

CONTENTS

ENVIRONMENTAL HEALTH CRITERIA FOR FLAME RETARDANTS: TRIS(2-BUTOXYETHYL) PHOSPHATE, TRIS(2-ETHYLHEXYL) PHOSPHATE, TETRAKIS- (HYDROXYMETHYL) PHOSPHONIUM SALTS

PREAMBLE	xi
----------	----

ABBREVIATIONS	xix
---------------	-----

PART A: TRIS(2-BUTOXYETHYL) PHOSPHATE (TBEP) 1

A1.	SUMMARY, EVALUATION AND RECOMMENDATIONS	2
A1.1	Summary	2
A1.2	Evaluation	3
A1.3	Recommendations	5
A2.	IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, AND ANALYTICAL METHODS	6
A2.1	Identity	6
A2.2	Physical and chemicals properties	7
A2.3	Conversion factors	18
A2.4	Analytical methods	8
A2.4.1	Air	8
A2.4.2	Water	8
A2.4.3	Sediment	9
A2.4.4	Soils and foodstuffs	9
A2.4.5	Biological media	9
A3.	SOURCES OF HUMAN AND ENVIRONMENTAL EXPOSURE	11
A3.1	Natural occurrence	11
A3.2	Anthropogenic sources	11

	A3.2.1 Production levels and processes	11
	A3.2.2 Uses	11
A4.	ENVIRONMENTAL TRANSPORT, DISTRIBUTION AND TRANSFORMATION	12
	A4.1 Transport and distribution between media	12
	A4.2 Biodegradation	12
	A4.2.1 Migration	13
A5.	ENVIRONMENTAL LEVELS AND HUMAN EXPOSURE	14
	A5.1 Environmental levels	14
	A5.1.1 Air	14
	A5.1.2 Water (drinking-water and surface water)	15
	A5.1.3 Soils and sediment	16
	A5.1.4 Aquatic organisms	16
	A5.2 Human tissue levels	17
	A5.3 Food	17
	A5.4 Occupational exposure	19
A6.	KINETIC AND METABOLISM IN LABORATORY ANIMALS AND HUMANS	20
A7.	EFFECTS ON LABORATORY MAMMALS AND <i>IN VITRO</i> TEST SYSTEMS	21
	A7.1 Single exposure	21
	A7.1.1 Oral and dermal	21
	A7.1.2 Inhalation	21
	A7.2 Short-term repeated exposure	22
	A7.2.1 Oral	22
	A7.2.2 Dermal	23
	A7.3 Skin and eye irritation; sensitization	24
	A7.4 Reproductive toxicity, embryotoxicity and teratogenicity	24
	A7.5 Mutagenicity and related end-points	25
	A7.6 Carcinogenicity	25
	A7.7 Special studies	25
	A7.7.1 Neurotoxicity	25

	A7.7.1.1 Acute administration	25
	A7.7.1.2 Repeated oral administration	27
	A7.7.1.3 Effects on esterase activity	29
A8.	EFFECTS ON HUMANS	30
A9.	EFFECTS ON OTHER ORGANISMS IN THE LABORATORY AND FIELD	31
A9.1	Laboratory experiments	31
A9.1.1	Aquatics organisms	31
A9.1.1.1	Invertebrates	31
A9.1.1.2	Vertebrates	31
PART B:	TRIS(2-ETHYLHEXYL) PHOSPHATE (TEHP)	32
B1.	SUMMARY, EVALUATION AND RECOMMENDATIONS	33
B1.1	Summary	33
B1.2	Evaluation	35
B1.3	Recommendations	36
B2.	IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, AND ANALYTICAL METHODS	37
B2.1	Identity	37
B2.2	Physical and chemical properties	38
B2.3	Conversion factors	38
B2.4	Analytical methods	39
B2.4.1	Air	39
B2.4.2	Water	39
B2.4.3	Sediment	40
B3.	SOURCES OF HUMAN AND ENVIRONMENTAL EXPOSURE	41
B3.1	Natural occurrence	41
B3.2	Anthropogenic sources	41

B3.2.1	Production levels and processes	41
B3.2.2	Uses	41
B4.	ENVIRONMENTAL TRANSPORT, DISTRIBUTION AND TRANSFORMATION	42
B4.1	Biodegradation	42
B4.2	Bioaccumulation	43
B5.	ENVIRONMENTAL LEVELS AND HUMAN EXPOSURE	44
B5.1	Environmental levels	44
B5.1.1	Air	44
B5.1.2	Surface water	44
B5.1.3	Drinking-water	45
B5.1.4	Effluents	45
B5.1.5	Sediment	46
B5.1.6	Food	46
B6.	KINETICS AND METABOLISM IN LABORATORY ANIMALS	49
B7.	EFFECTS ON LABORATORY MAMMALS AND <i>IN VITRO</i> TEST SYSTEMS	50
B7.1	Single exposure	50
B7.2	Repeated exposure	50
B7.2.1	Oral	50
B7.2.2	Dermal	51
B7.2.3	Inhalation	52
B7.3	Skin and eye irritation; sensitization	53
B7.4	Reproductive toxicity, embryo toxicity and teratogenicity	54
B7.5	Mutagenicity	54
B7.5.1	<i>In vitro</i> assays	54
B7.5.2	<i>In vivo</i> assays	55
B7.6	Carcinogenicity	55
B7.7	Special studies	56
B7.7.1	Neurotoxicity	56

B8.	EFFECTS ON HUMANS	59
B9.	EFFECTS ON OTHER ORGANISMS IN THE LABORATORY AND FIELD	60
B9.1	Laboratory experiments	60
B9.1.1	Microorganisms	60
B9.1.2	Aquatic organisms	60
B9.1.2.1	Vertebrates	60
B9.1.3	Terrestrial organisms	60
PART C: TETRAKIS(HYDROXYMETHYL) PHOSPHONIUM SALTS		61
C1.	SUMMARY AND EVALUATION	62
C1.1	Summary	62
C1.2	Evaluation	64
C2.	IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, AND ANALYTICAL METHODS	65
C2.1	Identity	65
C2.1.1	Tetrakis(hydroxymethyl) phosphonium chloride (THPC)	65
C2.1.2	Tetrakis(hydroxymethyl) phosphonium sulfate (THPS)	66
C2.1.3	Tetrakis(hydroxymethyl