0.06
Trimethylolpropane propoxylate triacrylate	5.5	22	2.4	0.21	2	0.6	0.02
Trimethylolpropane triacrylate	4.1	23.0	2.4	0.21	2	0.6	0.02
Urea	> 1000	> 1000	> 1000	> 100	> 100	> 100	> 10

[a] No effects are expected because the chemical is a polymer or a high-molecular weight compound. The high molecular weight (greater than 600 or 1,000) prevents passage through biological membranes.

[b] No toxic effects are expected in a saturated solution during the prescribed test duration, or no toxic effects can be measured due to low water solubility.

[c] The first value (0.1) pertains to the stable complex of this chemical, and the second value (>1.0) pertains to the hydrolysis products.

Table 3-B.4 Environmental Hazard Ranking of Flexographic Ink Chemicals

Chemical	CAS number	Lowest chronic value (mg/L)	Hazard rank [a]
Acrylated epoxy polymer		[b]	L
Acrylated oligoamine polymer		[b]	L
Acrylated polyester polymer #1		[b]	L
Acrylated polyester polymer #2		[b]	L
Acrylic acid-butyl acrylate-methyl methacrylate-styrene polymer	27306-39-4	[b]	L
Acrylic acid polymer, acidic #1		1	M
Acrylic acid polymer, acidic #2		1	M
Acrylic acid polymer, insoluble		[b]	L
Alcohols, C11-15-secondary, ethoxylated	68131-40-8	0.2	M
Amides, tallow, hydrogenated	61790-31-6	0.002	H
Ammonia	7664-41-7	0.06	H
Ammonium hydroxide	1336-21-6	1	M
Barium	7440-39-3	7.7	L
2-Benzyl-2-(dimethylamino)-4'-morpholinobutyrophenone	119313-12-1	0.2	M
Butyl acetate	123-86-4	1.5	M
Butyl acrylate-methacrylic acid-methyl methacrylate polymer	25035-69-2	[b]	L
Butyl carbitol	112-34-5	40	L
C.I. Basic Violet 1, molybdatephosphate	67989-22-4	0.005	H
C.I. Basic Violet 1, molybdatetungstatephosphate	1325-82-2	0.005	H
C.I. Pigment Blue 15	147-14-8	[b]	L
C.I. Pigment Blue 61	1324-76-1	$\leq$ 1	M
C.I. Pigment Green 7	1328-53-6	[b]	L
C.I. Pigment Red 23	6471-49-4	[b]	L
C.I. Pigment Red 48, barium salt (1:1)	7585-41-3	2	M
C.I. Pigment Red 48, calcium salt (1:1)	7023-61-2	2	M
C.I. Pigment Red 52, calcium salt (1:1)	17852-99-2	3	M
C.I. Pigment Red 269	67990-05-0	[b]	L
C.I. Pigment Violet 23	6358-30-1	[b]	L
C.I. Pigment Violet 27	12237-62-6	0.005	H
C.I. Pigment White 6	13463-67-7	[b]	L
C.I. Pigment White 7	1314-98-3	[b]	L
C.I. Pigment Yellow 14	5468-75-7	[b]	L
C.I. Pigment Yellow 74	6358-31-2	[b]	L

Chemical	CAS number	Lowest chronic value (mg/L)	Hazard rank [a]
Citric acid	77-92-9	1	M
D&C Red No.7	5281-04-9	2	M
Dicyclohexyl phthalate	84-61-7	0.03	H

Table 3-B.4 Environmental Hazard Ranking of Flexographic Ink Chemicals (continued)

Chemical	CAS number	Lowest chronic value (mg/L)	Hazard rank [a]
Dioctyl sulfosuccinate, sodium salt	577-11-7	0.5	M
Diphenyl (2,4,6-trimethylbenzoyl) phosphine oxide	75980-60-8	0.35	M
Dipropylene glycol diacrylate	57472-68-1	0.25	M
Dipropylene glycol methyl ether	34590-94-8	95	L
Distillates (petroleum), hydrotreated light	64742-47-8	0.05	H
Distillates (petroleum), solvent-refined light paraffinic	64741-89-5	[b]	L
Erucamide	112-84-5	[b]	L
Ethanol	64-17-5	60	L
Ethanolamine	141-43-5	0.85	M
Ethoxylated tetramethyldecyndiol	9014-85-1	> 10	L
Ethyl acetate	141-78-6	3.7	M
Ethyl carbitol	111-90-0	150	L
Ethyl 4-dimethylaminobenzoate	10287-53-3	1.3	M
2-Ethylhexyl diphenyl phosphate	1241-94-7	0.03	H
Fatty acid, dimer-based polyamide		[b]	L
Fatty acids, C18-unsatd., dimers, polymers with ethylenediamine, hexamethylenediamine, and propionic acid	67989-30-4	[b]	L
Glycerol propoxylate triacrylate	52408-84-1	≤ 0.13	H
n-Heptane	142-82-5	0.08	H
1,6-Hexanediol diacrylate	13048-33-4	0.07	H
1-Hydroxycyclohexyl phenyl ketone	947-19-3	2.6	M
Hydroxylamine derivative		0.4	M
2-Hydroxy-2-methylpropiophenone	7473-98-5	18	L
Hydroxypropyl acrylate	25584-83-2	1.7	M
Isobutanol	78-83-1	25	L
Isopropanol	67-63-0	48	L
Isopropoxyethoxytitanium bis(acetylacetonate)	6858-02-7	4.6	M
2-Isopropylthioxanthone	5495-84-1	0.004	H

Table 3-B.4 Environmental Hazard Ranking of Flexographic Ink Chemicals (continued)

Chemical	CAS number	Lowest chronic value (mg/L)	Hazard rank [a]
4-Isopropylthioxanthone	83846-86-0	0.03	H
Kaolin	1332-58-7	50	L
Methylenedisalicylic acid	27496-82-8	3	M
2-Methyl-4'(methylthio)-2-morpholinopropiophenone	71868-10-5	3.6	M
Mineral oil	8012-95-1	0.002	H
Nitrocellulose	9004-70-0	> 10	L
Paraffin wax	8002-74-2	[b]	L
Phosphine oxide, bis(2,6-dimethoxybenzoyl) (2,4,4-trimethylpentyl)-	145052-34-2	0.6	M
Polyethylene	9002-88-4	[b]	L
Polyethylene glycol	25322-68-3	> 10	L
Polyol derivative A		> 100	L
Polytetrafluoroethylene	9002-84-0	[b]	L
Propanol	71-23-8	36	L
Propyl acetate	109-60-4	2.4	M
Propylene glycol methyl ether	107-98-2	160	L
Propylene glycol propyl ether	1569-01-3	≥ 44	L
Resin acids, hydrogenated, methyl esters	8050-15-5	0.001	H
Resin, acrylic	29003-01-4	1	M
Rosin, fumarated, polymer with diethylene glycol and pentaerythritol	68152-50-1	[b]	L
Rosin, fumarated, polymer with pentaerythritol, 2-propenoic acid, ethenylbenzene, and (1-methylethylenyl)benzene		[b]	L
Rosin, polymerized	65997-05-9	[b]	L
Silanamine, 1,1,1-trimethyl-N-(trimethylsilyl)-, hydrolysis products with silica	68909-20-6	>10	L
Silica	7631-86-9	[b]	L
Silicone oil	63148-62-9	> 10	L
Siloxanes and silicones, di-Me, 3-hydroxypropyl Me, ethers with polyethylene glycol acetate	70914-12-4	> 10	L
Solvent naphtha (petroleum), light aliphatic	64742-89-8	0.23	M
Styrene	100-42-5	0.06	H
Styrene acrylic acid polymer #1	25005-34-1	1	M
Styrene acrylic acid polymer #2		1	M
Styrene acrylic acid resin		1	M
Tetramethyldecyndiol	126-86-3	3	M

Table 3-B.4 Environmental Hazard Ranking of Flexographic Ink Chemicals (continued)

Chemical	CAS number	Lowest chronic value (mg/L)	Hazard rank [a]
Thioxanthone derivative		0.05	H
Titanium diisopropoxide bis (2,4-pentanedionate)	17927-72-9	5	M
Titanium isopropoxide	546-68-9	50	L
Trimethylolpropane ethoxylate triacrylate	28961-43-5	≥ 0.06	H
Trimethylolpropane propoxylate triacrylate	53879-54-2	≤ 0.21	M
Trimethylolpropane triacrylate	15625-89-5	0.21	M
Urea	57-13-6	> 100	L

[a] Ranking based on the lowest estimated chronic value; H = high, M = medium, L = low.
[b] No effects are expected because the chemical is a polymer or a high-molecular weight compound. The high molecular weight (greater than 600 or 1000) prevents passage through biological membranes.

Appendix 3-C (Risk Chapter)
Supplementary Environmental Air Release Information

Mass Balance Calculations

The mass balance calculations for determining environmental releases from the ink formulations were conducted as follows for each formulation:

- Determine which components will volatilize (i.e., have vapor pressure greater than or equal to 0.001 mmHg at 25ºC).

- Components that do not volatilize will remain on the substrate and are not expected to result in releases to the environment.

- Multiply volatile component masses by 99.9% to represent the amount of the compounds that volatilize.

- Multiply the mass of the component that volatilizes by 30% to determine the mass of the component that is released as fugitive emissions.

- Multiply mass of the component that volatilizes by 70% to determine the mass of the component that is captured by the exhaust system.

- For solvent-based formulations, multiply the mass of the component captured by the exhaust system by 5% to determine the mass of the component that is released as stack emissions (the catalytic oxidizer has a 95% destruction efficiency). For UV-cured and water-based formulations, the mass of the component that is released as stack emissions is equal to the mass of the component captured by the exhaust system (there are no controls on the UV-cured or water-based systems).

- Convert the release amounts from pounds per 7.5 hours to grams per second.

Sample Calculation of Environmental Releases

Following the methodology outlined above, the fugitive and stack releases for each component of the ink formulations were calculated. Applying the above methodology to the example data presented in Table 3.8 resulted in the data presented in Table D.1 below.

- The non-volatile components of the mixture are pigment, nitrocellulose, and resin; their vapor pressures are less than 0.001 mmHg at 25ºC.

- From Table 3.8, the total mass of ink mixture consumed per 7.5 hour run is 95.815 pounds.

The mass of ethanol consumed per 7.5 hour run is the total mass of ink mixture consumed (95.815 pounds) times the weight percent of ethanol in the ink mixture (19.8%) or 18.971 pounds. Of this amount, 99.9%, or 18.952 pounds, volatilizes per 7.5 hour run. The total mass of the five volatile components consumed per 7.5 hour run is 77.131 pounds. Applying the same methodology, the total mass of ink mixture that volatilizes per 7.5 hour run (99.9% of the amount consumed) is 77.054 pounds.

95.815 lbs. ink mixture consumed (19.8%) = 18.971 lbs. ethanol consumed
18.971 lbs. ethanol consumed (99.9%) = 18.952 lbs. ethanol volatilized

Table 3-C Example Data for a Flexographic Printing Solvent-Based Formulation*

Chemical Component	Weight Percent	Vapor Pressure (mmHg at 25°C)	Fugitive Air Release (grams/sec)	Stack Air Release (grams/sec)
Ethanol	19.8%	59.03	0.096	0.011
Pigment	14.6%	$<10^{-6}$	0	0
Propyl acetate	10.0%	33.7	0.048	0.0056
Propanol	43.3%	21	0.21	0.024
Nitrocellulose	2.7%	$<10^{-6}$	0	0
Resin	2.2%	$2x10^{-4}$	0	0
Glycol ether	1.3%	10.2	0.0063	0.00073
Extender compound	6.1%	0.001	0.029	0.0034

*The solvent-based formulation presented above is a fictional formulation.

In this example:

The mass of ethanol released as fugitive emissions (30% of the total amount released) per 7.5 hour run is 5.686 pounds, which converts to 0.0957 grams of ethanol emitted per second. Similarly, the total mass of the five volatile components released as fugitive emissions per 7.5 hour run is 23.116 pounds, which converts to 0.389 grams of volatiles emitted per second.

18.952 lbs. ethanol volatilized (30%) = 5.686 lbs. fugitive ethanol emissions
5.686 lbs./7.5hrs. (1000g/kg)(1kg/2.2lbs.)(1hr/3600sec)=0.0957 g/sec

The mass of ethanol captured by the exhaust system per 7.5 hour run is the amount of ethanol that volatilizes (18.952 pounds) times the capture efficiency (70%), or 13.266 pounds. The corresponding total mass of the five volatile components captured by the exhaust system per 7.5 hour run is 77.054 pounds times the capture efficiency of 70%, or 53.938 pounds.

18.952 lbs. ethanol volatilized (70%) = 13.266 lbs. ethanol captured

The mass of ethanol destroyed by the air control system is the amount of ethanol captured by the exhaust system (13.266 pounds) times the destruction efficiency (95%), or 12.603 pounds. The total mass of the five volatile components destroyed by the air control system is 53.938 pounds times the destruction efficiency of 95%, or 51.241 pounds.

13.266 lbs. ethanol captured (95%) = 12.603 lbs. ethanol destroyed

The mass of ethanol released as stack emissions per 7.5 hour run from the exhaust system is 5% of the mass of ethanol captured (13.266 pounds), or 0.663 pounds, which converts to 0.011 grams of ethanol emitted per second. The total mass of ink mixture that is released as stack emissions per 7.5 hour run is 2.697 pounds, or 0.045 grams of ink mixture emitted per second.

13.266 lbs. ethanol captured (5%) = 0.663 lbs. ethanol stack emissions

Appendix 3-D (Risk Chapter)
Environmental Air Release Data

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
Solvent-based Ink #S1 – Site 9B															
Alcohols	0.031	0.009	0.001	0.022	0.007	0.001	0.082	0.025	0.003	0.011	0.003	0.000	0.014	0.004	0.000
Alcohols	0.194	0.058	0.007	0.165	0.049	0.006	1.069	0.321	0.037				0.073	0.022	0.003
Alkyl acetates	0.103	0.031	0.004	0.118	0.035	0.004	0.219	0.066	0.008				0.063	0.019	0.002
Alkyl acetates	0.004	0.001	0.000				0.082	0.025	0.003						
Propylene glycol ethers				0.022	0.007	0.001				0.026	0.008	0.001	0.021	0.006	0.001
Alkyl acetates				0.022	0.007	0.001				0.042	0.013	0.001	0.010	0.003	0.000
Alcohols				0.329	0.099	0.011				0.384	0.115	0.013	0.353	0.106	0.012
Hydrocarbons - low molecular weight							0.945	0.284	0.033						
Additive: Propanol	*0.106*	*0.032*	*0.004*				*0.053*	*0.016*	*0.002*						
Additive: Propyl acetate										*0.025*	*0.007*	*0.001*			
Additive: Trade secret													*ND*[b]	*ND*	*ND*
Additive: Propylene glycol ether													*0.018*	*0.005*	*0.001*
Solvent-based Ink #S2 – Site 5															
Alcohols	0.574	0.172	0.020	0.550	0.165	0.019	1.112	0.334	0.039	0.768	0.230	0.027	0.519	0.156	0.018
Alkyl acetates	0.132	0.039	0.005	0.117	0.035	0.004	0.053	0.016	0.002	0.217	0.065	0.008	0.134	0.040	0.005
Hydrocarbons - low molecular weight	0.119	0.036	0.004	0.176	0.053	0.006	0.584	0.175	0.020	0.152	0.046	0.005	0.266	0.080	0.009
Alcohols	0.071	0.021	0.002	0.081	0.024	0.003	0.120	0.036	0.004	0.106	0.032	0.004	0.086	0.026	0.003
Hydrocarbons - low molecular weight	0.006	0.002	0.000	0.005	0.001	0.000	0.025	0.007	0.001	0.010	0.003	0.000	0.009	0.003	0.000
Alcohols	0.073	0.022	0.002	0.084	0.025	0.003				0.096	0.029	0.003	0.146	0.044	0.005

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
Solvent-based Ink #S2 – Site 7															
Alcohols	0.243	0.073	0.008	0.239	0.072	0.008	0.461	0.138	0.016	0.206	0.062	0.007	0.252	0.076	0.009
Alkyl acetates	0.218	0.065	0.008	0.203	0.061	0.007	0.263	0.079	0.009	0.191	0.057	0.007	0.223	0.067	0.008
Hydrocarbons - low molecular weight	0.092	0.027	0.003	0.100	0.030	0.003	0.378	0.113	0.013	0.062	0.019	0.002	0.166	0.050	0.006
Alcohols	0.055	0.016	0.002	0.046	0.014	0.002	0.078	0.023	0.003	0.043	0.013	0.001	0.091	0.027	0.003
Hydrocarbons - low molecular weight	0.005	0.001	0.000	0.002	0.001	0.000	0.016	0.005	0.001	0.004	0.001	0.000	0.006	0.002	0.000
Alcohols	0.609	0.183	0.021	0.627	0.188	0.022				0.497	0.149	0.017	0.644	0.193	0.022
Additive: Propanol							*1.029*	*0.309*	*0.036*						
Solvent-based Ink #S2 – Site 10															
Alcohols	0.197	0.059	0.007	0.244	0.073	0.008	0.407	0.122	0.014	0.199	0.060	0.007	0.208	0.062	0.007
Alkyl acetates	0.126	0.038	0.004	0.125	0.038	0.004	0.142	0.043	0.005	0.154	0.046	0.005	0.062	0.019	0.002
Hydrocarbons - low molecular weight	0.074	0.022	0.003	0.102	0.030	0.004	0.334	0.100	0.012	0.060	0.018	0.002	0.137	0.041	0.005
Alcohols	0.045	0.013	0.002	0.047	0.014	0.002	0.069	0.021	0.002	0.042	0.013	0.001	0.075	0.023	0.003
Hydrocarbons - low molecular weight	0.004	0.001	0.000	0.003	0.001	0.000	0.014	0.004	0.000	0.004	0.001	0.000	0.005	0.001	0.000
Alcohols	0.603	0.181	0.021	0.659	0.198	0.023				0.345	0.104	0.012	0.792	0.238	0.028
Additive: Propanol							*1.220*	*0.366*	*0.043*						
Additive: Propylene glycol monomethyl ether										*0.315*	*0.095*	*0.011*	*0.069*	*0.021*	*0.002*
Additive: 2-Methoxy-1-propanol										*0.006*	*0.002*	*0.000*	*0.001*	*0.000*	*0.000*

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
Water-based Ink #W1 – Site 4															
Amides or nitrogenous compounds	0.013	0.004	0.009	0.011	0.003	0.008	0.082	0.024	0.057	0.003	0.001	0.002	0.003	0.001	0.002
Alcohols	0.100	0.030	0.070	0.057	0.017	0.040	0.164	0.049	0.114	0.012	0.004	0.009			
Ethylene glycol ethers	0.032	0.009	0.022	0.019	0.008	0.013				0.022	0.007	0.016	0.023	0.007	0.016
Alcohols	0.005	0.001	0.004	0.003	0.001	0.002									
Hydrocarbons - high molecular weight	0.019	0.006	0.013	0.010	0.003	0.007									
Water-based Ink #W2 – Site 1															
Amides or nitrogenous compounds	0.002	0.000	0.001	0.003	0.001	0.002	0.092	0.028	0.065				0.002	0.001	0.002
Hydrocarbons - high molecular weight	0.001	0.000	0.001	0.002	0.001	0.001	0.015	0.005	0.011				0.001	0.000	0.000
Hydrocarbons - low molecular weight	0.001	0.000	0.000	0.001	0.000	0.001									
Alcohols							0.038	0.011	0.027						
Ethylene glycol ethers							0.038	0.011	0.027						
Additive: Isobutanol	*0.001*	*0.000*	*0.000*							*0.001*	*0.000*	*0.001*	*0.001*	*0.000*	*0.001*
Additive: Ethyl carbitol	*0.001*	*0.000*	*0.000*							*0.001*	*0.000*	*0.001*	*0.001*	*0.000*	*0.001*
Additive: Propanol	*0.043*	*0.013*	*0.030*				*0.009*	*0.003*	*0.007*						
Additive: Ammonia										*0.002*	*0.001*	*0.001*			

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
Water-based Ink #W3 – Site 2															
Amides or nitrogenous compounds	0.021	0.006	0.015	0.028	0.008	0.020	0.046	0.014	0.032	0.016	0.005	0.011	0.017	0.005	0.012
Propylene glycol ethers										0.002	0.001	0.002	0.003	0.001	0.002
Alcohols				0.013	0.004	0.009									
Ethylene glycol ethers				0.006	0.002	0.004									
Alcohols							0.013	0.004	0.009						
Additive: Ammonia	*0.002*	*0.000*	*0.001*	*0.001*	*0.000*	*0.001*	*0.002*	*0.000*	*0.001*	*0.002*	*0.001*	*0.001*	*0.002*	*0.001*	*0.001*
Additive: Propanol	*0.019*	*0.006*	*0.013*	*0.010*	*0.003*	*0.007*	*0.039*	*0.012*	*0.027*						
Additive: Other components	*ND*	*ND*	*ND*												
Water-based Ink #W3 – Site 3															
Amides or nitrogenous compounds	0.015	0.004	0.010	0.028	0.008	0.019	0.065	0.020	0.046	0.008	0.002	0.005	0.005	0.001	0.003
Propylene glycol ethers										0.001	0.000	0.009	0.001	0.000	0.001
Alcohols				0.012	0.004	0.009									
Ethylene glycol ethers				0.006	0.002	0.004									
Alcohols							0.018	0.005	0.013						
Additive: Ammonia	*0.012*	*0.004*	*0.009*				*0.020*	*0.006*	*0.014*	*0.002*	*0.001*	*0.002*	*0.002*	*0.001*	*0.001*
Additive: Propanol	*0.033*	*0.010*	*0.023*				*0.147*	*0.044*	*0.103*						
Additive: Extender							*ND*	*ND*	*ND*						
Additive: 2-Butoxyethanol													*0.001*	*0.000*	*0.001*

Chemical category (*additives in italics*)	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
Water-based Ink #W4 – Site 9A															
Alcohols	0.011	0.003	0.008	0.005	0.001	0.004	0.050	0.015	0.035	0.017	0.005	0.012	0.007	0.002	0.005
Amides or nitrogenous compounds	0.001	0.000	0.001	0.001	0.000	0.001	0.012	0.004	0.009	0.002	0.001	0.001	0.002	0.001	0.002
Hydrocarbons - high molecular weight	0.001	0.000	0.001	0.001	0.000	0.001	0.012	0.004	0.009	0.001	0.000	0.009	0.001	0.000	0.001
Amides or nitrogenous compounds	0.001	0.000	0.001	0.005	0.002	0.004				0.001	0.000	0.001	0.007	0.002	0.005
Alcohols				0.017	0.005	0.012	0.050	0.015	0.035				0.010	0.003	0.007
Propylene glycol ethers	0.011	0.003	0.008												
Propylene glycol ethers	0.011	0.003	0.008							0.017	0.005	0.012			
Amides or nitrogenous compounds				0.001	0.000	0.001	0.012	0.004	0.009						
Alcohols										0.005	0.001	0.003			
Additive: Ammonia	*0.002*	*0.000*	*0.001*	*0.001*	*0.000*	*0.001*				*0.002*	*0.000*	*0.001*	*0.001*	*0.000*	*0.000*
Additive: Propanol	*0.009*	*0.003*	*0.007*							*0.010*	*0.003*	*0.007*			
Additive: Ethyl carbitol										*ND*	*ND*	*ND*			
Additive: Petroleum distillate										*ND*	*ND*	*ND*			
UV-cured Ink #U1 – Site 11															
Amides or nitrogenous compounds	0.003	0.001	0.002	0.004	0.001	0.002	0.020	0.006	0.014	0.001	0.000	0.001	0.001	0.000	0.001
Aromatic esters	0.016	0.005	0.011	0.017	0.005	0.012	0.096	0.029	0.067	0.006	0.002	0.004	0.006	0.002	0.004
Additive: 1,6-Hexanediol diacrylate				*0.010*	*0.003*	*0.007*									
UV-cured Ink #U2 – Site 6															
Acrylated polyols	0.059	0.018	0.041	0.050	0.015	0.034	0.437	0.131	0.306	0.019	0.006	0.013	0.031	0.009	0.021
Acrylated polyols	0.042	0.013	0.029	0.014	0.004	0.010	0.177	0.053	0.124	0.021	0.006	0.015	0.024	0.007	0.017
Aromatic ketones	0.014	0.004	0.010	0.007	0.002	0.005	0.049	0.015	0.034	0.006	0.002	0.004	0.009	0.003	0.006

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Air releases per press (g/sec)														
	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases	Total amount volati-lized	Amount of fugitive releases	Amount of stack releases
UV-cured Ink #U3 – Site 8															
Aromatic esters	0.006	0.002	0.005	0.006	0.002	0.004	0.057	0.017	0.040	0.005	0.001	0.003	0.004	0.001	0.003
Amides or nitrogeneous compounds	0.001	0.000	0.001	0.001	0.000	0.001	0.012	0.004	0.009	0.001	0.000	0.001	0.001	0.000	0.001
Acrylated polyols	0.028	0.008	0.020	0.026	0.008	0.019				0.020	0.006	0.014	0.017	0.005	0.012

[a] Shaded areas indicate where data are not applicable (i.e., the chemical category was not found in the particular color and formulation). If a chemical was found in a formulation, but resulted in zero air releases, then the chemical category was not included in the table for that formulation.
[b] No data or information available.

Appendix 3-E (Risk Chapter)
Supplemental Occupational Exposure Assessment Methodology

Scenario I

The mass balance calculations for Scenario I were conducted as follows for each chemical with a vapor pressure less than 35 mmHg at 25ºC (using the open surface model and the Fehrenbacher and Hummel vapor generation rate)[1]:

- All concentrations were converted from weight percent to mole percent.

- The diffusivity of each chemical in the formulation was calculated using the following equation:

  $$D_{ab} = (4.09 \times 10^{-5} T^{1.9} (1/29+1/M)^{0.5} M^{-0.33}) / P_t$$

  where:

D_{ab}	=	Diffusivity, cm^2/sec
T	=	Temperature, K
M	=	Molecular weight, g/g-mole
P_t	=	Total pressure, atm

- The vapor generation rate of each chemical in the formulation was calculated using the following equation (Fehrenbacher and Hummel vapor generation rate):

  $$G_i = (0.02 M X_i P_i^* (D_{ab} v_z/(Pi) z)^{0.5}) / (RT)$$

  where:

G_i	=	Vapor generation rate of substance i, g/m^2-sec
M	=	Molecular weight, g/g-mole
X_i	=	Mole fraction of substance i in solution, dimensionless
P_i^*	=	Vapor pressure of pure substance i, mmHg at 25ºC
D_{ab}	=	Diffusivity, cm^2/sec
v_z	=	Air velocity above can, m/sec
Pi	=	The constant pi, 3.14159
z	=	Pool length in direction of air flow, m
R	=	Gas constant, 0.0624 mmHg-m^3/mol-K
T	=	Temperature, K

- Using the assumptions presented in Section 3.5, the potential inhalation dose rate of each chemical in the formulation was estimated using the following equation:

  $I = 0.21G_iAt$

  where:

I	=	Total amount of substance inhaled, mg/day
G_i	=	Vapor generation rate of substance i, g/m^2-sec
A	=	Surface area of liquid/air interface, m^2
t	=	Duration of exposure, sec/day

The mass balance calculations for Scenario I were conducted for each chemical with a vapor pressure greater than or equal to 35 mmHg at 25°C (using the open surface model and the Engel and Reilly vapor generation rate)[2]:

- All concentrations were converted from weight percent to mole percent.

- The "generalized" Schmidt number was calculated using the following equation:

  $Sc = (2.94T^{-0.9}+0.0329T^{0.1})M^{0.33} / (1/28.9+1/M)^{0.5}$

  where:

Sc	=	Schmidt number, dimensionless
T	=	Temperature, K
M	=	Molecular weight, g/g-mole

- The vapor generation rate of each chemical in the formulation was calculated using the following equation (Engel and Reilly vapor generation rate):

  $G_i' = (2.1 \text{ x } 10^{-7}MX_iP_i^*Av_z^{0.78}) / (z^{0.11}Sc^{0.67}T)$

  where:

G_i'	=	Vapor generation rate of substance i, g/sec (Note: the units of the Fehrenbacher and Hummel vapor generation rate, G_i, are g/m^2-sec, the units of the Engel and Reilly vapor generation rate, G_i', are g/sec)
M	=	Molecular weight, g/g-mole
X_i	=	Mole fraction of substance i in solution, dimensionless
P_i^*	=	Vapor pressure of pure substance i, mmHg at 25°C
A	=	Surface area of liquid/air interface, cm^2
v_z	=	Air velocity above can, ft/min
z	=	Pool length in direction of air flow, cm
Sc	=	Schmidt number, dimensionless
T	=	Temperature, K

- Using the assumptions presented in Section 3.5, the potential inhalation dose rate of each chemical in the formulation was estimated using the following equation:

$I = 0.21G_i't$

where:

I	=	Total amount of substance inhaled, mg/day
G_i'	=	Vapor generation rate of substance i, g/sec
t	=	Duration of exposure, sec/day

Scenario II

The mass balance calculations for Scenario II were conducted for each formulation (printing room mass balance model):

- The concentration of each chemical in the printing room was calculated using the following equation:

$C_v = (1.7x10^5TG_iA) / (MQk)$

where:

C_v	=	Airborne concentration, ppm
T	=	Ambient temperature, K
G_i	=	Vapor generation rate of substance i, g/m^2-sec
A	=	Surface area of liquid/air interface, m^2
M	=	Molecular weight, g/g-mole
Q	=	Ventilation rate, ft^3/min
k	=	Mixing factor, dimensionless

It was assumed that G_iA equals the fugitive emission rate.

- The volume-based concentrations calculated above were converted to mass-based concentrations using the equation:

$C_m = C_vM/V$

where:

C_m	=	Airborne concentration, mg/m^3
C_v	=	Airborne concentration, ppm
M	=	Molecular weight, g/g-mole
V	=	Molar volume of ideal gas at 25ºC and 760 mmHg, L/mole

- Calculate the potential inhalation dose rate of each chemical in the formulation using the following equation:

$$I = bC_m t$$

where:

I	=	Total amount of substance inhaled, mg/day
b	=	Worker inhalation rate, m^3/hour
C_m	=	Airborne concentration, mg/m^3
t	=	Duration of exposure, hour/day

Assumptions — Occupational Exposure Assessment Methodology

Additional assumptions associated with the Fehrenbacher and Hummel vapor generation rate are listed below:

- The surface temperature of the liquid and the evaporation rate are constant.
- The heat of evaporation is provided by the surroundings.
- Diffusion at the edge of the pool and in the direction of the air stream is negligible.
- The air velocity is constant and flowing in only one direction.
- There is no mixing in the area above the pool of liquid.
- There is no local exhaust present.
- There are no physical barriers present at the edges of the pool.
- There are no effects from heat transfer.
- The incoming air flowing over the pool of liquid is free of the contaminant of concern.

Sample Calculation of Occupational Exposures

Following the method outlined above, occupational exposures for each chemical in the ink formulations were calculated. Applying this methodology to the example data presented in Table [3.10] results in the data presented in Table 3-E, below.

Table 3-E Example Data for a Flexographic Printing Solvent-Based Formulation [a]

Chemical component	Weight percent	Vapor pressure (mmHg at 25°C)	Scenario I (mg/day, typical)	Scenario II (mg/day, typical)
Ethanol	19.8%	59.03	6.2	530
Pigment	14.6%	$<10^{-6}$	0	0
Propyl acetate	10.0%	33.7	2.8	270
Propanol	43.3%	21	8.4	1,200
Nitrocellulose	2.7%	$<10^{-6}$	0	0
Resin	2.2%	$2x10^{-4}$	0	0
Glycol ether	1.3%	10.2	0.11	35
Extender	6.1%	0.001	$4.3x10^{-5}$	160

[a] The solvent-based formulation presented above is a fictional formulation.

Stepping through the calculations for ethanol:

Scenario I:

Ethanol has a vapor pressure greater than 35 mmHg at 25°C, so the open surface model and the Engel and Reilly vapor generation rate were used to estimate the worker exposure in Scenario I.

- $Sc = (2.94T^{-0.9}+0.0329T^{0.1})M^{0.33} / (1/28.9+1/M)^{0.5}$

where:

T = 298 K (Table [3.11])
M = 50 g/g-mole (Table [3.10])

Therefore:

$Sc = (2.94(298)^{-0.9}+0.0329(298)^{0.1})50^{0.33} / (1/28.9+1/50)^{0.5}$
$Sc = 1.18$

- $G_i' = (2.1 \times 10^{-7}MPAv_z^{0.78}) / (z^{0.11}Sc^{0.67}T)$

where:

M = 50 g/g-mole (Table [3.10])
X_i = 0.305 (Table [3.10])
P_i^* = 59.03 mmHg at 25°C (Table [3.10])
$A = [Pi\ (z/2)^2] = [3.14159(30.48/2)^2]\ cm^2 = 729.659\ cm^2$
(calculated from the diameter given below (z=0.3048m))
v_z= 100 ft/min (Table [3.11])
z = 1ft = 30.48 cm (Table [3.11])
Sc = 1.18 (calculated above)
T = 298 K (Table [3.11])

Therefore:

$G_i' = [2.1 \times 10^{-7}(50)(0.305)(59.03)(729.659)(100^{0.78})] / [(30.48^{0.11})(1.18^{0.67})(298)]$
$G_i' = 0.0103$ g/sec

- $I = 0.21G_i't$

where:

G_i' = 0.0103 g/sec (calculated above)
t = 48 min/day = 2,880 sec/day (Table [3.11])

Therefore:

$I = 0.21\ (0.0103)(2{,}880)$
$I = 6.23$ mg/day

Scenario II:

- $C_v = (1.7x10^5 TG_iA) / (MQk)$

where:

T = 298 K (Table [3.11])
$G_i A$= fugitive emission rate = 0.096 g/sec (Table [D.1])
M = 50 g/g-mole (Table [3.10])
Q = 7,000 ft^3/min (Table [3.11])
k = 0.5 (Table [3.11])

Therefore:

$C_v = [1.7x10^5(298)(0.096)] / [(50)(7{,}000)(0.5)]$
$C_v = 27.7$ ppm

- $C_m = C_vM/V$

where:

C_v = 27.7 ppm (calculated above)
M = 50 g/g-mole (Table [3.10])
V = 24.45 L/mole (molar volume of an ideal gas)

Therefore:

$C_m = [(27.7)(50)]/(24.45)$
$C_m = 56.7$ mg/m^3

- $I = bC_mt$

where:

b = 1.25 m^3/hour (medium work inhalation rate [3])
C_m = 56.7 mg/m^3 (calculated above)
t = 7.5 hours/day (Table [4.1])

Therefore:

$I = (1.25)(56.7)(7.5)$
$I = 531$ mg/day

Ethanol has a vapor pressure greater than 35 mmHg at 25°C; therefore, the Engel and Reilly vapor generation rate was used for Scenario I. Propyl alcohol has a vapor pressure less than 35 mmHg at 25°C; therefore, the Fehrenbacher and Hummel vapor generation rate was used for Scenario I. These calculations are shown below:

Scenario I:

- $D_{ab} = (4.09 \times 10^{-5} T^{1.9} (1/29+1/M)^{0.5} M^{-0.33}) / P_t$

where:

T= 298 K (Table [3.11])
M= 60 g/g-mole (Table [3.10])
P_t= 1 atm (standard pressure)

Therefore:

$D_{ab} = (4.09 \times 10^{-5}(298)^{1.9} (1/29+1/60)^{0.5} 60^{-0.33}) / 1$
$D_{ab} = 0.120\ cm^2/sec$

- $G_i = \{0.02 M X_i P_i^* [D_{ab} v_z/((Pi)z)]^{0.5}\} / RT$

where:

M= 60 g/g-mole (Table [3.10])
X_i= 0.555 (Table [3.10])
P_i^*= 21 mmHg at 25°C (Table [3.10])
D_{ab}= 0.120 cm^2/sec (calculated above)
v_z 100 ft/min = 0.508 m/sec (Table [3.11])
Pi= The constant Pi, 3.14159
z= 1 ft = 0.3048 m (Table [3.11])
R= 0.0624 mmHg-m^3/mol-K (gas constant)
T= 298 K (Table [3.11])

Therefore:

$G_i = \{0.02(60)(0.555)(21)[(0.120)(0.508)/((3.14159)(0.3048))]^{0.5}\}/[(0.0624)(298)]$
$G_i = 0.190\ g/m^2\text{-}sec$

- $I = 0.21 G_i A t$

where:

G_i = 0.190 g/m^2-sec (calculated above)
A = 0.0730 m^2 (calculated from the diameter given above (z=0.3048m))
t = 48 min/day = 2,880 sec/day (Table [3.11])

Therefore:

$$I = 0.21\ (0.190)(0.0730)(2{,}880)$$
$$I = 8.39\ \text{mg/day}$$

REFERENCES

1. Fehrenbacher, M.C. and A.A. Hummel. "Evaluation of the Mass Balance Model Used by EPA for Estimating Inhalation Exposure to New Chemical Substances," American Industrial Hygiene Association, submitted for publication.

2. Engel, A.J. and B. Reilly. *Evaporation of Pure Liquids from Open Surfaces.* U.S. Environmental Protection Agency, Pre-Publication Draft.

3. Chemical Engineering Branch (CEB). *Manual for the Preparation of Engineering Assessments*, U.S. Environmental Protection Agency, February, 1991.

Appendix 3-F (Risk Chapter)
Occupational Exposure Data

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a]

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Solvent-based Ink #S1 – Site 9B															
Alcohols	204	62	186	146	35	106	547	21	63	71	21	63	92	26	79
Polyol derivatives	0	83	248	0	71	212	0	11	32	0	53	158	0	49	148
Resins	0	72	217	0	26	79	0	74	221	0	95	285	0	61	182
Water	0	4	12	0	4	13	0	2	6	0	2	6	0	2	6
Alcohols	1,293	392	1,177	1,096	265	794	7,116	273	820				490	141	424
Alkyl acetates	687	208	625	785	189	568	1,457	56	168				420	121	363
Resins	0	7	22	0	9	26				0	8	25	0	5	14
Pigments - organometallic	0	83	248	0	35	106				0	169	506			
Alcohols				2,190	529	1,586				2,561	766	2,297	2,349	678	2,033
Alkyl acetates				146	35	106				282	84	253	70	20	61
Propylene glycol ethers				146	35	106				176	53	158	140	40	121
Resins	0	72	217				0	116	347						
Organotitanium compounds	0	10	31				0	6	19						
Alkyl acetates	24	7	22				547	21	63						
Organic acids or salts	0	1	3				0	2	6						
Pigments - organometallic	0	52	155												
Aromatic esters	0	31	93												
Organic acids or salts	0	1	3												
Inorganics				0	4	13									
Pigments - organic				0	62	185									
Pigments - inorganic							0	452	1,357						
Hydrocarbons - low molecular weight							6,295	242	726						
Hydrocarbons - high molecular weight							0	11	32						
Inorganics													0	20	61
Pigments - organometallic													0	61	182
Pigments - organometallic													0	7	20
Additive: Propanol	*706*	*214*	*642*				*353*	*14*	*41*						

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category ***(additives in italics)***	**Blue**			**Green**			**White**			**Cyan**			**Magenta**		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Additive: Propyl acetate										*164*	*49*	*147*			
Additive: Propylene glycol propyl ether													*119*	*34*	*103*
Additive: Trade secret													*ND* [b]	*ND*	*ND*
Solvent-based Ink #S2 – Site 5															
Alcohols	3,825	486	1,457	3,664	413	1,239	7,410	309	928	5,113	444	1,333	3,459	387	1,160
Alkyl acetates	877	111	334	777	88	263	351	15	44	1,442	125	376	892	100	299
Hydrocarbons - low molecular weight	790	100	301	1,172	132	396	3,889	162	487	1,016	88	265	1,771	198	594
Alcohols	475	60	181	540	61	183	800	33	100	707	61	184	975	109	327
Resins	0	267	801	0	279	838	0	266	798	0	286	858	0	193	580
Hydrocarbons - low molecular weight	40	5	15	31	3	10	166	7	21	64	6	17	63	7	21
Siloxanes	0	10	31	0	11	34	0	12	35	0	11	34	0	12	35
Amides or nitrogeneous compounds	0	10	31	0	11	34	0	12	35	0	11	34	0	12	35
Organic acids or salts	0	10	31	0	11	34	0	12	35	0	11	34	0	12	35
Alcohols	484	61	184	561	63	190				643	56	168	576	64	193
Polyol derivatives	0	38	114	0	22	66				0	38	114	0	30	91
Amides or nitrogeneous compounds	0	10	31	0	11	34				0	11	34	0	12	35
Organophosphorous compounds	0	10	31	0	11	34				0	11	34	0	12	35
Pigments - organometallic	0	77	230	0	21	62				0	140	419			
Pigments - inorganic				0	94	283	0	472	1,417						
Pigments - organometallic	0	43	129												
Pigments - organic				0	46	138									
Pigments - organometallic				0	20	60									
Pigments - inorganic													0	152	457

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category (*additives in italics*)	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.
Solvent-based Ink #S2 – Site 7															
Alcohols	1,619	191	573	1,591	191	574	3,073	149	447	1,373	195	586	1,677	188	563
Alkyl acetates	1,449	171	513	1,350	162	487	1,749	85	255	1,273	181	543	1,485	166	498
Hydrocarbons - low molecular weight	610	72	216	663	80	239	2,519	122	366	416	59	177	1,103	123	370
Alcohols	367	43	130	305	37	110	518	25	75	289	41	124	607	68	204
Resins	0	192	575	0	169	506	0	200	600	0	192	575	0	120	361
Hydrocarbons - low molecular weight	31	4	11	17	2	6	107	5	16	26	4	11	39	4	13
Siloxanes	0	7	22	0	7	21	0	9	26	0	7	22	0	7	22
Amides or nitrogeneous compounds	0	7	22	0	7	21	0	9	26	0	7	22	0	7	22
Organic acids or salts	0	7	22	0	7	21	0	9	26	0	7	22	0	7	22
Alcohols	4,053	478	1,434	4,173	502	1,506				3,312	471	1,414	4,290	480	1,439
Polyol derivatives	0	27	81	0	13	40				0	25	76	0	19	57
Amides or nitrogeneous compounds	0	7	22	0	7	21				0	7	22	0	7	22
Organophosphorous compounds	0	7	22	0	7	21				0	7	22	0	7	22
Pigments - organometallic	0	55	165	0	12	37				0	94	281			
Pigments - inorganic				0	57	171	0	355	1,066						
Pigments - organometallic	0	31	93												
Pigments - organic				0	28	83									
Pigments - organometallic				0	12	36									
Pigments - inorganic													0	95	285
Additive: Propanol							*6,855*	*332*	*997*						

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.
Solvent-based Ink #S2 – Site 10															
Alcohols	1,310	183	548	1,624	199	597	2,712	140	421	1,324	175	524	1,386	164	492
Alkyl acetates	838	117	350	835	102	307	945	49	147	1,028	135	406	415	49	147
Hydrocarbons - low molecular weight	494	69	206	677	83	249	2,223	115	345	401	53	159	911	108	323
Alcohols	297	41	124	312	38	115	457	24	71	279	37	110	502	59	178
Resins	0	183	550	0	175	525	0	188	565	0	171	514	0	105	316
Hydrocarbons - low molecular weight	25	4	11	18	2	6	95	5	15	25	3	10	32	4	11
Siloxanes	0	7	21	0	7	22	0	8	24	0	7	20	0	6	19
Amides or nitrogeneous compounds	0	7	21	0	7	22	0	8	24	0	7	20	0	6	19
Organic acids or salts	0	7	21	0	7	22	0	8	24	0	7	20	0	6	19
Alcohols	4,019	560	1,681	4,387	537	1,612				2,301	303	910	5,274	624	1,871
Polyol derivatives	0	26	78	0	14	41				0	23	68	0	17	50
Amides or nitrogeneous compounds	0	7	21	0	7	22				0	7	20	0	6	19
Organophosphorous compounds	0	7	21	0	7	22				0	7	20	0	6	19
Pigments - organometallic	0	53	158	0	13	39				0	84	251			
Pigments - inorganic				0	59	177	0	334	1,003						
Pigments - organometallic	0	29	88												
Pigments - organic				0	29	86									
Pigments - organometallic				0	13	38									
Pigments - inorganic													0	83	249
Additive: Propanol							*8,128*	*420*	*1,261*						
Additive: Propylene glycol methyl ether										*2,099*	*277*	*830*	*463*	*55*	*164*
Additive: 2-Methoxy-1-propanol										*43*	*6*	*17*	*9*	*1*	*3*

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room)[a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W1 – Site 4															
Water	0	342	1,025	0	438	1,314	0	265	795	0	567	1,700	0	603	1,809
Amides or nitrogenous compounds	86	19	56	73	19	57	545	27	82	22	10	29	24	10	31
Alcohols	668	146	437	383	99	298	1,089	55	164	81	36	107			
Acrylic acid polymers	0	522	1,566	0	371	1,113				0	39	118	0	39	118
Acrylic acid polymers	0	21	64	0	39	116				0	36	107	0	38	115
Ethylene glycol ethers	212	46	139	127	33	99				149	66	197	154	66	199
Resins	0	35	105	0	35	106	0	105	314						
Acrylic acid polymers							0	311	933	0	267	801	0	269	806
Organic acids or salts							0	37	112	0	49	147	0	36	107
Alcohols	34	8	23	20	5	15									
Hydrocarbons - high molecular weight	126	28	83	68	18	53									
Pigments - organometallic	0	108	325							0	223	670			
Pigments - organic	0	26	77												
Pigments - organometallic				0	195	585									
Pigments - organic				0	47	142									
Pigments - inorganic							0	467	1,400						
Ethylene glycol ethers										0	8	25			
Pigments - organic													0	239	716
Additive: Ethoxylated tetramethyldecyndiol							*0*	*33*	*100*						

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W2 – Site 1															
Water	0	687	2,062	0	731	2,192	0	463	1,390	0	686	2,057	0	523	1,569
Acrylic acid polymers	0	64	192	0	101	302	0	355	1,066				0	188	564
Amides or nitrogenous compounds	11	3	8	21	7	21	616	34	102				16	20	60
Hydrocarbons - high molecular weight	10	3	8	13	4	13	102	6	17				4	5	15
Ethylene glycol ethers	0	25	75	0	45	134				0	36	108	0	50	150
Resins	0	98	294	0	60	181				0	180	541			
Ethylene glycol ethers	0	4	12	0	6	18							0	11	34
Resins	0	125	376	0	223	670							0	251	752
Hydrocarbons - low molecular weight	5	1	4	7	2	7							2	2	7
Pigments - organometallic	0	147	441							0	361	1,082			
Pigments - organic	0	28	85										0	226	679
Hydrocarbons - high molecular weight	2	1	2												
Inorganics	0	5	16												
Pigments - organic	0	37	111												
Pigments - organic				0	121	362									
Pigments-inorganic							0	410	1,231						
Alcohols							256	14	42						
Ethylene glycol ethers							256	14	42						
Additive: Isobutanol	*4*	*1*	*3*							*9*	*11*	*33*	*9*	*11*	*34*
Additive: Ethyl carbitol	*4*	*1*	*3*							*9*	*11*	*33*	*9*	*11*	*34*
Additive: Propanol	*284*	*70*	*209*				*63*	*3*	*10*						
Additive: Ammonia										*13*	*15*	*45*			

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W3 – Site 2															
Water	0	952	2,855	0	831	2,492	0	618	1,853	0	750	2,251	0	884	2,653
Acrylic acid polymers	0	131	393	0	183	548	0	187	561	0	299	896	0	202	606
Amides or nitrogenous compounds	140	21	63	187	28	85	307	19	56	108	38	113	115	26	78
Acrylic acid polymers	0	45	135	0	85	255	0	64	193	0	65	195	0	75	224
Olefin polymers	0	6	17	0	8	24	0	10	31	0	16	48	0	11	32
Siloxanes	0	6	19	0	5	16	0	8	25	0	11	34	0	9	27
Organic acids or salts	0	1	3	0	2	5	0	2	6	0	2	7	0	2	5
Ethylene glycol ethers	0	9	26				0	13	40	0	14	41	0	11	32
Propylene glycol ethers										16	6	17	18	4	12
Alcohols										0	5	14	0	1	2
Pigments - organic	0	98	294												
Alcohols				86	13	39									
Ethylene glycol ethers				42	6	19									
Pigments - organic				0	28	84									
Pigments - organometallic				0	99	298									
Pigments - inorganic							0	357	1,072						
Alcohols							85	5	15						
Pigments - organometallic										0	90	270			
Pigments - organometallic													0	71	214
Additive: Ammonia	*10*	*2*	*5*	*6*	*1*	*3*	*11*	*1*	*2*	*13*	*5*	*14*	*13*	*3*	*9*
Additive: Propanol	*129*	*19*	*58*	*68*	*10*	*31*	*258*	*16*	*47*				*3*	*1*	*2*
Additive: Isopropanol	*2*	*0*	*1*	*ND*	*ND*	*ND*	*3*	*0*	*1*				*2*	*0*	*1*
Additive: Polyfunctional aziridine	*0*	*5*	*16*												
Additive: Other components	*ND*	*ND*	*ND*												

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W3 – Site 3															
Water	0	782	2,345	0	644	1,932	0	503	1,508	0	715	2,145	0	720	2,161
Acrylic acid polymers	0	178	535	0	262	785	0	197	592	0	315	944	0	274	822
Amides or nitrogenous compounds	99	28	85	185	40	121	435	19	58	52	40	119	33	35	105
Acrylic acid polymers	0	61	184	0	122	365	0	68	204	0	68	205	0	102	305
Olefin polymers	0	8	23	0	12	35	0	11	32	0	17	50	0	15	44
Siloxanes	0	9	26	0	8	23	0	9	26	0	12	36	0	12	37
Organic acids or salts	0	1	4	0	3	8	0	2	6	0	2	7	0	2	7
Ethylene glycol ethers	0	12	35				0	14	42	0	14	43	0	15	44
Propylene glycol ethers										8	6	18	5	6	17
Alcohols										0	5	14	0	1	3
Pigments - organic	0	134	401												
Alcohols				83	18	54									
Ethylene glycol ethers				42	9	27									
Pigments - organic				0	40	121									
Pigments - organometallic				0	143	428									
Pigments-inorganic							0	377	1,132						
Alcohols							121	5	16						
Pigments - organometallic										0	95	285			
Pigments - organometallic													0	97	291
Additive: Ammonia	*83*	*24*	*71*	*2*	*0*	*1*	*135*	*6*	*18*	*14*	*11*	*33*	*14*	*15*	*45*
Additive: Propanol	*221*	*63*	*190*				*977*	*44*	*131*						
Additive: Extenders							*ND*	*ND*	*ND*						
Additive: 2-Butoxyethanol													*6*	*6*	*19*

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category (*additives in italics*)	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W4 – Site 9A															
Water	0	678	2,035	0	527	1,582	0	395	1,185	0	659	1,978	0	728	2,185
Alcohols	73	42	125	34	20	61	335	24	73	117	58	174	48	36	107
Amides or nitrogenous compounds	9	5	16	9	5	15	84	6	18	14	7	21	16	12	36
Hydrocarbons - high molecular weight	9	5	16	9	5	15	84	6	18	8	4	13	8	6	18
Siloxanes	0	5	16	0	5	15	0	6	18	0	4	13	0	6	18
Alcohols	0	5	16	0	5	15	0	6	18	0	4	13	0	6	18
Acrylic acid polymers	0	130	390	0	127	381	0	152	456	0	105	314			
Amides or nitrogenous compounds	10	6	18	34	20	61				8	4	13	48	36	107
Resins	0	78	234	0	76	229				0	63	189			
Pigments - organometallic	0	182	545	0	20	61				0	147	440			
Alcohols				111	66	199	335	24	73				70	51	154
Propylene glycol ethers	73	42	125							0	60	180			
Propylene glycol ethers	73	42	125							110	55	164			
Pigments - inorganic				0	356	1,068	0	632	1,895						
Amides or nitrogenous compounds				9	5	15	84	6	18						
Pigments - organometallic	0	42	125												
Pigments - organic				0	36	107									
Pigments - organometallic				0	20	61									
Inorganics							0	43	128						
Alcohols										34	17	50			
Pigments - organometallic													0	208	624

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Resins													0	208	624
Additive: Ammonia	*10*	*6*	*18*	*8*	*5*	*14*				*12*	*6*	*18*	*4*	*3*	*8*
Additive: Propanol	*59*	*34*	*101*							*70*	*35*	*104*			
Additive: Solids										*0*	*71*	*214*			
Additive: Ethyl carbitol										*ND*	*ND*	*ND*			
Additive: Petroleum distillate										*ND*	*ND*	*ND*			
UV-cured Ink #U1 – Site 11															
Acrylated polymers	0	209	626	0	204	612	0	125	375	0	209	626	0	209	626
Amides or nitrogenous compounds	22	10	31	24	10	31	137	9	26	8	10	31	8	10	31
Aromatic esters	105	49	146	113	48	143	638	40	119	39	49	146	38	49	146
Aromatic ketones	0	28	83	0	27	82	0	9	26	0	28	83	0	28	83
Olefin polymers	0	10	31	0	10	31	0	9	26	0	10	31	0	10	31
Siloxanes	0	10	31	0	10	31	0	9	26	0	10	31	0	10	31
Acrylated polymers	0	765	2,294	0	748	2,245				0	765	2,294	0	765	2,294
Aromatic ketones	0	10	31	0	10	31				0	10	31	0	10	31
Pigments - organic	0	209	626												
Pigments - organometallic				0	204	612									
Pigments - inorganic							0	454	1,362						
Acrylated polymers							0	284	852						
Acrylated polymers							0	170	511						
Pigments - inorganic							0	170	511						
Organophosphorous compounds							0	23	68						
Pigments - organometallic										0	209	626			
Pigments - organometallic													0	209	626
Additive: 1,6-Hexanediol diacrylate				*66*	*28*	*83*									

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category (*additives in italics*)	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
UV-cured Ink #U2 – Site 6															
Acrylated polymers	0	347	1,041	0	280	839	0	91	274	0	369	1,108	0	225	675
Acrylated polyols	392	163	490	327	259	778	2,910	321	963	124	125	375	205	132	396
Acrylated polyols	281	117	351	92	73	218	1,181	130	391	141	142	425	161	104	312
Acrylated polyols	0	19	56	0	50	151	0	80	241	0	3	8	0	36	107
Alcohols	0	13	39	0	13	39	0	13	39	0	13	39	0	13	39
Aromatic ketones	0	39	117	0	39	117	0	39	117	0	39	116	0	39	117
Aromatic ketones	94	39	117	49	39	117	325	36	108	38	39	116	60	39	117
Aromatic ketones	0	39	117	0	39	117	0	20	59	0	39	116	0	39	117
Aromatic ketones	0	13	39	0	13	39	0	3	8	0	13	39	0	13	39
Olefin polymers	0	13	39	0	13	39	0	13	39	0	13	39	0	13	39
Acrylated polymers	0	147	441	0	160	479				0	141	424	0	191	573
Polyol derivatives	0	100	299	0	92	275				0	104	311	0	142	425
Acrylated polymers	0	60	179	0	55	165				0	62	187	0	104	312
Pigments - organometallic	0	136	408							0	200	599			
Pigments - organic	0	55	166												
Pigments - organometallic				0	136	407									
Pigments - organic				0	40	120									
Pigments - inorganic							0	521	1,564						
Organophosphorous compounds							0	33	98						
Pigments - organometallic													0	211	632

Table 3-F.1 Occupational Exposure Results, Scenario II (Press Room) [a] (continued)

Chemical category *(additives in italics)*	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
UV-cured Ink #U3 – Site 8															
Acrylated polymers	0	765	2,294	0	765	2,294	0	419	1,258	0	765	2,294	0	765	2,294
Aromatic esters	44	49	146	41	49	146	380	42	126	32	49	146	26	49	146
Amides or nitrogeneous compounds	9	10	31	9	10	31	81	9	27	7	10	31	6	10	31
Siloxanes	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Olefin polymers	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Aromatic ketones	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Acrylated polyols	187	209	626	177	209	626				136	209	626	111	209	626
Aromatic ketones	0	28	83	0	28	83				0	28	83	0	28	83
Pigments - organic	0	209	626												
Pigments - organometallic				0	209	626									
Pigments - inorganic							0	509	1,528						
Acrylated polymers							0	180	539						
Acrylated polymers							0	90	270						
Organophosphorous compounds							0	24	72						
Pigments - organic										0	209	626			
Pigments - organometallic													0	209	626

[a] Shaded areas indicate where data are not applicable (i.e., the chemical category was not found in the particular color and formulation).
[b] No data or information available.

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a]

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Solvent-based Ink #S1															
Alcohols	2	78	234	1	52	156	0	21	64	1	26	78	1	39	117
Polyol derivatives	0	104	312	0	104	312	0	11	32	0	65	195	0	65	195
Resins	0	91	273	0	39	117	0	75	224	0	117	351	0	117	351
Water	0	5	16	0	7	20	0	2	6	0	3	8	0	4	12
Alcohols	13	494	1,482	9	390	1,170	7	277	831				7	273	819
Alkyl acetates	4	195	585	3	156	468	1	53	160				2	104	312
Resins	0	9	27	0	13	39				0	10	31	0	9	27
Pigments-organometallic	0	104	312	0	52	156				0	208	624			
Alcohols				4	286	858				12	702	2,106	6	403	1,209
Alkyl acetates				0	52	156				1	104	312	0	39	117
Propylene glycol ethers				0	52	156				0	65	195	0	78	234
Resins	0	91	273				0	117	352						
Organotitanium compounds	0	13	39				0	6	19						
Alkyl acetates	0	9	27				1	21	64						
Organic acids or salts	0	1	4				0	2	6						
Pigments-organometallic	0	65	195												
Aromatic esters	0	39	117												
Organic acids or salts	0	1	4												
Inorganics				0	7	20									
Pigments-organic				0	91	273									
Pigments-inorganic															
Hydrocarbons - low molecular weight							30	245	735						
Hydrocarbons - high molecular weight							0	11	32						
Inorganics													0	39	117
Pigments-organometallic													0	117	351
Pigments-organometallic													0	13	39

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room)[a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Solvent-based Ink #S2															
Alcohols	11	328	983	10	345	1,036	6	219	657	11	335	1,006	10	325	975
Alkyl acetates	3	107	321	2	84	252	0	3	8	3	125	374	2	97	292
Hydrocarbons - low molecular weight	2	123	370	3	144	432	3	180	539	2	101	304	4	214	641
Alcohols	2	74	223	2	66	199	1	37	111	2	71	212	3	118	353
Resins	0	329	986	0	304	913	0	294	882	0	329	987	0	209	626
Hydrocarbons - low molecular weight	1	6	19	1	4	11	1	8	23	1	6	19	1	8	23
Siloxanes	0	13	38	0	13	38	0	13	38	0	13	39	0	13	38
Amides or nitrogeneous compounds	0	13	38	0	13	38	0	13	38	0	13	39	0	13	38
Organic acids or salts	0	13	38	0	13	38	0	13	38	0	13	39	0	13	38
Alcohols	1	76	227	1	69	207				1	64	193	1	70	209
Polyol derivatives	0	47	140	0	24	71				0	44	131	0	33	99
Amides or nitrogeneous compounds	0	13	38	0	13	38				0	13	39	0	13	38
Organophosphorous compounds	0	13	38	0	13	38				0	13	39	0	13	38
Pigments-organometallic	0	94	283	0	23	68				0	161	482			
Pigments-inorganic				0	103	308	0	522	1,566						
Pigments-organometallic	0	53	159												
Pigments-organic				0	50	150									
Pigments-organometallic				0	22	66									
Pigments-inorganic													0	164	493

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W1															
Water	0	326	979	0	424	1,273	0	254	761	0	551	1,652	0	588	1,765
Amides or nitrogenous compounds	15	20	59	12	19	58	22	29	86	5	10	29	5	10	31
Alcohols	1	130	390	1	94	281	1	57	172	0	37	110			
Acrylic acid polymers	0	542	1,626	0	381	1,142				0	40	121	0	40	121
Acrylic acid polymers	0	22	66	0	40	119				0	37	110	0	39	117
Ethylene glycol ethers	0	48	144	0	34	101				0	67	201	0	68	203
Resins	0	36	109	0	36	109	0	109	328						
Acrylic acid polymers							0	325	975	0	273	818	0	274	823
Organic acids or salts							0	39	117	0	50	150	0	36	109
Alcohols	0	8	23	0	5	16									
Hydrocarbons-high molecular weight	0	29	86	0	18	55									
Pigments-organometallic	0	112	337							0	228	685			
Pigments-organic	0	27	80												
Pigments-organometallic				0	200	600									
Pigments-organic				0	49	146									
Pigments-inorganic							0	488	1,463						
Ethylene glycol ethers										0	9	26			
Pigments-organic													0	244	731

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W2															
Water	0	721	2,162	0	666	1,999	0	455	1,365	0	706	2,117	0	539	1,617
Acrylic acid polymers	0	48	144	0	112	337	0	371	1,113				0	194	581
Amides or nitrogenous compounds	1	3	8	3	5	14	7	10	31				3	5	14
Hydrocarbons-high molecular weight	0	3	8	0	5	15	0	6	18				0	5	15
Ethylene glycol ethers	0	26	79	0	50	150				0	37	111	0	52	155
Resins	0	113	339	0	67	202				0	186	557			
Ethylene glycol ethers	0	3	9	0	7	20							0	12	35
Resins	0	131	393	0	250	750							0	258	775
Hydrocarbons-low molecular weight	0	1	4	0	2	7							0	3	8
Pigments-organometallic	0	170	509							0	371	1,114			
Pigments-organic	0	33	98										0	233	700
Hydrocarbons-high molecular weight	0	1	2												
Inorganics	0	6	19												
Pigments-organic	0	43	128												
Pigments-organic				0	135	405									
Pigments-inorganic							0	428	1,285						
Alcohols							0	15	44						
Ethylene glycol ethers							0	15	44						

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.	Inhalation exposure (mg/day)	Dermal exposure (mg/day) min.	Dermal exposure (mg/day) max.
Water-based Ink #W3															
Water	0	725	2,174	0	642	1,927	0	452	1,357	0	667	2,002	0	657	1,970
Acrylic acid polymers	0	238	714	0	263	788	0	238	714	0	347	1,041	0	316	948
Amides or nitrogenous compounds	15	38	113	18	40	121	12	23	70	19	44	131	18	40	121
Acrylic acid polymers	0	82	246	0	122	367	0	82	246	0	75	226	0	117	351
Olefin polymers	0	10	31	0	12	35	0	13	39	0	19	56	0	17	51
Siloxanes	0	12	35	0	8	23	0	10	31	0	13	40	0	14	43
Organic acids or salts	0	2	6	0	3	8	0	3	8	0	3	8	0	3	8
Ethylene glycol ethers	0	16	47				0	17	51	0	16	48	0	17	51
Propylene glycol ethers										0	7	20	0	7	20
Alcohols										0	5	16	0	1	4
Pigments-organic	0	178	534												
Alcohols				0	18	55									
Ethylene glycol ethers				0	9	27									
Pigments-organic				0	40	121									
Pigments-organometallic				0	143	429									
Pigments-inorganic							0	455	1,365						
Alcohols							0	7	20						
Pigments-organometallic										0	105	314			
Pigments-organometallic													0	112	335

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
Water-based Ink #W4															
Water	0	613	1,840	0	460	1,381	0	423	1,268	0	591	1,773	0	694	2,083
Alcohols	0	49	147	0	23	69	0	26	78	0	53	158	0	44	133
Amides or nitrogenous compounds	0	6	18	0	6	17	0	7	20	0	7	20	0	13	38
Hydrocarbons-high molecular weight	0	6	18	0	6	17	0	7	20	0	7	20	0	6	19
Siloxanes	0	6	18	0	6	17	0	7	20	0	7	20	0	6	19
Alcohols	0	6	18	0	6	17	0	7	20	0	7	20	0	6	19
Acrylic acid polymers	0	153	460	0	144	431	0	163	488	0	164	492			
Amides or nitrogenous compounds	0	6	18	0	23	69				0	7	20	0	44	133
Resins	0	92	276	0	86	259				0	98	295			
Pigments-organometallic	0	215	644	0	23	69				0	230	689			
Alcohols				0	46	138	0	26	78				0	44	133
Propylene glycol ethers	0	49	147							0	53	158			
Propylene glycol ethers	0	49	147							0	53	158			
Pigments-inorganic				0	403	1,208	0	585	1,755						
Amides or nitrogenous compounds				3	6	17	3	7	20						
Pigments-organometallic	0	49	147												
Pigments-organic				0	40	121									
Pigments-organometallic				0	23	69									
Inorganics							0	46	137						
Alcohols										0	26	79			
Pigments-organometallic													0	221	663
Resins													0	221	663

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room) [a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
UV-cured Ink #U1															
Acrylated polymers	0	209	626	0	209	626	0	125	375	0	209	626	0	209	626
Amides or nitrogenous compounds	0	10	31	0	10	31	0	9	26	0	10	31	0	10	31
Aromatic esters	0	49	146	0	49	146	0	40	119	0	49	146	0	49	146
Aromatic ketones	0	28	83	0	28	83	0	9	26	0	28	83	0	28	83
Olefin polymers	0	10	31	0	10	31	0	9	26	0	10	31	0	10	31
Siloxanes	0	10	31	0	10	31	0	9	26	0	10	31	0	10	31
Acrylated polymers	0	765	2,294	0	765	2,294				0	765	2,294	0	765	2,294
Aromatic ketones	0	10	31	0	10	31				0	10	31	0	10	31
Pigments-organic	0	209	626												
Pigments-organometallic				0	209	626									
Pigments-inorganic							0	454	1,362						
Acrylated polymers							0	284	852						
Acrylated polymers							0	170	511						
Pigments-inorganic							0	170	511						
Organophosphorous compounds							0	23	68						
Pigments-organometallic										0	209	626			
Pigments-organometallic													0	209	626

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room)[a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
UV-cured Ink #U2															
Acrylated polymers	0	347	1,041	0	280	839	0	91	274	0	369	1,108	0	225	675
Acrylated polyols	0	163	490	0	259	778	0	321	963	0	125	375	0	132	396
Acrylated polyols	0	117	351	0	73	218	0	130	391	0	142	425	0	104	312
Acrylated polyols	0	19	56	0	50	151	0	80	241	0	3	8	0	36	107
Alcohols	0	13	39	0	13	39	0	13	39	0	13	39	0	13	39
Aromatic ketones	0	39	117	0	39	117	0	39	117	0	39	116	0	39	117
Aromatic ketones	0	39	117	0	39	117	0	36	108	0	39	116	0	39	117
Aromatic ketones	0	39	117	0	39	117	0	20	59	0	39	116	0	39	117
Aromatic ketones	0	13	39	0	13	39	0	3	8	0	13	39	0	13	39
Olefin polymers	0	13	39	0	13	39	0	13	39	0	13	39	0	13	39
Acrylated polymers	0	147	441	0	160	479				0	141	424	0	191	573
Polyol derivatives	0	100	299	0	92	275				0	104	311	0	142	425
Acrylated polymers	0	60	179	0	55	165				0	62	187	0	104	312
Pigments-organometallic	0	136	408							0	200	599			
Pigments-organic	0	55	166												
Pigments-organometallic				0	136	407									
Pigments-organic				0	40	120									
Pigments-inorganic							0	521	1,564						
Organophosphorous compounds							0	33	98						
Pigments-organometallic													0	211	632

Table 3-F.2 Occupational Exposure Results, Scenario I (Ink Preparation Room)[a] (continued)

Chemical category	Blue			Green			White			Cyan			Magenta		
	Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)		Inhalation exposure (mg/day)	Dermal exposure (mg/day)	
		min.	max.		min.	max.		min.	max.		min.	max.		min.	max.
UV-cured Ink #U3															
Acrylated polymers	0	765	2,294	0	765	2,294	0	419	1,258	0	765	2,294	0	765	2,294
Aromatic esters	0	49	146	0	49	146	0	42	126	0	49	146	0	49	146
Amides or nitrogeneous compounds	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Siloxanes	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Olefin polymers	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Aromatic ketones	0	10	31	0	10	31	0	9	27	0	10	31	0	10	31
Acrylated polyols	0	209	626	0	209	626				0	209	626	0	209	626
Aromatic ketones	0	28	83	0	28	83				0	28	83	0	28	83
Pigments-organic	0	209	626												
Pigments-organometallic				0	209	626									
Pigments-inorganic							0	509	1,528						
Acrylated polymers							0	180	539						
Acrylated polymers							0	90	270						
Organophosphorous compounds							0	24	72						
Pigments-organic										0	209	626			
Pigments-organometallic													0	209	626

[a] Shaded areas indicate where data are not applicable (i.e., the chemical category was not found in the particular color and formulation).

Appendix 3-G (Risk Chapter)
Supplementary General Population Exposure Information

This appendix presents information used to model and calculate the general population exposure values presented in Chapter 3.

Generic Facility Assumptions

The following assumed values were used in the exposure modeling:

Table 3-G Generic Facility Assumptions for General Population Exposure Assessment

Ink type	Facility building height (m)	Facility stack height (m)	Facility stack diameter (m)	Stack exit temperature (K)	Stack exit velocity (m/s)
Solvent-based [a]	6.1	9.1	0.61	436	17.78
Water-based [a]	6.1	9.1	0.71	344	17.78
UV-cured [b]	6.1	9.4	0.61	317	7.87

[a] Reference 1
[b] Reference 2

Fugitive emissions from long web runs, e.g., vapors that leak from the building windows and roof vents, were assumed to take place over an area of 100 square meters for the generic facility.

The weather conditions of the facility were assumed to be the same as those at San Bernardino, California. These conditions were assumed because they would result in the highest average air concentration (from the facility's air releases) of any of the approximately 500 weather stations in the United States.

Since flexographic printing facilities were expected to be located in urban areas, the urban mode of the model was selected. Finally, the following distances from the facility were selected for concentration calculations: 100 meters (m), 200 m, 300 m, 400 m, 500 m, and 1000 m.

Model Input Parameters

The Industrial Source Complex Long Term (ISCLT) Model (3) calculated more than one chemical at a time and was run in "Urban 3" mode. Also entered into the model was the decay rate of the chemical, entered as its half-life in seconds.

The Industrial Source Complex Long Term (ISCLT) Model used in this report required entries for the following inputs:

Fugitive releases: substance average annual release rate ($g/s/m^2$)

Stack releases: substance average annual release rate (g/s)
stack height (m)
stack diameter (m)
stack exit temperature (°K)
stack exit velocity (m/s)

Both releases: zip code or latitude/longitude for weather station
distances from facility to calculate concentration (m)
rural or urban mode
building height (m)
substance half-life in air (s)

Sample Calculation of General Population Exposures

As discussed in Chapter 3, the toxicity concerns for the chemicals of interest dictated that either the Average Daily Dose (ADD) or the Average Daily Concentration (ADC) were the appropriate exposure values. The available toxicity factors indicated which of the two values should be used for subsequent risk calculations. The calculations were as follows:

ADD (mg/kg-day) = [(C)(IR)(ED)(1 mg/1000ug)]/[(BW)(AT)]

ADC (mg/m^3) = [(C)(ED)(mg/1000ug)]/(AT)

where:

C = chemical concentration in air from air dispersion modeling (ug/m^3)
IR = inhalation rate; 13.2 (m^3/d) average of adult male and female recommended rates (4)
ED = exposure duration (days): for residential exposures, this is a multiple of (time per day) by (years per residence), minus assumed vacation time of 14 days/yr. One source (5) has 30 years as the 95th percentile value for the latter, and time per day values of 16.4 hours/day average indoors and recommended 2 hours outdoors.
BW = average body weight; 70 kg, standard average of male and female adult weights
AT = averaging time; 30 years (time per residence, from above).

ADD for residence = (C)(13.2m^3/d)(30yr*[(365d/yr*18.4hrs/24hrs/d) - 14d vacation)](mg/1000ug)/[70kg*(30yrs*365d/yr)]

ADC for residence = (C)(13.2m^3/d)(30yr*[(365d/yr*18.4hrs/24hrs/d) - 14d vacation)](mg/1000ug)/(30yrs*365d/yr)

Regional Exposure

For determining regional exposure, the model used was BOXMOD, also implemented in the Graphical Exposure Modeling System (6). BOXMOD used a parameter called "Time Constant" to account for chemical degradation. The time constant is the inverse of the rate of decay used for the ISCLT model. BOXMOD modeling was discontinued after partial modeling placed individual exposures uniformly at one-half to one-third of the local exposure estimates.

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Appendix 3-H (Risk Chapter)
General Population Exposure Data

Table 3-H.1 General Population Exposure Results, Fugitive and Stack Concentrations [a, b]

Chemical category (*additives in italics*)	Blue		Green		White		Cyan		Magenta	
	Concentration (μg/m³)									
	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack
Solvent-based Ink #S1 – Site 9B										
Alcohols	2.86e+00	3.54e-02	2.05e+00	2.53e-02	7.68e+00	9.49e-02	9.89e-01	1.22e-02	1.28e+00	1.59e-02
Alcohols	1.79e+01	2.24e-01	1.52e+01	1.90e-01	9.88e+01	1.23e+00			6.80e+00	8.48e-02
Alkyl acetates	9.53e+00	1.19e-01	1.09e+01	1.36e-01	7.68e+00	9.49e-02			5.83e+00	7.27e-02
Alcohols			3.07e+01	3.83e-01			3.59e+01	4.48e-01	3.29e+01	4.11e-01
Alkyl acetates			2.03e+00	2.53e-02			3.92e+00	4.89e-02	9.71e-01	1.21e-02
Propylene glycol ethers							2.45e+00	3.06e-02	1.94e+00	2.42e-02
Hydrocarbons - low molecular weight					8.74e+01	1.09e+00				
Alkyl acetates					2.02e+01	2.52e-01				
Additive: Propanol	*9.89e+00*	*1.23e-01*			*4.95e+00*	*6.17e-02*				
Additive: n-Propyl acetate							*2.27e+00*	*2.84e-02*		
Additive: Propylene glycol ether									*1.66e+00*	*2.07e-02*
Solvent-based Ink #S2 – Site 5										
Alcohols	5.31e+01	6.63e-01	5.09e+01	6.35e-01	1.03e+02	1.28e+00	7.10e+01	8.86e-01	4.80e+01	6.00e-01
Alkyl acetates	1.22e+01	1.52e-01	1.08e+01	1.35e-01	4.88e+00	6.09e-02	2.00e+01	2.50e-01	1.24e+01	1.55e-01
Hydrocarbons - low molecular weight	1.11e+01	1.38e-01	1.64e+01	2.05e-01	5.45e+01	6.80e-01	1.42e+01	1.78e-01	2.48e+01	3.10e-01
Alcohols	6.67e+00	8.24e-02	7.57e+00	9.37e-02	1.12e+01	1.39e-01	9.91e+00	1.23e-01	1.37e+01	1.69e-01
Hydrocarbons - low molecular weight	5.61e-01	6.93e-03	4.25e-01	5.28e-03	2.30e+00	2.87e-02	8.94e-01	1.12e-02		
Alcohols	6.78e+00	8.45e-02	7.86e+00	9.82e-02			9.01e+00	1.13e-01	8.08e+00	1.01e-01
Solvent-based Ink #S2 – Site 7										
Alcohols	2.25e+01	2.81e-01	2.21e+01	2.76e-01	4.27e+01	5.33e-01	1.91e+01	2.38e-01	2.33e+01	2.91e-01
Alkyl acetates	2.01e+01	2.51e-01	1.87e+01	2.34e-01	2.43e+01	3.03e-01	1.77e+01	2.21e-01	2.06e+01	2.57e-01
Hydrocarbons - low molecular weight	8.56e+00	1.07e-01	9.29e+00	1.16e-01	3.53e+01	4.41e-01	5.83e+00	7.27e-02	1.55e+01	1.93e-01
Alcohols	5.15e+00	6.37e-02	4.28e+00	5.29e-02	7.26e+00	8.98e-02	4.06e+00	5.01e-02	8.51e+00	1.05e-01
Hydrocarbons - low molecular weight	4.32e-01	5.40e-03	2.40e-01	3.00e-03	1.49e+00	1.86e-02	3.65e-01	4.56e-03	5.44e-01	6.79e-03
Alcohols	5.68e+01	7.09e-01	5.85e+01	7.30e-01			4.64e+01	5.79e-01	6.02e+01	7.51e-01
Additive: Propanol					*9.61e+01*	*1.20e+00*				

Table 3-H.1 General Population Exposure Results, Fugitive and Stack Concentrations [a, b] (continued)

Chemical category *(additives in italics)*	Blue		Green		White		Cyan		Magenta	
	Concentration (μg/m³)									
	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack
Solvent-based Ink #S2 – Site 10										
Alcohols	1.82e+01	2.27e-01	2.25e+01	2.81e-01	3.76e+01	4.70e-01	1.84e+01	2.30e-01	1.92e+01	2.40e-01
Alkyl acetates	1.16e+01	1.45e-01	1.16e+01	1.45e-01	1.31e+01	1.64e-01	1.43e+01	1.78e-01	5.77e+00	7.20e-02
Hydrocarbons - low molecular weight	6.92e+00	8.63e-02	9.49e+00	1.18e-01	3.12e+01	3.89e-01	5.62e+00	7.01e-02	1.28e+01	1.59e-01
Alcohols	4.17e+00	5.15e-02	4.37e+00	5.41e-02	6.41e+00	7.92e-02	3.91e+00	4.84e-02	7.03e+00	8.69e-02
Hydrocarbons - low molecular weight	4.36e+01	4.36e-03	2.45e-01	3.06e-03	1.31e+00	1.64e-02	3.52e-01	4.40e-03	4.49e-01	5.61e-03
Alcohols	5.64e+01	7.03e-01	6.15e+01	7.67e-01			3.23e+01	4.03e-01	7.40e+01	9.23e-01
Additive: Propanol					*1.14e+02*	*1.42e+00*				
Additive: Propylene glycol methyl ether							*2.91e+01*	*3.64e-01*	*6.43e+00*	*8.03e-02*
Additive: 2-Methoxy-1-propanol							*5.95e-01*	*7.43e-03*	*1.31e-01*	*1.64e-03*
Water-based Ink #W1 – Site 4										
Amides or nitrogenous compounds	1.21e+00	4.18e-01	1.03e+00	3.56e-01	7.64e+00	2.65e+00	3.04e-01	1.05e-01	3.32e-01	1.15e-01
Alcohols	9.36e+00	3.25e+00	5.37e+00	1.86e+00	1.53e+01	5.29e+00	1.14e+00	3.96e-01		
Ethylene glycol ethers	2.95e+00	1.03e+00	1.76e+00	6.17e-01			2.07e+00	7.25e-01	2.14e+00	7.48e-01
Alcohols	4.82e-01	1.67e-01	2.74e-01	9.48e-02						
Hydrocarbons-high molecular weight	1.75e+00	6.13e-01	9.48e-01	3.32e-01						
Water-based Ink #W2 – Site 1										
Amides or nitrogenous compounds	1.55e-01	5.42e-02	2.90e-01	1.01e-01	8.56e+00	2.99e+00			2.28e-01	7.97e-02
Hydrocarbons-high molecular weight	1.43e-01	4.97e-02	1.87e-01	6.47e-02	1.43e+00	4.95e-01			5.79e-02	2.01e-02
Hydrocarbons-low molecular weight	7.17e-02	2.49e-02	9.23e-02	3.20e-02					2.89e-02	1.00e-02
Hydrocarbons-high molecular weight	3.20e-02	1.12e-02								
Alcohols							1.30e-01	4.56e-02		
Ethylene glycol ethers					3.55e+00	1.24e+00				
Additive: Isobutanol	*5.04e-02*	*1.76e-02*					*3.55e+00*	*1.24e+00*	*1.31e-01*	*4.59e-02*
Additive: Ethyl carbitol	*5.04e-02*	*1.76e-02*					*1.30e-01*	*4.56e-02*	*1.31e-01*	*4.59e-02*
Additive: Propanol	*3.98e+00*	*1.38e+00*			*8.84e-01*	*3.06e-01*				
Additive: Ammonia							*1.77e-01*	*6.20e-02*		

Table 3-H.1 General Population Exposure Results, Fugitive and Stack Concentrations [a, b] (continued)

Chemical category (*additives in italics*)	Blue		Green		White		Cyan		Magenta	
	Concentration (μg/m^3)									
	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack
Water-based Ink #W3 – Site 2										
Amides or nitrogenous compounds	1.96e+00	6.80e-01	2.62e+00	9.07e-01	4.31e+00	1.49e+00	1.51e+00	5.25e-01	1.62e+00	5.60e-01
Propylene glycol ethers							2.27e-01	7.95e-02	2.56e-01	8.95e-02
Alcohols	2.39e-02	8.27e-03	1.17e+00	4.05e-01						
Ethylene glycol ethers			5.79e-01	2.03e-01						
Alcohols					1.18e+00	4.12e-01				
Additive: Ammonia	*1.44e-01*	*5.05e-02*	*7.74e-02*	*2.71e-02*	*1.57e-01*	*5.51e-02*	*1.84e-01*	*6.43e-02*	*1.84e-01*	*6.43e-02*
Additive: Propanol	*1.81e+00*	*6.26e-01*	*9.54e-01*	*3.31e-01*	*3.62e+00*	*1.25e+00*			*3.53e-02*	*1.22e-02*
Additive: Isopropanol			*4.24e-02*	*1.47e-02*	*4.90e-02*	*1.70e-02*			*2.12e-02*	*7.35e-03*
Water-based Ink #W3 – Site 3										
Amides or nitrogenous compounds	1.38e+00	4.79e-01	2.59e+00	8.97e-01	6.10e+00	2.11e+00	7.27e-01	2.52e-01	4.66e-01	1.61e-01
Propylene glycol ethers							1.09e-01	3.82e-02	7.43e-02	2.60e-02
Alcohols			1.17e+00	4.05e-01						
Ethylene glycol ethers			5.79e-01	2.03e-01						
Alcohols					1.68e+00	5.87e-01				
Additive: Ammonia	*1.15e+00*	*4.04e-01*	*2.35e-02*	*8.21e-03*	*1.87e+00*	*6.54e-01*	*1.99e-01*	*6.96e-02*	*1.99e-01*	*6.96e-02*
Additive: Propanol	*3.09e+00*	*1.07e+00*			*1.37e+01*	*4.75e+00*				
Additive: 2-Butoxyethanol									*8.31e-02*	*2.91e-02*
Water-based Ink #W4 – Site 9A										
Alcohols	1.02e+00	3.52e-01	4.77e-01	1.65e-01	4.69e+00	1.63e+00	1.64e+00	5.67e-01	6.79e-01	2.35e-01
Amides or nitrogenous compounds	1.26e-01	4.43e-02	1.18e-01	4.16e-02	1.16e+00	4.09e-01	1.99e-01	7.00e-02	2.24e-01	7.89e-02
Hydrocarbons-high molecular weight	1.26e-01	4.43e-02	1.18e-01	4.16e-02	1.16e+00	4.09e-01	1.17e-01	4.12e-02	1.12e-01	3.95e-02
Amides or nitrogenous compounds	1.26e-01	4.40e-02	4.72e-01	1.65e-01			1.17e-01	4.10e-02	6.72e-01	2.35e-01
Alcohols			1.55e+00	5.39e-01	4.69e+00	1.63e+00			9.79e-01	3.39e-01
Propylene glycol ethers	1.01e+00	3.52e-01					0.00e+00	0.00e+00		
Propylene glycol ethers	1.01e+00	3.52e-01					1.53e+00	5.36e-01		
Amides or nitrogenous compounds			1.19e-01	4.13e-02	1.17e+00	4.06e-01				
Alcohols							4.73e-01	1.64e-01		
Additive: Ammonia	*1.44e-01*	*5.05e-02*	*1.05e-01*	*3.67e-02*			*1.71e-01*	*5.97e-02*	*5.25e-02*	*1.84e-02*
Additive: Propanol	*8.26e-01*	*2.86e-01*					*9.76e-01*	*3.38e-01*		

Table 3-H.1 General Population Exposure Results, Fugitive and Stack Concentrations [a, b] (continued)

Chemical category (*additives in italics*)	Blue		Green		White		Cyan		Magenta	
	Concentration (μg/m³)									
	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack	fugitive	stack
UV-cured Ink #U1 – Site 11										
Amides or nitrogenous compounds	3.12e-01	1.83e-01	1.97e+03	1.97e-01	1.11e+04	1.11e+00	6.78e+02	6.78e-02	6.57e+02	6.57e-02
Aromatic esters	1.46e+00	8.53e-01	9.20e+03	9.20e-01	5.19e+04	5.19e+00	3.16e+03	3.16e-01	3.07e+03	3.07e-01
Additive: 1,6-Hexanediol diacrylate			*5.40e+03*	*5.40e-01*						
UV-cured Ink #U2 – Site 6										
Acrylated polyols	5.44e+00	3.18e+00	2.66e+04	2.66e+00	2.37e+05	2.37e+01	1.01e+04	1.01e+00	1.67e+04	1.67e+00
Acrylated polyols	3.90e+00	2.29e+00	7.49e+03	7.49e-01	9.64e+04	9.64e+00	1.15e+04	1.15e+00	1.32e+04	1.32e+00
Aromatic ketones	1.30e+00	7.61e-01	4.00e+03	4.00e-01	2.64e+04	2.64e+00	3.12e+03	3.12e-01	4.92e+03	4.92e-01
UV-cured Ink #U3 – Site 8										
Aromatic esters	6.06e-01	3.55e-01	3.36e+03	3.36e-01	3.09e+04	3.09e+00	2.59e+03	2.59e-01	2.11e+03	2.11e-01
Amides or nitrogeneous compounds	1.30e-01	7.60e-02	7.19e+02	7.19e-02	6.62e+03	6.62e-01	5.55e+02	5.55e-02	4.52e+02	4.52e-02
Acrylated polyols	2.60e+00	1.53e+00	1.44e+04	1.44e+00			1.11e+04	1.11e+00	9.08e+03	9.08e-01

[a] Concentrations estimated using average annual release estimates in the Industrial Source Complex Long Term (ISCLT) model.
[b] Shaded areas indicate where data are not applicable (i.e., the chemical category was not found in the particular color and formulation). If a chemical was found in a formulation, but resulted in no exposure to the general population, then the chemical category was not included in the table for that formulation.

Table 3-H.2 General Population Exposure Results, Average Daily Dose (ADD) and Average Daily Concentration (ADC) [a]

Chemical category *(additives in italics)*	Blue		Green		White		Cyan		Magenta	
	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)
Solvent-based Ink #S1 – Site 9B										
Alcohols	3.98e-04	2.11e-03	2.85e-04	1.51e-03	1.07e-03	5.66e-03	1.38e-04	7.30e-04	1.79e-04	9.47e-04
Alcohols	2.50e-03	1.32e-02	2.12e-03	1.12e-02	1.37e-02	7.29e-02			9.45e-04	5.01e-03
Alkyl acetates	1.33e-03	7.03e-03	1.52e-03	8.04e-03	1.07e-03	5.66e-03			8.10e-04	4.30e-03
Alcohols			4.27e-03	2.26e-02			4.99e-03	2.65e-02	4.58e-03	2.43e-02
Alkyl acetates			2.82e-04	1.50e-03			5.45e-04	2.89e-03	1.35e-04	7.16e-04
Propylene glycol ethers							3.41e-04	1.81e-03	2.70e-04	1.43e-03
Hydrocarbons - low molecular weight					1.22e-02	6.44e-02				
Alkyl acetates					2.81e-03	1.49e-02				
Additive: Propanol	*1.38e-03*	*7.30e-03*			*6.88e-04*	*3.65e-03*				
Additive: Alkyl acetates							*3.16e-04*	*1.68e-03*		
Additive: Propylene glycol ether									*2.30e-04*	*1.22e-03*
Solvent-based Ink #S2 – Site 5										
Alcohols	7.38e-03	3.92e-02	7.07e-03	3.75e-02	1.43e-02	7.59e-02	9.87e-03	5.23e-02	6.68e-03	3.54e-02
Alkyl acetates	1.69e-03	8.98e-03	1.50e-03	7.96e-03	6.78e-04	3.60e-03	2.78e-03	1.48e-02	1.72e-03	9.13e-03
Hydrocarbons - low molecular weight	1.54e-03	8.16e-03	2.29e-03	1.21e-02	7.58e-03	4.02e-02	1.98e-03	1.05e-02	3.45e-03	1.83e-02
Alcohols	9.27e-04	4.92e-03	1.05e-03	5.58e-03	1.56e-03	8.27e-03	1.38e-03	7.31e-03	1.90e-03	1.01e-02
Hydrocarbons - low molecular weight	7.80e-05	4.14e-04	5.91e-05	3.14e-04	3.20e-04	1.69e-03	1.24e-04	6.59e-04		
Alcohols	9.43e-04	5.00e-03	1.09e-03	5.80e-03			1.25e-03	6.65e-03	1.12e-03	5.96e-03
Solvent-based Ink #S2 – Site 7										
Alcohols	3.13e-03	1.66e-02	3.07e-03	1.63e-02	5.93e-03	3.15e-02	2.65e-03	1.41e-02	3.24e-03	1.72e-02
Alkyl acetates	2.80e-03	1.48e-02	2.61e-03	1.38e-02	3.38e-03	1.79e-02	2.46e-03	1.30e-02	2.87e-03	1.52e-02
Hydrocarbons - low molecular weight	1.19e-03	6.31e-03	1.29e-03	6.85e-03	4.91e-03	2.60e-02	8.10e-04	4.30e-03	2.15e-03	1.14e-02
Alcohols	7.16e-04	3.80e-03	5.96e-04	3.16e-03	1.01e-03	5.36e-03	5.64e-04	2.99e-03	1.18e-03	6.28e-03
Hydrocarbons - low molecular weight	6.01e-05	3.19e-04	3.34e-05	1.77e-04	2.07e-04	1.10e-03	5.08e-05	2.69e-04	7.56e-05	4.01e-04
Alcohols	7.90e-03	4.19e-02	8.14e-03	4.31e-02			6.46e-03	3.43e-02	8.37e-03	4.44e-02
Additive: Propanol					*1.34e-02*	*7.09e-02*				

Table 3-H.2 General Population Exposure Results, Average Daily Dose (ADD) and Average Daily Concentration (ADC) [a] (continued)

Chemical category *(additives in italics)*	Blue		Green		White		Cyan		Magenta	
	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)
Solvent-based Ink #S2 – Site 10										
Alcohols	2.53e-03	1.34e-02	3.14e-03	1.66e-02	5.24e-03	2.78e-02	2.56e-03	1.36e-02	2.68e-03	1.42e-02
Alkyl acetates	1.62e-03	8.58e-03	1.61e-03	8.55e-03	1.82e-03	9.68e-03	1.98e-03	1.05e-02	8.02e-04	4.25e-03
Hydrocarbons - low molecular weight	9.62e-04	5.10e-03	1.32e-03	7.00e-03	4.33e-03	2.30e-02	7.82e-04	4.14e-03	1.78e-03	9.42e-03
Alcohols	5.79e-04	3.07e-03	6.08e-04	3.22e-03	8.91e-04	4.73e-03	5.44e-04	2.89e-03	9.78e-04	5.19e-03
Hydrocarbons - low molecular weight	4.86e-05	2.58e-04	3.41e-05	1.81e-04	1.83e-04	9.68e-04	4.90e-05	2.60e-04	6.25e-05	3.31e-04
Alcohols	7.84e-03	4.16e-02	8.55e-03	4.54e-02			4.49e-03	2.38e-02	1.03e-02	5.45e-02
Additive: Propanol					*1.58e-02*	*8.40e-02*				
Additive: Propylene glycol methyl ether							*4.05e-03*	*2.15e-02*	*8.94e-04*	*4.74e-03*
Additive: 2-Methoxy-1-propanol							*8.27e-05*	*4.39e-04*	*1.82e-05*	*9.68e-05*
Water-based Ink #W1 – Site 4										
Amides or nitrogenous compounds	2.23e-04	1.18e-03	1.90e-04	1.01e-03	1.41e-03	7.49e-03	5.63e-05	2.99e-04	6.14e-05	3.26e-04
Alcohols	1.73e-03	9.18e-03	9.93e-04	5.26e-03	2.83e-03	1.50e-02	2.11e-04	1.12e-03		
Ethylene glycol ethers	5.46e-04	2.90e-03	3.27e-04	1.73e-03			3.84e-04	2.04e-03	3.96e-04	2.10e-03
Alcohols	8.92e-05	4.73e-04	5.06e-05	2.68e-04						
Hydrocarbons-high molecular weight	3.25e-04	1.72e-03	1.76e-04	9.33e-04						
Water-based Ink #W2 – Site 1										
Amides or nitrogenous compounds	2.87e-05	1.52e-04	5.37e-05	2.85e-04	1.59e-03	8.41e-03			4.22e-05	2.24e-04
Hydrocarbons-high molecular weight	2.65e-05	1.41e-04	3.45e-05	1.83e-04	2.64e-04	1.40e-03			1.07e-05	5.68e-05
Hydrocarbons-low molecular weight	1.33e-05	7.03e-05	1.71e-05	9.05e-05					5.34e-06	2.83e-05
Hydrocarbons-high molecular weight	5.93e-06	3.15e-05								
Alcohols							2.41e-05	1.28e-04		
Ethylene glycol ethers					6.58e-04	3.49e-03				
Additive: Isobutanol	*9.34e-06*	*4.95e-05*					*6.58e-04*	*3.49e-03*	*2.43e-05*	*1.29e-04*
Additive: Ethyl carbitol	*9.34e-06*	*4.95e-05*					*2.41e-05*	*1.28e-04*	*2.43e-05*	*1.29e-04*
Additive: Propanol	*7.35e-04*	*3.90e-03*			*1.63e-04*	*8.67e-04*				
Additive: Ammonia							*3.28e-05*	*1.74e-04*		

Table 3-H.2 General Population Exposure Results, Average Daily Dose (ADD) and Average Daily Concentration (ADC) [a] (continued)

Chemical category *(additives in italics)*	Blue		Green		White		Cyan		Magenta	
	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)
Water-based Ink #W3 – Site 2										
Amides or nitrogenous compounds	3.63e-04	1.92e-03	4.84e-04	2.57e-03	7.97e-04	4.23e-03	2.80e-04	1.48e-03	2.99e-04	1.59e-03
Propylene glycol ethers							4.21e-05	2.23e-04	4.74e-05	2.52e-04
Alcohols	4.41e-06	2.34e-05	2.16e-04	1.15e-03						
Ethylene glycol ethers			1.07e-04	5.69e-04						
Alcohols					2.18e-04	1.16e-03				
Additive: Ammonia	*2.68e-05*	*1.42e-04*	*1.44e-05*	*7.61e-05*	*2.92e-05*	*1.55e-04*	*3.41e-05*	*1.81e-04*	*3.41e-05*	*1.81e-04*
Additive: Propanol	*3.34e-04*	*1.77e-03*	*1.76e-04*	*9.36e-04*	*6.69e-04*	*3.55e-03*			*6.54e-06*	*3.47e-05*
Additive: Isopropanol			*7.84e-06*	*4.16e-05*	*9.07e-06*	*4.81e-05*			*3.92e-06*	*2.08e-05*
Water-based Ink #W3 – Site 3										
Amides or nitrogenous compounds	2.56e-04	1.36e-03	4.79e-04	2.54e-03	1.13e-03	5.98e-03	1.35e-04	7.13e-04	8.61e-05	4.57e-04
Propylene glycol ethers							2.02e-05	1.07e-04	1.38e-05	7.31e-05
Alcohols			2.16e-04	1.15e-03						
Ethylene glycol ethers			1.07e-04	5.69e-04						
Alcohols					3.11e-04	1.65e-03				
Additive: Ammonia	*2.14e-04*	*1.13e-03*	*4.35e-06*	*2.31e-05*	*3.46e-04*	*1.84e-03*	*3.69e-05*	*1.95e-04*	*3.69e-05*	*1.95e-04*
Additive: Propanol	*5.72e-04*	*3.03e-03*			*2.53e-03*	*1.34e-02*				
Additive: 2-Butoxyethanol									*1.54e-05*	*8.17e-05*
Water-based Ink #W4 – Site 9A										
Alcohols	1.88e-04	9.97e-04	8.82e-05	4.68e-04	8.68e-04	4.60e-03	3.03e-04	1.60e-03	1.26e-04	6.66e-04
Amides or nitrogenous compounds	2.34e-05	1.24e-04	2.19e-05	1.16e-04	2.16e-04	1.14e-03	3.69e-05	1.96e-04	4.16e-05	2.21e-04
Hydrocarbons-high molecular weight	2.34e-05	1.24e-04	2.19e-05	1.16e-04	2.16e-04	1.14e-03	2.17e-05	1.15e-04	2.08e-05	1.10e-04
Amides or nitrogenous compounds	2.33e-05	1.24e-04	8.75e-05	4.64e-04			2.17e-05	1.15e-04	1.25e-04	6.61e-04
Alcohols			2.87e-04	1.52e-03	8.68e-04	4.60e-03			1.81e-04	9.60e-04
Propylene glycol ethers	1.87e-04	9.90e-04					0.00e+00	0.00e+00		
Propylene glycol ethers	1.87e-04	9.90e-04					2.84e-04	1.51e-03		
Amides or nitrogenous compounds			2.20e-05	1.17e-04	2.17e-04	1.15e-03				
Alcohols							8.75e-05	4.64e-04		
Additive: Ammonia	*2.68e-05*	*1.42e-04*	*1.95e-05*	*1.03e-04*			*3.16e-05*	*1.68e-04*	*9.73e-06*	*5.16e-05*
Additive: Propanol	*1.53e-04*	*8.10e-04*					*1.81e-04*	*9.57e-04*		

Table 3-H.2 General Population Exposure Results, Average Daily Dose (ADD) and Average Daily Concentration (ADC) [a] (continued)

Chemical category (*additives in italics*)	Blue		Green		White		Cyan		Magenta	
	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)	ADD (mg/kg-d)	ADC (mg/m^3)
UV-cured Ink #U1 – Site 11										
Amides or nitrogenous compounds	6.80e-05	3.61e-04	7.33e-05	3.89e-04	4.14e-04	2.19e-03	2.52e-05	1.34e-04	2.44e-05	1.30e-04
Aromatic esters	3.17e-04	1.68e-03	3.42e-04	1.82e-03	1.93e-03	1.02e-02	1.18e-04	6.24e-04	1.14e-04	6.05e-04
Additive: 1,6-Hexanediol diacrylate			*2.00e-04*	*1.06e-03*						
UV-cured Ink #U2 – Site 6										
Acrylated polyols	1.18e-03	6.28e-03	9.89e-04	5.24e-03	8.80e-03	4.67e-02	3.75e-04	1.99e-03	6.19e-04	3.28e-03
Acrylated polyols	8.50e-04	4.51e-03	2.78e-04	1.47e-03	3.58e-03	1.90e-02	4.26e-04	2.26e-03	4.88e-04	2.59e-03
Aromatic ketones	2.83e-04	1.50e-03	1.49e-04	7.88e-04	9.82e-04	5.21e-03	1.16e-04	6.15e-04	1.83e-04	9.70e-04
UV-cured Ink #U3 – Site 8										
Aromatic esters	1.32e-04	7.00e-04	1.25e-04	6.62e-04	1.15e-03	6.09e-03	9.63e-05	5.10e-04	7.84e-05	4.16e-04
Amides or nitrogeneous compounds	2.83e-05	1.50e-04	2.67e-05	1.42e-04	2.46e-04	1.31e-03	2.06e-05	1.09e-04	1.68e-05	8.91e-05
Acrylated polyols	5.66e-04	3.00e-03	5.36e-04	2.84e-03			4.13e-04	2.19e-03	3.37e-04	1.79e-03

[a] Shaded areas indicate where data are not applicable (i.e., the chemical category was not found in the particular color and formulation). If a chemical was found in a formulation, but resulted in no exposure to the general population, the chemical category was not included in the table for that formulation.

Appendix 3-I (Risk Chapter)
Systemic Toxicity
Risk Concern Results

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Solvent-based Ink #S1 – Site 9B							
BLUE							
Alcohols		??	potential	??	potential	$4.3x10^5$	low or negligible
Alkyl acetates	LM						
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Resins	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Alcohols		??	clear	??	clear	313	low or negligible
Pigments - organometallic	LM				no exposure		no exposure
Aromatic esters		??	low or negligible		no exposure		no exposure
Organotitanium compounds	M				no exposure		no exposure
Alkyl acetates		0.34 (HQ)	low or negligible	??	low or negligible	$5.1x10^6$	low or negligible
Resins	L				no exposure		no exposure
Water							
Organic acids or salts	LM				no exposure		no exposure
Organic acids or salts		$1.5 x10^4$	low or negligible		no exposure		no exposure
Alcohols		??	clear	??	clear	$2.3x10^4$	low or negligible
GREEN							
Alcohols		??	potential	??	low or negligible	$5.0x10^5$	low or negligible
Alcohols		??	clear	??	clear	7301	low or negligible
Alkyl acetates	LM						
Polyol derivatives	LM				no exposure		no exposure
Pigments - organic	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alkyl acetates		??	clear	??	clear	$1.4x10^5$	low or negligible
Alcohols		??	potential	??	clear	4371	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Propylene glycol ethers		2.16 (HQ)	potential	3.7 (HQ)	potential	$7.5x10^{-5}$ (HQ)	low or negligible
Resins	L				no exposure		no exposure
Resins	L				no exposure		no exposure
Inorganics		$5.3\ x10^{4}$	low or negligible		no exposure		no exposure
Water							
WHITE							
Pigments - inorganic		3.23 (HQ)	potential		no exposure [e]		no exposure
Alcohols		??	potential	??	potential	$7.8x10^{4}$	low or negligible
Hydrocarbons - low molecular weight	LM						
Resins	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Alkyl acetates	LM						
Alkyl acetates		1.00 (HQ)	potential	??	clear	$2.2x10^{5}$	low or negligible
Alcohols		??	potential	0.024	clear	117	low or negligible
Hydrocarbons - high molecular weight	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Organotitanium compounds	M				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Water							
Alcohols		??	clear	??	clear	$4.5x10^{4}$	low or negligible
CYAN							
Alcohols		??	clear	??	clear	6226	low or negligible
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Resins	L				no exposure		no exposure
Alkyl acetates		??	clear	??	clear	$7.3x10^{4}$	low or negligible
Propylene glycol ethers		3.23 (HQ)	potential	4.4 (HQ)	potential	$9.1x10^{-5}$ (HQ)	low or negligible
Polyol derivatives	LM				no exposure		no exposure
Alcohols		??	potential	??	clear	904	low or negligible
Resins	L				no exposure		no exposure
Water							
Alkyl acetates	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
MAGENTA							
Alcohols		??	clear	??	clear	6790	low or negligible
Alcohols		??	low or negligible	??	low or negligible	1.1×10^{6}	low or negligible
Pigments - organometallic	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Alkyl acetates	LM						
Propylene glycol ethers		2.47 (HQ)	potential	3.5 (HQ)	potential	7.2×10^{-5} (HQ)	low or negligible
Polyol derivatives	LM				no exposure		no exposure
Alkyl acetates		??	clear	??	clear	2.9×10^{5}	low or negligible
Alcohols		??	potential	??	clear	697	low or negligible
Inorganics		124 (HQ)	clear		no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Water							
Trade Secret							
Propylene glycol ethers		28	potential	24.3	potential	1.2×10^{5}	low or negligible
Solvent-based Ink #S2 – Site 5							
BLUE							
Alcohols		??	potential	??	potential	1.4×10^{5}	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	2.0×10^{5}	low or negligible
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	3.3×10^{4}	low or negligible
Alcohols		??	clear	0.028	clear	134	low or negligible
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
GREEN							
Alcohols		??	potential	??	potential	$1.5x10^5$	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$1.4x10^5$	low or negligible
Alkyl acetates	LM						
Pigments - inorganic		0.67 (HQ)	low or negligible		no exposure		no exposure
Alcohols		??	clear	??	clear	$2.8x10^4$	low or negligible
Alcohols		??	clear	0.024	clear	118	low or negligible
Pigments - organic	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
WHITE							
Pigments - inorganic		3.37 (HQ)	potential		no exposure		no exposure
Resins	L				no exposure		no exposure
Alcohols		??	potential	??	potential	$7.4x10^4$	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$4.1x10^4$	low or negligible
Alcohols		??	potential	0.017	clear	80	potential
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Siloxanes		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Alkyl acetates	LM						
CYAN							
Alcohols		??	potential	??	potential	$1.1x10^5$	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$1.6x10^5$	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alcohols		??	clear	0.019	clear	90	potential
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	$2.5x10^4$	low or negligible
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
MAGENTA							
Alcohols		??	potential	??	potential	$1.6x10^5$	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$8.9x10^4$	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Alcohols		??	clear	0.014	clear	65	potential
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	$2.8x10^4$	low or negligible
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Polyol derivatives	LM				no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
Solvent-based Ink #S2 – Site 7							
BLUE							
Alcohols		??	potential	??	potential	$3.4x10^5$	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$2.6x10^5$	low or negligible
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	3938	low or negligible
Alcohols		??	clear	0.036	clear	174	low or negligible
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
GREEN							
Alcohols		??	potential	??	potential	$3.5x10^5$	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$2.4x10^5$	low or negligible
Alkyl acetates	LM						
Pigments - inorganic		0.41 (HQ)	low or negligible		no exposure		no exposure
Alcohols		??	clear	??	clear	3828	low or negligible
Alcohols		??	clear	0.043	clear	209	low or negligible
Pigments - organic	LM				no exposure		no exposure

Formulation	SAT hazard level[d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure[a,b]	Concern level[c]	Margin of Exposure[a,b]	Concern level	Margin of Exposure[a,b]	Concern level
Polyol derivatives	LM				no exposure		no exposure
Pigments - organometallic		1.1 x10^4	low or negligible		no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
WHITE							
Pigments - inorganic		2.53 (HQ)	potential		no exposure		no exposure
Resins	L				no exposure		no exposure
Alcohols		??	low or negligible	??	potential	1.8x10^5	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	6.3x10^4	low or negligible
Alcohols		??	potential	0.025	clear	123	low or negligible
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	2327	low or negligible
CYAN							
Alcohols		??	potential	??	potential	4.0x10^5	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	3.8x10^5	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alcohols		??	clear	0.046	clear	221	low or negligible
Alkyl acetates	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Alcohols		??	clear	??	clear	4825	low or negligible
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
MAGENTA							
Alcohols		??	potential	??	potential	$3.3x10^5$	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$1.4x10^5$	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Alcohols		??	clear	0.022	clear	105	low or negligible
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	3716	low or negligible
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
Solvent-based Ink #S2 – Site 10							
BLUE							
Alcohols		??	low or negligible	??	potential	$4.2x10^5$	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$3.2x10^5$	low or negligible
Alkyl acetates	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Alcohols		??	clear	??	clear	3966	low or negligible
Alcohols		??	clear	0.044	clear	215	low or negligible
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
GREEN							
Alcohols		??	potential	??	potential	$3.4x10^5$	low or negligible
Resins	L				no exposure		no exposure
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$2.3x10^5$	low or negligible
Alkyl acetates	LM						
Pigments - inorganic		0.42 (HQ)	low or negligible		no exposure		no exposure
Alcohols		??	clear	??	clear	3634	low or negligible
Alcohols		??	clear	0.042	clear	205	low or negligible
Pigments - organic	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Pigments - organometallic		$1.1 x10^4$	low or negligible		no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Amides or nitrogenous compounds	LM				no exposure		no exposure
Organophosphorus compounds		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
WHITE							
Pigments - inorganic		2.38 (HQ)	potential		no exposure		no exposure
Resins	L				no exposure		no exposure
Alcohols		??	low or negligible	??	potential	2.0×10^5	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	7.1×10^4	low or negligible
Alcohols		??	potential	0.029	clear	140	low or negligible
Amides, tallow, hydrogenated	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	1964	low or negligible
CYAN							
Alcohols		??	low or negligible	??	potential	4.2×10^5	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	3.9×10^5	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alcohols		??	clear	0.047	clear	228	low or negligible
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	6933	low or negligible
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
Propylene glycol ethers		17 (HQ)	clear	53 (HQ)	clear		low or negligible
Propylene glycol ethers	LM						
MAGENTA							
Alcohols		??	low or negligible	??	potential	$4.0x10^5$	low or negligible
Hydrocarbons - low molecular weight		??	low or negligible	??	clear	$1.7x10^5$	low or negligible
Resins	L				no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Alcohols		??	clear	0.026	clear	127	low or negligible
Alkyl acetates	LM						
Alcohols		??	clear	??	clear	3028	low or negligible
Amides or nitrogenous compounds	L				no exposure		no exposure
Organic acids or salts		??	low or negligible		no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	LM				no exposure		no exposure
Polyol derivatives	LM				no exposure		no exposure
Hydrocarbons - low molecular weight	LM						
Organophosphorus compounds		??	potential		no exposure		no exposure
Propylene glycol ethers		3.36 (HQ)	potential	12 (HQ)	clear	$2.4x10^{-4}$ (HQ)	low or negligible
Propylene glycol ethers	LM						
Water-based Ink #W1 – Site 4							
BLUE							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alcohols		??	clear	??	clear	$1.8x10^4$	low or negligible
Water							
Pigments - organic	L				no exposure		no exposure
Ethylene glycol ethers		??	clear	??	clear	4586	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Resins	L				no exposure		no exposure
Hydrocarbons - high molecular weight		??	potential	??	potential	$1.2x10^6$	low or negligible
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	43 (HQ)	clear	0.012 (HQ)	low or negligible
Alcohols		??	potential	??	clear	1395	low or negligible
GREEN							
Pigments - organometallic		??	potential		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organic	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$3.1x10^4$	low or negligible
Water							
Resins	L				no exposure		no exposure
Ethylene glycol ethers		??	clear	??	clear	7688	low or negligible
Hydrocarbons - high molecular weight		??	potential	??	potential	$2.3x10^6$	low or negligible
Amides or nitrogenous compounds		??	clear	37 (HQ)	clear	0.010 (HQ)	low or negligible
Alcohols		??	potential	??	clear	2463	low or negligible
WHITE							
Pigments - inorganic		3.33 (HQ)	potential		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Water							
Resins	L				no exposure		no exposure
Alcohols		??	clear	??	clear	$1.1x10^4$	low or negligible
Organic acids or salts	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	272 (HQ)	clear	0.075 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
CYAN							
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Water							
Ethylene glycol ethers		??	clear	??	clear	6520	low or negligible
Organic acids or salts	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Acrylic acid polymers	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$1.5x10^5$	low or negligible
Ethylene glycol ethers		??	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds		??	clear	11 (HQ)	clear	0.003 (HQ)	low or negligible
MAGENTA							
Pigments - organic		??	clear		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Water							
Ethylene glycol ethers		??	clear	??	clear	6333	low or negligible
Acrylic acid polymers	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	12 (HQ)	clear	0.003 (HQ)	low or negligible
Water-based Ink #W2 – Site 1							
BLUE							
Water							
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Resins		??	low or negligible		no exposure		no exposure
Resins	L				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Inorganics			low or negligible[f]		no exposure		no exposure
Ethylene glycol ethers	M				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	5.6 (HQ)	potential	0.002 (HQ)	low or negligible
Hydrocarbons - high molecular weight		$1.6 x10^4$	low or negligible	$1.1 x10^4$	low or negligible	$6.3x10^7$	low or negligible
Hydrocarbons - low molecular weight		0.27 (HQ)	low or negligible	0.3 (HQ)	low or negligible	$7.0x10^{-5}$ (HQ)	low or negligible
Hydrocarbons - high molecular weight		$1.1 x 10^4$	low or negligible	$1.2 x10^4$	low or negligible	$6.8x10^7$	low or negligible
Alcohols		0.13 (HQ)	low or negligible	??	clear	2020	low or negligible
Ethylene glycol ethers		??	potential	??	clear	$5.4x10^5$	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Alcohols		??	clear	??	clear	4.2×10^4	low or negligible
GREEN							
Water							
Resins		??	low or negligible		no exposure		no exposure
Pigments - organic	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Ethylene glycol ethers	M				no exposure		no exposure
Hydrocarbons - high molecular weight		??	low or negligible	??	low or negligible	4.9×10^7	low or negligible
Amides or nitrogenous compounds		??	potential	10 (HQ)	clear	0.003 (HQ)	low or negligible
Hydrocarbons - low molecular weight		0.47 (HQ)	low or negligible	0.3 (HQ)	low or negligible	9.1×10^{-5} (HQ)	low or negligible
WHITE							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Ethylene glycol ethers		??	clear	??	clear	7599	low or negligible
Amides or nitrogenous compounds		??	clear	308 (HQ)	clear	0.084 (HQ)	low or negligible
Alcohols		2.01 (HQ)	potential	0.008	clear	29	potential
Hydrocarbons - high molecular weight		??	low or negligible	??	low or negligible	6.3×10^6	low or negligible
Pigments - inorganic		2.93 (HQ)	potential		no exposure		no exposure
Alcohols		??	potential	??	clear	1.9×10^5	low or negligible
CYAN							
Water							
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Resins	L				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Alcohols		1.58 (HQ)	potential	??	clear	781	low or negligible
Ethylene glycol ethers		11	clear	37.3	clear	2.1×10^5	low or negligible
Amides or nitrogenous compounds		??	potential	6.4 (HQ)	potential	0.002 (HQ)	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
MAGENTA							
Water							
Resins		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Ethylene glycol ethers	M				no exposure		no exposure
Hydrocarbons - high molecular weight		??	low or negligible	2.8×10^4	low or negligible	1.6×10^8	low or negligible
Amides or nitrogenous compounds		??	clear	8.2 (HQ)	potential	0.002 (HQ)	low or negligible
Hydrocarbons - low molecular weight		0.54 (HQ)	low or negligible	0.1 (HQ)	low or negligible	2.8×10^{-5} (HQ)	low or negligible
Pigments - organic	L				no exposure		no exposure
Alcohols		1.64 (HQ)	potential	??	clear	775	low or negligible
Ethylene glycol ethers		10	clear	37	clear	2.1×10^5	low or negligible
Water-based Ink #W3 – Site 2							
BLUE							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	70 (HQ)	clear	0.019 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	9.3×10^4	low or negligible
Amides or nitrogenous compounds		??	low or negligible	5.2 (HQ)	potential	0.001 (HQ)	low or negligible
Alcohols		1.4×10^4	low or negligible	??	clear	2.8×10^4	low or negligible
Polyfunctional aziridine					no exposure		no exposure
Other components							
GREEN							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	potential		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Amides or nitrogenous compounds		??	clear	93 (HQ)	clear	0.026 (HQ)	low or negligible
Pigments - organic	L				no exposure		no exposure
Alcohols		??	potential	??	clear	574	low or negligible
Olefin polymers	L				no exposure		no exposure
Ethylene glycol ethers		??	clear	??	clear	$4.7x10^4$	low or negligible
Siloxanes		??	potential		no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$1.8x10^5$	low or negligible
Amides or nitrogenous compounds		??	low or negligible	2.8 (HQ)	potential	$7.6x10^{-4}$ (HQ)	low or negligible
Alcohols						$1.6x10^4$	low or negligible
WHITE							
Pigments - inorganic		2.55 (HQ)	potential		no exposure		no exposure
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	154 (HQ)	clear	0.042 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Alcohols		0.73 (HQ)	low or negligible	0.024	clear	86	potential
Organic acids or salts	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$4.6 x10^4$	low or negligible
Amides or nitrogenous compounds		??	low or negligible	5.7 (HQ)	potential	0.002 (HQ)	low or negligible
Alcohols		$1.7 x10^4$	low or negligible	??	clear	$1.4x10^4$	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
CYAN							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	54 (HQ)	clear	0.015 (HQ)	low or negligible
Olefin polymers	L				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Propylene glycol ethers		1.9×10^4	low or negligible	??	low or negligible	5.4×10^6	low or negligible
Alcohols	LM				no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	6.6 (HQ)	potential	0.002 (HQ)	low or negligible
MAGENTA							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	clear		no exposure		no exposure
Amides or nitrogenous compounds		??	clear	58 (HQ)	clear	0.016 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Propylene glycol ethers		2.7×10^4	low or negligible	??	low or negligible	4.8×10^6	low or negligible
Organic acids or salts	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	6.6 (HQ)	potential	0.002 (HQ)	low or negligible
Alcohols		??	low or negligible	??	low or negligible	4.9×10^6	low or negligible
Alcohols		1.1×10^4	low or negligible	??	clear	3.2×10^4	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Water-based Ink #W3 – Site 3							
BLUE							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	49 (HQ)	clear	0.014 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$5.4x10^4$	low or negligible
Amides or nitrogenous compounds		??	clear	42 (HQ)	clear	0.011 (HQ)	low or negligible
GREEN							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	potential		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	92 (HQ)	clear	0.025 (HQ)	low or negligible
Pigments - organic	LM				no exposure		no exposure
Alcohols		??	potential	??	clear	574	low or negligible
Olefin polymers	L				no exposure		no exposure
Ethylene glycol ethers		??	clear	??	clear	$4.7x10^4$	low or negligible
Siloxanes		??	potential		no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	low or negligible	0.8 (HQ)	low or negligible	$2.3x10^{-4}$ (HQ)	low or negligible
WHITE							
Pigments - inorganic		2.70 (HQ)	potential		no exposure		no exposure
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	217 (HQ)	clear	0.060 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Alcohols		0.77 (HQ)	low or negligible	0.017	clear	61	potential
Organic acids or salts	LM				no exposure		no exposure
Extender							no exposure
Alcohols		??	clear	??	clear	1.2×10^4	low or negligible
Amides or nitrogenous compounds		??	potential	67 (HQ)	clear	0.018 (HQ)	low or negligible
CYAN							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	clear	26 (HQ)	clear	0.007 (HQ)	low or negligible
Olefin polymers	L				no exposure		no exposure
Ethylene glycol ethers	LM				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Propylene glycol ethers		1.8×10^4	low or negligible	??	low or negligible	1.1×10^7	low or negligible
Alcohols	LM				no exposure		no exposure
Organic acids or salts	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	7.2 (HQ)	potential	0.002 (HQ)	low or negligible
MAGENTA							
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Pigments - organometallic		??	clear		no exposure		no exposure
Amides or nitrogenous compounds		??	clear	17 (HQ)	clear	0.005 (HQ)	low or negligible
Ethylene glycol ethers	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Siloxanes		??	potential		no exposure		no exposure
Propylene glycol ethers		2.0×10^4	low or negligible	??	low or negligible	1.7×10^7	low or negligible
Organic acids or salts	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Ethylene glycol ethers		556	low or negligible	405	low or negligible	1.4×10^6	low or negligible
Amides or nitrogenous compounds		??	potential	7.2 (HQ)	potential	0.002 (HQ)	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Water-based Ink #W4 – Site 9A							
BLUE							
Water							
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Pigments - organometallic	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	662	low or negligible
Propylene glycol ethers		2.54 (HQ)	potential	1.8 (HQ)	potential	$5.0x10^{-5}$ (HQ)	low or negligible
Propylene glycol ethers		??	potential	??	potential	$1.5x10^{5}$	low or negligible
Hydrocarbons - high molecular weight	LM						
Amides or nitrogenous compounds		??	low or negligible	??	clear	$1.0x10^{5}$	low or negligible
Siloxanes	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Amides or nitrogenous compounds		$3.0\ x10^{4}$	low or negligible	$5.2\ x10^{4}$	low or negligible	$2.9x10^{8}$	low or negligible
Alcohols		??	clear	??	clear	$2.0x10^{5}$	low or negligible
Amides or nitrogenous compounds		??	potential	5.2 (HQ)	potential	0.001 (HQ)	low or negligible
GREEN							
Water							
Pigments - inorganic		2.55 (HQ)	potential	0 (HQ)	no exposure	0.0 (HQ)	no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$1.1x10^{5}$	low or negligible
Pigments - organic	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Alcohols		??	potential	??	clear	1410	low or negligible
Amides or nitrogenous compounds		??	low or negligible	$1.4\ x10^{4}$	low or negligible	$7.7x10^{7}$	low or negligible
Amides or nitrogenous compounds		??	clear	4.3 (HQ)	potential	0.001 (HQ)	low or negligible
Hydrocarbons - high molecular weight	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Amides or nitrogenous compounds		??	low or negligible	??	clear	$1.1x10^5$	low or negligible
Siloxanes	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	3.8 (HQ)	potential	0.001 (HQ)	low or negligible
WHITE							
Pigments - inorganic		4.52 (HQ)	potential		no exposure		no exposure
Water							
Acrylic acid polymers	LM				no exposure		no exposure
Inorganics			low or negligible[f]		no exposure		no exposure
Alcohols		??	potential	0.040	clear	143	low or negligible
Alcohols		??	clear	??	clear	$3.6x10^4$	low or negligible
Amides or nitrogenous compounds		??	clear	42 (HQ)	clear	0.012 (HQ)	low or negligible
Hydrocarbons - high molecular weight	LM						
Amides or nitrogenous compounds		??	low or negligible	??	clear	$1.1x10^4$	low or negligible
Siloxanes	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
CYAN							
Water							
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Resins	L				no exposure		no exposure
Alcohols		??	clear	??	clear	413	low or negligible
Propylene glycol ethers		3.36 (HQ)	potential	2.8 (HQ)	potential	$7.6x10^{-5}$ (HQ)	low or negligible
Propylene glycol ethers		??	potential		no exposure		no exposure
Alcohols		$1.1\ x10^4$	low or negligible	??	low or negligible	$1.2X10^7$	low or negligible
Hydrocarbons - high molecular weight	LM						
Amides or nitrogenous compounds		??	low or negligible	??	clear	$6.4x10^4$	low or negligible
Siloxanes	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Amides or nitrogenous compounds		$3.8\ x10^4$	low or negligible	$5.6\ x10^4$	low or negligible	$3.1x10^8$	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Solids					no exposure		no exposure
Ethylene glycol ethers							
Petroleum distillate	LM				no exposure		no exposure
Alcohols		??	clear	??	clear	$1.7x10^5$	low or negligible
Amides or nitrogenous compounds		??	potential	6.1 (HQ)	potential	0.0 (HQ)	low or negligible
MAGENTA							
Water							
Pigments - organometallic		??	clear		no exposure		no exposure
Acrylic acid polymers	LM				no exposure		no exposure
Alcohols		??	potential	??	clear	991	low or negligible
Alcohols		??	clear	??	clear	$1.7x10^5$	low or negligible
Amides or nitrogenous compounds		??	low or negligible	??	low or negligible	$5.4x10^7$	low or negligible
Amides or nitrogenous compounds		??	low or negligible	??	clear	$5.7x10^4$	low or negligible
Hydrocarbons - high molecular weight	LM						
Siloxanes	LM				no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Amides or nitrogenous compounds		??	potential	1.9 (HQ)	potential	$5.2x10^{-4}$ (HQ)	low or negligible
UV-cured Ink #U1 – Site 11							
BLUE							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylated polymers					no exposure		no exposure
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
GREEN							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	potential		no exposure		no exposure
Acrylated polymers					no exposure		no exposure
Aromatic esters	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Acrylated polyols	M						
WHITE							
Acrylated polymers	LM				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Acrylated polymers					no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Aromatic esters	LM						
Organophosphorus compounds		??	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Pigments - inorganic		3.25 (HQ)	potential		no exposure		no exposure
Pigments - inorganic	LM				no exposure		no exposure
CYAN							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylated polymers					no exposure		no exposure
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
MAGENTA							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	clear		no exposure		no exposure
Acrylated polymers					no exposure		no exposure
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
UV-cured Ink #U2 – Site 6							
BLUE							
Acrylated polymers	LM				no exposure		no exposure
Acrylated polymers		??	clear		no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylated polyols		??	clear	??	clear	4299	low or negligible
Acrylated polyols	M						
Polyol derivatives	L				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylated polyols		??	clear		no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
Aromatic ketones		??	potential	??	potential	3.5×10^5	low or negligible
Aromatic ketones		??	potential		no exposure		no exposure
Olefin polymers		1.1×10^4	low or negligible		no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
GREEN							
Acrylated polymers	LM				no exposure		no exposure
Acrylated polyols		??	clear		no exposure		no exposure
Acrylated polyols		??	clear	??	clear	5153	low or negligible
Acrylated polymers		??	clear		no exposure		no exposure
Pigments - organometallic		??	potential		no exposure		no exposure
Polyol derivatives	L				no exposure		no exposure
Acrylated polyols	M						
Acrylated polymers	LM				no exposure		no exposure
Pigments - organic	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
Aromatic ketones		??	potential	??	low or negligible	6.7×10^5	low or negligible
Aromatic ketones		??	potential		no exposure		no exposure
Olefin polymers		1.1×10^4	low or negligible		no exposure		no exposure

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Alcohols	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
WHITE							
Pigments - inorganic		3.72 (HQ)	potential		no exposure		no exposure
Acrylated polyols		??	clear		no exposure		no exposure
Acrylated polyols		??	clear	??	clear	578	potential
Acrylated polyols	M						
Acrylated polymers	LM				no exposure		no exposure
Organophosphorus compounds		??	clear		no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
Aromatic ketones		??	potential		no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Olefin polymers		1.1×10^4	low or negligible		no exposure		no exposure
Aromatic ketones		??	potential	??	potential	1.0×10^5	low or negligible
Aromatic ketones	L				no exposure		no exposure
CYAN							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylated polyols	M						
Acrylated polymers		??	clear		no exposure		no exposure
Acrylated polyols		??	clear	??	clear	1.4×10^4	low or negligible
Polyol derivatives	L				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
Aromatic ketones		??	potential	??	low or negligible	8.6×10^5	low or negligible
Aromatic ketones		??	potential		no exposure		no exposure
Olefin polymers		1.1×10^4	low or negligible		no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
Acrylated polyols		??	clear		no exposure		no exposure
MAGENTA							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	clear		no exposure		no exposure
Acrylated polymers		??	clear		no exposure		no exposure
Acrylated polyols		??	clear	??	clear	8232	low or negligible

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Acrylated polyols		??	clear		no exposure		no exposure
Polyol derivatives	L				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Acrylated polyols	M						
Aromatic ketones	L				no exposure		no exposure
Aromatic ketones		??	potential	??	low or negligible	$5.5x10^5$	low or negligible
Aromatic ketones		??	potential		no exposure		no exposure
Olefin polymers		$1.1 x10^4$	low or negligible		no exposure		no exposure
Alcohols	LM				no exposure		no exposure
Aromatic ketones	L				no exposure		no exposure
UV-cured Ink #U3 – Site 8							
BLUE							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylated polyols	M						
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
GREEN							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	potential		no exposure		no exposure
Acrylated polyols	M						
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
WHITE							
Pigments - inorganic		3.63 (HQ)	potential		no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Acrylated polymers	LM				no exposure		no exposure
Aromatic esters	LM						

Formulation	SAT hazard level [d]	Occupational				General population	
		Dermal		Inhalation		Inhalation	
		Margin of Exposure [a,b]	Concern level [c]	Margin of Exposure [a,b]	Concern level	Margin of Exposure [a,b]	Concern level
Organophosphorus compounds		??	potential		no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
CYAN							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organometallic		??	low or negligible		no exposure		no exposure
Acrylated polyols	M						
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure
MAGENTA							
Acrylated polymers	LM				no exposure		no exposure
Pigments - organic	L				no exposure		no exposure
Acrylated polyols	M						
Aromatic esters	LM						
Aromatic ketones		??	low or negligible		no exposure		no exposure
Aromatic ketones	LM				no exposure		no exposure
Amides or nitrogenous compounds	M						
Siloxanes	LM				no exposure		no exposure
Olefin polymers	L				no exposure		no exposure

[a] A Margin-of-Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater the level of concern. High MOE values, such as values greater than 100 for a NOAEL-based MOE or 1000 for a LOAEL-based MOE, imply a low level of concern. As the MOE decreases, the level of concern increases.
[b] The absence of HQ or MOE values in this table indicates that insufficient hazard data were available to calculate a HQ or MOE for that chemical.
[c] The Concern Level is derived from a MOE or an HQ. The criteria in Table 3.15 on page 3-48 were used.
[d] SAT Levels of Concern are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. L = low, LM = low to moderate, and M = moderate.
[e] No level of concern could be assigned to this chemical due to no exposure.
[f] A chronic/subchronic MOE was not available for this chemical due to a lack of hazard data for this route of exposure; however, the risk associated with dermal exposure to this chemical is expected to be very low.

Appendix 3-J (Risk Chapter)
Developmental Toxicity
Risk Concern Results

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Solvent-based Ink #S1 – Site 9B						
BLUE						
Alcohols	10.2	potential	467	low or negligible	$2.3x10^6$	low or negligible
Alkyl acetates						
Pigments - organometallic				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Resins				no exposure		no exposure
Resins				no exposure		no exposure
Alcohols	??	clear	843	potential	$4.1x10^6$	low or negligible
Pigments - organometallic		SAT		no exposure		no exposure
Aromatic esters	218	low or negligible		no exposure		no exposure
Organotitanium compounds		SAT		no exposure		no exposure
Alkyl acetates						
Resins				no exposure		no exposure
Water						
Organic acids or salts		SAT		no exposure		no exposure
Organic acids or salts	$1.4x10^5$	low or negligible		no exposure		no exposure
Alcohols	268	low or negligible	244	low or negligible	$1.2x10^6$	low or negligible
GREEN						
Alcohols	15.1	potential	550	low or negligible	$2.7x10^6$	low or negligible
Alcohols	108	low or negligible	78.2	potential	$3.8x10^5$	low or negligible
Alkyl acetates						
Polyol derivatives				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Alkyl acetates	??	low or negligible	973	potential	$4.7x10^6$	low or negligible
Alcohols	??	clear	1177	low or negligible	$5.7x10^6$	low or negligible
Propylene glycol ethers	1046	low or negligible	756	low or negligible	$3.7x10^6$	low or negligible
Resins				no exposure		no exposure
Resins				no exposure		no exposure
Inorganics	$5.3x10^4$	low or negligible		no exposure		no exposure
Water						
WHITE						
Pigments - inorganic				no exposure[d]		no exposure
Alcohols	14.6	potential	84.7	potential	$4.1x10^6$	low or negligible

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Resins				no exposure		no exposure
Alkyl acetates						
Alkyl acetates						
Alcohols	??	clear	314	potential	$1.5x10^6$	low or negligible
Hydrocarbons - high molecular weight				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Organotitanium compounds		SAT[e]		no exposure		no exposure
Organic acids or salts	$6.7x10^4$	low or negligible		no exposure		no exposure
Water						
Alcohols	4231	low or negligible	489	low or negligible	$2.4x10^6$	low or negligible
CYAN						
Alcohols	74.9	potential	67.2	potential	$3.2x10^5$	low or negligible
Pigments - organometallic				no exposure		no exposure
Resins				no exposure		no exposure
Alkyl acetates	561	potential	504	potential	$2.5x10^6$	low or negligible
Propylene glycol ethers	699	low or negligible	627	low or negligible	$3.1x10^6$	low or negligible
Polyol derivatives				no exposure		no exposure
Alcohols	??	clear	2437	low or negligible	$1.2x10^7$	low or negligible
Resins				no exposure		no exposure
Water						
Alkyl acetates						
MAGENTA						
Alcohols	84.8	potential	73.5	potential	$3.5x10^5$	low or negligible
Alcohols	28.3	potential	1231	low or negligible	$3.0x10^6$	low or negligible
Pigments - organometallic		SAT		no exposure		no exposure
Resins				no exposure		no exposure
Alkyl acetates						
Propylene glycol ethers	913	low or negligible	791	low or negligible	$3.9x10^6$	low or negligible
Polyol derivatives				no exposure		no exposure
Alkyl acetates	??	low or negligible	2031	low or negligible	$9.9x10^6$	low or negligible
Alcohols	??	clear	1878	low or negligible	$9.1x10^6$	low or negligible
Inorganics	20.8	clear		no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Resins				no exposure		no exposure
Water						
Trade secret						
Propylene glycol ethers	703	low or negligible	607	low or negligible	$3.0x10^6$	low or negligible

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Solvent-based Ink #S2 – Site 5						
BLUE						
Alcohols	8.22	clear	158	low or negligible	$7.7x10^5$	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Alcohols	935	low or negligible	355	low or negligible	$1.7x10^6$	low or negligible
Alcohols	??	clear	361	potential	$1.7x10^6$	low or negligible
Pigments - organometallic				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.4x10^4$	low or negligible		no exposure		no exposure
Siloxanes	456	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	328	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
GREEN						
Alcohols	9.66	clear	165	low or negligible	$8.0x10^5$	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Pigments - inorganic				no exposure		no exposure
Alcohols	907	low or negligible	307	low or negligible	$1.5x10^6$	low or negligible
Alcohols	??	clear	319	potential	$1.5x10^6$	low or negligible
Pigments - organic				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.2x10^4$	low or negligible		no exposure		no exposure
Siloxanes	406	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	292	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
WHITE						
Pigments - inorganic				no exposure		no exposure
Resins				no exposure		no exposure
Alcohols	12.9	potential	81.4	Potential	$4.0x10^5$	low or negligible
Hydrocarbons - low molecular weight						
Alcohols	??	clear	215	potential	$1.0x10^6$	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.2x10^4$	low or negligible		no exposure		no exposure
Siloxanes	405	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
CYAN						
Alcohols	9.0	clear	118	low or negligible	$5.8x10^5$	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Alcohols	??	clear	243	potential	$1.2x10^6$	low or negligible
Alkyl acetates						
Alcohols	1028	low or negligible	268	low or negligible	$1.3x10^6$	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.3x10^4$	low or negligible		no exposure		no exposure
Siloxanes	418	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	301	potential		no exposure		no exposure
MAGENTA						
Alcohols	10.3	potential	174	low or negligible	$8.5x10^5$	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Alcohols	0.003	clear	177	potential	$8.5x10^5$	low or negligible
Alkyl acetates						
Alcohols	891	low or negligible	299	low or negligible	$1.4x10^6$	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Organic acids or salts	$1.2x10^4$	low or negligible		no exposure		no exposure
Siloxanes	398	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	287	potential		no exposure		no exposure
Solvent-based Ink #S2 – Site 7						
BLUE						
Alcohols	20.9	potential	372	low or negligible	$1.8x10^6$	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Alcohols	120	low or negligible	42.4	potential	$2.1x10^5$	low or negligible
Alcohols	??	clear	467	potential	$2.3x10^6$	low or negligible
Pigments - organometallic				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$2.0x10^4$	low or negligible		no exposure		no exposure
Siloxanes	635	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	457	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
GREEN						
Alcohols	20.9	potential	379	low or negligible	$1.8x10^6$	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Pigments - inorganic				no exposure		no exposure
Alcohols	114	low or negligible	41.2	potential	$2.0x10^5$	low or negligible
Alcohols	??	clear	562	potential	$2.7x10^6$	low or negligible
Pigments - organic				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$2.0x10^4$	low or negligible		no exposure		no exposure
Siloxanes	673	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	485	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
WHITE						
Pigments - inorganic				no exposure		no exposure
Resins				no exposure		no exposure
Alcohols	26.8	potential	196	low or negligible	$9.6x10^5$	low or negligible
Hydrocarbons - low molecular weight						
Alcohols	??	clear	332	potential	$1.6x10^6$	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.6x10^4$	low or negligible		no exposure		no exposure
Siloxanes	539	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Alcohols	173	low or negligible	25.1	potential	$1.2x10^5$	low or negligible
CYAN						
Alcohols	20.4	potential	439	low or negligible	$2.1x10^6$	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Alcohols	??	clear	593	potential	$2.9x10^6$	low or negligible
Alkyl acetates						
Alcohols	122	low or negligible	51.8	potential	$2.5x10^5$	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	$1.9x10^4$	low or negligible		no exposure		no exposure
Siloxanes	623	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	449	potential		no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
MAGENTA						
Alcohols	21.3	potential	359	low or negligible	1.8×10^6	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Alcohols	??	clear	283	potential	1.4×10^6	low or negligible
Alkyl acetates						
Alcohols	119	low or negligible	40.0	potential	1.9×10^5	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	1.9×10^4	low or negligible		no exposure		no exposure
Siloxanes	639	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	460	potential		no exposure		no exposure
Solvent-based Ink #S2 – Site 10						
BLUE						
Alcohols	21.9	potential	??	clear	2.2×10^6	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Alcohols	102	low or negligible	42.8	potential	2.1×10^5	low or negligible
Alcohols	??	clear	577	potential	2.8×10^6	low or negligible
Pigments - organometallic				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	2.0×10^4	low or negligible		no exposure		no exposure
Siloxanes	664	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	478	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
GREEN						
Alcohols	20.1	potential	371	low or negligible	1.8×10^{6}	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Pigments - inorganic				no exposure		no exposure
Alcohols	107	low or negligible	39.3	potential	1.9×10^{5}	low or negligible
Alcohols	??	clear	551	potential	2.7×10^{6}	low or negligible
Pigments - organic				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	2.0×10^{4}	low or negligible		no exposure		no exposure
Siloxanes	647	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Organophosphorus compounds	466	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
WHITE						
Pigments - inorganic				no exposure		no exposure
Resins				no exposure		no exposure
Alcohols	28.4	potential	222	low or negligible	1.1×10^{6}	low or negligible
Hydrocarbons - low molecular weight						
Alcohols	??	clear	376	potential	1.8×10^{6}	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	1.7×10^{4}	low or negligible		no exposure		no exposure
Siloxanes	573	potential		no exposure		no exposure
Hydrocarbons - low molecular weight						
Alkyl acetates						
Alcohols	137	low or negligible	21.2	potential	1.0×10^{5}	low or negligible
CYAN						
Alcohols	22.9	potential	455	low or negligible	2.2×10^{6}	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Alcohols	??	clear	614	potential	3.0×10^{6}	low or negligible
Alkyl acetates						
Alcohols	189	low or negligible	74.8	potential	3.6×10^{5}	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	2.1×10^{4}	low or negligible		no exposure		no exposure
Siloxanes	697	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	502	potential		no exposure		no exposure
Propylene glycol ethers	133	low or negligible	52.7	potential	2.6×10^{5}	low or negligible
Propylene glycol ethers		SAT		SAT		SAT
MAGENTA						
Alcohols	24.4	potential	435	low or negligible	2.1×10^{6}	low or negligible
Hydrocarbons - low molecular weight						
Resins				no exposure		no exposure
Pigments - organometallic		SAT		no exposure		no exposure
Alcohols	??	clear	343	potential	1.7×10^{6}	low or negligible
Alkyl acetates						
Alcohols	92.1	potential	32.6	potential	1.6×10^{5}	low or negligible
Amides or nitrogenous compounds				no exposure		no exposure
Organic acids or salts	2.2×10^{4}	low or negligible		no exposure		no exposure
Siloxanes	733	potential		no exposure		no exposure
Amides or nitrogenous compounds				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Hydrocarbons - low molecular weight						
Organophosphorus compounds	527	potential		no exposure		no exposure
Propylene glycol ethers	672	low or negligible	238	low or negligible	1.2×10^{6}	low or negligible
Propylene glycol ethers		SAT		SAT		SAT
Water-based Ink #W1 – Site 4						
BLUE						
Acrylic acid polymers				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Alcohols	393	low or negligible	258	low or negligible	9.4×10^{5}	low or negligible
Water						
Pigments - organic				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Ethylene glycol ethers	??	low or negligible	165	low or negligible	$9.2x10^5$	low or negligible
Resins				no exposure		no exposure
Hydrocarbons - high molecular weight						
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Alcohols	??	clear	5000	low or negligible	$1.8x10^7$	low or negligible
GREEN						
Pigments - inorganic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Alcohols	577	low or negligible	450	low or negligible	$1.6x10^6$	low or negligible
Water						
Resins				no exposure		no exposure
Ethylene glycol ethers	1418	low or negligible	276	low or negligible	$1.5x10^6$	low or negligible
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds						
Alcohols	??	clear	8813	low or negligible	$3.2x10^7$	low or negligible
WHITE						
Pigments - inorganic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Water						
Resins				no exposure		no exposure
Alcohols	??	low or negligible	158	low or negligible	$5.7x10^5$	low or negligible
Organic acids or salts	??	potential		no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
CYAN						
Pigments - organometallic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Water						
Ethylene glycol ethers	712	low or negligible	235	low or negligible	$1.3x10^6$	low or negligible
Organic acids or salts	28.7	potential		no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Alcohols	1607	low or negligible	2114	low or negligible	$7.7x10^6$	low or negligible
Ethylene glycol ethers				no exposure		no exposure
Amides or nitrogenous compounds						

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
MAGENTA						
Pigments - organic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Water						
Ethylene glycol ethers	704	low or negligible	227	low or negligible	$1.3x10^6$	low or negligible
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Organic acids or salts	39.2	potential		no exposure		no exposure
Amides or nitrogenous compounds						
Water-based Ink #W2 – Site 1						
BLUE						
Water						
Pigments - organometallic				no exposure		no exposure
Resins	745	low or negligible		no exposure		no exposure
Resins				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Inorganics		low or negligible[f]		no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Amides or nitrogenous compounds						
Hydrocarbons - high molecular weight						
Hydrocarbons - low molecular weight	5576	low or negligible	832	potential	$3.0x10^6$	low or negligible
Hydrocarbons - high molecular weight						
Alcohols	$7.5x10^4$	low or negligible	$5.5x10^4$	low or negligible	$20.0x10^8$	low or negligible
Ethylene glycol ethers	$1.6x10^5$	low or negligible	$2.9x10^4$	low or negligible	$1.61x10^8$	low or negligible
Alcohols	825	low or negligible	606	low or negligible	$2.2x10^6$	low or negligible
GREEN						
Water						
Resins	418	low or negligible		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Resins				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Hydrocarbons - high molecular weight						

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Amides or nitrogenous compounds						
Hydrocarbons - low molecular weight	3168	low or negligible	647	potential	$2.4x10^6$	low or negligible
WHITE						
Water						
Acrylic acid polymers				no exposure		no exposure
Ethylene glycol ethers	9950	low or negligible	410	low or negligible	$2.3x10^6$	low or negligible
Amides or nitrogenous compounds						
Alcohols	??	low or negligible	781	low or negligible	$2.9x10^6$	low or negligible
Hydrocarbons - high molecular weight						
Pigments - inorganic				no exposure		no exposure
Alcohols	$1.6x10^4$	low or negligible	2731	low or negligible	$10.0x10^6$	low or negligible
CYAN						
Water						
Pigments - organometallic				no exposure		no exposure
Resins				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Alcohols					$7.8x10^7$	low or negligible
Ethylene glycol ethers	$1.3x10^4$	low or negligible	$1.1x10^4$	low or negligible	$6.2x10^7$	low or negligible
Amides or nitrogenous compounds						
MAGENTA						
Water						
Resins	374	low or negligible		no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds						
Hydrocarbons - low molecular weight	2804	low or negligible	??	low or negligible	$7.5x10^6$	low or negligible
Pigments - organic				no exposure		no exposure
Alcohols					$7.8x10^7$	low or negligible
Ethylene glycol ethers	$1.2x10^4$	low or negligible	$1.1x10^4$	low or negligible	$6.2x10^7$	low or negligible

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Water-based Ink #W3 – Site 2						
BLUE						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Siloxanes	725	potential		no exposure		no exposure
Olefin polymers				no exposure		no exposure
Organic acids or salts	1304	low or negligible		no exposure		no exposure
Alcohols	2976	low or negligible	1336	low or negligible	4.9×10^6	low or negligible
Amides or nitrogenous compounds						
Alcohols	1.38	clear	1.0×10^5	low or negligible	3.7×10^8	low or negligible
Polyfunctional aziridine				no exposure		no exposure
Other components						
GREEN						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Pigments - organic				no exposure		no exposure
Alcohols	??	clear	ERR	low or negligible	7.5×10^6	low or negligible
Olefin polymers				no exposure		no exposure
Ethylene glycol ethers	2.2×10^5	low or negligible	??	low or negligible	1.4×10^7	low or negligible
Siloxanes	862	potential		no exposure		no exposure
Organic acids or salts	774	low or negligible		no exposure		no exposure
Alcohols	5549	low or negligible	2530	low or negligible	9.2×10^6	low or negligible
Amides or nitrogenous compounds						
Alcohols					2.1×10^8	low or negligible
WHITE						
Pigments - inorganic				no exposure		no exposure
Water						
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Siloxanes	571	potential		no exposure		no exposure
Alcohols	$1.3x10^4$	low or negligible	2358	low or negligible	$8.6x10^6$	low or negligible
Organic acids or salts	686	low or negligible		no exposure		no exposure
Alcohols	3691	low or negligible	667	low or negligible	$2.4x10^6$	low or negligible
Amides or nitrogenous compounds						
Alcohols	1.66	clear	$4.9x10^4$	low or negligible	$1.8x10^8$	low or negligible
CYAN						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Olefin polymers				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Siloxanes	??	potential		no exposure		no exposure
Propylene glycol ethers						
Alcohols				no exposure		no exposure
Organic acids or salts	613	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds						
MAGENTA						
Water						
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Pigments - organometallic	327	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Siloxanes	510	potential		no exposure		no exposure
Propylene glycol ethers						
Organic acids or salts	843	low or negligible		no exposure		no exposure
Alcohols				no exposure		no exposure
Amides or nitrogenous compounds						
Alcohols	$1.0x10^5$	low or negligible	$6.8x10^4$	low or negligible	$2.5x10^8$	low or negligible
Alcohols	1.03	clear	$1.1x10^5$	low or negligible	$4.1x10^8$	low or negligible

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Water-based Ink #W3 – Site 3						
BLUE						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Siloxanes	532	potential		no exposure		no exposure
Olefin polymers				no exposure		no exposure
Organic acids or salts	957	low or negligible		no exposure		no exposure
Alcohols	907	low or negligible	782	low or negligible	2.8×10^{6}	low or negligible
Amides or nitrogenous compounds						
GREEN						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Pigments - organic				no exposure		no exposure
Alcohols	??	clear	2063	low or negligible	7.5×10^{6}	low or negligible
Olefin polymers						no exposure
Ethylene glycol ethers	1.5×10^{4}	low or negligible	??	low or negligible	1.4×10^{8}	low or negligible
Siloxanes	601	potential		no exposure		no exposure
Organic acids or salts	541	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds						
WHITE						
Pigments - inorganic				no exposure		no exposure
Water						
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Siloxanes	541	potential		no exposure		no exposure
Alcohols	1.2×10^{4}	low or negligible	1656	low or negligible	6.1×10^{6}	low or negligible
Organic acids or salts	649	low or negligible		no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Extender						
Alcohols	1314	low or negligible	176	low or negligible	6.4×10^5	low or negligible
Amides or nitrogenous compounds						
CYAN						
Water						
Acrylic acid polymers				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Amides or nitrogenous compounds						
Olefin polymers				no exposure		no exposure
Ethylene glycol ethers				no exposure		no exposure
Siloxanes	388	potential		no exposure		no exposure
Propylene glycol ethers						
Alcohols				no exposure		no exposure
Organic acids or salts	583	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds						
MAGENTA						
Water						
Acrylic acid polymers				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Pigments - organometallic	240	low or negligible		no exposure		no exposure
Amides or nitrogenous compounds						
Ethylene glycol ethers				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Siloxanes	376	potential		no exposure		no exposure
Propylene glycol ethers						
Organic acids or salts	620	low or negligible		no exposure		no exposure
Alcohols				no exposure		no exposure
Ethylene glycol ethers	8000	low or negligible	809	low or negligible	3.0×10^6	low or negligible
Amides or nitrogenous compounds						
Water-based Ink #W4 – Site 9A						
BLUE						
Water						
Pigments - organometallic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Resins				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Alcohols	??	clear	2369	low or negligible	$8.6x10^{6}$	low or negligible
Propylene glycol ethers	888	low or negligible	1523	low or negligible	$5.6x10^{6}$	low or negligible
Propylene glycol ethers	581	low or negligible	997	low or negligible	$3.7x10^{6}$	low or negligible
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds	224	potential	386	potential	$2.1x10^{6}$	low or negligible
Siloxanes				no exposure		no exposure
Alcohols				no exposure		no exposure
Amides or nitrogenous compounds	$2.2x10^{5}$	low or negligible	$3.9x10^{5}$	low or negligible	$2.15x10^{9}$	low or negligible
Alcohols	1695	low or negligible	2916	low or negligible	$1.1x10^{7}$	low or negligible
Amides or nitrogenous compounds						
GREEN						
Water						
Pigments - inorganic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Alcohols	865	low or negligible	1553	low or negligible	$5.7x10^{6}$	low or negligible
Pigments - organic				no exposure		no exposure
Resins				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Alcohols	??	clear	5059	low or negligible	$1.8x10^{7}$	low or negligible
Amides or nitrogenous compounds	$5.7x10^{4}$	low or negligible	$1.0x10^{5}$	low or negligible	$5.71x10^{8}$	low or negligible
Amides or nitrogenous compounds						
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds	229	potential	412	potential	$2.3x10^{6}$	low or negligible
Siloxanes				no exposure		no exposure
Alcohols				no exposure		no exposure
Amides or nitrogenous compounds						
WHITE						
Pigments - inorganic				no exposure		no exposure
Water						
Acrylic acid polymers				no exposure		no exposure
Inorganics		low or negligible[f]		no exposure		no exposure
Alcohols	??	clear	515	potential	$1.9x10^{6}$	low or negligible
Alcohols	2363	low or negligible	515	low or negligible	$1.9x10^{6}$	low or negligible

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Amides or nitrogenous compounds						
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds	192	potential	41.9	clear	2.3×10^5	low or negligible
Siloxanes				no exposure		no exposure
Alcohols				no exposure		no exposure
CYAN						
Water						
Pigments - organometallic				no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Resins				no exposure		no exposure
Alcohols	??	clear	1475	low or negligible	5.4×10^6	low or negligible
Propylene glycol ethers	672	low or negligible	1004	low or negligible	3.7×10^6	low or negligible
Propylene glycol ethers	401	low or negligible		no exposure		no exposure
Alcohols	238	low or negligible	1.8×10^4	low or negligible	6.5×10^7	low or negligible
Hydrocarbons - high molecular weight						
Amides or nitrogenous compounds	164	potential	244	potential	1.4×10^6	low or negligible
Siloxanes				no exposure		no exposure
Alcohols				no exposure		no exposure
Amides or nitrogenous compounds	2.8×10^5	low or negligible	4.1×10^5	low or negligible	2.30×10^9	low or negligible
Solids				no exposure		no exposure
Ethylene glycol ethers	no exp		no exp		no exp	
Hydrocarbon - high molecular weight						
Alcohols	1661	low or negligible	2472	low or negligible	9.0×10^6	low or negligible
Amides or nitrogenous compounds						
MAGENTA						
Water						
Pigments - organometallic	112	low or negligible		no exposure		no exposure
Acrylic acid polymers				no exposure		no exposure
Alcohols	??	clear	3554	low or negligible	1.3×10^7	low or negligible
Alcohols	1112	low or negligible	2465	low or negligible	9.0×10^6	low or negligible
Amides or nitrogenous compounds	3.3×10^4	low or negligible	7.2×10^4	low or negligible	40.0×10^8	low or negligible
Amides or nitrogenous compounds	98.0	clear	217	potential	1.2×10^6	low or negligible
Hydrocarbons - high molecular weight						

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Siloxanes				no exposure		no exposure
Alcohols				no exposure		no exposure
Amides or nitrogenous compounds						
UV-cured Ink #U1 – Site 11						
BLUE						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylated polymers	112	low or negligible		no exposure		no exposure
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
GREEN						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Acrylated polymers	114	low or negligible		no exposure		no exposure
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Acrylated polyols	630	potential	793	potential	1.99×10^7	low or negligible
WHITE						
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polymers	187	low or negligible		no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Aromatic esters						
Organophosphorus compounds				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Pigments - inorganic		SAT		no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
CYAN						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylated polymers	112	low or negligible		no exposure		no exposure
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
MAGENTA						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organometallic	112	low or negligible		no exposure		no exposure
Acrylated polymers	112	low or negligible		no exposure		no exposure
Aromatic esters						
Aromatics ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
UV-cured Ink #U2 – Site 6						
BLUE						
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polymers				no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylated polyols						
Acrylated polyols	150	potential	188	potential	$8.8x10^5$	low or negligible
Polyol derivatives				no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylated polyols	623	low or negligible		no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Aromatic ketones						
Aromatic ketones				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Alcohols				no exposure		no exposure
Aromatic ketones				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
GREEN						
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polyols	231	low or negligible		no exposure		no exposure
Acrylated polyols						
Acrylated polymers				no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Acrylated polyols	240	potential	572	potential	$2.7x10^6$	low or negligible
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Aromatic ketones						
Aromatic ketones				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Alcohols				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
WHITE						
Pigments - inorganic				no exposure		no exposure
Acrylated polyols	145	low or negligible		no exposure		no exposure
Acrylated polyols						
Acrylated polyols	134	potential	44.4	clear	$2.1x10^5$	low or negligible
Acrylated polymers		SAT		no exposure		no exposure
Organophosphorus compounds				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Alcohols				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Aromatic ketones						
Aromatic ketones				no exposure		no exposure
CYAN						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylated polyols	124	potential	373	potential	$1.8x10^6$	low or negligible
Acrylated polymers				no exposure		no exposure
Acrylated polyols						
Polyol derivatives				no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Aromatic ketones						
Aromatic ketones				no exposure		no exposure
Olefin polymers				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
Alcohols				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Acrylated polyols	4545	low or negligible		no exposure		no exposure
MAGENTA						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organometallic	111	low or negligible		no exposure		no exposure
Acrylated polymers				no exposure		no exposure
Acrylated polyols						
Acrylated polyols	327	low or negligible		no exposure		no exposure
Polyol derivatives				no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polyols	168	potential	326	potential	$1.5x10^6$	low or negligible
Aromatic ketones				no exposure		no exposure
Aromatic ketones						
Aromatic ketones				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Alcohols				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
UV-cured Ink #U3 – Site 8						
BLUE						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylated polyols		SAT		SAT		SAT
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
GREEN						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - inorganic				no exposure		no exposure
Acrylated polyols		SAT		SAT		SAT
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure

Formulation	Occupational				General Population	
	Dermal		Inhalation		Inhalation	
	MOE[a,b]	Concern Level[c]	MOE	Concern Level	MOE	Concern Level
WHITE						
Pigments - inorganic				no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Acrylated polymers		SAT		no exposure		no exposure
Aromatic esters						
Organophosphorus compounds				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
CYAN						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organometallic				no exposure		no exposure
Acrylated polyols		SAT		SAT		SAT
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure
MAGENTA						
Acrylated polymers		SAT		no exposure		no exposure
Pigments - organic				no exposure		no exposure
Acrylated polyols		SAT		SAT		SAT
Aromatic esters						
Aromatic ketones				no exposure		no exposure
Aromatic ketones				no exposure		no exposure
Amides or nitrogenous compounds		SAT		SAT		SAT
Siloxanes				no exposure		no exposure
Olefin polymers				no exposure		no exposure

[a] A Margin of Exposure (MOE) or a Hazard Quotient (HQ) gives an estimate of the "margin of safety" between an estimated exposure level and the level at which adverse effects may occur. Hazard Quotient values below unity imply that adverse effects are very unlikely to occur. The more the Hazard Quotient exceeds unity, the greater the level of concern. High MOE values, such as values greater than 100 for a NOAEL-based MOE or 1000 for a LOAEL-based MOE, imply a low level of concern. As the MOE decreases, the level of concern increases.

[b] The absence of HQ or MOE values in this table indicates that insufficient hazard data were available to calculate a HQ or MOE for that chemical.

[c] The Concern Level is derived from a MOE or an HQ. Concern Levels for developmental toxicity were assessed by criteria presented in a memorandum from J. Seed to T. O'Bryan, "Criteria for 8(e) CAP Submissions", USEPA, OPPTS, March 25, 1994.

[d] No level of concern could be assigned to this chemical due to no exposure.

[e] The OPPT Structure Activity Team has indicated a concern for developmental toxicity for this chemical. SAT concerns are provided only for those chemicals with insufficient developmental hazard data available. It should be noted that SAT-based developmental toxicity concerns were not ranked as were systemic toxicity concerns; the SAT indicated only if a concern for developmental toxicity existed for a given chemical.

[f] A developmental MOE was not available for this chemical due to a lack of hazard data for this route of exposure; however, the risk associated with dermal exposure to this chemical is expected to be very low.

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Appendix 3-K (Risk Chapter)
Summary of Occupational Systemic Toxicity Risk Concern — Dermal[a]

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Solvent-based Ink #S1 - Site 9B								
BLUE (15)[d]	4	1	2	2	5	1	-	-
GREEN (12)	2	3	2	2	3	-	-	-
WHITE (13)	1	4	1	1	5	1	-	-
CYAN (9)	1	2	2	2	2	-	-	-
MAGENTA (14)	1	3	3	2	4	-	-	1
TOTALS (63)	9/63 (14%)	13/63 (21%)	10/63 (16%)	9/63 (14%)	19/63 (30%)	2/63 (3%)	-	1/63 (2%)
Solvent-based Ink #S2 - Site 5								
BLUE (15)	3	3	2	2	5	-	-	-
GREEN (17)	5	3	2	2	5	-	-	-
WHITE (10)	2	4	-	2	2	-	-	-
CYAN (14)	3	3	2	2	4	-	-	-
MAGENTA (14)	2	3	2	2	5	-	-	-
TOTALS (70)	15/70 (21%)	16/70 (23%)	8/70 (11%)	10/70 (14%)	21/70 (30%)	-	-	-
Solvent-based Ink #S2 - Site 7								
BLUE (15)	3	3	2	2	5	-	-	-
GREEN (17)	5	3	2	2	5	-	-	-
WHITE (11)	3	3	1	2	2	-	-	-
CYAN (14)	3	3	2	2	4	-	-	-
MAGENTA (14)	2	3	2	2	5	-	-	-
TOTALS (71)	16/71 (23%)	15/71 (21%)	9/71 (13%)	10/71 (14%)	21/71 (30%)	-	-	-
Solvent-based Ink #S2 - Site 10								
BLUE (15)	4	2	2	2	5	-	-	-
GREEN (17)	5	3	2	2	5	-	-	-
WHITE (11)	3	3	1	2	2	-	-	-
CYAN (16)	4	2	3	2	5	-	-	-
MAGENTA (16)	3	3	2	2	6	-	-	-
TOTALS (75)	19/75 (25%)	13/75 (17%)	10/75 (13%)	10/75 (13%)	23/75 (31%)	-	-	-

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Water-based Ink #W1 - Site 4								
BLUE (10)	1	2	3	2	2	-	-	-
GREEN (10)	-	3	3	1	3	-	-	-
WHITE (7)	-	1	2	1	3	-	-	-
CYAN (9)	2	-	3	-	4	-	-	-
MAGENTA (7)	-	-	3	-	4	-	-	-
TOTALS (43)	3/43 (7%)	6/43 (14%)	14/43 (33%)	4/43 (9%)	16/43 (37%)	-	-	-
Water-based Ink #W2 - Site 1								
BLUE (16)	7	2	1	3	2	1	-	-
GREEN (9)	3	1	-	1	3	1	-	-
WHITE (7)	1	3	2	-	1	-	-	-
CYAN (6)	1	2	1	1	1	-	-	-
MAGENTA (10)	3	1	2	1	2	1	-	-
TOTALS (48)	15/48 (31%)	9/48 (19%)	6/48 (13%)	6/48 (13%)	9/48 (19%)	3/48 (6%)	-	-
Water-based Ink #W3 - Site 2								
BLUE (13)	2	1	2	1	5	-	-	2
GREEN (13)	1	3	3	1	4	-	-	1
WHITE (12)	3	2	2	-	5	-	-	-
CYAN (11)	2	2	1	-	6	-	-	-
MAGENTA (13)	3	2	2	-	6	-	-	-
TOTALS (62)	11/62 (18%)	10/62 (16%)	10/62 (16%)	2/62 (3%)	26/62 (42%)	-	-	3/62 (5%)
Water-based Ink #W3 - Site 3								
BLUE (10)	0	1	3	1	5	-	-	-
GREEN (11)	1	3	2	-	5	-	-	-
WHITE (12)	1	3	2	-	5	-	-	1
CYAN (11)	2	2	1	-	6	-	-	-
MAGENTA (12)	2	2	2	-	6	-	-	-
TOTALS (56)	6/56 (11%)	11/56 (20%)	10/56 (18%)	1/56 (2%)	27/56 (48%)	-	-	1/56 (2%)
Water-based Ink #W4 - Site 9A								
BLUE (14)	3	3	2	1	5	-	-	-
GREEN (15)	4	3	2	1	5	-	-	-
WHITE (10)	2	2	2	-	4	-	-	-
CYAN (17)	4	3	2	1	5	-	-	2
MAGENTA (10)	2	2	2	-	4	-	-	-
TOTALS (66)	15/66 (23%)	13/66 (20%)	10/66 (15%)	3/66 (5%)	23/66 (35%)	-	-	2/66 (3%)

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
UV-cured Ink #U1 - Site 11								
BLUE (9)	1	-	-	1	6	1	-	-
GREEN (10)	1	1	-	-	6	2	-	-
WHITE (11)	1	1	-	-	8	1	-	-
CYAN (9)	2	-	-	-	6	1	-	-
MAGENTA (9)	1	-	1	-	7	1	-	-
TOTALS (48)	6/48 (13%)	2/48 (4%)	1/48 (2%)	1/48 (2%)	32/48 (67%)	6/48 (13%)	-	-
UV-cured Ink #U2 - Site 6								
BLUE (15)	2	2	3	4	3	1	-	-
GREEN (15)	1	3	3	3	4	1	-	-
WHITE (12)	1	3	3	2	2	1	-	-
CYAN (14)	2	2	3	3	3	1	-	-
MAGENTA (14)	1	2	4	3	3	1	-	-
TOTALS (70)	7/70 (10%)	12/70 (17%)	16/70 (23%)	15/70 (21%)	15/70 (21%)	5/70 (7%)	-	-
UV-cured Ink #U3 - Site 8								
BLUE (9)	1	-	-	1	5	2	-	-
GREEN (9)	1	1	-	-	5	2	-	-
WHITE (10)	-	2	-	-	7	1	-	-
CYAN (9)	2	-	-	-	5	2	-	-
MAGENTA (9)	1	-	-	1	5	2	-	-
TOTALS (46)	5/46 (11%)	3/46 (7%)	-	2/46 (4%)	27/46 (59%)	9/46 (20%)	-	-

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available. Criteria for SAT concern levels are presented on page 3-49.
[d] Number of chemicals in the color.

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Appendix 3-L (Risk Chapter)
Summary of Occupational
Systemic Toxicity Risk Concern — Inhalation[a]

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Solvent-based Ink #S1 - Site 9B								
BLUE (15)[d]	1	1	2	-	1	-	10	-
GREEN (12)	1	1	3	1	-	-	6	-
WHITE (13)	0	1	3	-	2	-	7	-
CYAN (9)	-	1	3	-	1	-	4	-
MAGENTA (14)	1	2	3	-	1	-	6	1
TOTALS (63)	3/63 (5%)	6/63 (10%)	14/63 (22%)	1/63 (2%)	5/63 (8%)	-	33/63 (52%)	1/63 (2%)
Solvent-based Ink #S2 - Site 5								
BLUE (15)	-	1	3	-	2	-	9	-
GREEN (17)	-	1	3	-	2	-	11	-
WHITE (10)	-	1	2	-	2	-	5	-
CYAN (14)	-	1	3	-	2	-	8	-
MAGENTA (14)	-	1	3	-	2	-	8	-
TOTALS (70)	-	5/70 (7%)	14/70 (20%)	-	10/70 (14%)	-	41/70 (59%)	-
Solvent-based Ink #S2 - Site 7								
BLUE (15)	-	1	3	-	2	-	9	-
GREEN (17)	-	1	3	-	2	-	11	-
WHITE (11)	-	1	3	-	2	-	5	-
CYAN (14)	-	1	3	-	2	-	8	-
MAGENTA (14)	-	1	3	-	2	-	8	-
TOTALS (71)	-	5/71 (7%)	15/71 (21%)		10/71 (14%)	-	41/71 (58%)	-
Solvent-based Ink #S2 - Site 10								
BLUE (15)	-	1	3	-	2	-	9	-
GREEN (17)	-	1	3	-	2	-	11	-
WHITE (11)	-	1	3	-	2	-	5	-
CYAN (16)	-	1	4	-	3	-	8	-
MAGENTA (16)	-	1	4	-	3	-	8	-
TOTALS (75)	-	5/75 (7%)	17/75 (23%)	-	12/75 (16%)	-	41/75 (55%)	-

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Water-based Ink #W1 - Site 4								
BLUE (10)	-	1	4	-	-	-	5	-
GREEN (10)	-	1	4	-	-	-	5	-
WHITE (7)	-	-	2	-	-	-	5	-
CYAN (9)	-	-	3	-	-	-	6	-
MAGENTA (7)	-	-	2	-	-	-	5	-
TOTALS (43)	-	2/43 (5%)	15/43 (35%)	-	-	-	26/43 (60%)	-
Water-based Ink #W2 - Site 1								
BLUE (16)	3	1	3	-	-	-	9	-
GREEN (9)	2	-	1	-	-	-	6	-
WHITE (7)	1	-	4	-	-	-	2	-
CYAN (6)	-	1	2	-	-	-	3	-
MAGENTA (10)	2	1	2	-	-	-	5	-
TOTALS (48)	8/48 (17%)	3/48 (6%)	12/48 (25%)	-	-	-	25/48 (52%)	-
Water-based Ink #W3 - Site 2								
BLUE (13)	-	1	3	-	-	-	8	1
GREEN (13)	-	1	4	-	-	-	7	1
WHITE (12)	-	1	4	-	-	-	7	-
CYAN (11)	1	1	1	-	-	-	8	-
MAGENTA (13)	2	1	2	-	-	-	8	-
TOTALS (62)	3/62 (5%)	5/62 (8%)	14/62 (23%)	-	-	-	38/62 (61%)	2/62 (3%)
Water-based Ink #W3 - Site 3								
BLUE (10)	-	-	3	-	-	-	7	-
GREEN (11)	1	-	3	-	-	-	7	-
WHITE (12)	-	-	4	-	-	-	7	1
CYAN (11)	1	1	1	-	-	-	8	-
MAGENTA (12)	2	1	1	-	-	-	8	-
TOTALS (56)	4/56 (7%)	2/56 (4%)	12/56 (21%)	-	-	-	37/56 (66%)	1/56 (2%)
Water-based Ink #W4 - Site 9A								
BLUE (14)	1	3	3	-	1	-	6	-
GREEN (15)	1	2	3	-	1	-	8	-
WHITE (10)	-	-	4	-	1	-	5	-
CYAN (17)	2	2	3	-	1	-	8	1
MAGENTA (10)	1	1	3	-	1	-	4	-
TOTALS (66)	5/66 (8%)	8/66 (12%)	16/66 (24%)	-	5/66 (8%)	-	31/66 (47%)	1/66 (2%)

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
UV-cured Ink #U1 - Site 11								
BLUE (9)	-	-	-	-	1	1	7	-
GREEN (10)	-	-	-	-	1	2	7	-
WHITE (11)	-	-	-	-	1	1	9	-
CYAN (9)	-	-	-	-	1	1	7	-
MAGENTA (9)	-	-	-	-	1	1	7	-
TOTALS (48)	-	-	-	-	5/48 (10%)	6/48 (13%)	37/48 (77%)	-
UV-cured Ink #U2 - Site 6								
BLUE (15)	-	1	1	-	-	1	12	-
GREEN (15)	1	-	1	-	-	1	12	-
WHITE (12)	-	1	1	-	-	1	9	-
CYAN (14)	1	-	1	-	-	1	11	-
MAGENTA (14)	1	-	1	-	-	1	11	-
TOTALS (70)	3/70 (4%)	2/70 (3%)	5/70 (7%)	-	-	5/70 (7%)	55/70 (79%)	-
UV-cured Ink #U3 - Site 8								
BLUE (9)	-	-	-	-	1	2	6	-
GREEN (9)	-	-	-	-	1	2	6	-
WHITE (10)	-	-	-	-	1	1	8	-
CYAN (9)	-	-	-	-	1	2	6	-
MAGENTA (9)	-	-	-	-	1	2	6	-
TOTALS (46)	-	-	-	-	5/46 (11%)	9/46 (20%)	32/46 (70%)	-

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available. Criteria for SAT concern levels are presented on page 3-49.
[d] Number of chemicals in the color.

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Appendix 3-M (Risk Chapter)
Summary of Occupational Developmental Toxicity Risk Concern — Dermal[a]

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation[b]			SAT developmental concern[c]		
	low concern	potential concern	clear concern			
Solvent-based Ink #S1 - Site 9B						
BLUE (15)[d]	3	1	1	3	-	7
GREEN (12)	4	1	1	-	-	6
WHITE (13)	2	1	1	1	-	8
CYAN (9)	1	2	1	-	-	5
MAGENTA (14)	2	2	2	1	-	7
TOTALS (63)	12/63 (19%)	7/63 (11%)	6/63 (10%)	5/63 (8%)	-	33/63 (52%)
Solvent-based Ink #S2 - Site 5						
BLUE (15)	2	2	2	1	-	8
GREEN (17)	2	2	2	-	-	11
WHITE (10)	1	2	1	-	-	6
CYAN (14)	2	2	2	-	-	8
MAGENTA (14)	2	3	1	1	-	7
TOTALS (70)	9/70 (13%)	11/70 (16%)	8/70 (11%)	2/70 (3%)	-	40/70 (57%)
Solvent-based Ink #S2 - Site 7						
BLUE (15)	2	3	1	1	-	8
GREEN (17)	2	3	1	-	-	11
WHITE (11)	2	2	1	-	-	6
CYAN (14)	2	3	1	-	-	8
MAGENTA (14)	2	3	1	1	-	7
TOTALS (71)	10/71 (14%)	14/71 (20%)	5/71 (7%)	2/71 (3%)	-	40/71 (56%)
Solvent-based Ink #S2 - Site 10						
BLUE (15)	2	3	1	1	-	8
GREEN (17)	2	3	1	-	-	11
WHITE (11)	2	2	1	-	-	6
CYAN (16)	3	3	1	1	-	8
MAGENTA (16)	2	4	1	2	-	7
TOTALS (75)	11/75 (15%)	15/75 (20%)	5/75 (7%)	4/75 (5%)	-	40/75 (53%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation [b]			SAT developmental concern [c]		
	low concern	potential concern	clear concern			
Water-based Ink #W1 - Site 4						
BLUE (10)	2	-	1	-	-	7
GREEN (10)	2	-	1	-	-	7
WHITE (7)	1	1	-	-	-	5
CYAN (9)	2	1	-	-	-	6
MAGENTA (7)	1	1	-	-	-	5
TOTALS (43)	8/43 (19%)	3/43 (7%)	2/43 (5%)	-	-	30/43 (70%)
Water-based Ink #W2 - Site 1						
BLUE (16)	6	-	-	-	-	10
GREEN (9)	2	-	-	-	-	7
WHITE (7)	3	-	-	-	-	4
CYAN (6)	1	-	-	-	-	5
MAGENTA (10)	3	-	-	-	-	7
TOTALS (48)	15/48 (31%)	-	-	-	-	33/48 (69%)
Water-based Ink #W3 - Site 2						
BLUE (13)	2	1	1	-	-	9
GREEN (13)	3	1	1	-	-	8
WHITE (12)	3	1	1	-	-	7
CYAN (11)	1	1	-	-	-	9
MAGENTA (13)	3	1	1	-	-	8
TOTALS (62)	12/62 (19%)	5/62 (8%)	4/62 (6%)	-	-	41/62 (66%)
Water-based Ink #W3 - Site 3						
BLUE (10)	2	1	-	-	-	7
GREEN (11)	2	1	1	-	-	7
WHITE (12)	3	1	-	-	-	8
CYAN (11)	1	1	-	-	-	9
MAGENTA (12)	3	1	-	-	-	8
TOTALS (56)	11/56 (20%)	5/56 (9%)	1/56 (2%)	-	-	39/56 (70%)
Water-based Ink #W4 - Site 9A						
BLUE (14)	4	1	1	-	-	8
GREEN (15)	2	1	1	-	-	11
WHITE (10)	2	1	1	-	-	6
CYAN (17)	5	1	1	-	-	10
MAGENTA (10)	3	-	2	-	-	5
TOTALS (66)	16/66 (24%)	4/66 (6%)	6/66 (9%)	-	-	40/66 (61%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation[b]			SAT developmental concern[c]		
	low concern	potential concern	clear concern			
UV-cured Ink #U1 - Site 11						
BLUE (9)	1	-	-	2	-	6
GREEN (10)	1	1	-	2	-	6
WHITE (11)	1	-	-	4	-	6
CYAN (9)	1	-	-	2	-	6
MAGENTA (9)	2	-	-	2	-	5
TOTALS (48)	6/48 (13%)	1/48 (2%)	-	12/48 (25%)	-	29/48 (60%)
UV-cured Ink #U2 - Site 6						
BLUE (15)	1	1	-	2	-	11
GREEN (15)	1	1	-	2	-	11
WHITE (12)	1	1	-	1	-	9
CYAN (14)	1	1	-	2	-	10
MAGENTA (14)	2	1	-	2	-	9
TOTALS (70)	6/70 (9%)	5/70 (7%)	-	9/70 (13%)	-	50/70 (71%)
UV-cured Ink #U3 - Site 8						
BLUE (9)	-	-	-	3	-	6
GREEN (9)	-	-	-	3	-	6
WHITE (10)	-	-	-	4	-	6
CYAN (9)	-	-	-	3	-	6
MAGENTA (9)	-	-	-	3	-	6
TOTALS (46)	-	-	-	16/46 (35%)	-	30/46 (65%)

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available.
[d] Number of chemicals in the color.

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Appendix 3-N (Risk Chapter)
Summary of Occupational
Developmental Toxicity Risk Concern — Inhalation[a]

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation[b]			SAT developmental concern[c]		
	low concern	potential concern	clear concern			
Solvent-based Ink #S1 - Site 9B						
BLUE (15)[d]	2	1	-	-	10	2
GREEN (12)	3	2	-	-	6	1
WHITE (13)	1	2	-	-	7	3
CYAN (9)	2	2	-	-	4	1
MAGENTA (14)	4	1	-	-	6	3
TOTALS (63)	12/63 (19%)	8/63 (13%)	-	-	33/63 (52%)	10/63 (16%)
Solvent-based Ink #S2 - Site 5						
BLUE (15)	2	1	-	-	9	3
GREEN (17)	2	1	-	-	11	3
WHITE (10)	-	2	-	-	5	3
CYAN (14)	2	1	-	-	8	3
MAGENTA (14)	2	1	-	-	8	3
TOTALS (70)	8/70 (11%)	6/70 (9%)	-	-	41/70 (59%)	15/70 (21%)
Solvent-based Ink #S2 - Site 7						
BLUE (15)	1	2	-	-	9	3
GREEN (17)	1	2	-	-	11	3
WHITE (11)	1	2	-	-	5	3
CYAN (14)	1	2	-	-	8	3
MAGENTA (14)	1	2	-	-	8	3
TOTALS (71)	5/71 (7%)	10/71 (14%)	-	-	41/71 (58%)	15/71 (21%)
Solvent-based Ink #S2 - Site 10						
BLUE (15)	-	2	1	-	9	3
GREEN (17)	1	2	-	-	11	3
WHITE (11)	1	2	-	-	5	3
CYAN (16)	1	3	-	1	8	3
MAGENTA (16)	2	2	-	1	8	3
TOTALS (75)	5/75 (7%)	11/75 (15%)	1/75 (1%)	2/75 (3%)	41/75 (55%)	15/75 (20%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation [b]			SAT developmental concern [c]		
	low concern	potential concern	clear concern			
Water-based Ink #W1 - Site 4						
BLUE (10)	3	-	-	-	5	2
GREEN (10)	3	-	-	-	5	2
WHITE (7)	1	-	-	-	5	1
CYAN (9)	2	-	-	-	6	1
MAGENTA (7)	1	-	-	-	5	1
TOTALS (43)	10/43 (23%)	-	-	-	26/43 (60%)	7/43 (16%)
Water-based Ink #W2 - Site 1						
BLUE (16)	3	1	-	-	9	3
GREEN (9)	-	1	-	-	6	2
WHITE (7)	3	-	-	-	2	2
CYAN (6)	1	-	-	-	3	2
MAGENTA (10)	2	-	-	-	5	3
TOTALS (48)	9/48 (19%)	2/48 (4%)	-	-	25/48 (52%)	12/48 (25%)
Water-based Ink #W3 - Site 2						
BLUE (13)	2	-	-	-	8	3
GREEN (13)	3	-	-	-	7	3
WHITE (12)	3	-	-	-	7	2
CYAN (11)	-	-	-	-	8	3
MAGENTA (13)	2	-	-	-	8	3
TOTALS (62)	10/62 (16%)	-	-	-	38/62 (61%)	14/62 (23%)
Water-based Ink #W3 - Site 3						
BLUE (10)	1	-	-	-	7	2
GREEN (11)	2	-	-	-	6	3
WHITE (12)	2	-	-	-	7	3
CYAN (11)	-	-	-	-	8	3
MAGENTA (12)	1	-	-	-	8	3
TOTALS (56)	6/56 (11%)	-	-	-	36/56 (66%)	14/56 (25%)
Water-based Ink #W4 - Site 9A						
BLUE (14)	5	1	-	-	6	2
GREEN (15)	3	1	-	-	8	3
WHITE (10)	1	1	1	-	5	2
CYAN (17)	5	1	-	-	7	4
MAGENTA (10)	3	1	-	-	4	2
TOTALS (66)	17/66 (26%)	5/66 (8%)	1/66 (2%)	-	30/66 (45%)	13/66 (20%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation[b]			SAT developmental concern[c]		
	low concern	potential concern	clear concern			
UV-cured Ink #U1 - Site 11						
BLUE (9)	-	-	-	1	7	1
GREEN (10)	-	1	-	1	7	1
WHITE (11)	-	-	-	1	9	1
CYAN (9)	-	-	-	1	7	1
MAGENTA (9)	-	-	-	1	7	1
TOTALS (48)	-	1/48 (2%)	-	5/48 (10%)	37/48 (77%)	5/48 (10%)
UV-cured Ink #U2 - Site 6						
BLUE (15)	-	1	-	-	12	2
GREEN (15)	-	1	-	-	12	2
WHITE (12)	-	-	1	-	9	2
CYAN (14)	-	1	-	-	11	2
MAGENTA (14)	-	1	-	-	11	2
TOTALS (70)	-	4/70 (6%)	1/70 (1%)	-	55/70 (79%)	10/70 (14%)
UV-cured Ink #U3 - Site 8						
BLUE (9)	-	-	-	2	6	1
GREEN (9)	-	-	-	2	6	1
WHITE (10)	-	-	-	1	8	1
CYAN (9)	-	-	-	2	6	1
MAGENTA (9)	-	-	-	2	6	1
TOTALS (46)	-	-	-	9/46 (19%)	32/46 (70%)	5/46 (11%)

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available.
[d] Number of chemicals in the color.

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Appendix 3-O (Risk Chapter)
Summary of General Population
Systemic Toxicity Risk Concern— Inhalation[a]

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Solvent-based Ink #S1 - Site 9B								
BLUE (15)[d]	4	-	-	-	1	-	10	-
GREEN (12)	5	-	-	-	1	-	6	-
WHITE (13)	4	-	-	-	2	-	7	-
CYAN (9)	4	-	-	-	1	-	4	-
MAGENTA (14)	6	-	-	-	1	-	6	1
TOTALS (63)	23/63 (37%)	-	-	-	6/63 (10%)	-	33/63 (52%)	1/63 (2%)
Solvent-based Ink #S2 - Site 5								
BLUE (15)	4	-	-	-	2	-	9	-
GREEN (17)	4	-	-	-	2	-	11	-
WHITE (10)	2	1	-	-	2	-	5	-
CYAN (14)	3	1	-	-	2	-	8	-
MAGENTA (14)	3	1	-	-	2	-	8	-
TOTALS (70)	16/70 (23%)	3/70 (4%)	-	-	10/70 (14%)	-	41/70 (59%)	-
Solvent-based Ink #S2 - Site 7								
BLUE (15)	4	-	-	-	2	-	9	-
GREEN (17)	4	-	-	-	2	-	11	-
WHITE (11)	4	-	-	-	2	-	5	-
CYAN (14)	4	-	-	-	2	-	8	-
MAGENTA (14)	4	-	-	-	2	-	8	-
TOTALS (71)	20/71 (28%)	-	-	-	10/71 (14%)	-	41/71 (58%)	-
Solvent-based Ink #S2 - Site 10								
BLUE (15)	4	-	-	-	2	-	9	-
GREEN (17)	4	-	-	-	2	-	11	-
WHITE (11)	4	-	-	-	2	-	5	-
CYAN (16)	5	-	-	-	3	-	8	-
MAGENTA (16)	5	-	-	-	3	-	8	-
TOTALS (75)	22/75 (29%)	-	-	-	12/75 (16%)	-	41/75 (55%)	-

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
Water-based Ink #W1 - Site 4								
BLUE (10)	5	-	-	-	-	-	5	-
GREEN (10)	5	-	-	-	-	-	5	-
WHITE (7)	2	-	-	-	-	-	5	-
CYAN (9)	3	-	-	-	-	-	6	-
MAGENTA (7)	2	-	-	-	-	-	5	-
TOTALS (43)	17/43 (40%)	-	-	-	-	-	26/43 (60%)	-
Water-based Ink #W2 - Site 1								
BLUE (16)	7	-	-	-	-	-	9	-
GREEN (9)	3	-	-	-	-	-	6	-
WHITE (7)	4	1	-	-	-	-	2	-
CYAN (6)	3	-	-	-	-	-	3	-
MAGENTA (10)	5	-	-	-	-	-	5	-
TOTALS (48)	22/48 (46%)	1/48 (2%)	-	-	-	-	25/48 (52%)	-
Water-based Ink #W3 - Site 2								
BLUE (13)	4	-	-	-	-	-	8	1
GREEN (13)	6	-	-	-	-	-	7	-
WHITE (12)	4	1	-	-	-	-	7	-
CYAN (11)	3	-	-	-	-	-	8	-
MAGENTA (13)	5	-	-	-	-	-	8	-
TOTALS (62)	22/62 (35%)	1/62 (2%)	-	-	-	-	38/62 (61%)	1/62 (2%)
Water-based Ink #W3 - Site 3								
BLUE (10)	3	-	-	-	-	-	7	-
GREEN (11)	4	-	-	-	-	-	7	-
WHITE (12)	3	1	-	-	-	-	8	-
CYAN (11)	3	-	-	-	-	-	8	-
MAGENTA (12)	4	-	-	-	-	-	8	-
TOTALS (56)	17/56 (30%)	1/56 (2%)	-	-	-	-	38/56 (68%)	-
Water-based Ink #W4 - Site 9A								
BLUE (14)	7	-	-	-	1	-	6	-
GREEN (15)	6	-	-	-	1	-	8	-
WHITE (10)	4	-	-	-	1	-	5	-
CYAN (17)	7	-	-	-	1	-	8	1
MAGENTA (10)	5	-	-	-	1	-	4	-
TOTALS (66)	29/66 (44%)	-	-	-	5/66 (8%)	-	31/66 (47%)	1/66 (2%)

Ink system, color	Number of chemicals						No exposure	No data
	Risk-based evaluation [b]			SAT-based evaluation [c]				
	low concern	potential concern	clear concern	low concern	low-moderate concern	moderate concern		
UV-cured Ink #U1 - Site 11								
BLUE (9)	-	-	-	-	1	1	7	-
GREEN (10)	-	-	-	-	1	2	7	-
WHITE (11)	-	-	-	-	1	1	9	-
CYAN (9)	-	-	-	-	1	1	7	-
MAGENTA (9)	-	-	-	-	1	1	7	-
TOTALS (48)	-	-	-	-	5/48 (10%)	6/48 (13%)	37/48 (77%)	-
UV-cured Ink #U2 - Site 6								
BLUE (15)	2	-	-	-	-	1	12	-
GREEN (15)	2	-	-	-	-	1	12	-
WHITE (12)	1	1	-	-	-	1	9	-
CYAN (14)	2	-	-	-	-	1	11	-
MAGENTA (14)	2	-	-	-	-	1	11	-
TOTALS (70)	9/70 (13%)	1/70 (1%)	-	-	-	5/70 (7%)	55/70 (70%)	-
UV-cured Ink #U3 - Site 8								
BLUE (9)	-	-	-	-	1	2	6	-
GREEN (9)	-	-	-	-	1	2	6	-
WHITE (10)	-	-	-	-	1	1	8	-
CYAN (9)	-	-	-	-	1	2	6	-
MAGENTA (9)	-	-	-	-	1	2	6	-
TOTALS (46)	-	-	-	-	5/46 (11%)	9/46 (20%)	32/46 (70%)	-

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available. Criteria for SAT concern levels are presented on page 3-49.
[d] Number of chemicals in the color.

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Appendix 3-P (Risk Chapter)
Summary of General Population Developmental Toxicity Risk Concern — Inhalation[a]

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation[b]			SAT developmental concern[c]		
	low concern	potential concern	clear concern			
Solvent-based Ink #S1 - Site 9B						
BLUE (15)[d]	3	-	-	-	10	2
GREEN (12)	5	-	-	-	6	1
WHITE (13)	3	-	-	-	7	3
CYAN (9)	4	-	-	-	4	1
MAGENTA (14)	5	-	-	-	6	3
TOTALS (63)	20/63 (32%)	-	-	-	33/63 (52%)	10/63 (16%)
Solvent-based Ink #S2 - Site 5						
BLUE (15)	3	-	-	-	9	3
GREEN (17)	3	-	-	-	11	3
WHITE (10)	2	-	-	-	5	3
CYAN (14)	3	-	-	-	8	3
MAGENTA (14)	3	-	-	-	8	3
TOTALS (70)	14/70 (20%)	-	-	-	41/70 (59%)	15/70 (21%)
Solvent-based Ink #S2 - Site 7						
BLUE (15)	3	-	-	-	9	3
GREEN (17)	3	-	-	-	11	3
WHITE (11)	3	-	-	-	5	3
CYAN (14)	3	-	-	-	8	3
MAGENTA (14)	3	-	-	-	8	3
TOTALS (71)	15/71 (21%)	-	-	-	41/71 (59%)	15/71 (21%)
Solvent-based Ink #S2 - Site 10						
BLUE (15)	3	-	-	-	9	3
GREEN (17)	3	-	-	-	11	3
WHITE (11)	3	-	-	-	5	3
CYAN (16)	4	-	-	1	8	3
MAGENTA (16)	4	-	-	1	8	3
TOTALS (75)	17/75 (23%)	-	-	2/75 (3%)	41/75 (55%)	15/75 (20%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation [b]			SAT developmental concern [c]		
	low concern	potential concern	clear concern			
Water-based Ink #W1 - Site 4						
BLUE (10)	3	-	-	-	5	2
GREEN (10)	3	-	-	-	5	2
WHITE (7)	1	-	-	-	5	1
CYAN (9)	2	-	-	-	6	1
MAGENTA (7)	1	-	-	-	5	1
TOTALS (43)	10/43 (23%)	-	-	-	26/43 (60%)	7/43 (16%)
Water-based Ink #W2 - Site 1						
BLUE (16)	4	-	-	-	9	3
GREEN (9)	1	-	-	-	6	2
WHITE (7)	3	-	-	-	2	2
CYAN (6)	2	-	-	-	3	1
MAGENTA (10)	3	-	-	-	5	2
TOTALS (48)	13/48 (27%)	-	-	-	25/48 (52%)	10/48 (21%)
Water-based Ink #W3 - Site 2						
BLUE (13)	2	-	-	-	8	3
GREEN (13)	4	-	-	-	7	2
WHITE (12)	3	-	-	-	7	2
CYAN (11)	-	-	-	-	8	3
MAGENTA (13)	2	-	-	-	8	3
TOTALS (62)	11/62 (18%)	-	-	-	38/62 (61%)	13/62 (21%)
Water-based Ink #W3 - Site 3						
BLUE (10)	1	-	-	-	7	2
GREEN (11)	2	-	-	-	7	2
WHITE (12)	2	-	-	-	7	3
CYAN (11)	-	-	-	-	8	3
MAGENTA (12)	1	-	-	-	8	3
TOTALS (56)	6/56 (11%)	-	-	-	37/56 (66%)	13/56 (23%)
Water-based Ink #W4 - Site 9A						
BLUE (14)	6	-	-	-	6	2
GREEN (15)	4	-	-	-	8	3
WHITE (10)	3	-	-	-	5	2
CYAN (17)	6	-	-	-	7	4
MAGENTA (10)	4	-	-	-	4	2
TOTALS (66)	23/66 (35%)	-	-	-	30/66 (45%)	13/66 (20%)

Ink system, color	Number of chemicals				No exposure	No data
	Risk-based evaluation [b]			SAT developmental concern [c]		
	low concern	potential concern	clear concern			
UV-cured Ink #U1 - Site 11						
BLUE (9)	-	-	-	1	7	1
GREEN (10)	1	-	-	1	7	1
WHITE (11)	-	-	-	1	9	1
CYAN (9)	-	-	-	1	7	1
MAGENTA (9)	-	-	-	1	7	1
TOTALS (48)	1/48 (2%)	-	-	5/48 (10%)	37/48 (77%)	5/48 (10%)
UV-cured Ink #U2 - Site 6						
BLUE (15)	1	-	-	-	12	2
GREEN (15)	1	-	-	-	12	2
WHITE (12)	1	-	-	-	9	2
CYAN (14)	1	-	-	-	11	2
MAGENTA (14)	1	-	-	-	11	2
TOTALS (70)	5/70 (7%)	-	-	-	55/70 (79%)	10/70 (14%)
UV-cured Ink #U3 - Site 8						
BLUE (9)	-	-	-	2	6	1
GREEN (9)	-	-	-	2	6	1
WHITE (10)	-	-	-	1	8	1
CYAN (9)	-	-	-	2	6	1
MAGENTA (9)	-	-	-	2	6	1
TOTALS (46)	-	-	-	9/46 (20%)	32/46 (70%)	5/46 (10%)

[a] The numbers in each column show the number of chemicals within each risk-based or SAT-based classification.
[b] Criteria for level of concern are presented in Table 3.15 (page 3-48).
[c] SAT concern levels are generated by the OPPT Structure Activity Team to predict toxicity based on analog data and/or structure-activity considerations. SAT concern levels are provided for chemicals with insufficient systemic hazard data available.
[d] Number of chemicals in the color.

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Appendix 4-A (Performance Chapter)
Overall Performance Demonstration Methodology

I. PERFORMANCE TESTING OVERVIEW

A. Goal

The objective of the performance demonstration is to collect specific information from flexographic printing facilities about the print quality, costs, and environmental and human health risks associated with different types of ink systems, as they are printed on different types of film substrates. This data will be incorporated into the overall project report, called the Cleaner Technologies Substitutes Assessment (CTSA).

B. Methodology Overview

The DfE Flexography Project will demonstrate the performance of three ink systems (solvent, water-based, and UV) on three different film substrates (oriented polypropylene, low-density polyethylene, and polyethylene/ethyl vinyl acetate). Each substrate/ink combination will be run on a wide web press in at least two separate volunteer printing facilities. During each demonstration, the press will be run at production speeds (300-500 ft/min) for approximately two hours to produce up to 60,000 feet of printed product. The 20" x 16" image will include both process tone printing in various gradations and two-color line printing. During and following the demonstration run, laboratory tests will be conducted to determine how well each ink system performed the desired task. To allow a comparison of the different ink systems, data will be collected on performance, cost, human health and environmental risks, and energy and natural resources use for each ink system.

The materials used in the demonstrations are expected to be donated to the Project by industry participants. Ink manufacturers will be asked to submit the required quantity of ink to the Project. Substrate manufacturers will be asked to submit the required length of film substrate. And, finally, printers will be donating their press time to the DfE Project.

Flexographic printing experts from Western Michigan University's (WMU) Department of Paper and Printing Science and Engineering will oversee the on-site demonstrations to ensure that the performance demonstration methodology outlined in this documented is followed consistently at all demonstration sites. Following the demonstrations, they will conduct laboratory tests to evaluate the print quality of the printed substrate.

Project Participants

This performance demonstration methodology was developed by a group of volunteers from the flexography industry with input from the DfE Flexography Project partners including representatives of: California Film Extruders and Converters Association (CFECA), Film and Bag Federation (FBF, previously the Plastic Bag Association), Flexible Packaging Association (FPA), Flexographic Technical Association (FTA), Industrial Technology Institute (ITI), National Association of Printing Ink Manufacturers (NAPIM), RadTech International, National Institute of Standards and Technology (NIST), Tag and Label Manufacturers Institute (TLMI), University of Tennessee (UT), and Western Michigan University (WMU).

II. INFORMATION TO BE COLLECTED

A. Performance Information

Performance data will provide printers with information on the effectiveness of the different ink systems evaluated under comparable conditions. While the DfE Flexography Project has made every attempt to ensure that these demonstrations will be run under consistent conditions, they are being conducted in actual printing facilities nationwide. As no two printing facilities are identical, it should be noted that the performance demonstrations are not rigorous scientific investigations. Instead, they couple the more qualitative performance evaluations with quantitative laboratory testing results. This combination of performance information in conjunction with the cost and risk data, will allow printers to compare the trade-offs between the various ink systems.

B. Costing Information

A cost analysis for each ink system will be conducted using supplier data, industry statistics, and information from the performance demonstration. Data collected during the performance demonstration that will be used in the cost analysis includes: amount of ink used; labor requirements for makeready, demonstration run, and clean-up; materials used; waste generated; energy and natural resources used; waste management requirements; and clean-up products used.

C. Environmental and Human Health Risk Information

A third component of this project is a technical evaluation of the human health and environmental concerns associated with each ink system. While much of this analysis will be based on the chemical formulation of each ink system (to be submitted by the ink suppliers), information on the associated occupational exposures will be collected through the performance demonstration.

III. PRODUCTS TO BE DEMONSTRATED

A. Ink Specifications

1. Eligibility of Inks

The performance demonstration is open to any commercially available flexographic ink system. Ink manufacturers who would like to submit their ink as a candidate for the demonstrations will be asked to supply a volume of their ink needed for the initial laboratory tests.

2. Number of Ink Systems

Inks are needed for printing on three substrates: Oriented Polypropylene (OPP), Low-density polyethylene (LDPE), and Polyethylene/Ethyl Vinyl Acetate (PE/EVA)). A detailed description of the substrates follows in section III.D. If each substrate requires a different ink system, a maximum of nine different ink systems will be needed.

Nomenclature is as follows:

	Ink System Name	Ink	Substrate
1.	S-OPP	Solvent	OPP
2.	W-OPP	Water	OPP
3.	UV-OPP	Ultra Violet Curable	OPP
4.	S-LDPE	Solvent	LDPE
5.	W-LDPE	Water	LDPE
6.	UV-LDPE	Ultra Violet Curable	LDPE
7.	S-PE/EVA	Solvent	PE/EVA
8.	W-PE/EVA	Water	PE/EVA
9.	UV-PE/EVA	Ultra Violet Curable	PE/EVA

3. Colors to be Demonstrated

The demonstration will include printing line colors and process colors, as identified in the Pantone Color Selector/Film Guide. For the OPP substrate, the film will be reverse printed and used as a laminate. The colors printed will be:

Line colors

White - Opacity target (48-50), to be used with the OPP and LDPE
Reflex Blue
354 Green

Process colors

Magenta (rubine red)
Cyan (phthalocyanine blue)

B. Initial Laboratory Testing

Within the three ink systems (solvent-based, water-based, and UV-curable), one product line may be selected for each of the three substrates (OPP, LPDE, PE/EVA), for a maximum of nine ink systems. If certain product lines can be used on more than one substrate type, fewer product lines will be required. If more than one product line within an ink system is submitted for the same substrate, the ink that most closely matches the ink currently used by the volunteer facility will be selected. Prior to sending inks to the field, WMU will test the inks in their Pilot Printing Plant as follows:

1. The ink suppliers will be asked to provide WMU with samples of white, cyan and green inks for the initial laboratory testing.

2. At the WMU pilot plant, each ink sample will be mixed for color and viscosity at the press to the manufacturer's specification, using solvents/additives provided by the ink supplier.

3. One printing station will be used for the tests. A 440 line anilox will be used to print the cyan and green inks. A 220 line anilox will be used for printing the white inks.

4. One test plate will be used for evaluation of the cyan and green inks.

5. Non-UV curable inks will be assigned to either the solvent or water category, based on the chemical and volatile organic compound (VOC) content information on each ink's MSDS. If the press side VOC content of the water-based inks exceeds 25% of the volatile component (e.g., 75% water, 25% VOC), the ink will be classified as solvent-based.

6. Each ink will be printed on each type of substrate (OPP, LPDE, PE/EVA) at the maximum attainable press speed (up to 500 ft/min).

7. Once maximum attainable press speed is reached, total run time will not exceed 3 minutes.

8. A series of performance tests will be conducted to evaluate the quality of the printed samples.

C. Dry Run at WMU Pilot Plant

The inks selected for the field demonstrations will be "dry run" at the WMU Pilot Plant prior to sending them to the volunteer facilities. The purpose of this one hour dry run is to determine if any problems are likely to occur during a longer run. The dry run procedure will be:

1. Each substrate will be run with the selected ink using the following color combinations:

Solvent Inks (1 - 3 different inks)		
Run 1	OPP	White + Green
Run 2	LDPE	White + Green
Run 3	PE/EVA	Green + Cyan
Water Inks (1 - 3 different inks)		
Run 4	OPP	White + Green
Run 5	LDPE	White + Green
Run 6	PE/EVA	Green + Cyan
UV Inks (1 - 3 different inks)		
Run 7	OPP	White + Green
Run 8	LDPE	White + Green
Run 9	PE/EVA	Green + Cyan

2. Each ink sample will be mixed for color and viscosity at the press to the manufacturer's specification, using solvents/additives supplied by the ink supplier.

3. Two printing stations will be used. A 440 line anilox will be used to print the cyan and green inks. A 220 line anilox will be used for printing the white inks.

4. The plates used in initial laboratory test run will also be used for the dry run.

5. Each ink will be printed on each type of substrate (OPP, LPDE, PE/EVA) at the maximum attainable press speed (up to 500 ft/min).

6. Once maximum attainable press speed is reached, total run time will be one hour.

7. During the dry run, exposure monitoring will be conducted in two testing zones — at the operator consol and the dryer exhaust stream. In each zone, testing will be conducted for two time periods: 0 to 15 minutes and 15 to 60 minutes.

8. During the dry run, data will be collected on energy used by the drying systems, corona treater, UV lamps, ink pumps, press, and emission control devices.

9. For each printed substrate, a select series of performance tests will be conducted.

D. Substrates Used in Testing

Each ink system will be run on three different film substrates. These substrates were selected by the Project Technical Committee to represent "typical" substrates used in flexography.

1. Substrate Types

It is expected that the film will be donated by film substrate manufacturers and sent directly to participating facilities. The three types of film that will be used are:

- **OPP (Oriented Polypropylene)** - *75 gauge - slip modified*
  Film to be reverse printed and used as a laminate. Typical products manufactured from this film are snack food bags and candy bar wrappers.
- **LDPE (Low-density polyethylene)** - *1.25 mil - medium slip - clear - 0.2 to 0.5 C.O.F. (ASTM D 1984)*
  Film to be surface printed. Typical products manufactured from this film are shopping bags and bread bags.
- **PE/EVA (Polyethylene/Ethyl Vinyl Acetate co-extruded film)** - *2.5 mil - white high slip - 0.2 C.O.F. (ASTM D 1984) - print PE side*
  Film to be surface printed. Typical products manufactured from this film are frozen food bags.

2. Substrate Quantities

For each substrate type, each of the three ink types will be printed during the initial laboratory tests and for two hours in at least two different facilities during field demonstrations. Total substrate quantities required are as follows:

	at WMU	**at TEST FACILITIES**					
Ink Type	**Laboratory Testing**	**+ Make-ready**	**+**	**Run Time x Press Speed = Run Footage**	**Per Facility Sub-Total**	**x 2 Facilities =**	**Total**
Solvent-based	60,000 ft.	+ 15,000 ft.	+	2 hrs. x 500 ft/min = 60,000 ft.	75,000 ft.	x 2 facilities = 150,000 ft.	210,000 ft.
Water-based	60,000 ft.	+ 15,000 ft.	+	2 hrs. x 500 ft/min = 60,000 ft.	75,000 ft.	x 2 facilities = 150,000 ft.	210,000 ft.
UV-curable	60,000 ft.	+ 15,000 ft.	+	2 hrs. x 500 ft/min = 60,000 ft.	75,000 ft.	x 2 facilities = 150,000 ft.	210,000 ft.
Total footage*	180,000 ft.	+ 45,000 ft.	+	180,000 ft. =	225,000 ft.	x 2 facilities = 450,000 ft.	**630,000 ft.**

*needed for each substrate

3. Other Substrate-related Requirements

- All films are to be treated on press with corona treatment to a specified dyne level that meets the specific ink manufacturer's specification. The exact treatment level will vary for the different ink systems (solvent, water, UV) and will be recommended by the printer. Target dyne levels may range from 38-45 dynes/cm^2.
- Core specifications are press reel dependent and will be determined after the list of participating facilities is finalized.
- All demonstrations will be run on wide web presses. The target web width is 24".
- The identification number and the date of manufacture for the films will be recorded during the performance demonstration. Substrate preferably will be manufactured no later than 6 months prior to the press run.

E. Image and Plates

Each demonstration facility will receive a new set of plates to minimize the variables associated with plate wear. The image will include both process tone printing in various gradations and two-color line printing, as described below:

1. Image

The same test image will be used for all demonstrations. Image width will be 20" and length will be 16". The image is designed so all required tests can be conducted on the printed substrate. A black and white, size-reduced copy of the image used can be found in Appendix 4-D.

2. Plate Manufacturing - recommended[1]

The plates will be manufactured according to the following specifications:

- All plates will be manufactured in the same lot by the same manufacturer to maximize consistency.
- Plates will all be made of the same photopolymer material.
- Plate gauge is press dependent and will be finalized when the list of participating facilities is finalized.
- Plate cylinder circumference will be 16" to 18" (single repeat). Circumference will be finalized when the list of facilities is finalized.

3. Plate Configuration

- OPP will be reverse printed. LDPE and PE/EVA will be surface printed.
- The image will be a combination of line and halftone as follows:

  <u>Configuration 1: Magenta + Cyan</u>
  - Two color combination to include process tones, trap and tone scales.
  - 120 line screen.
  - Tone to be multiple gradations of 3, 10, 15 , 20, 25, 35, 40, 50, 60, 70, 80, and 100 percent.
  - Magenta + cyan to meet with 50% trap of tones and solids.

  <u>Configuration 2: White Background with Reflex Blue and Green Overprinted</u>
  - The image will emphasize large solid formation and trap.

F. Press Configuration

While the specific make and model of press used will vary from one participating facility to the next, the DfE Flexography Project partners have established some guidelines to maximize consistency in the type of press used. While the Project does not intend to exclude any printers who may be interested in participating, an effort to maintain consistency in the press type will provide more comparable data from the demonstrations. All press configuration parameters will be documented for each printing facility.

1. Press Configuration - recommended

- Central impression press.
- Six-color.
- Production speeds of 300 - 500 feet/minute or optimized for print quality.
- Wide web press with a target width of 24 inches.

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[1] This is the recommended method for platemaking. However, if a participating facility has special requirements for their plates, the plates for that facility may be manufactured on-site, using the same image.

- Plate cylinder circumference of 16" to 18" (single repeat).
- Inking system with chambered doctor blade units.
- Target specifications for **anilox rolls**: *(note these are **target** values only)*
  - Process anilox rolls
    Screen count = 600 to 700 lines per inch (LPI)
    Volume = 1.5 billion cubic microns (BCM)
  - Line anilox rolls
    Screen count = 440 LPI
    Volume = 4 to 6 BCM
  - White
    Screen count = 150 LPI
    Volume = 6 to 8 BCM
    or
    Up to 15 BCM may be appropriate for UV applications.

2. Dryer configuration
- Temperature: substrate dependent; will be measured and recorded.
- Velocity: press dependent; will be measured and recorded.
- Web dwell: press dependent; will be measured and recorded.
- Balance: press dependent; will be measured and recorded.

IV. DEMONSTRATIONS

The observation team from WMU will oversee each of the demonstrations to insure that the methodology is followed. The team will also record all relevant data regarding the press, the substrate, the ink, energy use, and general information on the demonstration and the facility. To insure that consistent data are collected among participating facilities, the observation team will complete a set of data collection forms for each demonstration run. See Appendices 4-B and 4-C for blank copies of these forms. The DfE Flexography Project highly recommends that a representative of the ink manufacturer be on site during demonstration of the ink, if possible.

A. Pre-Makeready

Before ink and substrate impression starts, information will be recorded on the steps taken to prepare for the print run and on the operating conditions under which the demonstration will take place:

1. Record background information on:
   - ***Ink:*** ink system type, ink manufacturer name and ink name.
   - ***Plate:*** plate gauge, plate mounting method.
   - ***Press:*** manufacturer and model, press width, maximum web width, number of print units, distance between color stations, drum diameter, anilox roll configuration (type, lines per inch, volume, diameter, and condition), ink pumping system, type of doctor blade system, and a description of adjacent equipment running during the performance demonstration.

   - ***Drying System:*** make and model of each drying (or UV) unit, drying area of each of the interstation dryers (or UV lamps), dryer area of main tunnel dryer (or final UV-curing lamp), air flow capacity in cfm, and, if applicable, the make and model and location of chillers.
   - ***Energy Requirements:*** from the equipment nameplates or from facility maintenance

records, record the energy specifications for the drying systems (electrical or gas-fired dryers), corona treater, UV lamps, chillers, ink pumps, press, and emissions control devices.
- ***Substrate:*** identification number of the roll, date of manufacture, corona pre-treatment level.
- ***Waste Treatment:*** description of on-site waste treatment capabilities (including incineration), reliance on off-site waste treatment and disposal, annual or quarterly costs and volumes for the facilities waste disposal and treatment, an estimate of the percentage of these costs attributable to the facility's flexographic operations.
- ***History:*** the experience this facility and of the press operator assigned to help with the demonstration. Include the length of time the facility and this operator have been running this ink system and substrates, how frequently they run it, and the operator's opinion of the ink system and substrates being demonstrated.

2. Web the press.

3. Measure and record the surface tension on the operator side and on the gear side of the web following the procedure in Appendix 4-I.

4. Mount the printing plates.

5. Pre-align anilox cylinder to plate, and plate to impression cylinder.

6. For surface print runs, the desired sequence of colors is white, magenta, cyan, green blue. For reverse printing, the desired color sequence is magenta, cyan, green, blue, white. Record the print unit number for each color.

7. Add inks and pre-mix in sumps. Record the manufacturer name and number of each of the components added. Components may include ink, extender, solvent, and any other additives. Weigh each component and record the quantity used.

8. For each color, measure and record the viscosity of the ink using a #2 Zahn efflux cup. For UV inks, record the manufacturer's reported viscosity.

9. Record any observations or occurrences during the pre-makeready step (e.g., any problem with the ink, plates, or substrate that may influence the demonstration results).

B. Makeready

Prior to production, makeready activities (set-up operations to optimize image quality) will be performed. For the performance demonstration, collect information on the makeready activities:

1. Record the start time for makeready.

2. Record (or zero) the meter reading for the length of substrate printed.

3. Record the treat level before and after corona discharge treatment. Also record the corona treater power level.

4. Measure and record the surface tension on the operator side and on the gear side of the web

following the procedure described in Appendix 4-I.

5. Complete the alignment of the anilox cylinders to the plates, and of the plates to the impression cylinder.

6. Optimize the press speed. Record.

7. Optimize the ink viscosity and color by matching it to the Pantone color swatches. Weigh and record the quantity of any components added to the ink to optimize viscosity and color. Record the ink viscosity after each addition. Repeat for each color.

8. Optimize the dryer settings. For each interstation dryer and for the main tunnel, record the air temperature and velocity.

9. When the print and color quality are acceptable, record the time the makeready is complete.

10. Record the meter reading for substrate length printed during the makeready.

11. Record the quantity of substrate waste generated during makeready.

12. Following the test procedure specified in Appendix 4-E, measure and record the print density after acceptable color and print quality is achieved. If any additions are made to the ink, repeat the measurement and record the print density.

13. Perform the tape adhesiveness test on all colors. Record the results. If any adhesion failure occurs, record an estimate of the percentage of ink lifted from the substrate. A detailed description of the test procedure can be found in Appendix 4-E.

14. Visually inspect the printed image for the following qualities and record a qualitative assessment of each:

- Trap
- Dimensional stability
- Blocking
- Mottle

15. Record any other observations or occurrence during the makeready.

C. Demonstration Run

During the print run, information will be collected on any problems encountered and any changes made to maintain constant print quality.

1. Record the start time of the demonstration run and run for 2 hours. If a problem is encountered and the 2 hour run can not be completed, any run of 1 hour or longer will be considered complete with sufficient data for the evaluation of performance, costs and risk.

2. Record (or zero) the meter measuring substrate length printed.

3. Mark the substrate roll to indicate the end of the makeready printing.

4. Mark the roll every 30 minutes for post-run laboratory testing.

5. Using a reflection densitometer and following the test procedure specified in Appendix 4-E, measure the print density at the start of the run for each color. If any additions are made to the ink, repeat the measurement and record the print density.

6. Measure and record the ink viscosity for each color every 15 minutes. Record the quantity of any additions made to the ink.

7. Record the press speed.

8. Record the time the run is completed.

9. At the end of the run, record the meter reading for linear feet of substrate used.

10. Record the quantity of substrate waste generated during the demonstration run.

11. Record any other observations or occurrence during the demonstration run. Record any of the practices of the facility that may have affected the demonstration results (e.g., equipment malfunction, substrate problem).

12. Visually inspect the printed image for the following qualities and record a qualitative assessment of each:

- Trap
- Dimensional stability
- Blocking
- Mottle

13. Wrap and secure the printed roll.

14. For the OPP, which will be reverse printed and used as a laminate, the adhesive and the second substrate will be applied to approximately 200 feet of film taken from the middle of the print run. If the demonstration facility has the capability to laminate in-house, the substrate will be laminated on-site. The lamination equipment procedure, adhesive, and the second substrate used will be recorded. If the facility does not have lamination capabilities, the substrate will be sent off-site to a lamination facility. Once the volunteer facilities are finalized, every effort will be made to standardize the lamination materials and procedures used.

V. CLEAN-UP

After the print run is complete, record information on the steps taken and products used to clean the press in preparation for the next print job.

A. Clean-up Methods

Record the procedures used at each facility for clean-up. If the facility is unfamiliar with the clean-up procedures for the type of ink used in the demonstration, follow manufacturer’s recommendations.

1. Record start time for clean-up.

2. Allow the excess ink to drain into an empty container. Squeegee any remaining ink from the pans into the same container. Weigh the excess ink and record.

3. Record the washing procedure for cleaning the ink pumps, ink rolls, ink and other components.

4. Record the time when cleaning is complete.

5. Record any procedures or occurrences that may influence clean-up time.

B. Clean-Up Chemicals

1. Record the manufacturer's name and the product name for all chemicals used. Make a copy of the MSDS for each product used during cleanup.

2. Record all clean-up steps where water was used.

3. Record the quantity of each chemical used for clean-up.

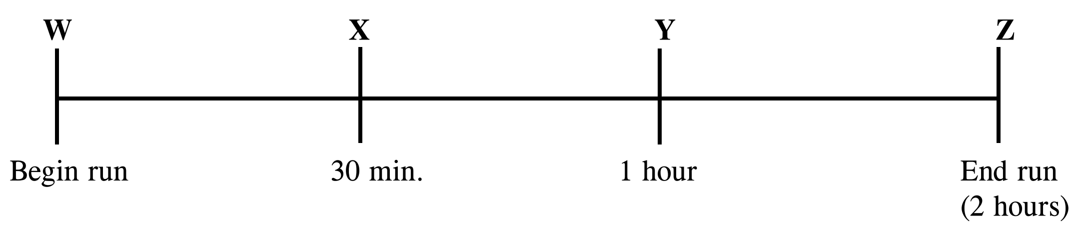
4. If clean-up products are reused or recycled, document the technique used and the percentage of product reclaimed or recycled.

VI. POST-RUN LABORATORY TESTS

After the demonstration run is complete, the roll of printed substrate should be wrapped and shipped immediately back to WMU. At the WMU laboratory, a series of tests will be performed to assess the print quality. These tests are listed in the table on the following page. While the tests checked off under "Makeready" and "Press" will be conducted visually during the demonstration, more quantitative testing will be conducted for the tests checked off under the "Laboratory" heading. The testing protocol for each of these can be found in Appendix 4-E.

A. Location of Samples

All tests will be repeated at four different position in the printed roll:



- All samples will be collected from each location (W, X, Y, Z).
- At each location (W, X, Y, Z) either 1 or 5 repeats will be taken, as indicated in the "**# of Samples**" column of the table.
- Test measurements will be conducted at 2 cross web points on each repeat.
- For the Coat Weight test, 50 images will be pulled and weighed at each of the testing time locations.

B. Colors to be Sampled

The "Colors" column of the table indicates the colors on which the results for this specified test will be recorded. "White +1" indicates that test results will be recorded for the white ink and one other color. In the case of PE/EVA printed substrate, only the results of the one color test will be recorded since white ink will not be printed on this white substrate. If this column is Not Applicable, as in the case of Coat Weight, "NA" is noted in the column.

C. Laboratory Tests List

	TEST METHOD	Initial Lab Test	Dry Run	Make-ready	Press	Lab	# of Samples	Colors
1-A	Adhesion/Flexible Pack.		X			X	5	white+1
1-B	Adhesive Lamination (laminate only)					X	5	NA
2	Adhesiveness -Tape		X	X	X		5	white+1
3	Extrusion Lamination (laminate only)					X	5	NA
4	Sutherland Rub (surface print only)	X	X			X	5	white+1
5	Block Resistance		X	X	X	X	5	white+1
6	Color L*a*b*	X	X			X	1	all
7	Density - Print	X	X	X	X	X	1	all
8	Image Analysis (quantitatively - dot structure)		X			X	1	all
9	Opacity (white only)	X	X			X	1	white
10	Gloss (Gardner 60°) (not for reverse print)		X			X	1	all
11	Mottle/Lay (Tobias tester)	X	X	X	X	X	1	all
12	Dimensional Stability		X	X	X	X	1	all
13	Coat Weight (dry lbs./ream)		X			X	50	NA
14	Coefficient of Friction (not reverse)		X		X	X	5	NA
15	Heat Resistance - Heat Seal (Sentinel - OPP only)					X	5	white+1
16	Ice Water Crinkle Resistance (PE & PE/EVA)		X			X	5	white+1
17	Odor		X			X	5	NA
18	Surface Tension - Film (dynes)		X	X	X		1	NA
19	Solvent Retention (MS)		X			X	5	all
20	UV- Uncured Residue		X				5	all
21	Trap	X	X		X	X	1	cyan+ magenta

NA= Not Applicable

Appendix 4-B (Performance Chapter)
Facility Background Questionnaire

BACKGROUND

Approximate total sales:	
Percent of sales from flexographic-printed products:	

Total flexographic output of facility (by weight, surface area, or linear feet):	

Type of product	Percent of total sales	Type of product	Percent of total sales
Flexible packaging	%	Folding cartons	%
Commercial printing	%	Gift wraps and papers	%
Corrugated containers	%	Newspapers	%
Tags and labels	%	Other:	%

Type of ink	Percent of total product sales
Solvent-based	%
Water-based	%
UV-curable	%

Type of substrate	Percent of total product sales
Film:	%
Film:	%
Film:	%
Other:	%

Production hours:			
Daily		Annually	
Average length of time of job run			
Average length of time of makeready			

ENVIRONMENTAL PERFORMANCE

Ink disposal/treatment method (please describe):

Annual ink waste treatment and disposal costs:

Substrate recycling (please describe):

Annual costs or savings for substrate recycling:

Solid/hazardous waste treatment and disposal (please describe):

Annual costs for solid/hazardous waste treatment and disposal:

COSTS

Bulbs for drying lamps, annual cost and annual quantity used:

Doctor blades, annual cost and annual quantity used:

Ink cleaning equipment price and year of purchase:

Ink cleaning supplies, annual cost:

Explosion protection measures cost:

Ventilation/air filtering equipment price and year of purchase:
Annual cost for filters, etc.:

CLEANING PROCEDURE

What is the cleaning procedure for removing ink after a run?

How are used rags handled (industrial laundry or disposal):

What employee protective gear is used when cleaning (circle all that apply):
eye shields gloves apron respirator

Is the total volume of cleaning solution captured?

If yes, how is the captured solution disposed of?

Is the total volume of cleaning solution reused?

If yes, how often is the solution reused?
Is it processed in any way prior to reuse?

Is the used cleaning solution discharged directly to the sewer?
Is it pretreated?

PROCESS HISTORY

If you are using water-based or UV ink to print on film substrates, when did you switch from solvent-based inks?

Why did you switch?

What changes were required to the equipment, the substrate, or your work practices to make this ink work?

What costs or savings are associated with the switch?

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Appendix 4-C (Performance Chapter)
Performance Demonstration Data Collection Form

I. Press Configuration

A. The press

Press manufacturer		Model	
Age of press		Typical production speed	
Press type *(circle)*	CI in-line stack	Maximum web width	(in)

B. Print units

Number of print units	
Distance between color stations	
Drum diameter	

C. Anilox

Print unit					
Surface Type					
Volume (BCM)					
Screen count (LPI)					
Diameter					
Condition					

D. Ink metering system

Doctor blade	Describe:

E. Ink pumping and mixing system

Type		Manufacturer	
Description			

F. Corona treater

Manufacturer		Model	
Maximum power output			

G. UV lamp(s)

Start time for lamp warm-up	
Stop time for lamp warm-up	
Energy consumption for UV lamp during warm-up	

H. Dimensions of …

… Dryers *(sketch)*	
Interstation	
Main	

or

… UV lamps	
Interstation	
Main	

I. Blowers

Total number		Rated output	(cfm)
Location and size *(sketch)*			

J. Chillers

Total number		Location and size *(sketch)*	

K. VOC treatment

Type		Efficiency	

Observations:

II. Set-Up (Pre-Makeready)

A. Substrate: *(circle one)* PE PE/EVA OPP

Roll ID number		Manufacturer Name		Date of manufacture	

B. Ink: *(circle one)* Water UV Solvent

Ink manufacturer		Ink manufacturer on-site	

Record the ink components on the **Ink Set-up Sheet (Pre-Makeready)**

C. Plate

Material		Manufacturer	
Gauge		Plate-mounting method	

D. Observations:

III. Makeready

A. Substrate

Corona treatment specs			
Power = kW	Current = A	Voltage = V	Frequency = kHz

Surface Tension (dynes):

	Before corona treatment		After corona treatment	
Across Web	*Reading 1*	*Reading 2*	*Reading 1*	*Reading 2*
Left				
Right				

B. Record the ink compositions and adjustments on the **Ink Setup Sheet (Makeready)**.

C. Start

Start time	
Start footage (counter)	

D. Printing speed

Optimal printing speed obtained	

E. Stop

Stop time	
Stop footage (counter)	

F. Record the results of the ink densities on the **Density Sheet (Makeready)**.

G. Record the results of the tape-adhesiveness test on the **Tape-Adhesiveness Test Sheet.**

H. Record the results of the visual tests (mottle/lay, trap, dimensional stability, blocking) on the **Visual Quality Test Sheet.**

I. Observations:

IV. Running Parameters

A. Start

Start time	
Start footage (counter)	

B. At the beginning of the run, record the ink densities on the **Density Sheet**.

C. Record the ink viscosity on the **Running Viscosity Sheet** every 15 minutes during the run.

Observations:

D. Press speed

Press speed obtained	

Observations:

E. Dryers

	CI dryer #1	CI dryer #2	CI dryer #3	CI dryer #4	Main dryer
Temperature:					
Velocity:					
Area:					
Balance:					

Describe the number and type of adjacent presses. Note which were in operation during the performance demonstration and record the type of ink they were running:

F. Energy consumption

Measure and record energy consumption during the demonstration run

Printing press	
Ink pumps	
Corona treater	
Interstation UV lamp	
Final UV lamp	
Interstation dryer	
Final dryer	
Blowers	
Chillers	
VOC incinerators/ recovery units	

G. Ambient Conditions

Temperature	°F	Humidity	%

H. Stop

Stop time	
Stop footage (counter)	

I. Record the results of the ink densities on the **Density Sheet.**

J. Record the results of the tape-adhesiveness test on the **Tape-Adhesiveness Test Sheet.**

K. Record the results of the visual tests (mottle/lay, trap, dimensional stability, blocking) on the **Visual Quality Test Sheet.**

L. Waste substrate

Quantity generated during the 2-hr run (estimate)	

V. Clean-Up

A. Start time

Start time	

B. Cleaning chemical

Product name	Manufacturer	Type
1.		
2.		
3.		

C. Clean-up procedure

1.
2.
3.
4.
5.

D. Stop time

Stop time	

Ink Set-Up Sheet: REFLEX BLUE

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

Print Unit	

Pre-Makeready and Makeready

Ink	(lbs)	Manufacturer's number	
Water	(lbs)		
Extender	(lbs)	Manufacturer's number	
Solvent	(lbs)	Manufacturer's number	
Other additive:	(lbs)	Manufacturer's number	

During Run

Record when added…

Ink	(lbs)	Manufacturer's #		# impressions	
Water	(lbs)			# impressions	
Extender	(lbs)	Manufacturer's #		# impressions	
Solvent	(lbs)	Manufacturer's #		# impressions	
Other additive:	(lbs)	Manufacturer's #		# impressions	

Clean-Up

Ink remaining in bucket	(lbs)	Comments:			
Cleaning solutions added	(lbs)	Type		Manufacturer # (attach MSDS)	
	(lbs)	Type		Manufacturer # (attach MSDS)	
Ink scraped out	(lbs)	Comments:			
Ink wiped out	(lbs)	Dry rag weight	(lbs)	Rag weight after cleaning	(lbs)
Ink and cleaning solution removed	(lbs)	Comments:			

Calculate Total Ink Used

Calculate Ink Used	(lbs)	For how many substrates?	

Ink Set-Up Sheet: CYAN

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

Print Unit	

Pre-Makeready and Makeready

Ink	(lbs)	Manufacturer's number	
Water	(lbs)		
Extender	(lbs)	Manufacturer's number	
Solvent	(lbs)	Manufacturer's number	
Other additive:	(lbs)	Manufacturer's number	

During Run

Record when added…

Ink	(lbs)	Manufacturer's #		# impressions	
Water	(lbs)			# impressions	
Extender	(lbs)	Manufacturer's #		# impressions	
Solvent	(lbs)	Manufacturer's #		# impressions	
Other additive:	(lbs)	Manufacturer's #		# impressions	

Clean-Up

Ink remaining in bucket	(lbs)	Comments:			
Cleaning solutions added	(lbs)	Type		Manufacturer # (attach MSDS)	
	(lbs)	Type		Manufacturer # (attach MSDS)	
Ink scraped out	(lbs)	Comments:			
Ink wiped out	(lbs)	Dry rag weight	(lbs)	Rag weight after cleaning	(lbs)
Ink and cleaning solution removed	(lbs)	Comments:			

Calculate Total Ink Used

Calculate Ink Used	(lbs)	For how many substrates?	

Ink Set-Up Sheet: GREEN

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

Print Unit	

Pre-Makeready and Makeready

Ink	(lbs)	Manufacturer's number	
Water	(lbs)		
Extender	(lbs)	Manufacturer's number	
Solvent	(lbs)	Manufacturer's number	
Other additive:	(lbs)	Manufacturer's number	

During Run

Record when added…

Ink	(lbs)	Manufacturer's #		# impressions	
Water	(lbs)			# impressions	
Extender	(lbs)	Manufacturer's #		# impressions	
Solvent	(lbs)	Manufacturer's #		# impressions	
Other additive:	(lbs)	Manufacturer's #		# impressions	

Clean-Up

Ink remaining in bucket	(lbs)	Comments:			
Cleaning solutions added	(lbs)	Type		Manufacturer # (attach MSDS)	
	(lbs)	Type		Manufacturer # (attach MSDS)	
Ink scraped out	(lbs)	Comments:			
Ink wiped out	(lbs)	Dry rag weight	(lbs)	Rag weight after cleaning	(lbs)
Ink and cleaning solution removed	(lbs)	Comments:			

Calculate Total Ink Used

Calculate Ink Used	(lbs)	For how many substrates?	

Ink Set-Up Sheet: MAGENTA

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

Print Unit	

Pre-Makeready and Makeready

Ink	(lbs)	Manufacturer's number	
Water	(lbs)		
Extender	(lbs)	Manufacturer's number	
Solvent	(lbs)	Manufacturer's number	
Other additive:	(lbs)	Manufacturer's number	

During Run

Record when added…

Ink	(lbs)	Manufacturer's #		# impressions	
Water	(lbs)			# impressions	
Extender	(lbs)	Manufacturer's #		# impressions	
Solvent	(lbs)	Manufacturer's #		# impressions	
Other additive:	(lbs)	Manufacturer's #		# impressions	

Clean-Up

Ink remaining in bucket	(lbs)	Comments:			
Cleaning solutions added	(lbs)	Type		Manufacturer # (attach MSDS)	
	(lbs)	Type		Manufacturer # (attach MSDS)	
Ink scraped out	(lbs)	Comments:			
Ink wiped out	(lbs)	Dry rag weight	(lbs)	Rag weight after cleaning	(lbs)
Ink and cleaning solution removed	(lbs)	Comments:			

Calculate Total Ink Used

Calculate Ink Used	(lbs)	For how many substrates?	

Ink Set-Up Sheet: WHITE

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

Print Unit	

Pre-Makeready and Makeready

Ink	(lbs)	Manufacturer's number	
Water	(lbs)		
Extender	(lbs)	Manufacturer's number	
Solvent	(lbs)	Manufacturer's number	
Other additive:	(lbs)	Manufacturer's number	

During Run

Record when added…

Ink	(lbs)	Manufacturer's #		# impressions	
Water	(lbs)			# impressions	
Extender	(lbs)	Manufacturer's #		# impressions	
Solvent	(lbs)	Manufacturer's #		# impressions	
Other additive:	(lbs)	Manufacturer's #		# impressions	

Clean-Up

Ink remaining in bucket	(lbs)	Comments:			
Cleaning solutions added	(lbs)	Type		Manufacturer # (attach MSDS)	
	(lbs)	Type		Manufacturer # (attach MSDS)	
Ink scraped out	(lbs)	Comments:			
Ink wiped out	(lbs)	Dry rag weight	(lbs)	Rag weight after cleaning	(lbs)
Ink and cleaning solution removed	(lbs)	Comments:			

Calculate Total Ink Used

Calculate Ink Used	(lbs)	For how many substrates?	

Tape-Adhesiveness Test Sheet

Record after makeready and after print run.

Substrate: *(circle one)* PE PE/EVA OPP

End of makeready

	Pass	Fail	Comment
White Pull 1			
2			
Green Pull 1			
2			
Blue Pull 1			
2			
Magenta Pull 1			
2			
Cyan Pull 1			
2			

End of run

	Pass	Fail	Comment
White Pull 1			
2			
Green Pull 1			
2			
Blue Pull 1			
2			
Magenta Pull 1			
2			
Cyan Pull 1			
2			

Visual Quality Test Sheet

Record at end of makeready and end of print run.

Makeready

A. Mottle/Lay - visual quality:____

____

B. Trap:____

____

C. Dimensional Stability:____

____

D. Blocking:____

____

End of Run

A. Mottle/Lay:____

____

B. Trap:____

____

C. Dimensional Stability:____

____

D. Blocking:____

____

Density Sheet

Record at the end of the makeready and end of the print run.

End of Makeready:

	Green	Blue	Magenta	Cyan
Density 1				
Density 2				
Density 3				
Density 4				
Density 5				
Average Density				
Standard Deviation				

End of run:

	Green	Blue	Magenta	Cyan
Density 1				
Density 2				
Density 3				
Density 4				
Density 5				
Average Density				
Standard Deviation				

Observations:

Running Viscosity Sheet

Record every 15 minutes during the press run.

Ink: *(circle)* | Water | UV | Solvent | - | PE | PE/EVA | OPP |

REFLEX BLUE

Time	Start	15 min.	30 min.	45 min.	1 hour	1 hr. 15	1 hr. 30	1 hr. 45	2 hrs.
Viscosity									

CYAN

Time	Start	15 min.	30 min.	45 min.	1 hour	1 hr. 15	1 hr. 30	1 hr. 45	2 hrs.
Viscosity									

GREEN

Time	Start	15 min.	30 min.	45 min.	1 hour	1 hr. 15	1 hr. 30	1 hr. 45	2 hrs.
Viscosity									

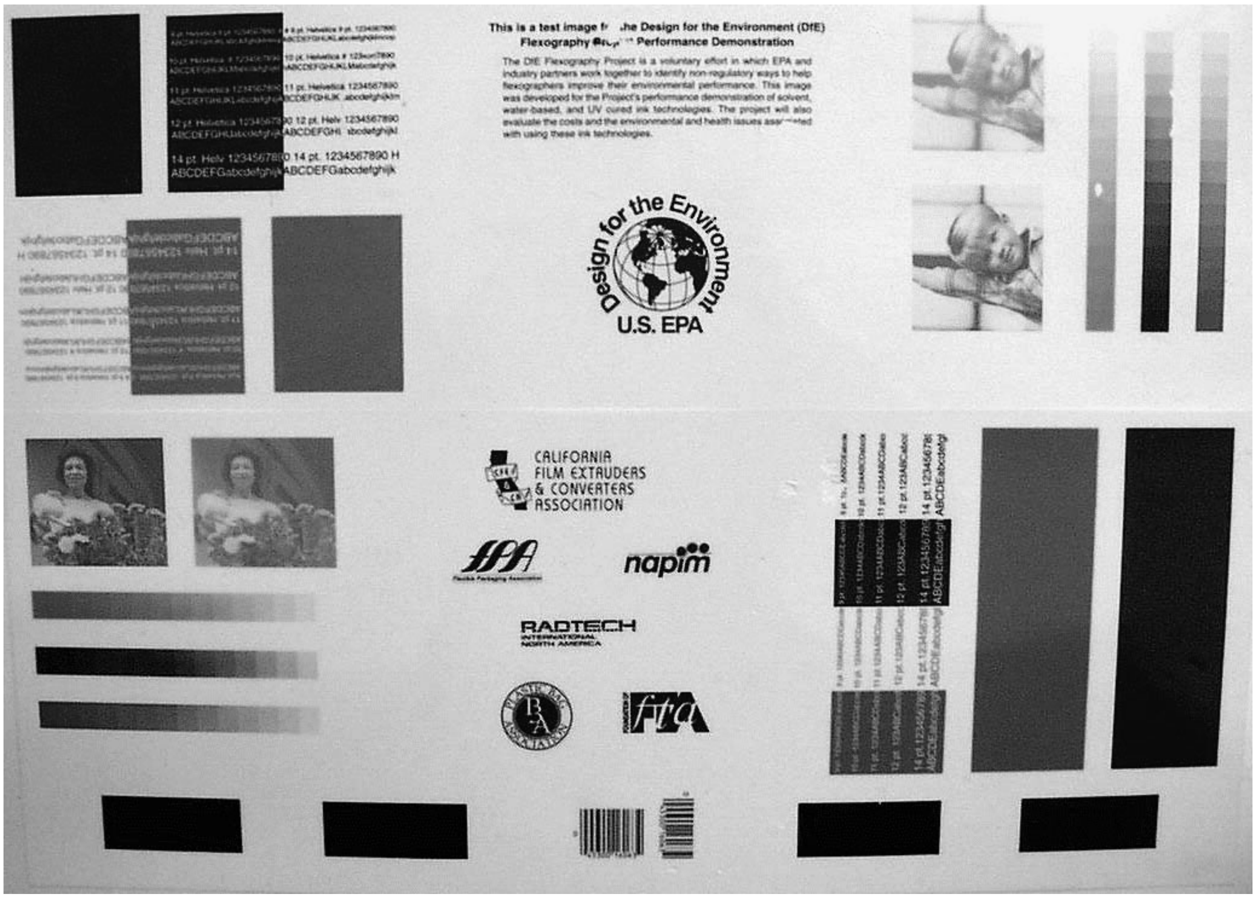
MAGENTA

Time	Start	15 min.	30 min.	45 min.	1 hour	1 hr. 15	1 hr. 30	1 hr. 45	2 hrs.
Viscosity									

WHITE

Time	Start	15 min.	30 min.	45 min.	1 hour	1 hr. 15	1 hr. 30	1 hr. 45	2 hrs.
Viscosity									

Appendix 4-D (Performance Chapter)
Test Image Design



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Appendix 4-E (Performance Chapter)
Laboratory Test Procedures and Performance Data

Adhesive Lamination

Purpose
The purpose of this test is to measure the bond strength of the adhesive layer of the lamination to the ink. The adhesive lamination test is based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment
Force measurement instrument
#6 Meyer bar
Oven
Adhesive (Morton's Lamal HSA or Adcote 333)

Procedure
1. Make a print of ink to be tested on designated stock using a #6 Meyer bar.

2. Dry print in oven at 180°F for 30 seconds.

3. Apply a second down of adhesive (Morton's Lamal HSA or Adcote 333) using a #6 bar.

4. Dry the adhesive at 120°F for 30 seconds.

5. Place the stock to which the ink is to be laminated in contact with the printed sample. Use a flexographic hand proofer to apply pressure to the lamination and to remove any trapped air.

6. Place the sample in a 180°F oven for 45 seconds to cure the adhesive.

7. Let sample age for a minimum of 24 hours before testing.

8. Cut a one-inch test strip from the laminated sample and use the force measurement instrument to determine the force (in kilograms) which is necessary to separate the two pieces of stock.

Results
Delamination tests were done in the machine direction of the laminated film. The delamination force was the average of five measurements. Samples were cut from one location during the run as indicated by the following symbol:

x = thirty minutes into run

Results appear in Chapter 4.

Block Resistance

Purpose

The purpose of the block resistance test is to check the bond of the ink to the substrate when heat and pressure are applied. The block resistance test is based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment

I.C. Block Tester
Calibrated compression springs
Oven
Humidity-controlled environment (if not available, conditions should be reported)

Procedure

1. The adhesion of the ink is tested two ways: "face to face" (printed side to printed side) and "face to back" (printed side to unprinted side). "Back to back" (unprinted substrate on unprinted substrate) should be tested as the control.

Only surface printed samples are tested "face to face." The original protocol stated, "The test should be conducted at 5 pounds per square inch (psi) for 16 hours at 80% relative humidity. These humidity conditions must be met in order to properly interpret the results." However, the actual tests were conducted at 100 psi for 8 hours at 43% humidity in a 120°F oven.

Surface and lamination printed samples are tested "face to back." The original protocol stated, "The standard test should be conducted at 50 psi for 16 hours at 80% relative humidity. If 80% relative humidity cannot be met, use 125 psi at 120°F at ambient humidity." However, the actual tests were conducted at 100 psi for 8 hours at 43% humidity in a 120°F oven.

2. Test prints should be two inches wide by six inches long. The minimum size is two inches wide by two inches long.

3. Place test prints (face-to-face, face-to-back, or back-to-back) on the base of the block tester immediately after printing and drying.

4. Insert the centering place without disturbing the position of the test prints.

5. Select a calibrated compression spring, depending on the pressure required.

6. Place the spring (bottom in centering plate opening) into the assembly and tighten to the desired pressure (indicator and scale attached to spring).

7. Place the block tester in an environment with the specified humidity.

8. Remove the print and separate it carefully to observe the tendency to block.

9. When the test print is on vinyl or highly plasticized film, check the block test after the recommended period of time, then place it back in the test chamber and check it again after several days. Blocking may occur after a prolonged period of time due to plasticizer migration.

Results

The OPP substrate from sites 1, 4, 9, and 10 was tested in the in the pre-laminated state, to simulate rewind conditions that it would be subjected to prior to converting. The results are reported on a scale from 0 to 5 as described in Table 4-E.1.

Table 4-E.1 Description of Block Resistance Results

Score	Block Resistance Result	Description
0	No blocking	No adhesion or cohesion between contiguous surfaces, which slide or peel freely upon one another. Surfaces of specimens are not marred.
1	Slight cling	A slight “ticking” can be heard as the samples are carefully peeled apart, but there is no visible marring of the surface.
2	Cling	There is a noticeable adhesion between adjacent surfaces or a visual marring of the surfaces but no distortion of webs or offset of printing inks, lacquers, or other coatings.
3	Slight blocking	Slight adhesion, adjacent surfaces do not slide or peel freely, but do with frictional pressure. Surface of specimen may show very slight evidence of web distortion or marring of the coating or transfer of ink or coating to the immediate contact surface of next specimen.
4	Considerable blocking	Adhesion or cohesion of contiguous surfaces. Layers may be separated with difficulty. Surfaces will be distorted, marred, or partially destroyed showing ink, lacquer, or coating transfer to the immediate contact surface of next specimen. Paper based materials will show loss of fiber. Synthetics may or may not display surface mar.
5	Complete blocking	Blocking to the extent of a complete seal or weld between adjacent surfaces which cannot be separated without destructing the specimen.

For the testing of the samples printed at the performance demonstration facilities and at Western Michigan University, samples were cut from two locations during the run length as indicated by location identification symbols as follows:

w = beginning of run
z = end of run

Table 4-E.2 shows the block resistance of samples from each site. When a site number begins with an “L,” the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.2 Block Resistance For Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	F-F/ F-B[b]	Result[c]	Score[c]
Solvent-based	LDPE	#S2	5	w	F-F	slight blocking	3
					F-B	slight blocking	3
				z	F-F	slight cling	1
					F-B	slight cling	1
			7	w	F-F	considerable blocking on blue	4
					F-B	considerable blocking on blue	4
				z	F-F	slight blocking	3
					F-B	considerable blocking on blue	4
			L5[d]	w	F-F	slight blocking	3
					F-B	slight cling	1
				z	F-F	slight blocking	3
					F-B	slight blocking	3
	PE/EVA	#S2	5	w	F-F	slight cling	1
					F-B	considerable blocking	4
				z	F-F	slight cling	1
					F-B	slight blocking on green	3
			7	w	F-F	slight blocking	3
					F-B	considerable blocking on blue	4
				z	F-F	slight blocking	3
					F-B	considerable blocking	4
			L7				
	OPP	#S1	9B	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	considerable blocking on blue	4
		#S2	10	w	F-F	slight blocking	3
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight blocking	3
			L4	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight cling	1

Ink System	Film	Product Line	Site	Location of Sample[a]	F-F/ F-B[b]	Result[c]	Score[c]
UV	LDPE	#U2	6	w	F-F	slight cling	1
					F-B	considerable blocking	4
				z	F-F	slight cling	1
					F-B	considerable blocking	4
	PE/EVA	#U2	6	w	F-F	slight cling	1
					F-B	considerable blocking	4
				z	F-F	slight cling	1
					F-B	slight cling	1
		#U3	8	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight cling	1
UV (no slip)	LDPE	#U1	11	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight cling	1
Water-based	LDPE	#W3	2	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight cling	1
			3	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight blocking on green	3
			L1	w	F-F	slight blocking	3
					F-B	slight blocking	3
					F-F	slight cling	1
					F-B	slight cling	1
	PE/EVA	#W3	2	w	F-F	slight cling	1
					F-B	slight blocking on blue	3
				z	F-F	slight cling	1
					F-B	slight cling	1
			3	w	F-F	slight cling	1
					F-B	slight cling	1
				z	F-F	slight cling	1
					F-B	slight cling	1
			L6	w	F-F	slight cling	1
					F-B	slight blocking	3
				z	F-F	slight cling	1
					F-B	slight blocking	3

Ink System	Film	Product Line	Site	Location of Sample[a]	F-F/ F-B[b]	Result[c]	Score[c]
	OPP	#W1	4	w	F-F	considerable blocking	4
					F-B	considerable blocking	4
				z	F-F	considerable blocking	4
					F-B	considerable blocking	4
Water-based	OPP	#W2	1	w	F-F	considerable blocking	4
					F-B	slight blocking	3
				z	F-F	considerable blocking	4
					F-B	slight cling	1
			L3	w	F-F	slight blocking	3
					F-B	slight blocking	3
				z	F-F	slight blocking	3
					F-B	slight cling	1
		#W4	9A	w	F-F	considerable blocking	4
					F-B	slight cling	1
				z	F-F	considerable blocking	4
					F-B	slight cling	1
			L2	w	F-F	slight blocking	3
					F-B	slight cling	1
				z	F-F	slight blocking	3
					F-B	slight cling	1

[a]Samples were taken at two locations from the printed sample:
w = beginning of run
z = end of run

[b]Samples were tested in two ways:
F-F = face to face (printed substrate to printed substrate)
F-B = face to back (printed substrate to unprinted substrate)

[c]The score is a number corresponding to the test result based on the following scale:
no blocking = 0
slight cling = 1
cling = 2
slight blocking = 3
considerable blocking = 4
complete blocking = 5

[d]"L" indicates data from a laboratory run.

See Table 4-E.1 for a complete description.

CIE L*a*b*

Purpose

The purpose of the CIE (International Commission on Illumination) L*a*b* test is to measure the reflected light and calculate a numerical value for the light/darkness, hue, and chroma of a printed color. The CIE L*a*b* test is based on methods developed by Western Michigan University.

Equipment

Spectrophotometer/colorimeter (Datacolor Spectraflash 600)

Procedure

1. Measure the CIE L*a*b* values using the Datacolor Spectraflash 600. Operate the colorimeter in accordance with the manufacturer's specifications.

2. Measurements will be performed using the Small Area View (SAV) port, so calibrations should also be made to this port size. Following the instructions on the computer screen, calibrate to the black cavity holding it over the port. Then attach the white standard 529 to the arm and calibrate according to the instructions.

3. Measure the samples using the SAV port size. Two samples are to be taken from four locations of the run. All three substrates will be tested (LDPE, PE/EVA, and OPP). Generally, select the mode for CIE L*a*b* and place the sample area at port. Follow the instructions on the screen to proceed with the testing.

4. Take readings of solid ink densities at several areas of the specimen surface to obtain an indication of uniformity.

5. Measure each sample on both sides of the sheet for each color. The instrument will automatically take five measurements and report the average as one value.

Results

CIE L*a*b* values were measured in the laboratory with samples collected from each site. Samples were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Table 4-E.3 shows the CIE L*a*b* measurements for these samples. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
Solvent-based	LDPE	#S2	5	w	magenta	46.81	59.05	-5.10	x	magenta	46.34	58.61	-3.03
					cyan	59.71	-40.72	-26.94		cyan	58.69	-39.99	-27.68
					green	53.46	-49.05	29.66		green	52.00	-48.27	28.43
					blue	39.57	2.75	-49.81		blue	38.94	4.29	-49.91
				y	magenta	48.30	57.32	-6.33	z	magenta	46.82	58.67	-4.87
					cyan	60.41	-40.17	-25.94		cyan	60.48	-40.35	25.98
					green	54.87	-48.20	30.38		green	53.33	-48.85	29.77
					blue	37.32	6.32	-50.93		blue	36.46	7.64	-50.67
			#7	w	magenta	50.44	54.92	-8.45	x	magenta	48.58	55.49	-4.91
					cyan	62.12	-38.74	-23.57		cyan	61.02	-39.20	-24.42
					green	63.90	-38.92	31.15		green	62.57	-40.98	32.19
					blue	43.86	-2.34	-45.69		blue	42.25	1.02	-47.05
				y	magenta	49.80	54.95	-6.91	z	magenta	51.29	52.57	-7.45
					cyan	60.67	-39.37	-24.86		cyan	63.19	-38.07	-22.73
					green	60.94	-43.01	32.33		green	67.27	-34.46	30.01
					blue	41.04	1.49	-48.26		blue	42.58	-0.05	-46.81
			L5[b]	w	green	53.54	-47.45	28.56	x	green	66.57	-36.54	30.52
				y	not sampled				z	green	65.09	-38.19	31.21

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
	PE/EVA	#S2	5	w	magenta	51.94	50.92	-0.09	x	magenta	52.53	52.18	-2.41
					cyan	61.82	-27.62	-37.92		cyan	62.41	-28.84	-37.96
					green	58.18	-56.64	34.24		green	57.22	-56.62	33.88
					blue	37.61	15.70	-56.09		blue	38.30	15.26	-57.75
				y	magenta	54.08	47.24	1.47	z	magenta	57.90	40.56	-0.49
					cyan	61.49	-29.06	-38.91		cyan	62.95	-24.43	-35.65
					green	55.68	-53.52	30.48		green	56.02	-53.53	30.66
					blue	35.32	18.08	-57.43		blue	36.14	16.78	-57.70
Solvent-based	PE/EVA	#S2	7	w	magenta	52.05	51.69	-3.39	x	not sampled			
					cyan	61.97	-30.98	-36.12					
					green	67.66	-46.77	31.92					
					blue	38.17	13.76	-53.99					
				y	not sampled				z	magenta	49.91	56.31	-4.38
										cyan	60.47	-32.37	-38.11
										green	67.71	-47.19	32.25
										blue	39.37	12.46	-53.74
			L7	w	green	65.08	-37.95	31.41	x	green	65.57	-36.25	31.36
					cyan	63.68	-28.18	-38.08		cyan	62.79	-29.25	-36.79
				y	not sampled				z	green	65.09	-38.16	31.21
										cyan	63.42	-28.95	-37.46

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
	OPP	#S1	9B	w	magenta	52.62	51.76	-3.70	x	magenta	50.91	52.69	-4.77
					cyan	60.46	-37.66	-26.45		cyan	60.38	-37.29	-26.26
					green	64.43	-35.65	30.61		green	64.68	-35.43	30.04
					blue	47.80	-5.45	-39.48		blue	48.71	-6.12	-38.04
				y	not sampled				z	magenta	52.40	52.16	-3.41
										cyan	59.06	-37.48	-28.35
										green	65.18	-34.52	30.62
										blue	46.41	-4.07	-41.13
		#S2	10	w	magenta	66.76	29.93	-5.30	x	magenta	67.18	29.04	-5.74
					cyan	71.08	-26.11	-12.23		cyan	71.20	-26.64	-12.13
					green	55.72	-48.65	29.45		green	57.11	-44.59	28.27
					blue	39.31	2.28	-47.28		blue	41.27	3.59	-43.80
				y	magenta	68.22	28.71	-4.87	z	magenta	65.87	32.22	-7.01
					cyan	71.05	-27.89	-12.55		cyan	70.09	-29.05	-13.76
					green	56.07	-47.92	29.87		green	56.26	-47.57	29.98
					blue	39.19	2.59	-47.38		blue	40.26	1.58	-45.98
			L4	w	green	70.87	-33.35	31.11	x	green	70.16	-35.22	32.07
				y	not sampled				z	green	68.54	-38.30	33.95

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
UV	LDPE	#U2	6	w	magenta	42.11	48.82	11.17	x	magenta	42.11	49.73	10.84
					cyan	60.94	-37.61	-23.79		cyan	61.65	-37.44	-23.34
					green	65.40	-51.71	32.99		green	65.06	-50.43	33.35
					blue	40.36	2.63	-44.68		blue	40.76	1.84	-44.67
				y	magenta	42.02	49.46	11.56	z	magenta	48.97	48.12	10.03
					cyan	61.38	-37.14	-23.52		cyan	60.72	-38.14	-24.38
					green	65.78	-50.83	32.90		green	65.93	-50.06	32.60
					blue	40.63	2.24	-44.79		blue	40.54	2.28	-44.79
	PE/EVA	#U2	6	w	magenta	46.82	55.69	3.11	x	magenta	46.35	55.23	5.88
					cyan	60.61	-30.79	-38.40		cyan	61.21	-30.22	-38.54
					green	65.39	-58.63	31.76		green	64.14	-57.25	31.55
					blue	38.39	11.49	-52.13		blue	38.93	11.65	-49.91
				y	magenta	48.54	51.93	4.59	z	magenta	48.70	52.53	2.44
					cyan	60.77	-30.70	-38.71		cyan	60.52	-30.88	-38.67
					green	64.18	-57.78	31.66		green	64.18	-57.99	31.95
					blue	39.33	10.91	-50.18		blue	38.58	11.15	-49.45
		#U3	8	w	magenta	54.14	52.66	-2.81	x	magenta	51.45	56.13	-1.44
					cyan	63.48	-27.03	-36.39		cyan	62.51	-26.58	-36.70
					green	72.45	-51.68	5.85		green	70.12	-55.25	6.88
					blue	49.08	8.48	-46.97		blue	48.04	8.59	-46.95
				y	not sampled				z	magenta	54.05	51.72	-2.97
										cyan	61.14	-28.06	-37.85
										green	70.22	-54.56	6.78
										blue	48.79	8.29	-46.38

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
UV (no slip)	LDPE	#U1	11	w	magenta	54.18	46.31	-4.60	x	magenta	53.37	48.78	-4.05
					cyan	60.44	-32.03	-22.90		cyan	60.08	-32.78	-24.64
					green	64.56	-54.70	10.24		green	64.09	-56.67	10.51
					blue	34.90	15.02	-50.88		blue	34.85	14.39	-51.32
				y	magenta	51.64	50.84	-5.14	z	magenta	51.64	49.31	-5.01
					cyan	58.96	-34.73	-25.38		cyan	60.02	-33.54	-24.74
					green	63.59	-58.06	10.88		green	63.20	-58.17	11.16
					blue	34.32	15.93	-51.98		blue	34.31	16.21	-52.35
Water-based	LDPE	#W3	2	w	magenta	51.52	50.03	-0.48	x	magenta	51.12	50.45	-1.05
					cyan	54.65	-25.74	-38.83		cyan	55.59	-26.05	-38.44
					green	63.34	-51.49	36.40		green	63.63	-50.78	35.99
					blue	34.12	16.15	-51.01		blue	34.51	15.58	-50.67
				y	magenta	50.18	51.39	-0.77	z	magenta	52.88	50.32	-4.71
					cyan	55.38	-25.69	-38.55		cyan	59.90	-34.29	-26.92
					green	63.28	-50.47	35.41		green	58.98	-51.87	29.54
					blue	34.56	15.37	-51.11		blue	33.26	16.95	-46.48
			3	w	magenta	52.63	53.02	-6.74	x	magenta	52.54	50.84	-7.85
					cyan	63.48	-32.33	-22.45		cyan	62.63	-34.43	-23.86
					green	62.00	-54.24	37.49		green	61.66	-55.06	38.24
					blue	33.51	16.91	-51.59		blue	33.56	17.72	-50.93
				y	magenta	52.36	51.41	-7.88	z	magenta	52.29	49.96	-6.18
					cyan	65.89	-29.05	-19.15		cyan	64.38	-32.32	-21.36
					green	62.07	-54.09	37.37		green	61.34	-54.58	37.49
					blue	33.41	18.35	-50.44		blue	33.23	18.62	-50.04
			L1	w	green	68.96	-43.96	31.91	x	green	68.64	-43.96	32.44
					not sampled				z	green	67.56	-44.95	32.64

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
	PE/EVA	#W3	2	w	magenta	54.16	52.02	-0.81	x	magenta	57.12	44.64	-0.61
					cyan	58.72	-22.49	-40.88		cyan	58.79	-23.84	-40.54
					green	63.04	-57.39	33.24		green	61.58	-59.99	35.40
					blue	37.39	16.33	-48.76		blue	32.72	20.43	-51.31
				y	magenta	54.22	51.16	-1.98	z	magenta	55.37	46.26	-0.78
					cyan	57.81	-21.33	-40.99		cyan	58.97	-20.70	-38.74
					green	63.15	-57.23	33.39		green	61.49	-58.03	34.18
					blue	32.38	20.89	-49.57		blue	32.98	20.34	-47.44
Water-based	PE/EVA	#W3	3	w	magenta	52.43	56.66	-1.30	x	magenta	53.95	55.12	-2.64
					cyan	61.74	-28.56	-39.27		cyan	62.75	-26.86	-37.87
					green	61.80	-60.18	35.32		green	62.98	-58.85	34.27
					blue	33.13	20.45	-48.64		blue	35.13	19.36	-50.23
				y	magenta	54.44	54.37	-2.59	z	magenta	55.28	54.17	-3.63
					cyan	61.55	-28.31	-39.73		cyan	61.96	-28.71	-39.36
					green	61.31	-59.85	35.04		green	62.98	-59.92	35.06
					blue	34.96	19.25	-49.28		blue	36.82	16.71	-53.41
			L6	w	green	69.76	-53.37	30.45	x	green	70.23	-50.37	28.23
					cyan	64.85	-29.29	-36.93		cyan	65.79	-28.72	36.45
				y	not sampled				z	green	71.22	-51.03	29.15
										cyan	63.68	-28.81	-38.08

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
	OPP	#W1	4	w	magenta	49.29	52.86	-3.68	x	magenta	48.53	48.22	-4.52
					cyan	58.59	-30.91	-25.31		cyan	60.57	-32.81	-24.62
					green	53.50	-54.28	31.02		green	53.51	-54.29	31.16
					blue	39.52	1.25	-45.51		blue	39.50	1.08	-46.23
				y	magenta	50.05	50.20	-3.96	z	magenta	49.02	53.58	-4.02
					cyan	60.21	-33.05	-25.00		cyan	58.47	-35.07	-27.34
					green	52.90	-54.39	31.03		green	53.36	-55.34	31.72
					blue	40.52	0.72	-44.19		blue	39.45	2.07	-45.99
		#W2	1	w	magenta	50.58	50.16	-0.26	x	magenta	49.78	46.08	3.69
					cyan	58.33	-31.15	-27.22		cyan	56.87	-31.51	-28.55
					green	63.99	-57.96	44.50		green	63.51	-57.74	44.05
					blue	29.81	17.42	-38.53		blue	30.36	15.12	-37.15
				y	magenta	49.93	47.93	2.99	z	magenta	50.39	47.12	3.35
					cyan	57.63	-29.06	-27.14		cyan	56.78	-31.14	-28.55
					green	64.74	-57.46	44.15		green	64.51	-57.46	44.95
					blue	30.43	15.05	-37.04		blue	30.16	15.00	-36.46
			L3	w	green	73.10	-32.01	25.16	x	green	72.32	-32.99	25.36
					not sampled				z	green	72.31	-33.04	25.11

Table 4-E.3 CIE L*a*b* Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	L*	a*	b*	Location of Sample[a]	Color	L*	a*	b*
Water-based	OPP	#W4	9A	w	magenta	48.84	53.10	3.72	x	magenta	47.67	53.31	6.09
					cyan	57.76	-36.13	-30.30		cyan	57.55	-36.02	-30.47
					green	62.18	-52.99	31.33		green	60.77	-54.17	32.18
					blue	42.38	-2.15	-45.35		blue	41.95	-1.11	-45.58
				y	not sampled				z	magenta	49.08	50.66	2.67
										cyan	58.08	-35.07	-29.12
										green	61.23	-52.82	32.79
										blue	42.17	-0.87	-43.77
			L2	w	green	66.08	-44.94	28.90	x	green	66.00	-46.12	28.95
					not sampled				z	green	66.88	-42.01	26.93

[a]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run
[b]"L" indicates data from a laboratory run.

Coating Weight

Purpose

The purpose of this test was to evaluate the coating weight of the printed substrate. Coating weight is the weight of the ink film layer coverage on a substrate. The coating weight test was based on methods developed by Western Michigan University.

Equipment

Conventional laboratory oven
Scale (accurate to 0.001 ounces)

Procedure

1. Scan each color separation to determine the percent of ink coverage per square centimeter of one printed repeat (16” x 20”).

2. Determine the total area of printed substrate (in square centimeters).

3. Take 50 samples from the middle of the run (30 minutes into the run).

4. Cut 25 samples of the solid 100% ink coverage test blocks for each color printed. Measure and record the area of the ink blocks in square centimeters.

5. Cut equal areas of unprinted film (matching the areas to those cut out in step 4 above).

6. Dry the solvent-based and water-based ink samples in the oven at 150°F for one hour to remove any remaining solvents. The UV ink samples do not need to be dried in the oven.

7. For each color, weigh the two groups of 25 samples (printed and unprinted) separately. Divide the total weights of each group by 25 to determine the weight of the ink per area for each signature. Using the weight per square centimeter, calculate the total dry ink coat weight for the total linear footage for the press run.

Results

Samples were cut from a standard location during the run length as indicated by the following symbol:

x = 30 minutes into run

Only one location was needed for testing, since there was no significant difference between the various locations (e.g., the beginning, middle, and end of the run). The solid 100% ink coverage blocks that served as test samples were printed with green, blue, and white inks. Table 4-E.4 shows the coating weights for these ink colors at different sites. When a site number begins with an “L,” the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.4 Coating Weight Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Color	Weight Per Area (1 x 10^{-4} g/cm^2)
Solvent-based	LDPE	#S2	5	blue	1.88
				green	2.99
				white	2.33
			7	blue	1.65
				green	0.97
				white	2.08
			L5*	green	4.33
				white	6.68
	PE/EVA	#S2	5	blue	1.22
				green	1.39
			L7		4.33
	OPP	#S1	9B	blue	1.33
				green	0.94
				white	2.75
		#S2	10	blue	1.15
				green	1.47
				white	1.73
			L4	green	1.05
				white	1.79
UV	LDPE	#U2	6	blue	1.92
				green	2.77
				white	3.51
	PE/EVA	#U2	6	blue	4.50
				green	3.00
		#U3	8	blue	1.64
				green	1.20
UV (no slip)	LDPE	#U1	11	blue	1.94
				green	2.98
				white	3.71

Table 4-E.4 Coating Weight Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Color	Weight Per Area (1×10^{-4} g/cm^2)
Water-based	LDPE	#W3	2	blue	1.79
				green	1.58
				white	2.39
			3	blue	1.43
				green	1.20
				white	2.32
			L1	green	2.14
				white	2.42
	PE/EVA	#W3	2	blue	1.80
				green	1.77
			3	blue	2.23
				green	1.52
			L6	green	4.71
Water-based	OPP	#W1	4	blue	1.59
				green	2.05
				white	3.90
		#W2	1	blue	1.70
				green	2.04
				white	3.58
			L3	green	1.03
				white	1.35
		#W4	9A	blue	0.87
				green	0.83
				white	2.31
			L2	green	0.88
				white	1.21

* ”L” indicates data from a laboratory run.

Coefficient of Friction

Purpose

The purpose of the coefficient of friction (COF) test is to determine the resistance to slide of a printed sample. The COF of printed ink on film is important when converting the printed rolls and meeting the requirements of the end product. This test is based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment

Friction/Peel Tester Thwing Albert
Sled (standard weight block — 200 grams)

Procedure

1. Press the COF button on the display unit to select the friction test.

2. Press the sled button repeatedly until the sled weight at display matches the weight of the sled used.

3. Press the time button repeatedly until the desired duration of time is displayed (20 seconds).

4. Press the zero load switch to provide zero reading.

5. Use the test, stop, and return switches to position the load cell at the starting point for the test. Loosen the Left Limit Switch Actuator and slide it next to the load cell to set the left-hand limit motion.

6. Press the return switch to place the load cell at the starting point.

7. Secure one strip of material to the test sled (face up).

8. Secure a second piece of material (face up) to the top plate of the lower chassis.

9. Attach the sled to the load cell and align it in the direction of travel.

10. Initiate the test by depressing the test switch. When a test is completed, the test results are displayed.

11. Record the static COF. Repeat the measurement five times.

12. Calculate the average COF measurements and use the standard Tappi T548 pm-90 test procedure to covert COF to angle of inclination.

Results

COF was measured in the laboratory using an Instron Tensile tester equipped with a friction sled. Sites 1, 4, 9, and 10 were not tested because the OPP substrate printed at these sites were laminated to another substrate. The COF was measured from samples taken from only one location (at the beginning of the run), as the COF was not expected to differ throughout the length of the run or across the web. The COF values were converted to angle of inclination.

Table 4-E.5 presents the data from all of the performance demonstration sites and laboratory runs. When a site number begins with an “L,” the data were taken from a run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.5 Coefficient of Friction Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Condition[a]	Average Angle of Inclination (degrees)
Solvent-based	LDPE	#S2	5	blue/clear	26.6
				blue/blue	33.0
				green/clear	30.1
				green/green	40.0
				control	22.3
			7	blue/clear	24.2
				blue/blue	35.0
				green/clear	26.1
				green/green	35.8
				control	23.3
			L5[c]	green/clear	20.8
				green/green	30.6
				control	23.3
	PE/EVA	#S2	5	blue/clear	19.8
				blue/blue	32.2
				green/clear	31.4
				green/green	44.2
				control	16.7
Solvent-based	PE/EVA	#S2	7	blue/clear	19.6
				blue/blue	19.2
				green/clear	27.4
				green/green	25.2
				control	16.7
			L7	green/clear	
				green/green	
				control	

Table 4-E.5 Coefficient of Friction Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Condition[a]	Average Angle of Inclination (degrees)
UV	LDPE	#U2	6	blue/clear	30.1
				blue/blue	50.5
				green/clear	32.2
				green/green	57.2
				control	23.3
	PE/EVA	#U2	6	blue/clear	20.8
				blue/blue	21.8
				green/clear	20.8
				green/green	20.8
				control	16.7
		#U3	8	blue/clear	24.2
				blue/blue	24.2
				green/clear	27.6
				green/green	25.2
				control	16.7
UV (no slip)	LDPE	#U1	11	blue/clear	44.2
				blue/blue	60+[b]
				green/clear	29.6
				green/green	60+[b]
				control	45.0
Water-based	LDPE	#W3	2	blue/clear	29.2
				blue/blue	32.2
				green/clear	26.1
				green/green	33.8
				control	23.2
			3	blue/clear	22.3
				blue/blue	31.4
				green/clear	23.3
				green/green	27.4
				control	23.3
			L1	green/clear	34.2
				green/green	34.2
				control	23.3

Table 4-E.5 Coefficient of Friction Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Condition[a]	Average Angle of Inclination (degrees)
Water-based	PE/EVA	#W3	2	blue/clear	27.4
				blue/blue	40.0
				green/clear	22.3
				green/green	25.2
				control	16.7
			3	blue/clear	23.3
				blue/blue	30.6
				green/clear	19.8
				green/green	35.0
				control	17.2
			L6	green/clear	26.6
				green/green	40.0
				control	16.7

[a] Samples were tested under five different conditions:
blue/clear = printed substrate (blue ink) against unprinted substrate
blue/blue = printed substrate (blue ink) against printed substrate (blue ink)
green/clear = printed substrate (green ink) against unprinted substrate
green/green = printed substrate (green ink) against printed substrate (green ink)
control = unprinted substrate against unprinted substrate
[b]The angle of inclination was higher than 60 degrees.
[c]"L" indicates data from a laboratory run.

Density

Purpose
The purpose of the density test is to evaluate the degree of darkness (light-absorption) of a printed solid. The density test is based on methods developed by Western Michigan University.

Equipment
X-Rite 418 reflection densitometer

Procedure
1. Calibrate the densitometer. For all color references, follow calibration instructions obtained by pressing the function key and color key together. Using instructions on the instrument, set low (white standard) and high values (black standard) for each color, then read individual color patches as determined by the instrument. Verify calibration values for each standard patch and make adjustments as necessary.

2. Take two samples of each substrate (LDPE, PE/EVA, and OPP) from four locations on the press run.

3. The DEN function of the densitometer is used to take measurements. Take readings at 10 locations of the sample for each of the 5 colors in solid ink density areas.

Results

Density was measured in the laboratory with samples collected from each site. Five samples were cut from each of four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Density measurements were taken for areas of the test images printed with magenta, cyan, green, and blue. Table 4-E.6 shows the results of the density measurements. The amounts listed in the "Density" column are the averages of five measurements taken at each location. The table also presents the standard deviation of these five measurements. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
Solvent-based	LDPE	#S2	5	w	magenta	1.53	0.04	x	magenta	1.55	0.04
					cyan	1.58	0.02		cyan	1.51	0.03
					green	1.39	0.02		green	1.41	0.06
					blue	1.90	0.04		blue	1.97	0.02
				y	magenta	1.45	0.04	z	magenta	1.52	0.03
					cyan	1.46	0.04		cyan	1.50	0.05
					green	1.28	0.02		green	1.36	0.01
					blue	2.04	0.02		blue	2.04	0.03
			7	w	magenta	1.33	0.02	x	magenta	1.31	0.02
					cyan	1.29	0.01		cyan	1.34	0.02
					green	0.86	0.02		green	0.96	0.02
					blue	1.61	0.02		blue	1.68	0.02
				y	magenta	1.32	0.02	z	magenta	1.19	0.02
					cyan	1.22	0.02		cyan	1.22	0.02
					green	1.02	0.02		green	0.74	0.01
					blue	1.69	0.03		blue	1.60	0.02
			L5[b]	w	green	0.70	0.02	x	green	0.75	0.01
				y	not sampled			z	green	0.91	0.02
	PE/EVA	#S2	5	w	magenta	1.51	0.04	x	magenta	1.52	0.04
					cyan	1.46	0.01		cyan	1.61	0.02
					green	1.31	0.02		green	1.35	0.03
					blue	1.87	0.03		blue	1.94	0.07
				y	magenta	1.16	0.04	z	magenta	1.21	0.06
					cyan	1.56	0.02		cyan	1.57	0.03
					green	1.34	0.05		green	1.42	0.04
					blue	1.96	0.09		blue	1.94	0.05

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
Solvent-based	PE/EVA	#S2	7	w	magenta	1.25	0.02	x	not sampled		
					cyan	1.36	0.02				
					green	0.83	0.02				
					blue	1.70	0.01				
				y	not sampled			z	magenta	1.27	0.04
									cyan	1.47	0.02
									green	0.82	0.02
									blue	1.71	0.03
			L7[b]	w	cyan	0.96	0.01	x	cyan	0.98	0.02
					green	0.75	0.02		green	0.78	0.01
				y	not sampled			z	cyan	0.89	0.02
									green	0.82	0.02
	OPP	#S1	9B	w	magenta	1.21	0.01	x	magenta	1.29	0.02
					cyan	1.36	0.03		cyan	1.43	0.03
					green	0.67	0.02		green	0.67	0.01
					blue	1.23	0.02		blue	1.28	0.03
				y	not sampled			z	magenta	1.24	0.02
									cyan	1.52	0.02
									green	0.67	0.02
									blue	1.28	0.05

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
		#S2	10	w	magenta	0.48	0.01	x	magenta	0.50	0.04
					cyan	0.59	0.01		cyan	0.66	0.01
					green	1.16	0.01		green	1.09	0.02
					blue	1.77	0.02		blue	1.76	0.02
				y	magenta	0.48	0.01	z	magenta	0.52	0.02
					cyan	0.64	0.02		cyan	0.70	0.01
					green	1.13	0.04		green	1.15	0.02
					blue	1.72	0.02		blue	1.71	0.01
			L4	w	green	0.60	0.03	x	green	0.70	0.02
				y	not sampled			z	green	0.74	0.01
UV	LDPE	#U2	6	w	magenta	1.61	0.03	x	magenta	1.87	0.03
					cyan	1.36	0.02		cyan	1.28	0.02
					green	1.17	0.01		green	1.18	0.01
					blue	1.87	0.05		blue	1.87	0.03
				y	magenta	1.86	0.05	z	magenta	1.39	0.05
					cyan	1.30	0.03		cyan	1.41	0.03
					green	1.17	0.02		green	1.16	0.01
					blue	1.86	0.04		blue	1.91	0.03
UV	PE/EVA	#U2	6	w	magenta	1.57	0.01	x	magenta	1.60	0.03
					cyan	1.32	0.07		cyan	1.40	0.02
					green	1.26	0.02		green	1.30	0.01
					blue	1.87	0.04		blue	1.73	0.03
				y	magenta	1.63	0.04	z	magenta	1.70	0.03
					cyan	1.37	0.02		cyan	1.44	0.01
					green	1.28	0.01		green	1.28	0.01
					blue	1.78	0.01		blue	1.83	0.04

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
		#U3	8	w	magenta	1.10	0.03	x	magenta	1.22	0.08
					cyan	1.07	0.01		cyan	1.08	0.02
					green	0.92	0.01		green	1.06	0.03
					blue	1.07	0.02		blue	1.16	0.02
				y	not sampled			z	magenta	1.21	0.05
									cyan	1.10	0.02
									green	0.97	0.01
									blue	1.10	0.01
UV (no slip)	LDPE	#U1	11	w	magenta	1.02	0.01	x	magenta	1.07	0.01
					cyan	1.12	0.04		cyan	1.19	0.04
					green	1.44	0.03		green	1.46	0.03
					blue	2.11	0.04		blue	2.20	0.04
				y	magenta	1.13	0.05	z	magenta	1.15	0.10
					cyan	1.26	0.07		cyan	1.42	0.01
					green	1.49	0.04		green	1.59	0.04
					blue	2.18	0.12		blue	2.19	0.03
Water-based	LDPE	#W3	2	w	magenta	1.19	0.02	x	magenta	1.21	0.04
					cyan	1.41	0.02		cyan	1.38	0.01
					green	1.32	0.01		green	1.25	0.03
					blue	2.13	0.04		blue	2.13	0.03
				y	magenta	1.28	0.01	z	magenta	1.24	0.01
					cyan	1.42	0.04		cyan	1.37	0.01
					green	1.22	0.03		green	1.24	0.04
					blue	2.13	0.04		blue	1.98	0.09

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
Water-based	LDPE	#W3	3	w	magenta	1.20	0.02	x	magenta	1.21	0.01
					cyan	0.99	0.03		cyan	1.12	0.04
					green	1.45	0.03		green	1.45	0.03
					blue	2.19	0.04		blue	2.21	0.02
				y	magenta	1.23	0.02	z	magenta	1.29	0.02
					cyan	0.87	0.11		cyan	0.97	0.04
					green	1.46	0.03		green	1.37	0.07
					blue	2.17	0.05		blue	2.15	0.04
			L1	w	green	0.92	0.05	x	green	0.87	0.04
				y	not sampled			z	green	0.96	0.02
	PE/EVA	#W3	2	w	magenta	1.13	0.05	x	magenta	1.10	0.06
					cyan	1.30	0.02		cyan	1.23	0.03
					green	1.39	0.02		green	1.44	0.03
					blue	1.67	0.04		blue	2.18	0.03
				y	magenta	1.10	0.03	z	magenta	1.32	0.04
					cyan	1.30	0.03		cyan	1.04	0.01
					green	1.41	0.01		green	1.39	0.05
					blue	2.14	0.06		blue	2.07	0.04
			3	w	magenta	1.31	0.09	x	magenta	1.21	0.04
					cyan	1.33	0.02		cyan	1.10	0.03
					green	1.55	0.02		green	1.42	0.02
					blue	1.95	0.06		blue	1.89	0.04
				y	magenta	1.24	0.03	z	magenta	1.20	0.01
					cyan	1.12	0.04		cyan	1.17	0.02
					green	1.45	0.01		green	1.38	0.03
					blue	1.94	0.02		blue	1.92	0.03

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
			L6	w	cyan	1.15	0.08	x	cyan	1.08	0.05
					green	0.88	0.02		green	0.86	0.01
				y	not sampled			z	cyan	1.16	0.02
									green	0.93	0.01
Water-based	OPP	#W1	4	w	magenta	1.27	0.01	x	magenta	1.22	0.02
					cyan	1.27	0.01		cyan	1.12	0.01
					green	1.68	0.01		green	1.67	0.02
					blue	1.86	0.02		blue	1.86	0.03
				y	magenta	1.14	0.03	z	magenta	1.31	0.08
					cyan	1.07	0.03		cyan	1.31	0.04
					green	1.66	0.01		green	1.68	0.01
					blue	1.84	0.03		blue	1.55	0.01
		#W2	1	w	magenta	1.34	0.07	x	magenta	1.44	0.03
					cyan	1.40	0.06		cyan	1.43	0.05
					green	1.40	0.02		green	1.32	0.05
					blue	2.29	0.01		blue	2.29	0.01
				y	magenta	1.42	0.03	z	magenta	1.18	0.05
					cyan	1.42	0.04		cyan	1.41	0.03
					green	1.35	0.03		green	1.34	0.03
					blue	2.31	0.03		blue	2.35	0.01
			L3	w	green	0.57	0.02	x	green	0.61	0.01
				y	not sampled			z	green	0.72	0.05

Table 4-E.6 Density Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Density (unitless)	Standard Deviation	Location of Sample[a]	Color	Density (unitless)	Standard Deviation
		#W4	9A	w	magenta	1.32	0.02	x	magenta	1.39	0.03
					cyan	1.53	0.06		cyan	1.51	0.04
					green	1.20	0.02		green	1.25	0.02
					blue	1.66	0.01		blue	1.68	0.01
				y	not sampled			z	magenta	1.42	0.03
									cyan	1.53	0.03
									green	1.25	0.01
									blue	1.70	0.02
			L2	w	green	1.02	0.03	x	green	0.99	0.02
				y	not sampled			z	green	0.98	0.02

[a]Samples were taken at four locations from the printed sample:
- w = beginning of the run
- x = 30 minutes into the run
- y = 60 minutes into the run
- z = end of the run

[b]"L" indicates data from a laboratory run.

Dimensional Stability

Purpose

The purpose of the dimensional stability test is to measure how the substrate responds structurally during printing. The dimensional stability test is based on methods developed by Western Michigan University.

Equipment

Accurate 10 inch x 10 inch template for cutting sample sheets
Steel measuring scale graduated in divisions of 0.01 inches and at least 12 inches in height
Controlled temperature and humidity in a room or convection oven

Procedure

1. Using the 10 inch x 10 inch template, cut three samples from the test web: one from each edge and one from the center. On very wide webs, more than three locations may be advisable.

2. Mark each sample with the location and directional information before cutting it from the original web or sheet to avoid any possibility of error in subsequent identification.

3. The standard test reference is A.S.T.M. designation D-1204.

4. Record the results in thousandths of an inch (0.001 inch) per the standard test reference.

Results

Dimensional stability for width and length was measured on samples cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Green and blue printed samples were tested for dimensional stability. Samples from the left and right sides of the web were tested for each color also. Table 4-E.7 presents the complete data from each of the performance demonstration sites.

Table 4-E.7 Dimensional Stability for Performance Demonstrations

Ink System	Film	Product Line	Site	Location of Sample[a]	Width (mm)				Length (mm)			
					Left Blue	Left Green	Right Blue	Right Green	Left Blue	Left Green	Right Blue	Right Green
Original plate dimensions					57.84	56.83	51.50	50.90	77.80	76.15	75.44	75.32
Solvent-based	LDPE	#S2	5	w	57.70	56.19	50.95	51.01	79.53	77.49	77.44	76.83
				x	57.92	56.75	51.35	51.02	79.58	77.45	77.12	77.19
				y	58.13	56.90	51.16	51.29	79.34	77.24	77.21	76.57
				z	58.56	56.95	51.31	51.04	79.41	76.98	77.10	77.11
			7	w	58.18	57.14	51.12	51.12	77.82	76.18	76.25	76.11
				x	58.00	56.71	51.32	51.32	78.23	75.95	75.69	75.70
				y	58.42	57.12	51.26	51.53	77.21	75.95	75.70	75.38
				z	58.22	57.14	51.25	51.13	77.83	75.94	75.87	75.78
	PE/EVA	#S2	5	w	58.02	56.43	51.11	51.24	79.98	77.74	77.75	77.51
				x	57.89	56.77	51.56	51.27	79.68	77.64	77.72	76.95
				y	57.04	56.89	50.91	51.34	79.83	77.88	77.10	76.70
				z	58.30	56.72	51.26	51.33	80.05	77.62	77.35	77.17
			7	w	57.94	56.92	50.89	50.51	78.71	76.69	76.76	76.52
				z	57.77	56.42	51.06	51.05	79.38	77.14	77.10	77.00
	OPP	#S1	9B	w	57.44	56.08	51.25	50.92	78.83	76.32	76.62	76.35
				x	57.50	55.95	51.13	50.60	79.07	76.49	76.62	76.66
				z	57.77	56.32	51.04	50.67	78.59	76.22	76.55	76.22
		#S2	10	w	57.46	56.40	50.73	50.99	79.05	77.04	77.50	77.42
				x	57.86	56.77	51.06	50.61	80.35	77.67	77.80	77.25
				y	57.96	56.07	51.14	51.01	80.04	77.82	77.99	77.54
				z	57.68	56.52	50.79	51.05	79.35	77.23	77.59	77.47

Table 4-E.7 Dimensional Stability for Performance Demonstrations (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Width (mm)				Length (mm)			
					Left Blue	Left Green	Right Blue	Right Green	Left Blue	Left Green	Right Blue	Right Green
UV	LDPE	#U2	6	w	58.61	57.09	51.48	50.98	78.48	75.36	76.43	75.42
				x	58.09	56.83	51.08	50.72	79.05	77.05	76.81	76.38
				y	58.05	56.74	51.37	50.98	79.17	76.72	77.07	76.81
				z	58.30	56.89	51.26	50.90	79.47	77.91	77.40	76.25
	PE/EVA	#U2	6	w	57.91	56.68	51.19	51.05	80.28	77.67	77.19	77.61
				x	57.79	57.04	51.22	51.23	79.75	77.00	77.01	76.93
				y	57.75	56.54	51.07	50.80	80.07	77.43	77.30	76.33
				z	57.79	57.07	51.43	51.33	79.97	77.35	77.64	77.16
UV	PE/EVA	#U3	8	w	57.41	56.80	50.86	50.91	77.57	75.05	75.36	75.28
				x	57.43	56.55	51.14	51.01	77.50	75.40	75.39	75.45
				z	57.67	56.94	50.97	51.22	77.31	75.47	74.99	75.23
UV (no slip)	LDPE	#U1	11	w	57.83	56.82	51.18	51.02	79.52	77.23	77.24	76.73
				x	58.15	56.71	51.04	50.84	79.49	77.01	77.98	77.05
				y	58.03	57.00	51.37	50.92	79.28	77.38	77.41	76.71
				z	57.77	56.89	51.35	51.01	79.90	77.63	77.86	77.36
Water-based	LDPE	#W3	2	w	58.09	56.76	51.54	51.72	78.32	75.99	76.47	76.34
				x	57.00	56.12	51.25	51.17	78.76	76.17	76.60	76.44
				y	57.92	56.82	51.17	51.01	78.21	76.06	76.77	76.56
				z	58.02	56.81	51.33	51.18	78.32	76.04	76.42	76.35
			3	w	57.96	57.22	51.35	50.98	78.29	75.87	76.68	76.78
				x	57.76	56.37	51.18	50.97	78.25	76.69	76.13	75.96
				y	57.93	56.90	50.97	50.80	78.54	76.38	76.33	75.90
				z	58.26	56.95	51.35	51.18	78.91	76.35	76.58	75.93

Table 4-E.7 Dimensional Stability for Performance Demonstrations (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Width (mm)				Length (mm)			
					Left Blue	Left Green	Right Blue	Right Green	Left Blue	Left Green	Right Blue	Right Green
	PE/EVA	#W3	2	w	57.64	57.02	51.09	51.16	79.76	77.39	76.40	77.09
				x	58.15	57.03	51.42	51.35	80.00	77.25	77.64	77.41
				y	58.36	57.46	51.61	51.19	80.14	77.51	77.58	76.84
				z	58.23	56.95	51.45	51.36	79.62	77.51	76.96	77.33
			3	w	58.18	56.47	51.10	51.02	78.90	76.61	76.54	76.91
				x	57.78	56.74	51.28	51.02	78.91	77.15	76.82	76.37
				y	58.15	56.78	51.05	51.41	78.60	77.16	76.82	76.26
				z	57.95	57.00	51.07	51.23	78.76	76.80	77.07	76.99
	OPP	#W1	4	w	57.96	56.81	50.69	50.91	79.26	76.82	76.69	76.96
				x	58.06	56.12	50.51	50.98	79.34	77.06	76.45	76.45
				y	57.89	56.85	51.18	50.83	79.23	76.87	76.67	76.33
				z	57.86	56.70	51.04	50.92	79.79	76.80	76.76	76.13
		#W2	1	w	57.75	56.85	51.12	50.16	78.69	77.49	76.88	77.08
				x	57.97	55.82	50.09	51.31	79.09	76.67	76.88	74.89
				y	57.97	56.96	50.89	50.97	79.00	76.97	77.09	76.63
				z	57.84	56.96	51.33	50.37	79.51	76.91	77.12	76.56
Water-based	OPP	#W4	9A	w	57.92	56.32	51.18	51.11	78.87	76.57	77.07	77.17
				x	57.74	56.63	50.54	50.63	79.39	77.45	76.66	76.52
				z	57.81	56.48	50.83	51.33	78.91	76.63	76.20	76.16

[a]Samples were taken at three locations from the printed sample:
- w = beginning of the run
- x = thirty minutes into the run
- y = sixty minutes into the run
- z = end of the run

Gloss

Purpose
The purpose of the gloss test is to evaluate the light that is reflected off the ink surface when a light is shined at that surface from an angle. The gloss test is based on methods developed by Western Michigan University.

Equipment
Gardner Micrometer (60° angle)

Procedure
1. Light energy is applied to a surface through a special aperture and reflected back through a photocell. The reflected light is converted into electrical energy to drive a meter reading from 0 to 100 (the greater the reflective light, the greater the meter reading). For this experiment, the Gardner Micrometer will be used.

2. Follow the manufacturer's recommended procedure for calibration to the standard tiles. Clean the tile standards before calibration to increase accuracy. Place the glossmeter port over the center of the black tile (note that the direction of the arrows should align). Verify the instrument while holding the meter in position and adjusting the control knob to the indicated number on the black standard. Do the same with the white tile using the white standard calibration number.

3. Take measurements of five samples from four locations of the run. The selected area for the readings should be consistent in ink coverage or solid ink densities. On LDPE, the gloss was measured for magenta, cyan, blue, and green over a white ink background, and also for white, green, and blue on clear film. On PE/EVA, the gloss was measured for magenta, cyan, blue, and green on white film.

4. Place the glossmeter over the sample area (at least 3 readings on a 3 inch x 6 inch area) and press the operate button. For each sample there will be 10 readings, 5 each side across the sheet. Repeat the readings for all five colors.

Results
Gloss was measured in the laboratory with samples collected from each site. Five readings are taken from each of four locations on the run, and the average of these readings is what is recorded for each location. Samples were cut for four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

For LDPE, magenta, cyan, green, and blue samples were tested on a white ink background; white, green, and blue samples were tested on clear LDPE film. Magenta, cyan, green, and blue samples were also tested on a white PE/EVA substrate. Table 4-E.8 presents the complete data from each of the performance demonstration sites and laboratory runs. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.8 Gloss for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Color[a]	Location of Sample[b]	Gloss	Location of Sample	Gloss	Location of Sample	Gloss	Location of Sample[b]	Gloss
Solvent-based	LDPE	#S2	5	magenta	w	42.5	x	53.5	y	54.2	z	50.1
				cyan		44.4		43.7		58.0		52.3
				green		47.5		49.3		57.8		45.8
				blue		52.4		46.5		56.9		50.5
				white on clear		20.0		42.7		41.7		38.5
				green on clear		43.5		35.9		50.2		39.4
				blue on clear		41.2		33.4		45.0		42.9
			7	magenta	w	53.9	x	51.3	y	45.1	z	56.1
				cyan		45.3		45.2		39.5		53.6
				green		51.0		50.3		53.2		64.0
				blue		51.9		52.0		49.8		49.5
				white on clear		42.4		58.2		57.7		60.1
				green on clear		62.5		73.2		56.7		67.2
				blue on clear		67.5		69.6		61.6		54.3
			L5[c]	green	w	37.5	x	37.2	y	not sampled	z	31.2
				white on clear		39.6		39.4				34.2
				green on clear		34.5		35.6				29.0
	PE/EVA	#S2	5	magenta	w	62.1	x	75.0	y	62.8	z	63.7
				cyan		58.1		62.9		55.1		52.2
				green		59.2		60.6		56.0		45.7
				blue		60.4		49.1		51.6		49.8
			7	magenta	w	56.5	x	not sampled	y	not sampled	z	63.3
				cyan		61.4						63.7
				green		72.9						75.8
				blue		42.8						57.2
			L7	cyan	w	39.6	x	39.4	y	not sampled	z	38.2
				green		35.6		35.9				31.8

Table 4-E.8 Gloss for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Color[a]	Location of Sample[b]	Gloss	Location of Sample	Gloss	Location of Sample	Gloss	Location of Sample[b]	Gloss
UV	LDPE	#U2	6	magenta	w	29.2	x	27.3	y	26.6	z	30.6
				cyan		37.6		50.9		52.6		51.8
				green		43.2		46.8		39.0		49.4
				blue		48.6		37.9		29.1		44.0
				white on clear		40.9		44.3		50.3		59.7
				green on clear		55.3		63.9		61.9		50.5
				blue on clear		50.0		67.0		58.9		64.0
	PE/EVA	#U2	6	magenta	w	36.4	x	27.8	y	28.3	z	30.1
				cyan		44.1		47.5		45.3		61.0
				green		52.8		49.7		51.6		49.0
				blue		65.5		61.1		52.3		54.4
		#U3	8	magenta	w	44.1	x	37.1	y	not sampled	z	37.3
				cyan		55.2		38.0				49.3
				green		28.4		22.3				22.6
				blue		30.2		33.0				33.2
UV (no slip)	LDPE	#U1	11	magenta	w	29.7	x	46.0	y	34.2	z	37.3
				cyan		27.9		24.1		21.8		22.9
				green		21.6		24.3		22.2		30.4
				blue		24.1		35.4		26.3		48.4
				white on clear		35.6		37.2		36.6		38.6
				green on clear		41.8		41.9		41.1		43.7
				blue on clear		29.2		24.6		22.4		35.5
Water-based	LDPE	#W3	2	magenta	w	38.9	x	43.9	y	31.3	z	28.7
				cyan		39.5		40.1		42.8		32.2
				green		47.9		49.3		29.0		33.6
				blue		47.9		47.0		30.4		34.5
				white on clear		46.0		44.8		47.5		50.1
				green on clear		61.1		47.5		57.9		59.0
				blue on clear		34.9		42.4		52.3		58.7

Table 4-E.8 Gloss for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Color[a]	Location of Sample[b]	Gloss	Location of Sample	Gloss	Location of Sample	Gloss	Location of Sample[b]	Gloss
Water-based	LDPE	#W3	3	magenta	w	29.5	x	48.7	y	47.3	z	32.1
				cyan		47.0		37.6		40.7		33.4
				green		36.8		35.3		31.1		25.0
				blue		34.8		31.1		23.7		19.9
				white on clear		42.7		51.1		45.1		42.0
				green on clear		39.0		61.6		61.0		56.0
				blue on clear		56.4		56.4		41.8		36.1
			L1	green	w	21.3	x	22.9	y	not sampled	z	22.3
				white on clear		41.4		27.7				30.6
				green on clear		40.4		49.6				42.6
	PE/EVA	#W3	2	magenta	w	61.4	x	55.0	y	43.6	z	47.6
				cyan		53.1		49.2		39.0		42.8
				green		60.5		61.7		57.1		53.1
				blue		55.7		56.1		46.2		41.0
			3	magenta	w	59.9	x	62.3	y	49.7	z	73.9
				cyan		57.6		57.8		50.0		42.2
				green		45.7		57.6		54.9		62.7
				blue		53.8		56.0		54.8		69.0
			L6	green	w	32.7	x	56.7	y	not sampled	z	32.7
				blue		56.2		45.1				39.4

[a]For LDPE, magenta, cyan, green, and blue were tested on a white ink background. White, green, and blue were also tested on a clear LDPE film, and are denoted in the table as "white on clear," "green on clear," and "blue on clear." Magenta, cyan, green, and blue were tested on a white PE/EVA film.
[b]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run
[c]"L" indicates data from a laboratory run.

Heat Resistance/Heat Seal

Purpose

The purpose of this test was to determine the heat resistance of the printed product. Heat resistance is the degree to which a printed substrate will resist transfer to itself or to an unprinted surface when heated. The heat resistance/heat seal test is based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment

A Sentinel Heat Sealer was used to measure heat resistance.

Procedure

1. Preheat the jaws of the heat sealer until the desired temperature is obtained. Record the temperature.

2. Set the desired pressure and dwell time. Record.

3. Sandwich the sample between aluminum foil or paper and place the sample between the jaws of the heat sealer.

4. Depress the foot pedal to activate machine.

5. When dwell time is completed, remove the samples and allow them to cool.

6. Test the heat seal.

Results

This test was accomplished by checking for ink transfer upon peeling apart the heated samples. Results are recorded as "pass" (no ink transfer), or "fail" (transfer of ink). In the case of a failure, the percent of ink transferred is evaluated and recorded. Samples were tested for both printed substrate to unprinted substrate and printed substrate to printed substrate.

Heat resistance was measured in the laboratory with samples collected from the four sites (Sites 1, 4, 9, and 10) which laminated the printed OPP substrate. Samples were cut from up to four locations during the run as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

The images used in the heat resistance/heat seal tests had areas printed with blue, green, and white ink. Table 4-E.9 shows the heat resistance test results for each site. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.9 Heat Resistance/Heat Seal Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Ink-Un[b] Pass/ Fail	Ink-Un Result	Ink-Ink[c] Pass/ Fail	Ink-Ink Result
Solvent-based	OPP	#S1	9B	w	blue	P		F	10%
					green	P		P	
					white	F	10%	F	10%
				x	blue	F	10%	F	10%
					green	P		P	
					white	F	10%	F	10%
				z	blue	P		P	
					green	P		P	
					white	F	20%	F	20%
		#S2	10	w	blue	F	40%	F	50%
					green	F	40%	F	50%
					white	F	30%	F	50%
				x	blue	F	30%	F	40%
					green	F	40%	F	40%
					white	F	40%	F	30%
				z	blue	F	30%	F	40%
					green	F	40%	F	40%
					white	F	40%	F	30%
			L4[d]	w	green	P		P	
					white	P		P	
				x	green	P		P	
					white	P		P	
				z	green	P		P	
					white	P		P	
Water-based	OPP	#W1	4	w	blue	P		F	20%
					green	P		F	20%
					white	F	10%	F	20%
				x	blue	P		F	20%
					green	P		F	20%
					white	F	10%	F	40%
				y	blue	P		F	20%
					green	P		F	20%
					white	F	10%	F	20%
				z	blue	P		F	20%
					green	P		F	20%
					white	F	20%	F	30%

Table 4-E.9 Heat Resistance/Heat Seal Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Ink-Un[b] Pass/ Fail	Ink-Un Result	Ink-Ink[c] Pass/ Fail	Ink-Ink Result
		#W2	1	w	blue	F	20%	F	20%
					green	F	20%	F	30%
					white	F	10%	F	50%
				x	blue	F	10%	F	20%
					green	F	20%	F	40%
					white	F	10%	F	50%
				y	blue	F	20%	F	20%
					green	F	20%	F	50%
					white	F	10%	F	50%
				z	blue	F	20%	F	20%
					green	F	20%	F	20%
					white	F	20%	F	60%
			L3	w	green	F	10%	P	
					white	F	10%	F	10%
				x	green	F	10%	F	10%
					white	F	10%	F	10%
				z	green	F	10%	F	10%
					white	F	10%	F	10%
		#W4	9A	w	blue	F	5%	F	10%
					green	F	5%	F	10%
					white	P		P	
				x	blue	F	10%	F	10%
					green	F	10%	F	10%
					white	P		P	
				z	blue	F	10%	F	10%
					green	F	10%	F	10%
					white	P		P	
			L2	w	green	F	10%	F	20%
					white	F	10%	F	20%
				x	green	F	30%	F	20%
					white	F	30%	F	20%
				z	green	F	10%	F	40%
					white	F	10%	F	40%

[a]Samples were taken at four locations from the printed sample:
- w = beginning of the run
- x = 30 minutes into the run
- y = 60 minutes into the run
- z = end of the run

[b]"Ink-Un" represents ink transferred from a printed substrate to an unprinted substrate.
[c]"Ink-Ink" represents ink transferred from a printed substrate to a printed substrate.
[d]"L" indicates data from a laboratory run.

Ice Water Crinkle Adhesion

Purpose

The purpose of the ice water crinkle adhesion test is to evaluate the integrity and flexibility of the ink on the substrate when exposed to refrigerator and freezer conditions. This test measures a combination of the ink's adhesive and flexibility properties. The ice water crinkle adhesion test is based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment

Rollout of ink on appropriate substrate
Four-ounce jar
Ice water
Freezer

Procedure

1. Roll out the standard and batch side by side.

2. Submerge the split roll-out into ice water for thirty minutes.

3. Remove the print.

4. While the print is still wet, firmly grasp the print between the thumb and forefinger of each hand with about one inch of print between the two thumbs.

5. Bring the hands together and rub in opposite directions fairly rapidly ten times. One complete cycle consists of both a back and forward motion of the wrists.

6. Inspect the proof for ink removal.

Results

The ice water crinkle adhesion test was measured in the laboratory with samples collected from each site. Sites 1, 4, 9, and 10 were not tested in the laboratory because the OPP substrate printed at these sites were laminated to another substrate. Samples for testing were cut from four locations during the run as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Due to the aborted run using the PE/EVA substrate at Site 7, samples were only taken from the beginning (w) and the end (z) of the run for testing in the laboratory. Site 8 also had a shorter run for the PE/EVA substrate, so samples were only taken from the beginning (w), thirty minutes into run (x), and the end of the run (z). The laboratory runs conducted at Western Michigan were shorter in duration than the demonstration runs, so samples for testing were only cut from three locations (w, x, and z).

Table 4-E.10 presents the data from all of the performance demonstration sites and laboratory runs. When a site number begins with an "L," the data were taken from a run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.10 Ice Water Crinkle Adhesion Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Any Ink Removal?
Solvent-based	LDPE	#S2	5	w	no
				x	no
				y	no
				z	no
			7	w	no
				x	no
				y	no
				z	no
			L5[b]	w	no
				x	no
				z	no
	PE/EVA	#S2	5	w	no
				x	no
				y	no
				z	no
			7	w	no
				z	no
			L7	w	no
				x	no
				z	no
UV	LDPE	#U2	6	w	yes, less than 15%
				x	yes, less than 15%
				y	yes, less than 15%
				z	yes, less than 15%
	PE/EVA	#U2	6	w	yes, less than 15%
				x	yes, less than 15%
				y	yes, less than 15%
				z	yes, less than 15%
		#U3	8	w	no
				x	no
				y = z	no
UV (no slip)	LDPE	#U1	11	w	no
				x	no
				y	no
				z	no

Table 4-E.10 Ice Water Crinkle Adhesion Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Any Ink Removal?
Water-based	LDPE	#W3	2	w	no
				x	no
				y	no
				z	no
			3	w	yes, less than 5%
				x	yes, less than 5%
				y	yes, less than 5%
				z	yes, less than 5%
			L1	w	no
				x	no
				z	no
	PE/EVA	#W3	2	w	no
				x	no
				y	no
				z	no
			3	w	no
				x	yes, less than 5%
				y	no
				z	no
			L6	w	yes, about 30% of the green ink and less than 15% of the blue ink
				x	yes, about 30% of the green ink and less than 15% of the blue ink
				z	yes, about 30% of the green ink and less than 15% of the blue ink

[a]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run

[b]"L" indicates data from a laboratory run.

Image Analysis

Purpose
The purpose of the image analysis test is to measure how well the image is formed as it appears under magnification. The image analysis test is based on methods developed by Western Michigan University.

Equipment
High resolution optics
RGB digital frame grabber
Computer with Image ProPlus Analysis software

Procedure
1. Using the equipment listed above, quantify the following dot characteristics:
   - maximum and minimum dot area
   - maximum and minimum perimeter

2. Take readings from five random places of each sample color. A minimum of 50 dots per sample must be measured. Record the average and standard deviation.

Results
Image analysis was measured in the laboratory with samples collected from each site. Samples were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Since the purpose of this test was to evaluate screened dot detail as used in process color reproduction, only the magenta and cyan process inks were analyzed. Table 4-E.11 shows the results of the image analysis measurements. The results for dot area and perimeter are the averages of two scans; each scan measured 50 dots. The standard deviation is also shown in Table 4-E.11. When a site number begins with an “L,” the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
Solvent-based	LDPE	#S2	5	w	magenta	978.40	67.75	120.20	6.50
					cyan	710.55	65.90	103.25	5.25
				x	magenta	975.60	70.95	131.30	7.75
					cyan	697.35	46.60	101.95	4.05
				y	magenta	948.75	75.75	132.60	6.95
					cyan	730.90	61.10	104.80	4.35
				z	magenta	910.35	70.35	116.15	5.40
					cyan	764.65	56.85	107.05	4.50
			#7	w	magenta	1296.40	94.05	145.30	7.85
					cyan	776.40	54.95	113.10	5.95
				x	magenta	902.40	74.95	123.60	9.65
					cyan	423.00	66.00	102.50	13.30
				y	magenta	1024.15	79.00	129.95	8.35
					cyan	463.85	70.25	111.80	9.90
				z	magenta	975.90	69.80	123.70	6.20
					cyan	564.55	60.15	101.75	12.25
	PE/EVA	#S2	5	w	magenta	1365.65	79.90	146.60	8.00
					cyan	689.55	46.95	99.20	3.65
				x	magenta	902.45	71.45	120.75	6.35
					cyan	825.50	57.60	112.40	4.85
				y	magenta	596.60	66.25	97.30	6.50
					cyan	653.85	52.75	101.60	4.25
				z	magenta	784.00	65.80	110.60	5.65
					cyan	715.10	69.05	105.60	6.50
			7	w	magenta	419.10	55.05	112.00	15.95
					cyan	273.45	85.40	90.30	21.05
				x	magenta	1088.50	107.90	134.25	17.20
					cyan	374.30	63.50	116.85	18.75

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
Solvent-based	OPP	#S1	9B	w	magenta	504.85	31.40	89.50	5.65
					cyan	463.90	32.00	80.00	3.40
				x	magenta	664.20	52.75	104.30	8.75
					cyan	569.05	34.70	89.40	3.45
				z	magenta	692.70	45.25	114.00	7.60
					cyan	466.30	36.25	83.20	4.30
		#S2	10	w	magenta	342.80	126.65	106.10	31.45
					cyan	753.75	118.55	131.55	16.20
				x	magenta	580.95	129.95	128.35	24.65
					cyan	937.05	113.05	131.50	21.25
				y	magenta	671.10	84.40	130.30	14.25
					cyan	1093.25	115.05	148.50	25.95
				z	magenta	678.80	82.55	124.80	17.30
					cyan	1087.85	120.10	644.05	27.45
UV	LDPE	#U2	6	w	magenta	730.90	68.95	116.75	8.10
					cyan	937.95	55.65	120.10	5.85
				x	magenta	748.65	75.10	121.10	5.85
					cyan	1069.40	63.75	130.00	4.90
				y	magenta	779.85	80.30	121.80	7.90
					cyan	983.65	77.70	129.05	9.95
				z	magenta	605.70	47.80	92.55	4.30
					cyan	876.91	155.45	159.40	22.80

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
	PE/EVA	#U2	6	w	magenta	651.10	65.00	103.25	6.05
					cyan	1365.05	80.50	147.05	5.60
				x	magenta	643.80	55.10	97.25	4.95
					cyan	1177.05	67.45	142.20	9.30
				y	magenta	679.30	60.00	99.50	5.30
					cyan	557.05	71.40	132.40	7.30
				z	magenta	715.30	59.80	104.50	5.10
					cyan	469.75	75.45	133.50	17.25
UV	PE/EVA	#U3	8	w	magenta	463.75	43.00	81.50	8.30
					cyan	307.35	38.65	84.30	5.05
				x	magenta	463.45	50.45	100.35	9.30
					cyan	410.70	27.75	78.20	3.45
				z	magenta	513.65	53.05	93.50	9.55
					cyan	436.30	32.15	79.30	4.55
UV (no slip)	LDPE	#U1	11	w	magenta	374.74	42.46	73.92	4.10
					cyan	507.24	31.40	86.52	3.17
				x	magenta	481.49	50.30	82.62	4.57
					cyan	611.68	53.09	95.98	4.83
				y	magenta	487.06	50.59	83.52	4.82
					cyan	555.78	31.01	91.52	2.98
				z	magenta	482.81	53.27	83.16	5.16
					cyan	611.93	55.35	98.31	4.71

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
Water-based	LDPE	#W3	2	w	magenta	577.95	67.70	93.35	5.80
					cyan	942.85	66.25	119.90	4.70
				x	magenta	550.30	54.20	88.15	5.75
					cyan	986.60	51.40	122.90	4.65
				y	magenta	651.10	57.25	95.85	4.85
					cyan	1019.85	77.45	131.55	6.85
				z	magenta	654.75	72.40	95.85	5.40
					cyan	751.39	68.05	109.10	6.15
			3	w	magenta	1093.00	114.60	148.90	9.10
					cyan	578.55	47.65	95.65	4.15
				x	magenta	888.00	119.15	133.05	10.35
					cyan	560.70	33.90	89.90	3.20
				y	magenta	737.30	56.50	106.70	5.30
					cyan	716.35	46.40	105.75	4.70
				z	magenta	832.75	74.05	120.55	9.30
					cyan	579.25	40.75	97.35	5.30

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
Water-based	PE/EVA	#W3	2	w	magenta	551.35	68.40	92.30	7.60
					cyan	1022.00	32.55	127.35	7.95
				x	magenta	846.70	88.55	113.65	9.00
					cyan	909.40	103.35	115.25	7.10
				y	magenta	554.05	37.25	96.40	6.45
					cyan	950.95	72.60	116.90	5.30
				z	magenta	871.20	93.55	126.10	11.05
					cyan	761.85	99.60	115.00	10.70
			3	w	magenta	690.00	58.80	100.90	6.20
					cyan	891.65	67.25	117.25	6.85
				x	magenta	824.20	58.10	107.95	4.60
					cyan	984.35	51.40	126.15	8.75
				y	magenta	613.45	47.20	94.05	4.05
					cyan	776.05	54.65	109.10	3.90
				z	magenta	471.40	37.65	84.80	6.55
					cyan	709.30	36.75	104.25	5.05
	OPP	#W1	4	w	magenta	830.25	47.45	121.05	8.10
					cyan	829.35	54.70	114.45	6.50
				x	magenta	829.65	61.60	117.20	5.90
					cyan	700.10	44.60	107.90	5.45
				y	magenta	850.90	45.50	113.65	5.20
					cyan	758.65	34.35	110.60	5.35
				z	magenta	840.70	49.90	114.20	5.35
					cyan	836.75	44.15	115.15	5.55

Table 4-E.11 Image Analysis Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Dot Area (micron^2)	Standard Deviation - Area	Dot Perimeter (microns)	Standard Deviation - Perimeter
		#W2	1	w	magenta	450.70	69.85	110.75	18.50
					cyan	397.94	28.70	81.55	4.25
				x	magenta	361.65	79.80	111.45	13.50
					cyan	354.55	29.90	85.35	4.85
				y	magenta	347.10	56.10	84.15	16.25
					cyan	292.60	31.45	78.30	7.85
				z	magenta	326.90	39.35	84.15	16.25
					cyan	309.75	35.40	81.23	12.05
Water-based	OPP	#W4	9A	w	magenta	701.65	42.90	101.40	3.90
					cyan	535.65	106.45	90.55	12.25
				x	magenta	716.85	47.35	111.45	4.45
					cyan	861.10	100.10	82.70	14.00
				z	magenta	728.26	41.40	112.90	8.80
					cyan	849.65	110.55	114.15	8.35

[a]Samples were taken at four locations from the printed sample:
- w = beginning of the run
- x = 30 minutes into the run
- y = 60 minutes into the run
- z = end of the run

Jar Odor

Purpose
The purpose of this test is to evaluate the type and strength of the odor produced by the ink film on the substrate. The jar odor test is based on methods developed by Western Michigan University.

Equipment
Glass jars (eight ounces) with screw caps having foil liners.
Oven

Procedure
1. Clean the jars and dry them in an oven.

2. Collect samples from the interior of the rolls.

3. Place the printed sample in a jar and seal the jar with the screw cap.

4. Place the jar in the oven at 100°F for two hours.

5. Repeat the procedure for a sample of unprinted substrate as the test control.

6. Open the jar and sniff immediately. Record qualitative assessment of odor.

Results
The jar odor test was measured in the laboratory with samples collected from each site. Samples for testing were cut from two locations as indicated by the following symbols:

c = unprinted area (control)
x = printed area

Results are presented in Chapter 4.

Mottle/Lay

Purpose
The purpose of this test was to evaluate the mottle of the printed substrate. Mottle is the non-uniformity in appearance, or variation in density, of an ink film layer. The mottle/lay test is based on methods developed by Western Michigan University.

Equipment
The Tobias Associates Model MTI Mottle Tester is used to measure mottle. The MTI Model is made up of four main component: a probe or measurement head, a rotating drum that carries the sample, a microprocessor that performs all control and analysis functions, and a video display monitor.

Procedure

1. Calibrate the Mottle Tester before use. Calibrate by placing the calibration standard on the scanning drum with the "center line" marks aligned with the "scan start" mark. Follow the instructions through the main menu of computer. There are two standards for calibration: a white area for setting the ZERO (high reflectivity) and a black area for setting CAL (gain adjustment).

2. For testing, use samples of all substrates (LDPE, PE/EVA, OPP) with two samples from each of the front, middle, and end of the runs. Perform testing on all five colors. Use approximate sample widths of 38 mm (2 inches) with a scannable length of 100 mm (4 inches). This will produce 500 data points, 0.2 mm per point. The scannable length is the length of the sample that is free from any marks or obstructions. Samples must be cut from solid (100% coverage) area.

3. Samples should be mounted to the drum with masking tape, making sure that the tape is out of the scanning area.

4. Set the scan parameters and then select operating functions from the main menu. Follow the instructions manual for an explanation of menu options.

Results

This test was accomplished by using a Mottle Tester (a device specifically designed for this test) to measure the difference in reflective density of a printed sample. For this test, a twelve inch square sample was attached to the Mottle Tester and scanned. Multiple density measurement points (250 - 500) were collected during twenty linear scans over the sample area. The result is a Mottle Index which is derived from these measurement points.

Mottle was measured in the laboratory with samples collected from each site. Samples were cut from three locations during the run as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
z = end of run

The test image had areas printed with green and blue which were used to test for mottle. Table 4-E.12 shows the Mottle Index and standard deviation for these two ink colors from each site. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.12 Mottle Index for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Mottle Index	Standard Deviation
Solvent-based	LDPE	#S2	5	w	green	59.0	3.5
					blue	302.5	46.5
				x	green	93.5	17.0
					blue	286.5	36.0
				z	green	64.5	7.0
					blue	875.0	535.5
			7	w	green	45.5	4.0
					blue	216.5	18.5
				x	green	46.0	6.5
					blue	311.0	26.0
				z	green	34.5	3.5
					blue	258.5	28.5
Solvent-based	LDPE	#S2	L5[b]	w	green	219.5	9.0
				x	green	193.0	15.0
				z	green	262.0	62.0
	PE/EVA	#S2	5	w	green	71.5	5.5
					blue	288.5	25.5
				x	green	87.5	28.0
					blue	276.5	49.0
				z	green	74.0	9.5
					blue	306.0	30.5
			7	w	green	89.5	4.0
					blue	410.0	63.0
				z	green	45.5	3.5
					blue	349.0	27.0
			L7	w	green	362.5	26.0
				x	green	357.5	31.9
				z	green	349.4	21.7

Table 4-E.12 Mottle Index for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Mottle Index	Standard Deviation
	OPP	#S1	9B	w	green	43.0	4.0
					blue	257.0	20.5
				x	green	44.5	6.0
					blue	353.0	35.5
				z	green	43.5	5.0
					blue	408.5	37.5
		#S2	10	w	green	79.5	4.5
					blue	380.5	27.0
				x	green	111.5	7.5
					blue	420.5	33.0
				z	green	97.5	7.5
					blue	401.5	32.0
			L4	w	green	107.5	10.0
				x	green	137.5	13.0
				z	green	116.5	11.0
UV	LDPE	#U2	6	w	green	87.5	7.0
					blue	320.5	24.0
				x	green	73.0	5.5
					blue	281.0	28.0
				z	green	58.5	3.5
					blue	251.5	30.5
	PE/EVA	#U2	6	w	green	62.5	11.0
					blue	312.5	57.0
				x	green	56.5	3.0
					blue	474.0	93.5
				z	green	57.0	4.0
					blue	424.5	101.5
UV	PE/EVA	#U3	8	w	green	48.0	3.5
					blue	379.0	29.0
				x	green	50.5	6.0
					blue	508.0	57.5
				z	green	53.0	6.0
					blue	599.5	74.0
UV (no slip)	LDPE	#U1	11	w	green	68.5	5.5
					blue	629.0	106.0
				x	green	47.0	5.0
					blue	382.5	43.0
				z	green	51.0	5.0
					blue	446.0	50.0

Table 4-E.12 Mottle Index for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Mottle Index	Standard Deviation
Water-based	LDPE	#W3	2	w	green	122.0	7.5
					blue	1144.0	84.5
				x	green	114.5	6.5
					blue	999.0	50.5
				z	green	155.0	11.0
					blue	763.0	42.5
			3	w	green	82.0	9.5
					blue	491.5	34.0
				x	green	87.5	5.5
					blue	588.5	50.5
				z	green	79.0	7.5
					blue	605.5	49.0
			L1	w	green	389.0	27.0
				x	green	399.0	26.0
				z	green	379.0	28.0
	PE/EVA	#W3	2	w	green	90.0	5.0
					blue	1324.0	89.5
				x	green	75.0	6.5
					blue	658.5	74.5
				z	green	107.5	9.0
					blue	1116.5	99.0
			3	w	green	87.0	5.5
					blue	793.5	45.5
				x	green	95.0	6.0
					blue	966.0	57.7
				z	green	95.5	5.5
					blue	838.5	71.5

Table 4-E.12 Mottle Index for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Color	Mottle Index	Standard Deviation
Water-based	PE/EVA	#W3	L6	w	green	227.0	14.0
				x	green	203.0	12.0
				z	green	88.0	8.0
	OPP	#W1	4	w	green	206.0	27.0
					blue	1063.0	98.0
				x	green	193.0	50.0
					blue	1004.5	156.5
				z	green	116.0	8.5
					blue	967.5	134.5
		#W2	1	w	green	44.5	3.5
					blue	219.5	48.0
				x	green	54.5	3.0
					blue	402.5	61.5
				z	green	50.5	4.0
					blue	343.0	40.5
			L3	w	green	169.0	9.5
				x	green	131.0	19.5
				z	green	262.0	62.0
		#W4	9A	w	green	38.0	3.0
					blue	174.5	17.0
				x	green	40.5	7.5
					blue	187.5	19.5
				z	green	36.5	3.5
					blue	212.5	15.5
			L2	w	green	99.0	15.5
				x	green	128.5	10.5
				z	green	251.5	22.0

[a]Samples were taken at three locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
z = end of the run

[b]"L" indicates data from a laboratory run.

Opacity

Purpose
The purpose of this test is to measure the opacity of an ink film. Opacity is the degree to which light can pass through an object. It is expressed as the percentage of light transmitted through both the ink film and substrate. The opacity test is based on methods developed by Western Michigan University.

Equipment
Datacolor Spectraflash 600
Diano-BLN opacity meter

Procedure
1. Adjust the standard and batch reflectance by magnesium oxide factors, and then calculate the A/2 degrees Y Tristimulus values.

2. Samples should be measured using the Small Area View (SAV) port size and calibrated to this size before use. Calibration procedures are noted in the CIE L* a* b* test method.

3. Take five samples from four locations of the run for both LDPE and OPP substrates.

4. Take readings for white color samples only.

5. Select the mode for Opacity from the indexes menu and choose Tappi 425 Opacity. Follow the instructions on the screen to proceed with testing. Back each sample with a standard and read 5 times in random places.

Results
Opacity was measured in the laboratory with samples collected from each site. Samples were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Only white printed samples were tested. Table 4-E.13 shows the opacity measurements and standard deviations for these samples. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.13 Opacity Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Average Opacity (%)	Standard Deviation
Solvent-based	LDPE	#S2	5	w	46.66	0.27
				x	48.50	0.40
				y	47.62	0.33
				z	48.28	0.53
			7	w	51.76	0.41
				x	51.22	0.21
				y	51.40	0.43
				z	48.72	0.19
			L5[b]	w	55.52	4.20
				x	50.40	2.02
				z	56.34	4.57
	OPP	#S1	9B	w	50.74	0.37
				x	51.44	1.93
				z	53.90	0.49
Solvent-based	OPP	#S2	10	w	49.24	0.34
				x	47.34	0.26
				y	47.94	0.16
				z	48.24	0.14
			L4	w	40.60	0.76
				x	38.38	1.05
				z	38.62	0.41
UV	LDPE	#U2	6	w	52.68	0.85
				x	52.92	0.36
				y	55.36	0.46
				z	57.60	1.13
UV (no slip)	LDPE	#U1	11	w	55.42	1.00
				x	56.90	0.54
				y	56.52	0.50
				z	56.74	0.48

Table 4-E.13 Opacity Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Average Opacity (%)	Standard Deviation
Water-based	LDPE	#W3	2	w	47.34	0.08
				x	46.62	0.55
				y	46.34	1.15
				z	46.62	0.50
			3	w	57.14	0.24
				x	54.84	0.38
				y	55.00	0.35
				z	52.92	0.38
			L1	w	43.12	0.95
				x	43.06	0.30
				z	43.66	0.74
	OPP	#W1	4	w	51.52	0.34
				x	52.86	0.31
				y	53.46	1.71
				z	52.82	0.33
			L2	w	29.10	0.91
				x	28.68	0.80
				z	27.86	0.81
		#W2	1	w	57.52	0.34
				x	58.20	0.06
				y	56.92	0.29
				z	57.22	0.37
			L3	w	36.74	0.42
				x	37.70	1.64
				z	37.84	0.54
		#W4	9A	w	54.74	0.34
				x	54.22	0.30
				z	53.98	0.17

[a]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run
[b]"L" indicates data from a laboratory run.

Rub Resistance

Purpose

The purpose of the dry and wet rub resistance tests is to check the ink's ability to resist being rubbed off of its substrate. The dry and wet rub resistance tests were based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment

Sutherland Ink Rub Tester and attachments.
Scoring device (included with the Rub Tester).
Supply of 80 × 80 count bleached muslin cloth which has been found useful in testing wet smear, wet rub, and wet bleed.

Procedure

1. Obtain a 6 inch × 3 inch printed sample which is representative of the rub in ink lay and coverage. When the printed area permits, the 6-inch direction should be cut across the grain of the sheet, but must not cross wrinkles, scores, creases, or other imperfections that would distort the results. Unprinted stock from the same run should be provided in 7½ inch × 2 inch sizes (for dry rub) and 5½ inch × 2 inch sizes (for wet rub). In both cases, cut the longer dimension across the grain of the flexible material.

2. **For dry rub resistance:** Clip a 7½ inch × 2 inch test strip (with a solid printed image 1 inch x 1½ inch centered on the sample) to the 4-pound testing block, with the printing surface away from the rubber pads. Mount the test specimen securely, print side up, on the rubber pad of the base plate. Place the weight over the sample, making sure that one of the 1 inch × 2 inch rubber pads of the test block is over the ink area being tested, and that both surfaces are free of dirt. Preset the tester for 100 strokes, or less if a failure occurs, for a particular printed surface. When the rubs have been completed, examine both the inked surface and the plain surface on the test block for signs of transfer.

3. **For wet rub resistance:** Mount the strips in the same manner as for the dry rub test, using the 2-pound test block. Preset the tester for one rub. Place 2 to 6 drops of distilled water on the printed surface so that they will be covered by the test block. Place the block in position and press the "start" button. After one stroke, examine both surfaces for color transfer. Repeat single strokes until ink failure is noted and record the number of strokes.

4. Record the appearance of the inked surface and/or (as appropriate) the blotter surface. Record the percent of ink transferred, the weight of the test block, and the number of strokes that cause total failure.

Table 4-E.14 summarizes the different conditions for these tests.

Table 4-E.14 Summary of Test Conditions for Dry and Wet Rub Resistance

Test	Test Block (pounds)	Size of Strip (inches)	Suggested Number of Strokes	Strip Material	Contact Time Before Rub
Dry Rub	4	2 × 7½	100	test sheet	0.00
Wet Rub	2	2 × 5½	1 (until failure)	test sheet	0.00

Results

Dry and wet rub resistance was measured in the laboratory with samples collected from each site. Sites 1, 4, 9, and 10 were not tested in the laboratory because the OPP substrate printed at these sites was laminated to another substrate. Samples were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Table 4-E.15 present the results for the dry rub resistance test for the performance demonstration sites and laboratory runs, and Table 4-E.16 presents the results for the wet rub resistance test. When a site number begins with an “L,” the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.15 Dry Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Original Density (unitless)	Density After 50 Strokes (unitless)	Percent Retained Density (%)
Solvent-based	LDPE	#S2	5	w	2.06	1.95	94.7
				x	2.06	1.96	95.1
				y	2.05	1.95	95.1
				z	2.12	1.96	92.5
			7	w	1.81	1.75	96.6
				x	1.77	1.65	93.2
				y	1.77	1.75	98.8
				z	1.76	1.65	93.7
			L5[b]	w	1.35	1.28	94.8
				x	0.79	0.78	98.7
				z	0.91	0.90	98.9

Table 4-E.15 Dry Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Original Density (unitless)	Density After 50 Strokes (unitless)	Percent Retained Density (%)
Solvent-based	PE/EVA	#S2	5	w	2.08	2.00	96.2
				x	2.03	1.91	94.1
				y	2.08	1.94	93.3
				z	2.05	1.96	95.6
			7	w	1.65	1.59	96.3
				z	1.64	1.59	96.9
			L7	w	0.75	0.71	94.0
				x	0.78	0.75	96.0
				z	0.82	0.79	97.0
UV	LDPE	#U2	6	w	2.13	1.95	91.5
				x	2.02	1.88	93.6
				y	2.00	1.80	94.5
				z	1.99	1.88	94.5
	PE/EVA	#U2	6	w	1.99	1.89	95.5
				x	1.97	1.80	91.4
				y	1.88	1.84	97.8
				z	1.89	1.84	97.3
		#U3	8	w	1.13	1.11	98.2
				x	1.08	1.10	100.0
				z	1.10	1.07	97.3
UV (no slip)	LDPE	#U1	11	w	2.18	1.88	86.2
				x	1.96	1.80	91.8
				y	2.14	1.86	86.9
				z	2.20	1.91	86.8
Water-based	LDPE	#W3	2	w	1.97	1.82	92.3
				x	1.95	1.80	92.3
				y	1.98	1.86	93.9
				z	2.02	1.93	95.5
			3	w	2.15	1.94	90.2
				x	2.16	2.00	92.6
				y	2.12	1.93	91.0
				z	2.03	1.89	93.0
			L1	w	1.03	1.02	99.0
				x	1.06	1.05	99.1
				z	1.04	1.04	100.0

Table 4-E.15 Dry Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Original Density (unitless)	Density After 50 Strokes (unitless)	Percent Retained Density (%)
	PE/EVA	#W3	2	w	1.67	1.63	97.6
				x	2.14	2.02	94.4
				y	2.08	1.97	94.7
				z	2.04	1.89	92.6
			3	w	1.95	1.90	97.4
				x	1.88	1.75	93.0
				y	1.82	1.75	96.1
				z	1.87	1.80	96.2
Water-based	PE/EVA	#W3	L6	w	0.93	0.88	94.6
				x	0.80	0.79	98.8
				z	0.88	0.85	96.6

[a]Samples were taken at four locations from the printed sample:
- w = beginning of the run
- x = 30 minutes into the run
- y = 60 minutes into the run
- z = end of the run

[b]"L" indicates data from a laboratory run.

Table 4-E.16 Wet Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Failure at Number of Strokes[b]
Solvent-based	LDPE	#S2	5	w	5
				x	4
				y	4
				z	4
			7	w	5
				x	5
				y	5
				z	5
			L5[c]	w	no failure at 10 strokes
				x	no failure at 10 strokes
				z	no failure at 10 strokes
	PE/EVA	#S2	5	w	3
				x	2
				y	2
				z	2
			7	w	5
				z	5

Table 4-E.16 Wet Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Failure at Number of Strokes[b]
			L7	w	5
				x	6
				z	6
UV	LDPE	#U2	6	w	6
				x	5
				y	5
				z	5
	PE/EVA	#U2	6	w	3
				x	4
				y	5
				z	5
		#U3	8	w	2
				x	3
				z	2
UV (no slip)	LDPE	#U1	11	w	3
				x	2
				y	2
				z	2
Water-based	LDPE	#W3	2	w	8
				x	8
				y	8
				z	8
			3	w	no failure at 10 strokes
				x	no failure at 10 strokes
				y	no failure at 10 strokes
				z	no failure at 10 strokes
			L1	w	no failure at 10 strokes
				x	no failure at 10 strokes
				z	no failure at 10 strokes

Table 4-E.16 Wet Rub Resistance Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Failure at Number of Strokes[b]
	PE/EVA	#W3	2	w	3
				x	3
				y	2
				z	2
			3	w	4
				x	3
				y	3
				z	3
			L6	w	7
				x	6
				z	no failure at 10 strokes

[a]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run
[b]A failure represents ink color transferred from the printed substrate to the unprinted substrate. A maximum of 10 strokes were used for the wet rub resistance test.
[c]"L" indicates data from a laboratory run.

Tape Adhesiveness

Purpose
The purpose of the tape adhesiveness test is to check the bond of the dry ink to the substrate. Adequate ink adhesion is critical, because if the ink doesn't adhere well enough, it will not be able to stand up to the normal demands placed on the finished product. The tape adhesiveness test was based on methods developed by Quality Assurance at Sun Chemical Corporation.

Equipment
Printed sample of ink
Adhesive tape (3M — #610)

Procedure
1. Air dry or oven dry the print per standard test procedure.

2. Place a length of adhesive tape (3M — #610) along the length of the print.

3. Hold the print down with one hand and quickly pull the tape off the print. The tape should be pulled at a 90 degree angle to the print, upwards, not against the tape.

4. Observe the tape; there should be no ink removal.

5. Observe the print. Again, there should be no signs of ink removal.

6. If 100% ink removal occurs, verify that the print has been made on the correct side of the substrate.

7. Record the degree of ink removal by estimating the percentage of ink removed.

Results

Tape adhesiveness was measured on site during the demonstration runs, and in the laboratory with samples collected from each site. Sites 1, 4, 9, and 10 were not tested in the laboratory because the OPP substrate printed at these sites was laminated to another substrate. This lamination trapped the ink between the two substrate layers, making it unnecessary to test the ink on the OPP substrate with this method.

Samples for testing were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Due to the aborted run using the PE/EVA substrate at Site 7, samples were only taken from the beginning (w) and the end (z) of the run for testing in the laboratory. Site 8 also had a shorter run for the PE/EVA substrate, so samples were only available at the beginning (w), 30 minutes into run (x), and the end of the run (z).

The laboratory runs at Western Michigan University were shorter in duration than the demonstration runs, so samples for testing were only cut from three locations (w, x, and z).

All ink colors that were printed on each substrate were tested. (White ink was not printed on the white PE/EVA). In the case of a failure, the color(s) of ink removed were listed in the "Comments" column, along with an indication of how much ink was removed.

Table 4-E.17 shows the tape adhesiveness results of samples from each site. When a site number begins with an "L," the data were taken from a laboratory run conducted at Western Michigan University, not from a volunteer printing facility.

Table 4-E.17 Tape Adhesiveness Results for Performance Demonstration Sites and Laboratory Runs

Ink System	Film	Product Line	Site	Location of Sample[a]	Pass/ Fail	Comments
Solvent-based	LDPE	#S2	5	w	P	
				x	P	
				y	P	
				z	P	
			7	w	P	
				x	P	
				y	P	
				z	P	
			L5[b]	w	P	
				x	P	
				z	P	
	PE/EVA	#S2	5	w	F	outline of cyan and magenta was removed
				x	F	outline of cyan and magenta was removed
				y	P	
				z	P	
			7	w	F	cyan and magenta were slightly removed
				z	F	cyan, magenta, and blue were removed
			L7	w	P	
				x	P	
				z	P	
	OPP	#S2	L4	w	P	
				x	P	
				z	P	
UV	LDPE	#U2	6	w	F	white and magenta were removed
				x	F	magenta was slightly removed
				y	P	
				z	P	
UV	PE/EVA	#U2	6	w	F	blue, green, and magenta were removed
				x	F	cyan, magenta, and blue were removed
				y	F	cyan, magenta, and blue were removed
				z	F	all colors were removed
		#U3	8	w	F	cyan was slightly removed
				x	P	
				z	F	cyan and green were slightly removed

Table 4-E.17 Tape Adhesiveness Results for Performance Demonstration Sites and Laboratory Runs (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Pass/ Fail	Comments
UV (no slip)	LDPE	#U1	11	w	P	
				x	P	
				y	P	
				z	P	
Water-based	LDPE	#W3	2	w	P	
				x	P	
				y	P	
				z	P	
			3	w	P	
				x	P	
				y	P	
				z	P	
			L1	w	P	
				x	P	
				z	P	
	PE/EVA	#W3	2	w	P	
				x	F	blue was removed
				y	F	blue was removed
				z	P	
			3	w	P	
				x	P	
				y	P	
				z	F	green was removed
			L6	w	F	all colors were removed
				x	F	all colors were removed
				z	F	all colors were removed
Water-based	OPP	#W2	L3	w	P	
				x	P	
				z	P	
		#W4	L2	w	P	
				x	P	
				z	P	

[a]Samples were taken at four locations from the printed sample:
w = beginning of the run
x = 30 minutes into the run
y = 60 minutes into the run
z = end of the run

[b]"L" indicates data from a laboratory run.

Trap

Purpose
The purpose of the trap test is to evaluate the efficiency of one ink printed over the top of the next. The trap test was based on methods developed by Western Michigan University.

Equipment
X-Rite 418 densitometer

Procedure
The procedure for measuring trap requires samples to be printed with solid ink densities of magenta, cyan, white, and blue. The trap combinations to be measured were magenta and cyan, and white and blue. However, the densitometer did not get viable results from the white and blue combination. Trap was measured for both 100% tone (solid) and 80% tone samples printed with magenta and cyan.

1. Calibrate the densitometer according to the manufacturer's instructions. For all color references, follow the calibration instructions obtained by pressing the function key and color key together. Using instructions on the instrument, set low (white standard) and high values (black standard) for each color; then read the individual color patches as determined by the instrument. Verify calibration values for each standard patch and make adjustments as necessary.

2. Two samples will be taken from four locations on the press runs for all substrates (LDPE, PE/EVA, OPP).

3. Follow the densitometer instructions for the order in which readings should be performed.

4. The apparent trap is calculated from densitometer readings using the GATF/Preucil trap formula:

$$\text{Apparent trap [\%]} = (D_{op} - D_1) \times 100 / D_2$$

where D_{op} = density of two-color overprint
D_1 = density of first ink down
D_2 = density of second ink down

D_{op}, D_1, and D_2 are measured using the complimentary filter of the second ink down minus the paper.

Results
Trap was measured in the laboratory with samples collected from each site. Samples on samples cut from two locations during the run length as indicated by the following symbols:

w = beginning of run
z = end of run

Table 4-E.18 shows the percent trap for these samples. Trap was measured for 100% tone (solid) and 80% tone areas. The results in Table 4-E.18 are the averages of five measurements taken at each location during the run length. The standard deviation of those five measurements is also shown in the table. The laboratory runs did not have any overprinting using the process colors referred to above, so they were not measured for trap.

Table 4-E.18 Trap Results for Performance Demonstration Sites

Ink System	Film	Product Line	Site	Location of Sample[a]	Tone of Sample (%)	Average Trap (%)	Standard Deviation
Solvent-based	LDPE	#S2	5	w	100	96.6	1.62
					80	99.8	2.79
				z	100	100.0	2.61
					80	99.8	3.71
			7	w	100	100.2	1.17
					80	101.6	1.36
				z	100	98.2	1.17
					80	98.8	1.17
	PE/EVA	#S2	5	w	100	104.2	1.72
					80	100.0	3.52
				z	100	97.4	1.74
					80	97.2	2.64
			7	w	100	93.2	3.82
					80	93.8	3.06
				z	100	92.4	1.36
					80	90.2	1.33
	OPP	#S1	9B	w	100	102.6	1.36
					80	99.0	3.29
				z	100	104.6	2.24
					80	103.8	2.04
		#S2	10	w	100	93.4	6.65
					80	107.6	4.84
				z	100	98.2	4.40
					80	95.8	2.71
UV	LDPE	#U2	6	w	100	88.8	1.72
					80	88.0	1.10
				z	100	89.4	2.80
					80	87.6	3.20
	PE/EVA	#U2	6	w	100	95.0	4.47
					80	91.2	0.75
				z	100	90.2	2.14
					80	90.4	0.49
		#U3	8	w	100	91.4	2.50
					80	94.6	1.62
				z	100	96.2	1.94
					80	97.2	3.60

Table 4-E.18 Trap Results for Performance Demonstration Sites (continued)

Ink System	Film	Product Line	Site	Location of Sample[a]	Tone of Sample (%)	Average Trap (%)	Standard Deviation
UV (no slip)	LDPE	#U1	11	w	100	85.2	4.53
					80	80.6	2.58
				z	100	80.8	1.47
					80	81.0	2.10
Water-based	LDPE	#W3	2	w	100	93.2	5.15
					80	88.0	4.20
				z	100	92.6	2.06
					80	89.6	4.22
			3	w	100	116.4	4.08
					80	105.2	3.31
				z	100	111.6	2.58
					80	109.0	4.05
	PE/EVA	#W3	2	w	100	76.2	1.94
					80	79.6	2.24
				z	100	73.4	3.93
					80	76.8	5.04
			3	w	100	97.6	1.36
					80	105.4	2.24
				z	100	88.4	1.02
					80	78.4	0.80
	OPP	#W1	4	w	100	87.4	1.20
					80	96.8	3.60
				z	100	87.6	1.85
					80	87.6	1.62
		#W2	1	w	100	87.6	3.56
					80	82.0	3.29
				z	100	91.4	1.96
					80	88.4	1.50
		#W4	9A	w	100	88.4	2.50
					80	91.0	5.44
				z	100	87.2	1.47
					80	89.2	1.47

[a]Samples were taken at two locations from the printed sample:
w = beginning of run
z = end of run

Uncured Residue — UV Ink

Purpose

The purpose of the uncured residue test is to determine if uncured residue from UV ink remains on the printed substrate after the final UV curing station. The uncured residue test for UV inks is based on methods developed by Maine Poly Inc.

Equipment

Three glass jars (approximately eight ounces) with lids
Alcohol

Procedure

1. Cut three samples from the roll of printed product.

2. Fill each of the three jars with enough alcohol to fully immerse the printed sample.

3. Place one sample in each jar.

4. After 24 hours, check jar #1. Note if there is any discoloration of the alcohol indicating uncured residue is present.

5. After 48 hours, check jar #2. Note if there is any discoloration of the alcohol.

6. After 72 hours, check jar #3. Note if there is any discoloration of the alcohol.

Results

The uncured residue test was measured in the laboratory with samples collected from Sites 6, 8 and 11. UV ink was not run at any other sites, nor was it used in the laboratory runs performed at Western Michigan University.

The uncured residue test was measured in the laboratory with samples collected from each site. Samples for testing were cut from four locations during the run length as indicated by the following symbols:

w = beginning of run
x = 30 minutes into run
y = 60 minutes into run
z = end of run

Table 4-E.19 presents the results of the uncured residue test for each of the sites. Uncured residue was only measured for green, blue, and white ink, as these colors had the largest areas of coverage. However, uncured residue was only found in blue print. There was no evidence of uncured residue for green and white print. Therefore, the results in Table 4-E.19 are only for blue ink.

Table 4-E.19 Uncured Residue Results for Performance Demonstration Sites

Ink System	Film	Product Line	Site	Location of Sample[a]	Percent of Ink Removed (by weight)[b]
UV	LDPE	#U2	6	w	0.00
				x	0.00
				y	0.00
				z	0.00
	PE/EVA	#U2	6	w	0.00
				x	0.00
				y	0.00
				z	0.00
		#U3	8	w	6.78
				x	7.00
				z	7.14
UV (no slip)	LDPE	#U1	11	w	11.27
				x	9.82
				y	11.51
				z	9.09

[a]Samples were taken at four locations from the printed sample:
- w = beginning of the run
- x = 30 minutes into the run
- y = 60 minutes into the run
- z = end of the run

[b]Uncured residue was found in blue print only. No uncured residue was found in green and white print.

Appendix 4-F (Performance Chapter)
Anilox Configuration Data from the Performance Demonstrations

See Site Profiles in Chapter 4 for color sequence.

	Site 1 water-based OPP		**Site 2 water-based LDPE, PE/EVA[1]**		**Site 3 water-based LDPE, PE/EVA[1]**		**Site 4 water-based OPP**		**Site 5 solvent-based LDPE, PE/EVA[1]**		**Site 6 UV LDPE, PE/EVA[1], OPP**	
	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm
blue	280	7.0	280	6.0	240	7.8	250	6.1	240	4.2	360	4.7
green	280	6.4	300	6.9	240	7.8	250	6.8	240	4.2	360	4.7
white	280	7.5	360	5.0	300	5.2	250	6.3	300	6.2	250	7.5
cyan	800	1.7	360	4.9	500	3.2	800	2.2	550	2.0	600	2.8
magenta	800	1.7	360	5.1	500	3.2	600	2.7	550	2.0	600	2.8

	Site 7 solvent-based LDPE, PE/EVA[1]		**Site 8 UV LDPE, PE/EVA[1], OPP[2]**		**Site 9A water-based OPP**		**Site 9B solvent-based OPP**		**Site 10 solvent-based OPP**		**Site 11 UV LDPE**	
	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm	lpi	bcm
blue	500	4.0	724	4.5	400	4.0	400	4.0	250	10.1	360	5.6
green	500	4.0	724	4.5	400	4.0	400	4.0	250	9.8	360	5.6
white	200	8.5	200	8.4	300	5.5	300	5.5	250	9.0	300	6.0
cyan	700	2.0	724	4.5	550	2.7	550	2.7	800	1.8	500	2.7
magenta	700	2.0	724	4.5	550	2.7	550	2.7	800	1.6	500	2.7

[1]white not used on PE/EVA

[2]magenta not used on LDPE, OPP

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Appendix 4-G (Performance Chapter)
Surface Tension Data From the Performance Demonstrations

Site	Ink System	Substrates	Surface Tension (dynes)	
			before corona treatment	after corona treatment
Site 1	Water-based	OPP	42	42
Site 2	Water-based	LDPE	39	41
		PE/EVA	40	41
Site 3	Water-based	LDPE	41	41
		PE/EVA	41	41
Site 4	Water-based	OPP	44	44+*
Site 5	Solvent-based	LDPE	42	41
		PE/EVA	42	41
Site 6	UV	LDPE	41	41
		PE/EVA	41	41
Site 7	Solvent-based	LDPE	41	42
		PE/EVA	41	42
Site 8	UV	LDPE	41	42
		PE/EVA	41	41
Site 9A	Water-based	OPP	43	44
Site 9B	Water-based	OPP	43	44
Site 10	Solvent-based	OPP	43	43
Site 11	UV	LDPE	40	40

*dyne pens only go up to 44 dynes

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Appendix 4-H (Performance Chapter)
Viscosity Data From the Performance Demonstrations

Ink System	Film	Product Line Number	Site	Zahn Cup	Color	Viscosity (seconds) at					
						0 minutes	30 minutes	45 minutes	1 hour	1 hour 45 minutes	2 hours
Solvent-based	LDPE	#2	5	#2	blue	19.6	19.4	20.0	21.7	23.1	27.8
					cyan	20.0	21.3	22.0	20.0	19.1	19.4
					green	21.6	24.3	30.0	21.3	22.4	25.6
					magenta	18.0	21.0	21.8	18.7	19.8	21.2
					white	18.4	19.2	23.0	20.3	20.1	21.5
			7	#2	blue	38.0	26.0	25.0			25.0
					cyan	38.0	30.0	29.0			26.0
					green	38.0	26.0	26.0			20.0
					magenta	38.0	30.0	29.0			28.0
					white	11.0	26.0	27.0			19.0
	PE/EVA	#2	5	#2	blue	19.6	19.4	20.0	21.7	23.1	27.8
					cyan	20.0	21.3	22.0	20.0	19.1	19.4
					green	21.6	24.3	30.0	21.3	22.4	25.6
					magenta	18.0	21.0	21.8	18.7	19.8	21.2
					white	N/A	N/A	N/A	N/A	N/A	N/A
			7	#2	blue	38.0	26.0	25.0		25.0	
					cyan	38.0	30.0	29.0		26.0	
					green	38.0	26.0	26.0		20.0	
					magenta	38.0	30.0	29.0		28.0	
					white	N/A	N/A	N/A		N/A	

Ink System	Film	Product Line Number	Site	Zahn Cup	Color	Viscosity (seconds) at					
						0 minutes	30 minutes	45 minutes	1 hour	1 hour 45 minutes	2 hours
	OPP	#2	10	#2	blue	41.1	19.7	22.3	22.3	22.0	25.0
					cyan	43.4	34.4	18.8	18.3	18.8	22.0
					green	34.8	25.0	25.0	25.9	25.0	25.0
					magenta	40.9	32.0	18.8	17.8	18.8	18.8
					white		22.2	22.3	23.9	22.2	22.0
Solvent-based	OPP	#4	9B	#2	blue	28.7	33.8	32.5	36.3	40.3	33.4
					cyan	23.5	24.3	24.1	24.1	27.1	27.6
					green	33.1	31.4	30.4	33.8	34.8	29.6
					magenta	31.3	32.5	32.3	37.2	35.1	28.6
					white	31.3	35.7	37.5	31.2	34.9	
Water-based	LDPE	#3	2	#3	blue		12.0	12.0	11.0	11.0	10.0
					cyan		14.0	14.0	16.0	16.0	18.0
					green		14.0	14.0	14.0	14.0	15.0
					magenta		15.0	16.0	17.0	14.0	17.0
					white		16.0	16.0	18.0	19.0	20.0
			3	#2	blue	≥90	≥90		≥90	≥90	
					cyan	70.0	75.0		≥90	≥90	
					green	≥90	≥90		≥90	≥90	
					magenta	60.0	65.0		≥90	≥90	
					white	25.0	27.0		27.0	26.0	

Ink System	Film	Product Line Number	Site	Zahn Cup	Color	Viscosity (seconds) at					
						0 minutes	30 minutes	45 minutes	1 hour	1 hour 45 minutes	2 hours
	PE/EVA	#3	2	#3	blue			15.0	too foamy		
					cyan			25.0	too foamy		
					green			18.0	too foamy		
					magenta			22.0	too foamy		
					white			N/A	N/A	N/A	N/A
			3	#2	blue	≥90	≥90		≥90		≥90
					cyan	≥90	≥90		≥90		≥90
					green	≥90	≥90		≥90		≥90
					magenta	70.0	≥90		≥90		≥90
					white	N/A	N/A		N/A		N/A
Water-based	OPP	#1	4	#2	blue	46.0			34.0		26.0
					cyan	14.0			17.0		15.0
					green	34.0			27.0		24.0
					magenta	14.0			12.0		13.0
					white	37.0			28.0		35.0
		#2	1	#2	blue		17.0	19.0	too foamy		
					cyan		13.0	21.0	too foamy		
					green		15.0		too foamy		
					magenta		11.0	20.0	too foamy		
					white		18.0		too foamy		
		#4	9A	#3	blue	12.1	12.4	12.4	12.0		
					cyan	10.0	10.0	10.0	9.9		
					green	16.1	18.6	13.5	16.1		
					magenta	15.3	14.9	13.4	16.7		
					white	13.1	11.1	11.1	11.1		

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Appendix 4-I (Performance Chapter)
Descriptions and Test Data for Performance Demonstration Sites

PERFORMANCE DEMONSTRATIONS

The inks, substrates, and test plates were shipped to each facility approximately two weeks prior to each test run. The five ink colors were delivered at press in sealed five-gallon containers. A press crew from the facility, and a team from the DfE Project was present at each performance demonstration. The DfE team consisted of John Serafano (WMU), accompanied by one or more individuals from either the DfE staff, WMU, or DfE contractor Abt Associates Inc.

Anilox placement and cylinder mounting were done prior to the arrival of the DfE team. The DfE team and the facility press crews then monitored the press runs, from makeready through clean-up. During each demonstration, the press was run at production speeds (300 to 500 feet per minute) for approximately two hours to produce up to 60,000 feet of printed product (exceptions are described in "Deviations from the Project Methodology").

During the runs, the necessary data was collected, and on-site tests were conducted. After each run, substrates were shipped to WMU, where more performance testing was conducted.

SITE 1: WATER-BASED INK #2 ON OPP

There was one pre-makeready, one makeready, and one demonstration run performed.

Makeready: OPP

The ink was mixed to the desired viscosity (see Appendix 4-H), and the doctor blade systems were pressurized, delivering ink to the anilox rolls. At this point, the press drive was engaged and the initial running makeready began. Impression was set for each color and registration was achieved. The press speed ranged from 148 to 412 feet per minute (ft/min). Most of the makeready was run on a similar substrate supplied by the site to ensure adequate supply of the control film for the run. A flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample was made. The samples had good lay and trap, there appeared to be no problems with web stability, and there was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.1. The makeready process lasted 64 minutes and consumed 8,975 feet of film. The site-supplied substrate was used first for the makeready, which lasted 27 minutes and consumed 2,783 feet of film. The makeready on the DfE control substrate lasted 37 minutes and consumed 6,192 feet of film.

Table 4-I.1 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.590	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.218	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.596	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.500	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

Viscosity measurements were to have been taken and logged every 15 minutes during the run. However the inks became too foamy, making this impossible. At 30 minutes, the green and white could no longer be measured, and at 45 minutes the blue, cyan, and magenta could no longer be measured. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was initially ramped to 412 ft/min for the demonstration run. It was determined that higher speeds were possible and the speed was increased to 430 ft/min after 10,000 impressions. The run was completed after 129 minutes, with 51,000 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.2.

Table 4-I.2 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.64	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.43	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.19	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.53	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 2: WATER-BASED INK #3 ON LDPE AND PE/EVA

Since the same product line was used for both substrates, only one pre-makeready and one makeready were necessary. However, a "makeready check" was performed at the beginning of the second demonstration run, before the PE/EVA. The only change made between the two demonstration runs was that Deck #1 (white ink) was disengaged because the PE/EVA is a white substrate and white is typically not printed over a white film.

Makeready: LDPE

To ensure adequate substrate supply for the run, a substrate similar to the control was substituted during the makeready.

The ink was mixed to the desired viscosity (see Appendix 4-H), and the doctor blade systems were pressurized, delivering ink to the anilox rolls. At this point, the press drive was engaged and the initial running makeready began. Once impression was set for each color and registration was achieved, the press was ramped up to 118 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed pinholing in all colors. There appeared to be no problems with web stability, and there was no evidence of blocking. The impression was adjusted to correct the pinholing. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.3. The makeready process lasted a total of 40 minutes (25 minutes with in-house substrate, and 15 minutes with DfE substrate), and consumed 6,050 feet of film (4,645 feet of in-house film, and 1,405 feet of DfE film.)

Table 4-I.3 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.46	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.98	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.23	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.74	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Pinholing. Poor trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

During the run, viscosity measurements were taken and logged every 15 minutes. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 500 ft/min for the demonstration run, but the speed had to be reduced to 403 ft/min because of poor drying and trap. The run was completed after 93 minutes because of an inadequate supply of DfE substrate. 37,053 feet of film were consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.4.

Table 4-I.4 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.592	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.250	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.608	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.594	Pinholing. Poor trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Pinholing. Poor trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: PE/EVA

As stated previously, there was no makeready for the PE/EVA because the press was already set up from the LDPE production run; however, a "makeready check" was performed after 6,000 feet of film were consumed. It was also necessary to disengage Deck #1 (white ink) because the PE/EVA film was white.

The PE/EVA film was mounted on the press unwind reel. The press drive and color decks were engaged and the press was ramped to 403 ft/min where a marker was inserted for sample identification. The press was stopped and a sample was taken for inspection. Density measurements and an adhesiveness test were performed on each color, and a visual quality inspection was made. The results are listed in Table 4-I.5.

Viscosity measurements were taken 15 minutes into the run. Subsequent viscosity measurements were not possible due to foaming of the ink. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

It was necessary to stop the press at 16,000 feet to wipe the plates clean. The run was ended after 37,868 feet of film consumed (102 minutes of run time) in order to match the run length of the LDPE substrate. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.6.

Table 4-I.5 Results of Tests Performed on PE/EVA at End of Makeready

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.55	Poor print quality. Trap variable. No problems with dimensional stability or blocking.
Blue	Fail	2.17	Poor print quality. Trap variable. No problems with dimensional stability or blocking.
Magenta	Pass	1.04	Poor print quality. Trap variable. No problems with dimensional stability or blocking.
Cyan	Pass	1.54	Poor print quality. Trap variable. No problems with dimensional stability or blocking.

[1]White was not used.

Table 4-I.6 Results of Tests Performed on PE/EVA at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.25	Poor print quality. Good trap. No problems with dimensional stability or blocking.
Blue	Fail	2.05	Poor print quality. Good trap. No problems with dimensional stability or blocking.
Magenta	Pass	1.16	Poor print quality. Good trap. No problems with dimensional stability or blocking.
Cyan	Pass	1.12	Poor print quality. Good trap. No problems with dimensional stability or blocking.

[1]White was not used.

SITE 3: WATER-BASED INK #3 ON LDPE AND PE/EVA

Since the same product line was used for both substrates, only one pre-makeready and one makeready were necessary. However, a "makeready check" was performed at the beginning of the demonstration run for the PE/EVA. Two demonstration runs were performed, one for each substrate. The only change made between the two runs was that Deck #1 (white ink) was disengaged because the PE/EVA is a white substrate.

Makeready: LDPE

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. Once impression was set for each color and registration was achieved, the press was ramped up to 250 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed that the lay of the blue over the white was marginal, and the lay of the green over the white was good, but over the film was marginal. The printability of the other colors was good. Trap was acceptable for all colors and there appeared to be no problems with web stability. There was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test, with some light dusting noted on the green and the blue. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.7. The makeready process lasted 63 minutes and consumed 4,220 feet of film. The press was stopped 43 minutes into the makeready, after 3,568 feet of film had been consumed, in order to clean the plates.

Table 4-I.7 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass (light dusting)	1.706	Lay over white is good, over film is marginal. Good trap and dimensional stability. No blocking.
Blue	Pass (light dusting)	2.234	Lay over white is marginal, over film is good. Good trap and dimensional stability. No blocking.
Magenta	Pass	1.676	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.830	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

Viscosity measurements were attempted, but the viscosity was too high to measure with equipment on site.

The press was initially ramped to 250 ft/min for the demonstration run. There were problems drying the white, and to compensate, the temperature of the dryers was increased. Press speed was reduced to 218 ft/min to improve drying. The run was completed after 126 minutes, with 26,927 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.8.

Table 4-I.8 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass (improved — no dusting)	1.830	Pinholing. Very good trap. No problems with dimensional stability. No blocking.
Blue	Pass (improved — no dusting)	2.022	Pinholing. Very good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.504	Good printability. Very good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.774	Good printability. Very good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Very good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: PE/EVA

As stated previously, there was no makeready for the PE/EVA because the press was already set up from the LDPE production run, but a "makeready check" was performed. It was necessary to disengage Deck #1 (white ink) because the PE/EVA film was white.

The PE/EVA film was mounted on the press unwind reel. The press drive and color decks were engaged and the press was ramped to 350 ft/min. The speed was increased to 430 ft/min. During the run, 6,300 feet of film were consumed. The demonstration team noted that there was a problem with the gearing on the magenta ink station which was causing poor register.

A marker was inserted for sample identification. The press was stopped and a sample was taken for inspection. Density measurements and an adhesiveness test were performed on each color, and a visual quality inspection was also made. The results are listed in Table 4-I.9.

Viscosity measurements were attempted but the viscosity was too high and over the recommended range of the viscosity cup. See Appendix 4-H for the full data table of viscosity measurements.

The run was completed after 131 minutes, with 47,884 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.10.

Table 4-I.9 Results of Tests Performed on PE/EVA at End of Makeready

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass (light dusting)	1.606	Poor wetting of green on white. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass (light dusting)	2.028	Pinholing of blue on white. Good trap. No problems with dimensional stability or blocking.
Magenta	Pass	1.342	Good printability and trap. No problems with dimensional stability or blocking.
Cyan	Pass	1.534	Good printability and trap. No problems with dimensional stability or blocking.

[1]White was not used.

Table 4-I.10 Results of Tests Performed on PE/EVA at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.440	Increased pinholing. Good trap. No problems with dimensional stability. No blocking.
Blue	Fail	1.768	Increased pinholing. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.256	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.384	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]White was not used.

SITE 4: WATER-BASED INK #1 ON OPP

There was one pre-makeready, one makeready, and one demonstration run performed.

Makeready: OPP

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. At this point, the press drive was engaged and the initial running makeready began. The start of the makeready was run on a site-supplied substrate similar to the DfE control film.

The press achieved an optimal speed of 200 ft/min, and it was stopped twice during the makeready due to low printed opacity. The first time the press was stopped (after running for 14 minutes) was to replace the white ink. It was determined that the first white ink used had a very low percentage of solids. It was replaced with another ink of the same type which had a higher percentage of solids. Changing the ink did not adequately correct the low opacity. The press was stopped a second time (after running for 11 more minutes) to replace the white anilox roll, again in an effort to improve opacity. The press crew and DfE team decided to continue despite low opacity.

Once impression was set for each color and registration was achieved, a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed slight pinholing of the green over the white, and moderate pinholing of the blue over the white. All other ink colors achieved good printability. Trap was acceptable and there appeared to be no problems with web stability. There was no evidence of blocking. The impression was adjusted in an effort to correct pinholing. The tape adhesiveness test was conducted, and all colors passed the test except cyan. The failure of the cyan was thought to be due to the foaminess of the ink, but was not proven. Alcohol was added in an effort to reduce the foam. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.11.

The makeready process lasted 136 minutes (45 minutes of actual press run time, and 91 minutes of down time for problems noted previously) and consumed 6,600 feet of film.

Table 4-I.11 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.962	Slight pinholing over white. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.114	Moderate pinholing over white. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.358	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Fail (possibly due to foam; alcohol was added to reduce foam)	1.448	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

During the run, viscosity measurements were taken and logged every 60 minutes. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was initially ramped to 400 ft/min for the demonstration run. The speed was then increased to 450 ft/min, after 7,500 feet of film had been consumed. Press speed was later slowed to 435 ft/min, and then to 415 ft/min for the last roll of substrate because of drying concerns. Samples printed at the last three speeds were used for the performance tests. The run was completed after 123 minutes, with 13,160 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.12.

Table 4-I.12 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.930	Increased pinholing. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.152	Plugging and pinholing. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.328	Slight pinholing. Good trap. No problems with dimensional stability. No blocking.
Cyan	Fail, but improved	1.174	Slight pinholing. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Slight pinholing. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 5: SOLVENT-BASED INK #2 ON LDPE AND PE/EVA

Since the same product line was used for both substrates, only one pre-makeready and one makeready were necessary. However, a "makeready check" was performed at the beginning of the second demonstration run, the one for the PE/EVA. Two demonstration runs were performed, one for each substrate. The only change made between the two runs was that Deck #1 (white ink) was disengaged because the PE/EVA is a white substrate.

Makeready: LDPE

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. Once impression was set for each color and registration was achieved, the press was ramped up to 400 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed pinholing on the operator side of the image in the green and blue solid blocks. Trap was acceptable and there appeared to be no problems with web stability. There was no evidence of blocking. The impression was adjusted to correct the pinholing. The tones were inspected for cleanliness and transfer.

Solvent was added as needed to adjust viscosity in each of the colors to improve printability. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.13. The makeready process lasted 59 minutes and consumed 1,933 feet of film.

Table 4-I.13 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.590	Pinholing on one side. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.218	Pinholing on one side. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.596	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.500	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1] The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

During the run, viscosity measurements were taken and logged every 15 minutes, with solvent and ink additions noted at each occurrence. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 400 ft/min for the demonstration run, and the run was completed after 57 minutes, with 21,924 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.14.

Table 4-I.14 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.592	Pinholing on one side. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.250	Plate contamination. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.608	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.594	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: PE/EVA

As stated previously, there was no makeready for the PE/EVA because the press was already set up from the LDPE production run. It was necessary to disengage Deck #1 (white ink) because the PE/EVA film was white.

The press drive and color decks were engaged and the press was ramped to 400 ft/min where a marker was inserted for sample identification. The press was stopped and a sample was taken for inspection. Density measurements and an adhesiveness test were performed on each color, and a visual quality inspection was made. The results are listed in Table 4-I.15.

During the run, viscosity measurements were taken and logged every 15 minutes, with solvent and ink additions noted at each occurrence. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The run was completed after 56 minutes, with 20,858 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.16.

Table 4-I.15 Results of Tests Performed on PE/EVA at End of Makeready

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.31	Good printability and trap. No problems with dimensional stability or blocking.
Blue	Pass	1.72	Good printability and trap. No problems with dimensional stability or blocking.
Magenta	Pass	1.51	Good printability and trap. No problems with dimensional stability or blocking.
Cyan	Pass	1.46	Good printability and trap. No problems with dimensional stability or blocking.

[1]White was not used.

Table 4-I.16 Results of Tests Performed on PE/EVA at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.51	Uneven impression in the trap. No problems with dimensional stability or blocking.
Blue	Pass	1.94	Uneven impression in the trap. No problems with dimensional stability or blocking.
Magenta	Pass	1.21	Tones plugging. Uneven impression in the trap. No problems with dimensional stability or blocking.
Cyan	Pass	1.57	Tones plugging. Uneven impression in the trap. No problems with dimensional stability or blocking.

[1]White was not used.

SITE 6: UV INK #2 ON LDPE, PE/EVA, AND OPP

Since the same product line was used for all three substrates, only one pre-makeready and one makeready were necessary. However, a “makeready check” was performed at the beginning of the second demonstration run, for the PE/EVA, and the third, for the OPP. The only change made between the demonstration runs was that Deck #1 (white ink) was disengaged to run the PE/EVA, because it is a white substrate, and re-engaged to run the clear OPP substrate.

Makeready: LDPE

Viscosity measurements were not taken for UV inks at press because of the thixotropic nature of the inks. Once impression was set for each color and registration was achieved, the press was ramped up to 310 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed slight pinholing in the white, the print quality appeared dirty, and there was evidence of plate contamination. There was acceptable printability in all other colors. Some wrinkling of the substrate was noted and attributed to the heat of the UV lamps. Trap was acceptable and there was no evidence of blocking. The impression was adjusted to correct the pinholing. The tones were inspected for cleanliness and transfer. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.17. The makeready process lasted 80 minutes and consumed 3,964 feet of film.

Table 4-I.17 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.54	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Blue	Pass	2.15	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Magenta	Pass	1.75	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Cyan	Pass	1.45	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
White	Pass	Not measured[1]	Pinholing. Dirty printing. Plate contamination. Good trap. Some wrinkling of substrate from heat. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

Viscosity measurements were not taken for the UV inks, and no adjustments were made to the inks.

The press was ramped to 338 ft/min for the first roll of LDPE for the demonstration run, and 351 ft/min for the second roll. The run was completed after 92 minutes, with 32,431 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.18. The LDPE film was unmounted in preparation for the PE/EVA run.

Table 4-I.18 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.46	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Blue	Pass	2.10	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Magenta	Pass	1.77	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
Cyan	Pass	1.50	Good printability. Good trap. Some wrinkling of substrate from heat. No blocking.
White	Pass	Not measured[1]	Pinholing. Dirty printing. Plate contamination. Good trap. Some wrinkling of substrate from heat. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: PE/EVA

As stated previously, there was no makeready for the PE/EVA because the press was already set up from the LDPE production run, however a “makeready check” was performed. It was necessary to disengage Deck #1 (white ink) because the PE/EVA film was white.

The PE/EVA film was mounted on the press unwind reel. The press drive and color decks were engaged and the press was ramped to 354 ft/min where a marker was inserted for sample identification. The press was stopped and a sample was taken for inspection. Density measurements and an adhesiveness test were performed on each color, and a visual quality inspection was made. The results are listed in Table 4-I.19.

Again, viscosity measurements were not taken for the UV inks, and no adjustments were made to the inks.

Table 4-I.19 Results of Tests Performed on PE/EVA at End of Makeready "Check"

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.41	Good ink lay. Dirty printing. Fair trap. No problems with dimensional stability or blocking.
Blue	Fail	2.14	Good ink lay. Dirty printing. Fair trap. No problems with dimensional stability or blocking.
Magenta	Fail	1.26	Good ink lay. Dirty printing. Fair trap. No problems with dimensional stability or blocking.
Cyan	Fail	1.54	Good ink lay. Dirty printing. Fair trap. No problems with dimensional stability or blocking.

[1]White was not used.

The run was completed after 95 minutes, with 27,691 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.20.

Table 4-I.20 Results of Tests Performed on PE/EVA at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.43	Good ink lay. Dirty printing. Good trap. No problems with dimensional stability or blocking.
Blue	Fail	1.92	Good ink lay. Dirty printing. Good trap. No problems with dimensional stability or blocking.
Magenta	Fail	1.53	Good ink lay. Dirty printing. Density high — unable to reduce. Good trap. No problems with dimensional stability or blocking.
Cyan	Pass	1.53	Good ink lay. Dirty printing. Good trap. No problems with dimensional stability or blocking.

[1]White was not used.

Demonstration Run: OPP

As stated previously, there was no makeready for the OPP because the press was already set up from the PE/EVA production run, however a “makeready check” was performed. Deck #1 (white ink) was re-engaged because the OPP film was a clear film.

The press drive and color decks were engaged and the press was ramped to 344 ft/min where a marker was inserted for sample identification. The press was stopped and a sample was taken for inspection. Density measurements and an adhesiveness test were performed on each color, and a visual quality inspection was made. The results are listed in Table 4-I.21.

Viscosity measurements were not taken for the UV inks, and no adjustments were made.

The run was stopped prematurely due to overheating of the chill roller by the UV lamp. This occurred after 38 minutes of run time, with 6,583 feet of film consumed. No samples were taken, and no measurements made for the end of the run, as shown in Table 4-I.22.

Table 4-I.21 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	0.60	Good printability. Fair trap. No problems with dimensional stability or blocking.
Blue	Fail	0.65	Good printability. Fair trap. No problems with dimensional stability or blocking.
Magenta	No data	1.51	Good printability. Fair trap. No problems with dimensional stability or blocking.
Cyan	Fail	1.32	Good printability. Fair trap. No problems with dimensional stability or blocking.
White	Fail	Not measured[1]	Pinholing. Dirty printing. Low opacity on visual inspection. Fair trap. No problems with dimensional stability or blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Table 4-I.22 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	n/a	n/a	No samples taken — run stopped prematurely due to overheating of chill roller by UV lamp.
Blue	n/a	n/a	No samples taken — run stopped prematurely due to overheating of chill roller by UV lamp.
Magenta	n/a	n/a	No samples taken — run stopped prematurely due to overheating of chill roller by UV lamp.
Cyan	n/a	n/a	No samples taken — run stopped prematurely due to overheating of chill roller by UV lamp.
White	n/a	n/a	No samples taken — run stopped prematurely due to overheating of chill roller by UV lamp.

SITE 7: SOLVENT-BASED INK #2 ON LDPE AND PE/EVA

Makeready: LDPE

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. After the press drive was engaged, the makeready began. Once impression was set for each color and registration was achieved, the press was ramped up to 450 ft/min. There was a web break 35 minutes into the makeready due to press and operator conditions.

A visual inspection of the makeready sample revealed that the printing quality of the tones appeared dirty, but the lay was good, trap was very good, and there appeared to be no problems with web stability. There was also no evidence of blocking. The demonstration team noted that the ink looked “a little too fast” (in the ink appeared to be drying on the plate).

The tones were inspected for cleanliness and transfer. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.23. The makeready process lasted 58 minutes and consumed 2,350 feet of film.

Table 4-I.23 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	0.988	“Dirty” printing in tones on one side. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.784	“Dirty” printing in tones on one side. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.406	“Dirty” printing in tones on one side. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.264	“Dirty” printing in tones on one side. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	“Dirty” printing in tones on one side. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

During the run, viscosity measurements were taken and logged at 15, 30, and 120 minutes into the run. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 450 ft/min for the demonstration run, and the run was completed after 148 minutes, with 42,000 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.24.

Table 4-I.24 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	0.840	Tones improved. Mottle/lay good. Very good trap. No blocking. No problems with dimensional stability.
Blue	Pass	1.742	Tones improved. Mottle/lay good. Very good trap. No blocking. No problems with dimensional stability.
Magenta	Pass	1.302	Tones improved. Mottle/lay good. Very good trap. No blocking. No problems with dimensional stability.
Cyan	Pass	1.150	Tones improved. Mottle/lay good. Very good trap. No blocking. No problems with dimensional stability.
White	Pass	Not measured[1]	Tones improved. Mottle/lay good. Very good trap. No blocking. No problems with dimensional stability.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: PE/EVA

As stated previously, it was intended that the PE/EVA substrate also be run at this location. The substrate was mounted on the press, and the "makeready check" was begun. After only 8,069 feet of film were consumed, the run was aborted. The demonstration team decided that the roll of substrate they were running was not the correct project control film, due to a supplier mix-up. In addition, the substrate had wrinkles from poor extrusion, the cores were not the correct size, and the cores were crushed.

No samples were taken from the PE/EVA run, and no measurements made.

SITE 8: UV INK #3 ON LDPE, PE/EVA, AND OPP

The PE/EVA substrate (a white substrate) was run first, followed by the LDPE, and finally the OPP. Since this was run on a four-color press, it was necessary to make a complete change on Deck #1 between the PE/EVA and LDPE substrates, changing from magenta ink and a process plate, to white ink and a line plate. No change was necessary between the LDPE and the OPP. There was only one pre-makeready, and the makeready was performed before the demonstration team arrived at the plant for the run. There were no "makeready checks" performed when the substrates were changed.

Makeready: PE/EVA

The makeready was performed before the demonstration team arrived. The press crew reported that the makeready took between 60 and 120 minutes, achieved a press speed of 262 ft/min, and consumed 800 feet of film.

Two samples were taken from the roll for analysis. A visual inspection revealed that the print quality of the green was good, and the quality of the process tones was excellent. It was noted, however, that the print quality of the blue solid appeared dirty. The trap was very good, there appeared to be no problems with web stability, and there was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.25.

Table 4-I.25 Results of Tests Performed on PE/EVA at End of Makeready

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.066	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.200	Dirty printing. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.150	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.312	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]White was not used.

Demonstration Run: PE/EVA

No viscosity measurements were taken on the UV inks during the run. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure.

The press was ramped to 262 ft/min for the demonstration run, and the run was completed after 63 minutes, with 15,912 feet of film consumed. A sample was taken at the end of the run for density measurements, and visual quality inspection. The results are listed in Table 4-I.26.

Table 4-I.26 Results of Tests Performed on PE/EVA at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.096	Dirty printing. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.280	Dirty printing in solid. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.332	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.410	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]White was not used.

Demonstration Run: LDPE

As stated previously, Deck #1 was changed from magenta to white ink, and the plate was also changed from a process plate to a line plate. No "makeready check" was performed.

The press drive and color decks were engaged and the press was ramped to 262 ft/min. The run was completed after 65 minutes, with 2,559 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.27. The LDPE film was unmounted in preparation for the OPP run.

No viscosity measurements were taken of the UV inks during the run. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure.

Table 4-I.27 Results of Tests Performed on LDPE at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	0.994	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Fail	0.976	Dirty printing in solid. Good trap. No problems with dimensional stability. No blocking.
Cyan	Fail	1.136	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Fail	Not measured[2]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]Magenta was not used.

[2]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

As stated previously, no "makeready check" was performed for the OPP.

A limited amount of OPP was available due to shipping concerns between the U.S. and Germany. The OPP film was mounted on the press unwind reel. The press was ramped to 262 ft/min. The run was completed after 15 minutes, with 4,265 feet of film consumed. The run was shortened due to the limited quantity of OPP. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.28.

No viscosity measurements were taken during the run. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure.

Table 4-I.28 Results of Tests Performed on OPP at End of Run

Ink Color[1]	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Fail	1.058	Slight dirty printing. Good trap. No problems with dimensional stability. No blocking.
Blue	Fail	1.116	Dirty printing. Good trap. No problems with dimensional stability. No blocking.
Cyan	Fail	1.174	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Fail	Not measured[2]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]Magenta not used.

[2]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 9A: WATER-BASED INK #4 ON OPP

One pre-makeready, one makeready, and one demonstration run were performed.

Makeready: OPP

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. Once impression was set for each color and registration was achieved, the press was ramped up to 680 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed very good printability. Trap was acceptable and there appeared to be no problems with web stability. There was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.29. The makeready process lasted 120 minutes and consumed 1,250 feet of film.

Table 4-I.29 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.422	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.064	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.434	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.710	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

During the run, viscosity measurements were taken and logged every 15 minutes. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 425 ft/min for the demonstration run, and the run was completed after 66 minutes, with 34,434 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.30.

Table 4-I.30 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.494	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.068	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.460	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.756	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 9B: SOLVENT-BASED INK #4 ON OPP

There was one pre-makeready, one makeready, and one demonstration run performed.

Makeready: OPP

The ink was mixed to the desired viscosity (see Appendix 4-H) and the doctor blade systems were pressurized, delivering ink to the anilox rolls. Once impression was set for each color and registration was achieved, the press was ramped up to 680 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed poor printability in the blue, and acceptable printing in the other colors. It was suggested by the demonstration team and press crew that the blue ink and doctor blade be replaced. After the changes were made, trap was acceptable and there appeared to be no problems with web stability. There was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.31. The makeready process lasted 135 minutes and consumed 1,930 feet of film.

Table 4-I.31 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.074	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.686	Poor printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.286	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.534	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an “at press” test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

During the run, viscosity measurements were taken and logged every 15 minutes. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 415 ft/min for the demonstration run, and the run was completed after 80 minutes, with 33,641 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.32.

Table 4-I.32 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.062	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.730	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.568	Good printability. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.870	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 10: SOLVENT-BASED INK #2 ON OPP

One pre-makeready, one makeready, and one demonstration run was performed.

Makeready: OPP

The ink was mixed to the desired viscosity (see Appendix 4-H). Once impression was set for each color and registration was achieved, the press was ramped up to 800 ft/min and a flag was inserted to mark a print for inspection.

The press was stopped after insertion of the marker and two samples were taken for analysis. A visual inspection of the makeready sample revealed poor solid formation in the magenta, with good printability in all other colors. Trap was acceptable and there appeared to be no problems with web stability.

There was no evidence of blocking. The press crew and demonstration team felt that the problem with the magenta was due to the system being too fast, so slow solvent was added to the red ink fountain to compensate. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull. The results of the visual inspection are noted in Table 4-I.33. The makeready process lasted 120 minutes and consumed 10,950 feet of film.

Table 4-I.33 Results of Tests Performed on OPP at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.35	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.93	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	0.81	Poor solid formation. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.03	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: OPP

During the run, viscosity measurements were taken and logged every 15 minutes. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure. See Appendix 4-H for the full data table of viscosity measurements.

The press was ramped to 600 ft/min for the demonstration run, and the run was completed after 90 minutes, with 56,700 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.34.

Table 4-I.34 Results of Tests Performed on OPP at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.36	Good printability. Good trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.83	Good printability. Good trap. No problems with dimensional stability. No blocking.
Magenta	Pass	0.85	Still poor solid formation. Good trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.10	Good printability. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Good trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

SITE 11: UV INK #1 ON LDPE (NO SLIP)

One pre-makeready, one makeready, and one demonstration run was performed.

Makeready: LDPE

Once impression was set for each color and registration was achieved, the press was ramped up to 700 ft/min and a flag was inserted to mark a print for inspection.

A visual inspection of the makeready sample revealed good ink lay in all colors, however there was blade streaking in the cyan image. There was also dry ink on the blue anilox roller. Trap was fair, and there were no problems with dimensional stability. There was no evidence of blocking. The tape adhesiveness test was conducted, and all colors passed the test. Density measurements were taken and recorded on each color of the sample pull.

The results of the visual inspection are noted in Table 4-I.35. The makeready process lasted 75 minutes and consumed 7,200 feet of film.

Table 4-I.35 Results of Tests Performed on LDPE at End of Makeready

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.408	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Blue	Pass	1.792	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.074	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.036	Good printability, with blade streaking. Fair trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Fair trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Demonstration Run: LDPE

Viscosity measurements were not taken for the UV inks, and no adjustments were made to the inks. Markers were used to identify the timed locations of start, 30 minutes, and end of the run within the rolls for sample removal during the laboratory testing procedure.

The press was ramped to 400 ft/min for the demonstration run, and the run was completed after 153 minutes, with 38,400 feet of film consumed. A sample was taken at the end of the run for density measurements, adhesiveness tests, and visual quality inspection. The results are listed in Table 4-I.36.

Table 4-I.36 Results of Tests Performed on LDPE at End of Run

Ink Color	Tape Adhesiveness Test (pass / fail)	Density [unitless] (average of five measurements)	Visual Quality
Green	Pass	1.495	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Blue	Pass	2.170	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Magenta	Pass	1.093	Good printability. Fair trap. No problems with dimensional stability. No blocking.
Cyan	Pass	1.248	Good printability, with blade streak-ing. Good trap. No problems with dimensional stability. No blocking.
White	Pass	Not measured[1]	Good printability. Fair trap. No problems with dimensional stability. No blocking.

[1]The white ink was not measured for density because the efficiency of white ink is measured by an opacity test. Opacity measurements are not typically an "at press" test and were measured during the laboratory testing portion of the project.

Appendix 4-J (Performance Chapter) Descriptions and Performance Test Data for the Laboratory Runs

Pre-makeready

Plates, substrates, and inks were delivered to the facility approximately two weeks prior to the print run. Each of the ink colors was delivered at press in sealed five-gallon containers. Anilox placement and cylinder mounting were done by the laboratory personnel.

Makeready

The inks were reduced to 25 seconds using a Zahn cup. The press was ramped up to its optimal speed for the ink/substrate combination. Two samples were collected for inspection to verify optimum conditions.

Laboratory Runs

A total of seven laboratory runs were conducted.

Printing viscosities were maintained at 25 seconds using a Zahn #2 efflux cup, for all colors on all runs. Since these press runs were performed at Western Michigan University (WMU), all performance testing was conducted after completion of the runs. The results of the tape adhesiveness test, density measurements, and visual quality inspection for each print run are listed in Table 4-J.1. The dryer temperatures are listed in Table 4-J.2.

Table 4-J.1. Performance Test Results (At Press) of Laboratory Runs

Run	Ink Color	Scotch Tape Adhesiveness Test (Pass / Fail)	Density	Opacity	Visual Quality
L1	Green	P	0.95		mottled, poor wetting, weak color
	White	P		43%	pinholing
L2	Green	F	0.99		slightly mottled, color weak
	White	P		29%	pinholing, low opacity
L3	Green	P	0.70		color weak, slight mottle
	White	P		37%	low opacity
L4	Green	P	0.72		weak color, slight mottle
	White	P		38%	acceptable coverage
L5	Green	P	0.90		slight mottle
	White	P		54%	good opacity coverage
L6	Green	F	0.90		mottle, poor coverage
	Cyan	F	1.09		slight mottle
L7	Green	P	1.12		good color and coverage
	Cyan	P	1.30		slight mottle

Table 4-J.2. Dryer Temperatures for Laboratory Runs

Run	Temperature Deck #1 (ºF)	Temperature Deck #2 (ºF)
L1	162	145
L2	170	165
L3	160	155
L4	120	110
L5	122	118
L6	162	160
L7	125	120

Appendix 4-K (Performance Chapter)
Performance Test Data from Laboratory Runs for Inks Not Used in the Performance Demonstrations

Five ink manufacturers submitted six product lines to be tested in the lab that were not printed at the performance demonstration sites. The lines were as follows:

(Ink manufacturer #1) 1 solvent product line – cyan, 354 green, and white

(Ink manufacturer #2, #3) 3 water product lines – cyan, 354 green, and white
ink manufacturer #3 supplied two product lines, one for lamination and one for surface printing

(Ink manufacturer #4, #5) 2 UV product lines – cyan, 354 green and white
the UV product lines were not printed due to lack of equipment capabilities on the lab press

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The following is used to identify the ink product lines:

IM #1 - PE
IM #1 - EVA
IM #2 - EVA
IM #2 - PE
IM #3 - EVA
IM #3 - PE
IM#3L - OPP
IM #4 - not run
IM #5 - not run

Ink sets #1, #2, and #3 were printed as two press runs listed below:

Run A - Deck #1 220 anliox white ink and, Deck #2 440 anilox cyan ink (two colors)
Run B - Deck #2 440 anliox 354 green (one color)

A combination plate containing both line and half tones was used for both the 354 green and cyan color inks in Deck #2.

Only run IM#3L was printed with the OPP substrate since this product line was specified as a lamination ink. IM #1, IM#2 and IM#3 was printed with both LDPE and LDPE/EVA substrates. IM #4 and IM #5 were not printed.

All inks were reduced to 25 seconds #2 Zahn cup. Each set was printed for 3 to 5 minutes to stabilize the press conditions and obtain registration. The dryers were set to 140^{o} F. All inks dried adequately at speed up to 350 ft/min.

Table 4-K reports the qualitative performance of each ink. Each ink was evaluated for scotch tape adhesion, and general visual print quality.

Table 4-K Qualitative Performance of Inks Not Used in Performance Demonstrations

Product Line	Tape Adhesion Test	Visual Quality
IM #1 - PE Cyan & White	pass all colors	white opacity low; slight mottle; no pinholing; trap acceptable
IM #1 - EVA Green	pass all colors	slight mottle all colors; trap acceptable
IM #2- PE Cyan & White	pass all colors	mottle in cyan from poor wetting, pinholing in cyan and white; cyan color weak; poor wetting and trap
IM #2 - EVA Green	pass all colors	slight mottle;. no pinholing
IM #3 - PE Cyan & White	pass all colors	slight mottle all colors; trap good; slight pinholing; color good
IM #3 - EVA Green	pass all colors	slight mottle all colors; no pinholing
IM #3L - OPP Cyan & White	pass all colors	slight mottle all colors; trap acceptable; no pinholing

Appendix 5-A (Cost Chapter)
Cost Analysis Methodology

I. INTRODUCTION

The methodology will be employed to estimate the cost of using three inks: solvent-based, water-based, and UV-cured. The cost research will focus on identifying those cost elements that are different for the three ink processes. It will not only identify traditional costs, but also costs that are typically "hidden" in printing operations.

The primary source for the cost information will be the performance demonstrations. These costs will be gathered at the printing sites. (Sample data collection sheets are provided in Appendices 4-B and 4-C.) This information will be supplemented with information from industry statistics, supplier information, and other sources. The cost estimation is intended to reflect standard industry practices and provide representative data for the given ink process.

Besides determining and categorizing the costs incurred while using the three inks, the less tangible benefits or costs that can result from the implementation of each ink will be identified in a qualitative manner with annual or quarterly costs as supporting documentation (if available).

In order to normalize the cost data for comparative purposes, two standards were chosen: 6,000 images and 6,000 square feet of image.

The final cost estimates for each ink system will consist of four major cost elements: materials, labor, capital, and energy use.

II. MATERIAL COSTS

Material costs will consist of those costs that differ between the three ink types (ink and additives). The performance demonstrations will be the main avenue for retrieval of these costs, but suppliers and industry experts will also be consulted. Costs associated with special storage requirements of the inks, such as additional fire protection, ventilation, or regulatory requirements will not be considered quantitatively in the cost analysis. For example, solvent-based ink storage requires a local fire inspection, registration, and storage room ventilation, whereas water-based and UV-cured may not require the same precautions. These cost differentials will be difficult to quantify in the performance demonstrations and hard to acquire from industry.

The main components of the material costs will be ink and additives. For these costs, the quantity used will be gathered during the performance demonstrations and multiplied by an industry average cost, gathered from manufacturers and industry reports. The cost differences associated with cleaning for each ink type, if substantial, will be discussed in a qualitative fashion.

1. Ink costs:
   a) Manufacturer's price for all three inks and for four or five colors/three substrates (based on a given volume purchased [110-500 lb allotment])
   b) Amount of ink used to come up with a similar appearance for all three inks during start-up and run-time
2. Diluent or reducer (usage and price); price will be based on a given volume purchased

For ink and additives, prices will be collected and presented to the project design subcommittee for review and confirmation. The following items will be dealt with in a qualitative manner if the differences among the ink processes are substantial.

- Doctor blades
- Plates
- Bulbs for drying lamps
- Clean-up procedures and industry recommendations

III. LABOR COSTS

Labor costs will include the time spent on press (start-up, run-time, and clean-up), the hourly wage rate for a press person and assistant, fringe costs per person, and overhead expenses per person. Because wage rates vary throughout the country and are dependent on union versus non-union shops, wage rates from the performance demonstration and from industry reports will be used to determine a fixed rate. This cost will then be multiplied by a fringe and overhead rate (from industry studies) to establish a reasonably inclusive cost of labor.

IV. CAPITAL COSTS

Equipment costs for the inks will be considered, but equipment costs common to all inks will be excluded from analysis. The capital costs will be amortized, and an average rate of return on capital will be used. Costs scenarios will be developed for both new equipment purchases and for retrofitting existing presses.

The equipment costs will take into account the costs of purchasing both new equipment and retrofitting existing equipment. The equipment costs will be gathered from manufacturer's prices and industry averages. A yearly equipment cost will be determined, which then will be divided by total production hours per year to get an hourly equipment rate.

A. Capital Costs for New Equipment

Costs above a baseline for the press equipment will include, when applicable, the following factors for each ink system:

1) Control technologies
2) Process equipment
3) Installation
4) Project engineering

B. Capital Costs for Retrofitting Equipment

Retrofitting costs will be estimated for all the auxiliary equipment. Retrofitting costs will reflect an average retrofit package that will identify the relevant equipment for four retrofits:

1. Solvent-based to water-based press:
   a) Dryer capacity enhancement: using enlarged exhaust and supply fans
   b) Additional ductwork and noise abatement equipment (possible)
   c) Ink handling equipment upgrade (ink metering rolls were replaced to facilitate drying; pumps may need to be replaced; press roller modification)
   d) Install an in-line corona treatment system
2. Solvent-based to UV-cured press:
   a) Remove inter-deck dryers
   b) Shut-off gas
   c) Turn off air blowers

d) Install interdeck UV lamps
e) Install chiller
f) Install blowers for lamps
g) Miscellaneous: may also require chambered doctor blades, peristaltic pumps, a corona treater, and web scrubber. These may be present on a newer solvent-based press.

3. Water-based to UV-cured press
4. UV-cured to water-based press

C. Depreciation Rate

The depreciation rate will be based on that used for standard industry accounting practices.

D. Depreciation Period

The depreciation period, or average lifetime of a press, can vary substantially depending on whether the equipment is upgraded or a retrofit is performed. The depreciation period for this calculation will be based on estimates of the lifetime of a press with no modifications or upgrades other than routine maintenance.

V. ENERGY COSTS

The energy usage differences associated with the three inks will be quantified, including that resulting from the use of dryers, corona treaters, exhaust air blowers, and the presses on standby.

A. Energy consumption

Energy consumption calculations will include the following considerations:

1. Process equipment (dryers, corona)
2. Exhaust air purification (measure the gas used to operate and then divide by the total # of presses)
3. Temperature conditioning

B. Cost of Electricity and Natural Gas

The average cost of electricity is about .05-.06 per unit, yet this varies considerably depending on the state. For example, in Michigan electricity costs .08 per unit, while in Ohio, electricity costs .30 per unit. Natural gas prices experience similar ranges. This type of variation will be noted in the cost analysis, and readers will be directed to adjust their calculations accordingly.

VI. WASTE TREATMENT AND DISPOSAL COSTS

Differences in the costs associated with safety equipment, waste treatment, insurance, liability, and regulatory compliance for the three ink processes will be dealt with in a qualitative manner. For example, costs associated with on-site treatment or shipping and off-site treatment may be difficult to quantify in the performance demonstrations for the three inks. Yet, there are some clear differences in the amount and type of disposal or treatment associated with solvent, water-based, and UV-cured inks. From the performance demonstrations and from industry reports and articles, these differences will be identified and presented in a qualitative manner.

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Appendix 5-B (Cost Chapter)
Supplemental Cost Analysis Information

This appendix provides details of costs provided in the text of the chapter. Sample calculations are included to more clearly illustrate the equations shown in Section 5.2. Tables showing cost estimates for the individual performance demonstrations also are provided.

SAMPLE CALCULATION FOR INK COSTS

For Site 5, solvent-based ink on LDPE:

Ink price (white)	=	\$1.40 per pound
Ink price (color)	=	\$2.80 per pound
Amount of white ink used	=	26.6 pounds
Amount of colored ink used	=	75.8 pounds
Substrate area covered (white)	=	39,762 ft^2
Substrate area covered (color)	=	74,515 ft^2
Image area	=	2.22 ft^2/image

Ink cost per 6,000 images (white)	=	ink price (\$/lb) × (amount of ink used [lb] / substrate area covered [ft^2]) × 2.22 ft^2/image × 6,000 images
	=	(\$1.40/lb) × (26.6 lbs / 39,762 ft^2) × 2.22 ft^2/image × 6,000 images
	=	\$12.48 per 6,000 images
Ink cost per 6,000 images (color)	=	ink price (\$/lb) × (amount of ink used [lb] / substrate area covered [ft^2]) × 2.22 ft^2/image × 6,000 images
	=	(\$2.80/lb) × (75.8 lbs / 74,515 ft^2) × 2.22 ft^2/image × 6,000 images
	=	\$37.60 per 6,000 images
Ink cost per 6,000 images (total)	=	\$12.47 + \$37.60
	=	\$50.07 per 6,000 images

DETERMINATION OF OVERHEAD RATE

The overhead rate was calculated with data from the National Association of Printers and Lithographers' *NAPL Heatset and Non-Heatset Web Press Operations Cost Study of 1989-1990*, which is presented below, and with information presented in the chapter. The overhead rate is used in labor cost calculations.

Table 5-B.1 Overhead Costs of an Average Printing Facility

Component	Comment	Cost
Rent and heat	$2.50 per square feet; use 1,000 square feet for model facility	$2,500
Fire and sprinkler insurance	$4.00 per $1,000 of equipment investment cost	$2,426
Indirect labor	10% of direct labor ($156,398)	$15,640
Direct supplies		$6,000
Repair to equipment	3% of equipment costs for three shifts	$18,195
Subtotal		**$44,761**
General factory	10% of subtotal	$4,476
Administrative and selling overhead	32% of subtotal	$14,324
Total overhead costs		**$63,561**

Source: NAPL, 1990.

The overhead rate was calculated using the formula shown below. The overhead factor is based on data from the NAPL study, and the derivation of the wage and fringe are presented in the chapter.

Overhead rate = Overhead factor × (wage + fringe)

where

Overhead factor = Total overhead costs / direct labor cost
= $63,561 / $156,398
= 0.41

Overhead rate = Overhead factor × (wage + fringe)
= 0.41 × ($11.49 + $4.14)
= $6.41

SAMPLE CALCULATION FOR LABOR COSTS

For Site 5, solvent-based ink on LDPE:

Labor rate, including overhead = $44.08 per hour (two workers)
Image width = 1.67 feet
Image area = 2.22 ft^2/image
Press speed = 400 feet per minute, 24,000 feet per hour

Labor cost per 6,000 images = labor cost per hour ($/hour) / ft^2 printed per hour × 2.22 ft^2/image × 6,000 images
= ($44.08/hour) / (24,000 feet/hour x 1.67 feet) × 2.22 ft^2/image × 6,000 images
= $14.69 per 6,000 images

Labor cost per 6,000 ft^2 of image = labor cost per ft^2 ($\$/ft^2$) × 6,000 ft^2
= (\$44.08/hr) / (24,000 feet/hour x 1.67 feet) × 6,000 ft^2
= \$6.61 per 6,000 ft^2 of image

SAMPLE CALCULATION FOR CAPITAL COSTS

For Site 5, solvent-based ink on LDPE,

Average press speed (solvent-based inks) = 400 feet per minute

Annual capital cost (\$/yr) = $$A = T * \frac{i(1+i)^n}{(1+i)^n - 1}$$

T = total cost (price of press) = \$2,600,000
i = interest or depreciation rate = 15%
n = lifetime of equipment = 20 years

A = annual capital cost = \$415,000

The hourly capital cost estimates were based on the following calculation:

Capital cost per 6,000 images = C × 2.22 ft^2/image × 6,000 images
Capital cost per 6,000 ft^2 of image = C × 6,000 ft^2

where

C = capital cost per ft^2 ($\$/ft^2$)
= hourly capital cost (\$/hr) × repeat length per ft^2 of image (ft/ft^2) / average press speed (ft/hr)

and

Annual operating hours = 4,200 hours per year

Hourly capital cost (\$/hr) = A (\$/yr) / annual operating hours (hr/yr)
= \$415,000 per year / 4,200 hours per year
= \$99 per hour

C = \$99 per hour × (1.33 ft / 2.22 ft^2) / (400 ft/min × 60 min/hr)
= \$0.0025 per ft^2

Capital cost per 6,000 images = C × 2.22 ft^2/image × 6,000 images
= \$0.0025 per ft^2 × 2.22 ft^2/image × 6,000 images
= \$33 per 6,000 images

Capital cost per 6,000 ft^2 of image = C × 6,000 ft^2
= \$0.0025 per ft^2 × 6,000 ft^2
= \$15 per 6,000 ft^2 of image

SAMPLE CALCULATION FOR ENERGY COSTS

For Site 5, solvent-based ink on LDPE,

Electricity consumption	=	55 kW
Natural gas consumption	=	650,000 Btu per hour
Electricity cost	=	\$0.0448 per kWh
Natural gas cost	=	\$3.05 per million Btu
Image area	=	2.22 ft^2/image
Press speed	=	400 feet per minute

E = electricity cost (\$/kWh) x [electricity consumption (kWh/hour) / press speed (ft/hour)] x repeat length per ft^2 of image (ft/ft^2)
= electricity cost per ft^2 (\$/ft^2)
= \$0.000062 per ft^2

G = natural gas cost (\$/Btu) x [natural gas consumption (Btu/hour) / press speed (ft/hour)] x repeat length per ft^2 of image (ft/ft^2)
= natural gas cost per ft^2 (\$/ft^2)
= \$0.000050 per ft^2

Energy cost per 6,000 images = (E + G) x 2.22 ft^2/image x 6,000 images
= (\$0.000062 + \$0.000050) x 2.22 ft^2/image x 6,000 images
= \$1.48 per 6,000 images

Energy cost per 6,000 ft^2 of image = (E + G) x 6,000 ft^2
= \$0.67 per 6,000 ft^2 of image

COST ESTIMATES FOR PERFORMANCE DEMONSTRATION SITES

Tables 5-B.1 through 5-B.13 present the calculated labor, material, capital, and energy costs for each performance demonstration site. Tables 5-B.14 and 5-B.15 present the ink costs and additive costs, respectively, for each site. Table 5-B.16 presents the labor costs for each site.

Table 5-B.2 Cost Summary for Water-based Ink at Site 1*

Cost Category		Cost per 6,000 images for OPP	Cost per 6,000 Sq. Feet for OPP
Labor		$13.67	$6.15
Materials	ink (white)	$11.49	$5.17
	ink (other colors)	$9.69	$4.35
	ink additives	$0.44	$0.22
Capital		$29.46	$13.27
Energy		$0.91	$0.41
Total		**$65.65**	**$29.56**

*Water-based ink #2; 55-inch press at 430 feet per minute

Table 5-B.3 Cost Summary for Water-based Ink at Site 2*

Cost Category		Cost per 6,000 images		Cost per 6,000 sq. feet	
		for LDPE	for PE/EVA	for LDPE	for PE/EVA
Labor		$14.59	$14.59	$6.56	$6.56
Materials	ink (white)	$8.61	$0.00	$3.87	$0.00
	ink (other colors)	$16.80	$16.80	$7.53	$7.53
	ink additives	$0.22	$0.12	$0.10	$0.05
Capital		$31.43	$31.83	$14.16	$14.16
Energy		$0.97	$0.97	$0.44	$0.44
Total		**$72.62**	**$63.91**	**$32.66**	**$28.74**

*Water-based ink #3; 54-inch press at 403 feet per minute

Table 5-B.4 Cost Summary for Water-based Ink at Site 3*

Cost Category		Cost per 6,000 images for LDPE	Cost per 6,000 images for PE/EVA	Cost per 6,000 sq. feet for LDPE	Cost per 6,000 sq. feet for PE/EVA
Labor		$26.96	$13.67	$12.13	$6.15
Materials	ink (white)	$12.27	$0.00	$5.52	$0.00
	ink (other colors)	$8.76	$8.76	$3.90	$3.90
	ink additives	$1.51	$0.34	$0.67	$0.16
Capital		$58.10	$29.46	$26.17	$13.27
Energy		$1.79	$0.91	$0.81	$0.41
Total		**$109.40**	**$53.14**	**$49.21**	**$23.89**

*Water-based ink #3; 50-inch press at 218 feet per minute (LDPE) and 430 feet per minute (PE/EVA)

Table 5-B.5 Cost Summary for Water-based Ink at Site 4*

Cost Category		Cost per 6,000 images for OPP	Cost per 6,000 sq. feet for OPP
Labor		$13.06	$5.88
Materials	ink (white)	$12.58	$5.66
	ink (other colors)	$15.69	$7.05
	ink additives	$0.60	$0.28
Capital		$28.15	$12.68
Energy		$0.87	$0.39
Total		**$70.95**	**$31.94**

*Water-based ink #1; 46-inch press at 450 feet per minute

Table 5-B.6 Cost Summary for Solvent-based Ink at Site 5*

Cost Category		Cost per 6,000 images for LDPE	Cost per 6,000 images for PE/EVA	Cost per 6,000 sq. feet for LDPE	Cost per 6,000 sq. feet for PE/EVA
Labor		$14.69	$14.69	$6.61	$6.61
Materials	ink (white)	$12.52	$0.00	$5.63	$0.00
	ink (other colors)	$37.94	$37.94	$17.08	$17.08
	ink additives	$2.73	$1.79	$1.23	$0.81
Capital		$32.93	$32.93	$14.83	$14.83
Energy		$1.48	$1.48	$0.67	$0.67
Total		**$102.29**	**$88.84**	**$46.05**	**$40.00**

*Solvent-based ink #2; 24.5-inch press at 400 feet per minute

Table 5-B.7 Cost Summary for UV-cured Ink at Site 6*

Cost Category		Cost per 6,000 images for LDPE	Cost per 6,000 images for PE/EVA	Cost per 6,000 sq. feet for LDPE	Cost per 6,000 sq. feet for PE/EVA
Labor		$17.09	$16.60	$7.69	$7.47
Materials	ink (white)	$27.12	$0.00	$12.18	$0.00
	ink (other colors)	$25.60	$25.60	$11.50	$11.50
	ink additives	$0.00	$0.00	$0.00	$0.00
Capital		$38.29	$37.21	$17.25	$16.76
Energy		$3.33	$3.23	$1.50	$1.46
Total		**$111.42**	**$82.65**	**$50.12**	**$37.19**

*UV-cured ink #2; 32-inch press at 344 feet per minute (LDPE) and 354 feet per minute (PE/EVA)

Table 5-B.8 Cost Summary for Solvent-based Ink at Site 7*

Cost Category		Cost per 6,000 images for LDPE	Cost per 6,000 images for PE/EVA	Cost per 6,000 sq. feet for LDPE	Cost per 6,000 sq. feet for PE/EVA
Labor		$13.06	$13.06	$5.88	$5.88
Materials	ink (white)	$8.11	$0.00	$3.65	$0.00
	ink (other colors)	$21.73	$56.26	$9.80	$3.50
	ink additives	$8.49	$5.76	$3.82	$2.59
Capital		$29.27	$29.27	$13.19	$13.19
Energy		$1.31	$1.31	$0.59	$0.59
Total		**$81.97**	**$105.67**	**$36.93**	**$25.75**

*Solvent-based ink #2; 45.5-inch press at 450 feet per minute

Table 5-B.9 Cost Summary for UV-cured Ink at Site 8*

Cost Category		Cost per 6,000 images for PE/EVA	Cost per 6,000 sq. feet for PE/EVA
Labor		$22.43	$10.10
Materials	ink (white)	$0.00	$0.00
	ink (other colors)	$12.10	$5.50
	ink additives	$0.00	$0.00
Capital		$50.28	$22.65
Energy		$4.37	$1.97
Total		**$89.18**	**$40.21**

*UV-cured ink #3; 25-inch press at 262 feet per minute

Table 5-B.10 Cost Summary for Water-based Ink at Site 9A*

Cost Category		Cost per 6,000 images for OPP	Cost per 6,000 sq. feet for OPP
Labor		$13.83	$6.22
Materials	ink (white)	$8.50	$3.82
	ink (other colors)	$6.81	$3.03
	ink additives	$0.71	$0.32
Capital		$29.80	$13.43
Energy		$0.92	$0.41
Total		**$60.57**	**$27.24**

*Water-based ink #4; 55-inch press at 425 feet per minute

Table 5-B.11 Cost Summary for Solvent-based Ink at Site 9B*

Cost Category		Cost per 6,000 images for OPP	Cost per 6,000 sq. feet for OPP
Labor		$14.16	$6.37
Materials	ink (white)	$14.84	$7.63
	ink (other colors)	$11.48	$5.55
	ink additives	$2.24	$1.02
Capital		$31.74	$14.30
Energy		$1.43	$0.64
Total		**$75.89**	**$35.52**

*Solvent-based ink #1; 45.5-inch press at 415 feet per minute

Table 5-B.12 Cost Summary for Solvent-based Ink at Site 10*

Cost Category		Cost per 6,000 images for OPP	Cost per 6,000 sq. feet for OPP
Labor		$9.80	$4.41
Materials	ink (white)	$7.15	$3.68
	ink (other colors)	$19.54	$9.39
	ink additives	$7.98	$3.60
Capital		$21.96	$9.89
Energy		$0.99	$0.44
Total		**$67.42**	**$31.41**

*Solvent-based ink #2; 61-inch press at 600 feet per minute

Table 5-B.13 Cost Summary for UV-cured Ink at Site 11*

Cost Category		Cost per 6,000 images for LDPE	Cost per 6,000 sq. feet for LDPE
Labor		$14.69	$6.61
Materials	ink (white)	$48.07	$21.61
	ink (other colors)	$24.80	$11.20
	ink additives	$0.00	$0.00
Capital		$32.93	$14.83
Energy		$2.86	$1.29
Total		**$123.36**	**$55.55**

*UV-cured ink #1; 61-inch press at 400 feet per minute

Table 5-B.14 Ink Costs for All Performance Demonstration Sites

	Site	White Ink			Colored Ink			Average total cost per 6,000 images	Average total cost per 6,000 ft² of image
		Price ($/lb)	Cost per 6,000 images	Cost per 6,000 ft² of image	Price ($/lb)	Cost per 6,000 images	Cost per 6,000 ft² of image		
Solvent-based ink									
LDPE	5	$1.40	$12.46	$5.63	$2.80	$37.88	$17.08	$50.34	$22.71
	7	$1.40	$8.11	$3.65	$2.80	$21.70	$9.77	$29.81	$13.42
PE/EVA	5	$1.40	$0.00	$0.00	$2.80	$37.94	$17.08	$37.94	$17.08
	7	$1.40	$0.00	$0.00	$2.80	$21.70	$9.77	$21.70	$9.77
OPP	9B	$1.40	$14.84	$6.68	$2.80	$11.48	$5.18	$26.32	$11.86
	10	$1.40	$7.15	$3.22	$2.80	$19.54	$8.79	$26.69	$12.01
Water-based ink									
LDPE	2	$1.60	$8.61	$3.87	$3.00	$16.77	$7.56	$25.38	$11.43
	3	$1.60	$12.27	$5.52	$3.00	$8.73	$3.93	$21.00	$9.45
PE/EVA	2	$1.60	$0.00	$0.00	$3.00	$16.77	$7.56	$16.77	$7.56
	3	$1.60	$0.00	$0.00	$3.00	$8.73	$3.93	$8.73	$3.93
OPP	1	$1.60	$11.49	$5.17	$3.00	$9.66	$4.35	$21.15	$9.52
	4	$1.60	$12.58	$5.66	$3.00	$15.72	$7.08	$28.30	$12.74
	9A	$1.60	$8.50	$3.82	$3.00	$6.78	$3.06	$15.28	$6.88
UV-cured ink									
LDPE	6	$8.50	$27.12	$12.18	$10.00	$25.60	$11.50	$52.72	$23.68
	11	$8.50	$48.07	$12.61	$10.00	$24.80	$11.20	$72.87	$32.81
PE/EVA	6	$8.50	$0.00	$0.00	$10.00	$25.60	$11.50	$25.60	$11.50
	8	$8.50	$0.00	$0.00	$10.00	$12.10	$5.50	$12.10	$5.50

Table 5-B.15 Ink Additive Costs for All Performance Demonstration Sites

	Site	Extender			Solvent			Other Additives			Average total cost per 6,000 images	Average total cost per 6,000 ft² of image
		Price ($/lb)	Average cost per 6,000 images	Average cost per 6,000 ft² of image	Price ($/lb)	Average cost per 6,000 images	Average cost per 6,000 ft² of image	Price ($/lb)	Average cost per 6,000 images	Average cost per 6,000 ft² of image		
Solvent-based ink												
LDPE	5	$2.00	$0.00	$0.00	$1.00	$2.73	$1.23	$0.45	$0.00	$0.00	$2.73	$1.23
	7	$2.00	$0.00	$0.00	$1.00	$8.49	$3.82	$0.45	$0.00	$0.00	$8.49	$3.82
PE/EVA	5	$2.00	$0.00	$0.00	$1.00	$1.79	$0.81	$0.45	$0.00	$0.00	$1.79	$0.81
	7	$2.00	$0.00	$0.00	$1.00	$5.76	$2.59	$0.45	$0.00	$0.00	$5.76	$2.59
OPP	9B	$2.00	$0.64	$0.30	$1.00	$1.60	$0.72	$0.45	$0.00	$0.00	$2.24	$1.02
	10	$2.00	$0.00	$0.00	$1.00	$7.28	$3.28	$0.45	$0.70	$0.32	$7.98	$3.60
Water-based ink												
LDPE	2	$2.00	$0.00	$0.00	$1.00	$0.14	$0.06	$0.45	$0.07	$0.04	$0.22	$0.10
	3	$2.00	$0.64	$0.28	$1.00	$0.38	$0.17	$0.45	$0.49	$0.22	$1.51	$0.67
PE/EVA	2	$2.00	$0.00	$0.00	$1.00	$0.06	$0.03	$0.45	$0.06	$0.02	$0.12	$0.05
	3	$2.00	$0.00	$0.00	$1.00	$0.07	$0.03	$0.45	$0.27	$0.13	$0.34	$0.16
OPP	1	$2.00	$0.24	$0.12	$1.00	$0.10	$0.05	$0.45	$0.10	$0.05	$0.44	$0.22
	4	$2.00	$0.56	$0.26	$1.00	$0.04	$0.02	$0.45	$0.00	$0.00	$0.60	$0.28
	9A	$2.00	$0.34	$0.16	$1.00	$0.36	$0.16	$0.45	$0.01	$0.00	$0.71	$0.32
UV-cured ink												
LDPE	6	$2.00	$0.00	$0.00	$1.00	$0.00	$0.00	$0.45	$0.00	$0.00	$0.00	$0.00
	11	$2.00	$0.00	$0.00	$1.00	$0.00	$0.00	[a]			$0.00	$0.00
PE/EVA	6	$2.00	$0.00	$0.00	$1.00	$0.00	$0.00	$0.45	$0.00	$0.00	$0.00	$0.00
	8	$2.00	$0.00	$0.00	$1.00	$0.00	$0.00	$0.45	$0.00	$0.00	$0.00	$0.00

[a]A price for the UV additive (monomer) was not determined, because ink manufacturers state that extra monomer is not typically added to UV ink at press side.

Table 5-B.16 Labor Costs for All Performance Demonstration Sites

Ink	Substrate	Formulation Number	Site	Press Speed (ft/min)	Cost per 6,000 images	Cost per 6,000 ft^2 of image
Solvent-based	LDPE	#S2	5	400	$14.69	$6.61
			7	450	$13.06	$5.88
	PE/EVA	#S2	5	400	$14.69	$6.61
			7	450[a]	$13.06	$5.88
	OPP	#S1	9B	415	$14.16	$6.37
		#S2	10	600	$9.80	$4.41
Water-based	LDPE	#W3	2	403	$14.59	$6.56
			3	218	$26.96	$12.13
	PE/EVA	#W3	2	403	$14.59	$6.56
			3	430	$13.67	$6.15
	OPP	#W1	4	450	$13.06	$5.88
		#W2	1	430	$13.67	$6.15
		#W4	9A	425	$13.83	$6.22
UV-cured	LDPE	#U1	11	400	$9.80	$4.41
		#U2	6	344	$17.09	$7.69
	PE/EVA	#U2	6	354	$16.60	$7.47
		#U3	8	262	$22.43	$10.10

[a]The PE/EVA run for Site 7 was aborted. For this analysis, the press speed was assumed to be the same as the LDPE run for Site 7.

Appendix 6-A (Energy Chapter)
Supplemental Resource and Energy Conservation Information

Table 6-A.1 Ink Consumption for All Performance Demonstration Sites

Substrate	Site	Ink (lbs)					Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Solvent-based ink							
LDPE, PE/EVA	5	14.8	18.8	26.6	23.1	19.1	102.4
	7	13.3	12.5	32.1	11.1	13.9	82.9
OPP	9B	4.8	5.2	47.7	5.0	3.3	66.0
	10	13.9	16.4	43.2	13.8	14.9	102.2
Water-based ink							
LDPE, PE/EVA	2	15.3	19.1	29.0	10.3	11.8	85.5
	3	10.6	10.0	29.9	4.8	3.3	58.6
OPP	1	11.4	8.6	56.5	2.7	2.6	81.8
	4	13.1	11.1	56.4	6.6	6.8	94.0
	9A	2.7	2.7	23.7	2.4	2.3	33.8
UV-cured ink							
LDPE, PE/EVA	6	8.8	4.6	20.4	3.6	5.8	43.2
LDPE	11	5.1	5.5	37.8	1.9	1.8	52.1
PE/EVA	8	1.1	1.0	3.6	0.8	0.6	7.1

[a]White ink was not printed on PE/EVA.

Table 6-A.2 Substrate Consumption for All Performance Demonstration Sites

Substrate	Site	Makeready (feet)			Finished (feet)			Total inc. mkrdy (ft)	Total not inc. mkrdy (ft)
		LDPE	PE/EVA	OPP	LDPE	PE/EVA	OPP		
Solvent-based ink									
LDPE, PE/EVA	5	1,933			21,924	20,852		44,709	42,776
	7	2,350			42,000	8,069		52,419	50,069
OPP	9B			1,930			33,641	35,571	33,641
	10			10,950			56,700	67,650	56,700
Water-based ink									
LDPE, PE/EVA	2	6,050	600		37,053	37,132		80,835	74,185
	3	4,220			26,297	47,884		78,401	74,181
OPP	1			11,892			51,000	62,892	51,000
	4			6,600			50,760	57,360	50,760
	9A			1,250			34,434	35,684	34,434
UV-cured ink									
LDPE, PE/EVA	6	3,964		650	32,432	27,261	6,583	70,890	66,276
LDPE	11	7,200			38,400			45,600	38,400
PE/EVA	8	800			2,559	15,912	4,265	23,536	22,736

Table 6-A.3 Ink and Ink Additive Consumption Rates for All Performance Demonstration Sites (per 6,000 Images)

Substrate	Site	Ink (lbs per 6,000 images)					Ink additives (lbs per 6,000 images)			Sub-total: ink (lbs per 6,000 images)	Sub-total: ink additives (lbs per 6,000 images)	Total (lbs per 6,000 images)
		Blue	Green	White[a]	Cyan	Magenta	Extender	Solvent	Other additives			
Solvent-based ink												
LDPE	5	2.64	3.36	8.94	4.13	3.42	0.00	2.73	0.00	22.49	2.73	25.22
	7	2.04	1.90	5.79	1.69	2.13	0.00	8.49	0.00	13.55	8.49	22.04
PE/EVA	5	2.64	3.36	0.00	4.13	3.42	0.00	1.79	0.00	13.55	1.79	15.34
	7	2.04	1.90	0.00	1.69	2.13	0.00	5.76	0.00	7.76	5.76	13.52
OPP	9B	1.08	1.16	10.60	1.12	0.74	0.32	1.60	0.00	14.70	1.92	16.62
	10	1.65	1.94	5.11	1.63	1.76	0.00	7.28	1.56	12.09	8.84	20.93
Water-based ink												
LDPE	2	1.52	1.89	5.38	1.02	1.17	0.00	0.14	0.18	10.98	0.32	11.30
	3	1.08	1.01	7.67	0.49	0.34	0.32	0.38	1.09	10.59	1.79	12.38
PE/EVA	2	1.52	1.89	0.00	1.02	1.17	0.00	0.06	0.13	5.60	0.19	5.79
	3	1.08	1.01	0.00	0.49	0.34	0.00	0.07	0.61	2.92	0.68	3.60
OPP	1	1.46	1.10	7.18	0.34	0.33	0.12	0.10	0.22	10.41	0.44	10.85
	4	1.82	1.55	7.86	0.92	0.94	0.28	0.04	0.00	13.09	0.32	13.41
	9A	0.61	0.61	5.31	0.53	0.52	0.17	0.36	0.02	7.58	0.55	8.13
UV-cured ink												
LDPE	6	0.99	0.52	3.74	0.41	0.64	0.00	0.00	0.00	6.30	0.00	6.30
	11	0.89	0.94	6.63	0.33	0.32	0.00	0.00	0.02	9.11	0.02	9.13
PE/EVA	6	0.99	0.52	0.00	0.41	0.64	0.00	0.00	0.00	2.56	0.00	2.56
	8	0.37	0.35	3.74	0.27	0.22	0.00	0.00	0.00	4.95	0.00	4.95

[a]White ink was not printed on PE/EVA.

Table 6-A.4 Ink and Ink Additive Consumption Rates for All Performance Demonstration Sites (per 6,000 Square Feet of Image)

Substrate	Site	Ink (lbs per 6,000 ft^2 of image)					Ink additives (lbs per 6,000 ft^2 of image)			Sub-total: ink (lbs per 6,000 ft^2 of image)	Sub-total: ink additives (lbs per 6,000 ft^2 of image)	Total (lbs per 6,000 ft^2 of image)
		Blue	Green	White[a]	Cyan	Magenta	Extender	Solvent	Other additives			
Solvent-based ink												
LDPE	5	1.19	1.51	4.02	1.86	1.54	0.00	1.23	0.00	10.12	1.23	11.35
	7	0.92	0.86	2.61	0.76	0.96	0.00	3.82	0.00	6.11	3.82	9.93
PE/EVA	5	1.19	1.51	0.00	1.86	1.54	0.00	0.81	0.00	6.10	0.81	6.91
	7	0.92	0.86	0.00	0.76	0.96	0.00	2.59	0.00	3.50	2.59	6.09
OPP	9B	0.49	0.52	4.77	0.50	0.34	0.15	0.72	0.00	6.62	0.87	7.49
	10	0.74	0.87	2.30	0.73	0.79	0.00	3.28	0.70	5.43	3.98	9.41
Water-based ink												
LDPE	2	0.68	0.85	2.42	0.46	0.52	0.00	0.06	0.09	4.93	0.15	5.08
	3	0.48	0.45	3.45	0.22	0.15	0.14	0.17	0.49	4.75	0.80	5.55
PE/EVA	2	0.68	0.85	0.00	0.46	0.52	0.00	0.03	0.05	2.51	0.08	2.59
	3	0.48	0.45	0.00	0.22	0.15	0.00	0.03	0.28	1.30	0.31	1.61
OPP	1	0.66	0.49	3.23	0.15	0.15	0.06	0.05	0.10	4.68	0.21	4.89
	4	0.82	0.70	3.54	0.41	0.42	0.13	0.02	0.00	5.89	0.15	6.04
	9A	0.27	0.27	2.39	0.24	0.23	0.08	0.16	0.01	3.40	0.25	3.65
UV-cured ink												
LDPE	6	0.45	0.23	1.68	0.18	0.29	0.00	0.00	0.00	2.83	0.00	2.83
	11	0.40	0.43	2.98	0.15	0.14	0.00	0.00	0.01	4.10	0.01	4.11
PE/EVA	6	0.45	0.23	0.00	0.18	0.29	0.00	0.00	0.00	1.15	0.00	1.15
	8	0.17	0.16	1.68	0.12	0.10	0.00	0.00	0.00	2.23	0.00	2.23

[a]White ink was not printed on PE/EVA.

Table 6-A.5 Solvent-based Ink and Ink Additive Consumption Rates (Additives per Color)

Substrate	Site	Component	Line colors						Process colors			
			Blue		Green		White[a]		Cyan		Magenta	
			lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image
LDPE, PE/EVA	5	ink	2.64	1.19	3.36	1.51	8.94	4.02	4.13	1.86	3.42	1.54
		solvent	0.61	0.27	0.30	0.13	0.94	0.42	0.62	0.28	0.27	0.12
		total	3.25	1.46	3.66	1.65	9.88	4.44	4.75	2.13	3.69	1.66
	7	ink	2.04	0.92	1.90	0.86	5.79	2.61	1.69	0.76	2.13	0.96
		solvent	1.46	0.66	1.53	0.69	2.72	1.23	1.21	0.55	1.56	0.70
		total	3.50	1.57	3.43	1.54	8.51	3.83	2.90	1.30	3.69	1.66
OPP	9B	ink	1.08	0.49	1.16	0.52	10.60	4.77	1.12	0.50	0.74	0.34
		extender	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.15
		solvent	0.28	0.13	0.55	0.25	0.14	0.06	0.26	0.12	0.37	0.17
		total	1.36	0.61	1.71	0.77	10.74	4.84	1.38	0.62	1.43	0.65
	10	ink	1.65	0.74	1.94	0.87	5.11	2.30	1.63	0.73	1.76	0.79
		solvent	1.18	0.53	1.29	0.58	2.58	1.16	0.65	0.29	1.58	0.71
		acetate	0.13	0.06	0.14	0.06	0.29	0.13	0.85	0.39	0.15	0.07
		total	2.96	1.33	3.37	1.52	7.98	3.59	3.13	1.41	3.49	1.57

[a]White ink was not printed on PE/EVA.

Table 6-A.6 Water-based Ink and Ink Additive Consumption Rates (Additives per Color)

Substrate	Site	Component	Line colors						Process colors			
			Blue		Green		White[a]		Cyan		Magenta	
			lbs per 6000 images	lbs per 6000 ft² of image	lbs per 6000 images	lbs per 6000 ft² of image	lbs per 6000 images	lbs per 6000 ft² of image	lbs per 6000 images	lbs per 6000 ft² of image	lbs per 6000 images	lbs per 6000 ft² of image
LDPE, PE/EVA	2	ink	1.52	0.68	1.89	0.85	5.38	2.40	1.02	0.46	1.17	0.53
		water	1.15	0.52	0.77	0.35	1.34	0.60	0.15	0.07	0.63	0.28
		solvent	0.04	0.02	0.02	0.01	0.08	0.04	0.00	0.00	0.00	0.00
		ammonia	0.01	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00
		reducer	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
		cross-linker	0.02	0.01	0.03	0.02	0.04	0.02	0.01	0.01	0.02	0.01
		total	2.76	1.25	2.72	1.23	6.85	3.07	1.18	0.54	1.83	0.83
	3	ink	1.08	0.49	1.01	0.45	7.67	3.50	0.49	0.22	0.34	0.15
		water	0.00	0.00	0.00	0.00	0.48	0.22	0.00	0.00	0.00	0.00
		extender	0.00	0.00	0.00	0.00	0.32	0.14	0.00	0.00	0.00	0.00
		solvent	0.07	0.03	0.00	0.00	0.31	0.14	0.00	0.00	0.00	0.00
		ammonia	0.29	0.13	0.18	0.08	0.47	0.21	0.05	0.02	0.05	0.02
		cross-linker	0.03	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
		total	1.47	0.66	1.21	0.54	9.25	4.21	0.54	0.24	0.39	0.17
OPP	1	ink	1.46	0.66	1.10	0.49	7.18	3.20	0.34	0.15	0.33	0.15
		water	0.01	0.01	0.10	0.03	0.16	0.07	0.00	0.00	0.00	0.00
		extender	0.12	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		solvent	0.09	0.04	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00
		ammonia	0.00	0.00	0.03	0.02	0.14	0.06	0.00	0.00	0.00	0.00
		slow reducer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		defoamer	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00
		total	1.68	0.77	1.23	0.54	7.53	3.35	0.34	0.15	0.33	0.15
	4	ink	1.82	0.82	1.55	0.70	7.86	3.54	0.92	0.41	0.94	0.42
		water	0.04	0.02	0.03	0.01	0.14	0.06	0.02	0.01	0.02	0.01
		extender	0.00	0.00	0.00	0.00	0.28	0.13	0.00	0.00	0.00	0.00
		solvent	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		wet out compound	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		total	1.89	0.85	1.59	0.71	8.28	3.73	0.94	0.42	0.96	0.43
	9A	ink	0.61	0.27	0.61	0.27	5.31	2.39	0.53	0.24	0.52	0.23
		water	0.00	0.00	0.00	0.00	0.37	0.17	0.00	0.00	0.00	0.00
		extender	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.08	0.00	0.00
		solvent	0.11	0.05	0.83	0.04	0.00	0.00	0.13	0.06	0.04	0.02
		defoamer	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
		total	0.72	0.32	1.44	0.31	5.69	2.56	0.83	0.38	0.56	0.25

[a]White ink was not printed on PE/EVA.

Table 6-A.7 UV-cured Ink and Ink Additive Consumption Rates (Additives per Color)

Substrate	Site	Component	Line colors						Process colors			
			Blue		Green		White[a]		Cyan		Magenta	
			lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image	lbs per 6000 images	lbs per 6000 ft^2 of image
LDPE, PE/EVA	6	ink	0.99	0.45	0.52	0.23	3.74	1.68	0.41	0.18	0.64	0.29
LDPE	11	ink	0.89	0.40	0.94	0.43	6.63	2.98	0.33	0.15	0.32	0.14
		low-viscosity monomer	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
		total	0.89	0.40	0.96	0.44	6.63	2.98	0.33	0.15	0.32	0.14
PE/EVA	8	ink	0.37	0.17	0.35	0.16	0.00	0.00	0.27	0.12	0.22	0.10

[a]White ink was not printed on PE/EVA.

Table 6-A.8 Ink and Additive Consumption for Water-based Ink on OPP at Site 1

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	35.90	32.80	45.70	24.70	24.90	164.00
	Water	0.40	2.90	2.00	0.20		5.50
	Extender	4.00					4.00
	Solvent	2.80		0.20		0.20	3.20
	Other	0.10	1.00	2.20	0.60	0.50	4.40
	Sub-total	43.20	36.70	50.10	25.60	25.60	181.20
Print run	Ink	11.70		45.22[a]	2.00		13.70
	Water						
	Extender						
	Solvent						
	Other						
	Other						
	Sub-total	11.70		45.22	2.00		58.92
Clean-up	Ink remaining	29.00	14.30	24.70	10.00	8.80	86.80
	Solution added	18.00	15.50	16.70	18.20	16.40	84.80
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed	20.50	18.60	19.80	21.90	19.60	100.40
Total ink used		23.40	19.30	67.52	13.90	13.60	137.72
Total excluding bearer bars		13.21	9.64	58.17	2.75	2.69	86.46

[a]estimated

Table 6-A.9 Ink and Additive Consumption for Water-based Ink on LDPE and PE/EVA at Site 2

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Makeready	Ink	21.00	19.00	22.50	21.60	21.60	105.70
	Water	2.50	2.00	1.00	1.00		6.50
	Extender						
	Solvent	0.50					0.50
	Other	0.70					0.70
	Sub-total	24.70	21.00	23.50	22.60	21.60	113.40
Print run	Ink		13.25	21.20			34.45
	Water	13.40	11.20	9.85	2.25	11.65	48.35
	Extender						
	Solvent		0.40	0.65			1.05
	Other		0.10	0.10	0.30	0.25	0.75
	Other		0.55	0.30		0.30	1.15
	Sub-total	13.40	25.50	32.10	2.55	12.20	85.75
Clean-up	Ink remaining	10.30	18.95	17.85	13.15	15.35	75.60
	Solution added			0.70			0.70
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed			1.60			1.60
Total ink used		27.80	27.55	36.85	12.00	18.45	122.65

[a]White ink was not printed on PE/EVA.

Table 6-A.10 Ink and Additive Consumption for Water-based Ink on LDPE and PE/EVA at Site 3

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Makeready	Ink	26.80	34.60	88.60	43.00	35.50	228.50
	Water			6.60			6.60
	Extender						
	Solvent	0.90				0.20	1.10
	Other	1.50	0.50	2.20	1.10		5.30
	Sub-total	29.20	35.10	97.40	44.10	35.70	241.50
Print run	Ink						
	Water						
	Extender			3.70			3.70
	Solvent	0.60		3.60		5.20	9.40
	Other	5.60	5.60	3.20	3.60		18.00
	Other	0.80	0.60				1.40
	Sub-total	7.00	6.20	10.50	3.60	5.20	32.50
Clean-up	Ink remaining	17.00	25.40	68.80	35.80	31.00	178.00
	Solution added	14.80	15.55[b]	3.50	13.40	14.35[b]	31.70
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed	14.65	15.40[b]	4.10	13.65	14.10[b]	32.40
Total ink used		19.35	15.90	38.50	11.65	9.90	95.30
Total excluding bearer bars		14.40	11.80	36.00	5.36	3.62	71.18

[a]White ink was not printed on PE/EVA.

[b]not included in calculation

Table 6-A.11 Ink and Additive Consumption for Water-based Ink on OPP at Site 4

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	35.20	45.00	45.90	42.40	41.40	209.90
	Water	0.80	0.80	0.80	0.80	0.80	4.00
	Extender			1.60			1.60
	Solvent						
	Other						
	Sub-total	36.00	45.80	48.30	43.20	42.20	215.50
Print run	Ink			43.00			43.00
	Water			0.80			0.80
	Extender			1.60			1.60
	Solvent	0.60	0.20				0.80
	Other		0.10				0.10
	Other						
	Sub-total	0.60	0.30	45.40	0.00	0.00	46.30
Clean-up	Ink remaining	19.20	31.00	31.60	34.00	32.20	148.00
	Solution added	32.40[a]	26.20[a]	20.40[a]	29.90[a]	23.10[a]	132.00
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed	36.20	29.90	23.10	32.40	26.20	147.80
Total ink used		13.60	11.40	59.40	6.70	6.90	98.00

[a]water

Table 6-A.12 Ink and Additive Consumption for Solvent-based Ink on LDPE and PE/EVA at Site 5

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Makeready	Ink	20.90	22.70	45.00	29.55	25.55	143.70
	Water						
	Extender						
	Solvent	2.01	2.01	2.25	2.01	2.00	10.28
	Other						
	Sub-total	22.91	24.71	47.25	31.56	27.55	153.98
Print run	Ink			8.25			8.25
	Water						
	Extender						
	Solvent	2.80		3.35	2.40		8.55
	Other						
	Other						
	Sub-total	2.80	0.00	11.60	2.40	0.00	16.80
Clean-up	Ink remaining	7.55	4.25	29.40	7.45	4.95	53.60
	Solution added						
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed						
Total ink used		18.16	20.46	29.45	26.51	22.60	117.18

[a]White ink was not printed on PE/EVA.

Table 6-A.13 Ink and Additive Consumption for UV-cured Ink on LDPE and PE/EVA at Site 6

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Makeready	Ink	37.65	36.50	50.70	25.00	35.65	185.50
	Water						
	Extender						
	Solvent						
	Other						
	Sub-total	37.65	36.50	50.70	25.00	35.65	185.50
Print run	Ink						
	Water						
	Extender						
	Solvent						
	Other						
	Other						
	Sub-total						
Clean-up	Ink remaining	28.80	31.90	30.31	21.35	29.90	142.26
	Solution added						
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed						
Total ink used		8.85	4.60	20.39	3.65	5.75	43.24

[a]White ink was not printed on PE/EVA.

Table 6-A.14 Ink and Additive Consumption for Solvent-based Ink on LDPE and PE/EVA at Site 7

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	27.90	24.85	47.40	25.90	25.25	151.30
	Water						
	Extender						
	Solvent						
	Other						
	Sub-total	27.90	24.85	47.40	25.90	25.25	151.30
Print run	Ink						
	Water						
	Extender						
	Solvent	20.00	20.00	22.30	18.60	18.60	99.50
	Other						
	Other						
	Sub-total	20.00	20.00	22.30	18.60	18.60	99.50
Clean-up	Ink remaining	25.00	22.40	22.50	25.50	19.70	115.10
	Solution added	11.23	11.23	11.23	11.23	11.23	56.15
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed	11.23	11.23	11.23	11.23	11.23	56.15
Total ink used		22.90	22.45	47.20	19.00	24.15	135.70

Table 6-A.15 Ink and Additive Consumption for UV-cured Ink on PE/EVA at Site 8

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White[a]	Cyan	Magenta	
Makeready	Ink	9.02	7.10	9.82	10.08	6.07	42.09
	Water						
	Extender						
	Solvent						
	Other						
	Sub-total	9.02	7.10	9.82	10.08	6.07	42.09
Print run	Ink						
	Water						
	Extender						
	Solvent						
	Other						
	Other						
	Sub-total						
Clean-up	Ink remaining	7.34	6.08	6.26	9.28	5.42	34.38
	Solution added						
	Ink scraped out						
	Ink wiped out						
	Ink and solution removed						
Total ink used		1.68	1.02	3.56	0.80	0.65	7.71

[a]White ink was not printed on PE/EVA.

Table 6-A.16 Ink and Additive Consumption for Water-based Ink on OPP at Site 9A

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	25.60	14.60	60.20	14.60	15.60	130.60
	Water			4.20			4.20
	Extender				4.60		4.60
	Solvent	4.60	2.00		3.60	1.20	11.40
	Other		0.10	0.10	0.10	0.10	0.40
	Sub-total	30.20	16.70	64.50	22.90	16.90	151.20
Print run	Ink						
	Water						
	Extender						
	Solvent						
	Other						
	Other	0.10					0.10
	Sub-total	0.10					0.10
Clean-up	Ink remaining	26.90	11.70	34.70	19.20	12.10	104.60
	Solution added	14.10[a]	14.10	26.10	14.20[a]	14.10	54.30
	Ink scraped out						
	Ink wiped out	0.20	1.20	2.50	0.40	1.40	5.70
	Ink and solution removed	13.80[a]	14.80	28.00	14.00[a]	15.00	57.80
Total ink used		3.20	3.10	25.40	3.30	2.50	37.50

[a]excluded from calculation

Table 6-A.17 Ink and Additive Consumption for Solvent-based Ink on OPP at Site 9B

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	10.80	12.20	74.40	10.00	9.20	116.60
	Water						
	Extender					4.00	4.00
	Solvent	2.80	5.80	1.00	2.30	4.60	16.50
	Other						
	Sub-total	13.60	18.00	75.40	12.30	17.80	137.10
Print run	Ink						
	Water						
	Extender						
	Solvent						
	Other						
	Other						
	Sub-total						
Clean-up	Ink remaining	5.54[a]	6.20	19.60	5.40	7.80	44.54
	Solution added	5.20	5.00	12.60	5.00	5.00	32.80
	Ink scraped out						
	Ink wiped out	1.00	2.00	4.20	0.40	1.60	9.20
	Ink and solution removed	6.20	7.20	16.40	5.40	6.60	41.80
Total ink used		6.06	7.60	47.80	6.10	6.80	74.36

[a]estimated

Table 6-A.18 Ink and Additive Consumption for Solvent-based Ink on OPP at Site 10

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	19.00	26.50	90.00	19.60	19.00	174.10
	Water						
	Extender						
	Solvent	16.20	7.20	15.30	6.50	11.50	56.70
	Other	1.80	0.80	1.70	7.00	2.50	13.80
	Sub-total	37.00	34.50	107.00	33.10	33.00	244.60
Print run	Ink	10.50	7.50		12.00	11.00	41.00
	Water						
	Extender						
	Solvent	4.95	15.30	30.15	6.00	15.50	71.90
	Other	0.55	1.70	3.35	9.50		15.10
	Other						
	Sub-total	16.00	24.50	33.50	27.50	26.50	128.00
Clean-up	Ink remaining	26.00	28.50	73.00	32.00	30.00	189.50
	Solution added	4.00	4.00	4.00	4.00	4.00	20.00
	Ink scraped out						
	Ink wiped out	2.00	2.00		2.00		6.00
	Ink and solution removed	4.00	4.00	4.00	4.00	4.00	20.00
Total ink used		25.00	28.50	67.50	26.60	29.50	177.10

Table 6-A.19 Ink and Additive Consumption for UV-cured Ink on LDPE at Site 11

Stage	Component	Line (lbs)			Process (lbs)		Total (lbs)
		Blue	Green	White	Cyan	Magenta	
Makeready	Ink	42.87	46.10	51.35	42.86	42.82	226.00
	Water						
	Extender						
	Solvent						
	Other						
	Sub-total	42.87	46.10	51.35	42.86	42.82	226.00
Print run	Ink						
	Water						
	Extender						
	Solvent						
	Other		1.00				1.00
	Other						
	Sub-total		1.00				1.00
Clean-up	Ink remaining	37.80	39.60	13.52	41.00	41.00	172.92
	Solution added	1.00[a]	1.00[a]	1.00[a]	1.00[a]	1.00[a]	0.00
	Ink scraped out						
	Ink wiped out		2.00				2.00
	Ink and solution removed						
Total ink used		5.07	5.50	37.83	1.86	1.82	52.08

[a]excluded from calculation

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Appendix 6-B (Energy Chapter)
Clean-Up and Waste Disposal Procedures for Each Site

Site 1

Use the pump to circulate water through the system for each color. After 10 minutes, pump clean water through once, without recirculating wipe down doctor blade with rag. Remove plastic liner from pan under doctor blade.

- Employees wear gloves.
- Rags handled by industrial laundry.
- Cleaning solution: water
- Ink is filtered; water sent to POTW and solids are incinerated.
- Annual costs: ~$30,000 for ink treatment and disposal costs
  $50,000 for solid/hazardous waste treatment and disposal

Retrofit: done internally — changed dryers to increase air flow; new higher anilox rolls. Do not recognize cost savings associated with using water-based inks. The cost is actually higher with lower press speeds and more complex color separations for process printing.

Site 2

Wipe out ink pans with water and alcohol mixture, pushing excess into drain. Scrape ink off of blade; wipe blade dampened with solution; scrape ink out of ink pan into drain; allow any ink/ink residue in pan to dry and scrape out later.

- Employees wear gloves.
- Rags handled by industrial laundry.
- Cleaning solution: water and alcohol
- Waste ink placed in waste drum and hauled away; off-site incineration.
- Annual costs: $10,000 for ink treatment and disposal costs (~40 drums @ $250/drum)
  $15,210 for solid/hazardous waste treatment and disposal

Retrofit: done internally — upgraded dryers to get more air flow through the ovens. Already had doctor blades that were sufficient. Operators trained on-the-job. It took 1½ years to switch all colors and get acceptable print quality. They didn't lose product, it was just their own internal standards.

Site 3

Flush system with ammonium and water blend. Wipe off remaining ink with towels soaked in the same blend.

- Employees wear gloves.
- Rags handled by industrial laundry.
- Collect waste ink/press clean-up water in containers for pick-up from waste hauler approximately four times a year. Hauler takes it to the incinerator.
- Nothing is discharged to sewer.
- Annual costs: $6,400 for ink treatment and disposal costs

Retrofit: done internally — they had a press that was previously used for solvent ink. They had to add a treater, increase the volume of the anilox rolls, and increase/improve the dryer capacity.

Site 4

Fill 5-gallon bucket half-way with water. Pump water from bucket through the white print station for 5 min. Stop pumping water. Wipe down anilox rolls, doctor blade with rag soaked in clean water. Move water bucket (now with white ink in it also) to the magenta station and repeat pumping followed by wiping process Reuse water bucket for green, cyan, and blue stations.

> Employees wear no personal protective equipment.
> Rags handled by industrial laundry.
> Water/ink mixture is shipped off-site for recovery and incineration; separates water and solids and incinerates the solids.
> Nothing is discharged to sewer.
> Annual costs: $15,390 for ink treatment and disposal costs

Retrofit: done internally — they upgraded a press that had been used for solvent-based inks by replacing the anilox rolls.

Site 5

Drain ink pans and scrape down. Flush with solvent, using 5 gallon sumps—four times—send to scrap. Some rags used for wiping. Sent to waste handling facility (cement kilns). Reutilize usable ink: 35% of ink issued is returned for reuse. Reclaim some of the solvent for in-house reuse.

> Employees wear recommended eye shields and gloves.
> Rags disposed of in landfill.
> Cleaning solution: solvent cleaning solution (n-propyl alcohol)

No retrofit.

Site 6

Solvent cleaning tank used for UV systems. Dry wipe with rags. Parts and rags are cleaned with spent, recycled solvent.

> Employees wear eye shields, gloves, and arm protectors.
> Rags washed in spent alcohol and then laundered for reuse.
> Cleaning solution: solvents; sent off-site to cement kilns.
> Nothing is discharged to sewer.

Retrofit done internally — UV lamps and power supplies; increased working capacity, web cleaner and pre-treater.

Site 7

Flush out with solvent; drain before laundry.

> Employees wear eye shields and gloves.
> Rags handled by industrial laundry.
> Cleaning solution: solvent; reused about three times, then sent out as hazardous waste.
> Nothing is discharged to sewer.
> Annual costs: $80 per job

No retrofit.

Site 8
Site 8 was a UV press manufacturer's demonstration press in Germany.

Employees wear gloves.

Site 9A
Pump clean with water; wipe anilox with rag of cleaning blend; dispose of waste clean-up water; waste water disposed through waste hauler.

Employees wear no personal protective equipment.
Rags handled by industrial laundry.
Cleaning solution: water; water/ NPA/ ammonia (80%/17%/3%)
Press wash water-based ink; diluted then discharged to sewer/POTW.

Retrofit: done internally — improve drying oven and blowers.

Site 9B
Same as above except the cleaning solution is solvent (acetate [n-propyl] and alcohol [n-propyl]).

Site 10
In-house batch distillation. Solvent recaptured and reused (ink blend, cleaning). Thick pumpable still bottom goes to kiln for burning. Color wash: flush and wipe out; solvent goes to distiller; rags go to drain tank. Drain each color down. Pour 4 lbs solvent into chamber and circulate. Drain clean-up solvent down. Wipe out systems using five solvent soaked rags. 5-7 minutes each color.

Employees wear eye shields and gloves.
Rags handled by industrial laundry.
Cleaning solution: solvent (blend made in-house); 100% reused until it loses its efficiency.
Nothing is discharged to sewer.
Annual costs: $8,000 for ink treatment/distillation
$15,000 for waste disposal and transportation

No retrofit.

Site 11
Pump ink back to 5 gallon containers. Wipe excess ink off with rags.

Employees wear eye shields, gloves, and apron.
Rags handled by industrial laundry
Cleaning solution: solvent (alcohol); after several cleanings, the dirty wash is run through the distilling unit. Solids are taken out.
Nothing is discharged to sewer.
Bulbs for UV lamps: $300 each
Doctor blades: ~$300/month; $3,600 annually
Ink cleaning equipment: distillation still purchased in 1992; ~ $30,000
Ink cleaning supplies: ~$500/month; $6,000 annually

No retrofit: brand new machine.

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Appendix 6-C (Energy Chapter)
Pollution Generation Reports

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 453 fpm
Product Life: 6000 sq ft processed

===

1. Pollution Generated per Unit-of-Use of product--
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
Overall environment	11. Kg	5.2 g	630. g	10. Kg(	
Human health impacts	87. g			87. g(	
Use impairment impacts	10. Kg	5.2 g		10. Kg(	
Disposal cap'cty impacts	630. g		630. g		

===

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 453 fpm
Product Life: 6000 sq ft processed

==

2. Pollution Generated per Unit-of-Use of product--
by Pollution Category, by Pollutant and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	11. Kg	5.2 g	630. g	10. Kg(	
Carbon dioxide	10. Kg			10. Kg(	
Carbon monoxide	9.6 g			9.6 g(	
Dissolved solids	1.4 g	1.4 g			
Hydrocarbons	60. g			60. g(	
Nitrogen oxides (NOx)	29. g			29. g(	
Particulates	8.8 g			8.8 g(	
Solid wastes	630. g		630. g		
Sulfur oxides (SOx)	48. g			48. g(	
Sulfuric acid	3.8 g	3.8 g			
*Human health impacts	87. g			87. g(	
Carbon monoxide*	9.6 g			9.6 g(	
Nitrogen oxides (NOx)	29. g			29. g(	
Sulfur oxides (SOx)	48. g			48. g(	
*Use impairment impacts	10. Kg	5.2 g		10. Kg(	
Carbon dioxide	10. Kg			10. Kg(	
Carbon monoxide	9.6 g			9.6 g(	
Dissolved solids	1.4 g	1.4 g			
Hydrocarbons	60. g			60. g(	
Nitrogen oxides (NOx)	29. g			29. g(	
Particulates	8.8 g			8.8 g(	
Sulfur oxides (SOx)	48. g			48. g(	
Sulfuric acid	3.8 g	3.8 g			
*Disposal cap'cty impacts	630. g		630. g		
Solid wastes	630. g		630. g		

==

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED---SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 453 fpm
Product Life: 6000 sq ft processed

3. Pollution Generated per Unit-of-Use of product--
by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution Category	Pollutant Class	Amount Prevented	Pollutant	Amount Prevented
Human Health impacts	Toxic Inorganics	77. g		
			Nitrogen oxides (NOx)	29. g
			Sulfur oxides (SOx)	48. g
	Toxic Organics	9.6 g		
			Carbon monoxide	9.6 g
Use impairment impacts	Acid Rain Precursors	77. g		
			Nitrogen oxides (NOx)	29. g
			Sulfur oxides (SOx)	48. g
	Corrosives	81. g		
			Nitrogen oxides (NOx)	29. g
			Sulfur oxides (SOx)	48. g
			Sulfuric acid	3.8 g
	Dissolved Solids	5.2 g		
			Dissolved solids	1.4 g
			Sulfuric acid	3.8 g
	Global Warmers	10. Kg		
			Carbon dioxide	10. Kg
			Nitrogen oxides (NOx)	29. g
	Odorants	60. g		
			Hydrocarbons	60. g
	Particulates	8.8 g		
			Particulates	8.8 g
	Smog Formers	99. g		
			Carbon monoxide	9.6 g
			Hydrocarbons	60. g
			Nitrogen oxides (NOx)	29. g
Disposal capacity impacts	Solid Wastes	630. g		
			Solid wastes	630. g

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED---SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

1. Pollution Generated per Unit-of-Use of product-
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
Overall environment	10. Kg	4.7 g	570. g	9.5 Kg(	
Human health impacts	7.9 g			79. g(	
Use impairment impacts	9.5 Kg	4.7 g		9.5 Kg(	
Disposal cap'cty impacts	570. g		570. g		

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION-GENERATED---SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

==

2. Pollution Generated per Unit-of-Use of product
by Pollution Category, by Pollutant and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	10. Kg	4.7 g	570. g	9.5 Kg(	
Carbon dioxide	9.4 Kg			9.4 Kg(	
Carbon monoxide	8.7 g			8.7 g(	
Dissolved solids	1.3 g	1.3 g			
Hydrocarbons	55. g			55. g(	
Nitrogen oxides (NOx)	26. g			26. g(	
Particulates	8.0 g			8.0 g(	
Solid wastes	570. g		570. g		
Sulfur oxides (SOx)	44. g			44. g(	
Sulfuric acid	3.4 g	3.4 g			
*Human health impacts	79. g			79. g(	
Carbon monoxide	8.7 g			8.7 g(	
Nitrogen oxides (NOx)	26. g			26. g(	
sulfur oxides (SOx)	44. g			44. g(	
*Use impairment impacts	9.5 Kg	4.7 g		9.5 Kg(	
Carbon dioxide	9.4 Kg			9.4 Kg(	
Carbon monoxide	8.7 g			8.7 g(	
Dissolved solids	1.3 g	1.3 g			
Hydrocarbons	55. g			55. g(	
Nitrogen oxides (NOx)	26. g			26. g(	
Particulates	8.0 g			8.0 g(	
Sulfur oxides (SOx)	44. g			44. g(	
Sulfuric acid	3.4 g	3.4 g			
*Disposal cap'cty impacts	570. g		570. g		
Solid wastes	570. g		570. g		

==

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Solvent
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

3. Pollution Generated per Unit-of-Use of product--
by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution Category	Pollutant Class	Amount Prevented	Pollutant	Amount Prevented
Human Health impacts	Toxic Inorganics	70. g		
			Nitrogen oxides (NOx)	26. g
			Sulfur oxides (SOx)	44. g
	Toxic Organics	8.7 g		
			Carbon monoxide	8.7 g
Use impairment impacts	Acid Rain Precursors	70. g		
			Nitrogen oxides (NOx)	26. g
			Sulfur oxides (SOx)	44. g
	Corrosives	73. g		
			Nitrogen oxides (NOx)	26. g
			Sulfur oxides (SOx)	44. g
			Sulfuric acid	3.4 g
	Dissolved Solids	4.7 g		
			Dissolved solids	1.3 g
			Sulfuric acid	3.4 g
	Global Warmers	9.4 Kg		
			Carbon dioxide	9.4 Kg
			Nitrogen oxides (NOx)	26. g
	Odorants	55. g		
			Hydrocarbons	55. g
	Particulates	8.0 g		
			Particulates	8.0 g
	Smog Formers	90. g		
			Carbon monoxide	8.7 g
			Hydrocarbons	55. g
			Nitrogen oxides (NOx)	26. g
Disposal capacity impacts	Solid Wastes	570. g		
			Solid wastes	570. g

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED-SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

==

1. Pollution Generated per Unit-of-Use of product-
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
Overall environment	6.8 Kg	2.8 g	340. g	6.5 Kg(	
Human health impacts	48. g			48. g(	
Use impairment impacts	6.5 Kg	2.8 g		6.5 Kg(	
Disposal cap'cty impacts	340. g		340. g		

==

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED -- SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

==

2. Pollution Generated per Unit-of-Use of product
by Pollution Category, by Pollutant and by medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	6.8 Kg	2.8 g	340. g	6.5 Kg(	
Carbon dioxide	6.4 Kg			6.4 Kg(	
Carbon monoxide	5.5 g			5.5 g(	
Dissolved solids	0.81 g	0.81 g			
Hydrocarbons	41. g			41. g(	
Nitrogen oxides (NOx)	16. g			16. g(	
Particulates	4.8 g			4.8 g(	
Solid wastes	340. g		340. g		
Sulfur oxides (SOx)	26. g			26. g(	
Sulfuric acid	2.0 g	2.0 g			
*Human health impacts	48. g			48. g(	
Carbon monoxide	5.5 g			5.5 g(	
Nitrogen oxides (NOx)	16. g			16. g(	
Sulfur oxides (SOx)	26. g			26. g(	
*Use impairment impacts	6.5 Kg	2.8 g		6.5 Kg(	
Carbon dioxide	6.4 Kg			6.4 Kg(	
Carbon monoxide	5.5 g			5.5 g(	
Dissolved solids	0.81 g	0.81 g			
Hydrocarbons	41. g			41. g(	
Nitrogen oxides (NOx)	16. g			16. g(	
Particulates	4.8 g			4.8 g(	
Sulfur oxides (SOx)	26. g			26. g(	
Sulfuric acid	2.0 g	2.0 g			
*Disposal cap’cty impacts	340. g		340. g		
Solid wastes	340. g		340. g		

==

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

3. Pollution Generated per Unit-of-Use of product--
by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution Category	Pollutant Class	Amount Prevented	Pollutant	Amount Prevented
Human Health impacts	Toxic Inorganics	43. g		
			Nitrogen oxides (NOx)	16. g
			Sulfur oxides (SOx)	26. g
	Toxic Organics	5.5 g		
			Carbon monoxide	5.5 g
Use impairment impacts	Acid Rain Precursors	43. g		
			Nitrogen oxides (NOx)	16. g
			Sulfur oxides (SOx)	26. g
	Corrosives	45. g		
			Nitrogen oxides (NOx)	16. g
			Sulfur oxides (SOx)	26. g
			Sulfuric acid	2.0 g
	Dissolved Solids	2.8 g		
			Dissolved solids	0.81 g
			Sulfuric acid	2.0 g
	Global Warmers	6.4 Kg		
			Carbon dioxide	6.4 Kg
			Nitrogen oxides (NOx)	16. g
	Odorants	41. g		
			Hydrocarbons	41. g
	Particulates	4.8 g		
			Particulates	4.8 g
	Smog Formers	63. g		
			Carbon monoxide	5.5 g
			Hydrocarbons	41. g
			Nitrogen oxides (NOx)	16. g
Disposal capacity impacts	Solid Wastes	340. g		
			Solid wastes	340. g

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 394 fpm
Product Life: 6000 sq ft processed

==

1. Pollution Generated per Unit-of-Use of product--
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
Overall environment	8.5 Kg	3.5 g	410. g	8.1 Kg(	
Human health impacts	60. g			60. g(	
Use impairment impacts	8.1 Kg	3.5 g		8.1 Kg(	
Disposal cap'cty impacts	410. g		410. g		

==

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 394 fpm
Product Life: 6000 sq ft processed

==

2. Pollution Generated per Unit-of-Use of product-
by Pollution Category, by Pollutant and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	8.5 Kg	3.5 g	410. g	8.1 Kg(	
Carbon dioxide	8.0 Kg			8.0 Kg(	
Carbon monoxide	6.8 g			6.8 g(	
Dissolved solids	1.0 g	1.0 g			
Hydrocarbons	52. g			52. g(	
Nitrogen oxides (NOx)	20. g			20. g(	
Particulates	5.9 g			5.9 g(	
Solid wastes	410. g		410. g		
Sulfur oxides (SOx)	33. g			33. g(	
Sulfuric acid	2.5 g	2.5 g			
*Human health impacts	60. g			60. g(	
Carbon monoxide	6.8 g			6.8 g(	
Nitrogen oxides (NOx)	20. g			20. g(	
Sulfur oxides (SOx)	33. g			33. g(	
*Use impairment impacts	8.1 Kg	3.5 g		8.1 Kg(	
Carbon dioxide	8.0 Kg			8.0 Kg(	
Carbon monoxide	6.8 g			6.8 g(	
Dissolved solids	1.0 g	1.0 g			
Hydrocarbons	52. g			52. g(	
Nitrogen oxides (NOx)	20. g			20. g(	
Particulates	5.9 g			5.9 g(	
Sulfur oxides (SOx)	33. g			33. g(	
Sulfuric acid	2.5 g	2.5 g			
*Disposal cap'cty impacts	410. g		410. g		
Solid wastes	410. g		410. g		

==

NOTE: Some totals in these reports may-appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: Water
Unit-of-Use: Press Speed 394 fpm
Product Life: 6000 sq ft processed

==

3. Pollution Generated per Unit-of-Use of product--
by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution Category	Pollutant Class	Amount Prevented	Pollutant	Amount Prevented
Human Health impacts	Toxic Inorganics	53. g		
			Nitrogen oxides (NOx)	20. g
			Sulfur oxides (SOx)	33. g
	Toxic Organics	6.8 g		
			Carbon monoxide	6.8 g
Use impairment impacts	Acid Rain Precursors	53. g		
			Nitrogen oxides (NOx)	20. g
			Sulfur oxides (SOx)	33. g
	Corrosives	56. g		
			Nitrogen oxides (NOx)	20. g
			Sulfur oxides (SOx)	33. g
			Sulfuric acid	2.5 g
	Dissolved Solids	3.5 g		
			Dissolved solids	1.0 g
			Sulfuric acid	2.5 g
	Global Warmers	8.0 Kg		
			Carbon dioxide	8.0 Kg
			Nitrogen oxides (NOx)	20. g
	Odorants	52. g		
			Hydrocarbons	52. g
	Particulates	5.9 g		
			Particulates	5.9 g
	Smog Formers	79. g		
			Carbon monoxide	6.8 g
			Hydrocarbons	52. g
			Nitrogen oxides (NOx)	20. g
Disposal capacity impacts	Solid Wastes	410. g		
			Solid wastes	410. g

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NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
Use STAGE(S)

Product: UV
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

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1. Pollution Generated per Unit-of-Use of product--
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
Overall environment	18. Kg	15. g	2.0 Kg	16. Kg(	
Human health impacts	230. g			230. g(	
Use impairment impacts	16. Kg	15. g		16. Kg(	
Disposal cap'cty impacts	2.0 Kg		2.0 Kg		

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NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED--SUMMARY REPORT FOR
Use STAGE(S)

Product: UV
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

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2. Pollution Generated per Unit-of-Use of product--
by Pollution Category, by Pollutant and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	18. Kg	15. g	2.0 Kg	16. Kg(	
Carbon dioxide	16. Kg			16. Kg(	
Carbon monoxide	23. g			23. g(	
Dissolved solids	3.0 g	3.0 g			
Hydrocarbons	20. g			20. g(	
Nitrogen oxides (NOx)	70. g			70. g(	
Particulates	27. g			27. g(	
Solid wastes	2.0 g		2.0 Kg		
Sulfur oxides (SOx)	140. g			140. g(	
Sulfuric acid	12. g	12. g			
*Human health impacts	230. g			230. g(	
Carbon monoxide	23. g			23. g(	
Nitrogen oxides (NOx)	70. g			70. g(	
Sulfur oxides (SOx)	140. g			140. g(	
*Use impairment impacts	16. Kg	15. g		16. Kg(	
Carbon dioxide	16. Kg			16. Kg(	
Carbon monoxide	23. g			23. g(	
Dissolved solids	3.0 g	3.0 g			
Hydrocarbons	20. g			20. g(	
Nitrogen oxides (NOx)	70. g			70. g(	
Particulates	27. g			27. g(	
Sulfur oxides (SOx)	140. g			140. g(	
Sulfuric acid	12. g	12. g			
*Disposal cap'cty impacts	2.0 Kg		2.0 Kg		
Solid wastes	2.0 Kg		2.0 Kg		

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NOTE: Some totals in these reports may-appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED -- SUMMARY REPORT FOR
Use STAGE(S)

Product: UV
Unit-of-Use: Press Speed 500 fpm
Product Life: 6000 sq ft processed

3. Pollution Generated per Unit-of-Use of product
by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution Category	Pollutant Class	Amount Prevented	Pollutant	Amount Prevented
Human Health impacts	Toxic Inorganics	210. g		
			Nitrogen oxides (NOx)	70. g
			Sulfur oxides (SOx)	140. g
	Toxic Organics	23. g		
			Carbon monoxide	23. g
Use impairment impacts	Acid Rain Precursors	210. g		
			Nitrogen oxides (NOx)	70. g
			Sulfur oxides (SOx)	140. g
	Corrosives	220. g		
			Nitrogen oxides (NOx)	70. g
			Sulfur oxides (SOx)	140. g
			Sulfuric acid	12. g
	Dissolved Solids	15. g		
			Dissolved solids	3.0 g
			Sulfuric acid	12. g
	Global Warmers	16. Kg		
			Carbon dioxide	16. Kg
			Nitrogen oxides (NOx)	70. g
	Odorants	20. g		
			Hydrocarbons	20. g
	Particulates	27. g		
			Particulates	27. g
	Smog Formers	110. g		
			Carbon monoxide	23. g
			Hydrocarbons	20. g
			Nitrogen oxides (NOx)	70. g
Disposal capacity impacts	Solid Wastes	2.0 Kg		
			Solid wastes	2.0 Kg

NOTE: Some totals in these reports may appear incorrect since all numbers displayed have been rounded to two significant figures.

POLLUTION GENERATED -- SUMMARY REPORT
All Previously Selected Stage(s)

Product: UV
Unit-of-Use: Press Speed 340 fpm
Product Life: 6000 sq ft processed

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1..Pollution Generated per Unit-of-Use of product-
by Pollution Category and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
overall environment	27. Kg	22. g	2.9 Kg	24. Kg(	
Human health impacts	350. g			350. g(	
Use impairment impacts	24. Kg	22. g		24. Kg(	
Disposal cap'cty impacts	2.9 Kg		2.9 Kg		

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POLLUTION GENERATED--SUMMARY REPORT FOR
All Previously Selected Stage(s)

Product: UV
Unit-of-Use: Press Speed 340 fpm
Product Life: 6000 sq ft processed

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2. Pollution Generated per Unit-of-Use of product-by Pollution Category, by Pollutant and by Medium

Pollution prevented for:	All Media	Water	Soil/ Grdwater	Air	Indoor Air
*Overall environment	27. Kg	22. g	2.9 Kg	24. Kg(	
Carbon dioxide	24. Kg			24. Kg(	
Carbon monoxide	33. g			33. g(	
Dissolved solids	4.5 g	4.5 g			
Hydrocarbons	29. g			29. g(	
Nitrogen oxides (NOx)	100. g			100. g(	
Particulates	40. g			40. g(	
Solid wastes	2.9 g		2.9 Kg		
Sulfur oxides (SOx)	210. g			210. g(	
Sulfuric acid	17. g	17. g			
*Human health impacts	350. g			350. g(	
Carbon monoxide	33. g			33. g(	
Nitrogen oxides (NOx)	4.5 g			100. g(	
Sulfur oxides (Sox)	210. g			210. g(	
*Use impairment impacts	24. Kg	22. g		24. Kg(	
Carbon dioxide	24. Kg			24. Kg(	
Carbon monoxide	33. g			33. g(	
Dissolved solids	4.5 g	4.5 g			
Hydrocarbons	29. g			29. g(	
Nitrogen oxides (NOx)	100. g			100. g(	
Particulates	40. g			40. g(	
Sulfur oxides (SOx)	210. g			210. g(	
Sulfuric acid	17. g	17. g			
*Disposal cap'cty impacts	2.9 Kg		2.9 Kg		
Solid wastes	2.9 Kg		2.9 Kg		

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NOTE: Some totals in these reports may-appear incorrect numbers displayed have been rounded to two significant figures.

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                    POLLUTION GENERATED -- SUMMARY REPORT FOR
                         All Previously Selected Staqe(s)

Product:              UV
Unit-of-Use:          Press Speed 340
Product Life:         6000 sq ft processed

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                3. Pollution Generated per Unit-of-Use of product
      by Pollution Category, Pollutant Class, and Pollutant for Overall Environment

Pollution   |     Pollutant         Amount                            Amount
Category    |       Class          Prevented       Pollutant         Prevented
              ----------------     ----------   ----------------     ----------
Human       /  Toxic Inorganics       310.   g
Health      |                                   Nitrogen oxides (NOx)      100.   g
impacts     |                                   Sulfur oxides (SOx)        210.   g
            |  Toxic Organics          33.   g
            \                                   Carbon monoxide             33.   g

            /  Acid Rain Precursors   310.   g
            |                                   Nitrogen oxides (NOx)      100.   g
            |                                   Sulfur oxides (SOx)        210.   g
            |  Corrosives             330.   g
            |                                   Nitrogen oxides (NOx)      100.   g
            |                                   Sulfur oxides (SOx)        210.   g
            |                                   Sulfuric acid               17.   g
            |
            |  Dissolved Solids        22.   g
            |                                   Dissolved solids            4.5   g
Use         |                                   Sulfuric acid               17.   g
impairment  |  Global Warmers          24.  Kg
impacts     |                                   Carbon dioxide              24.  Kg
            |                                   Nitrogen oxides (NOx)      100.   g
            |  Odorants                29.   g
            |                                   Hydrocarbons                29.   g
            |  Particulates            40.   g
            |                                   Particulates                40.   g
            |  Smog Formers           170.   g
            |                                   Carbon monoxide             33.   g
            |                                   Hydrocarbons                29.   g
            \                                   Nitrogen oxides (NOx)      100.   g

Disposal    /  Solid Wastes             2.9 Kg
capacity    |                                   Solid wastes                 2.9 Kg
impacts     \

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NOTE: Some totals in these reports may appear incorrect since all numbers
displayed have been rounded to two significant figures.
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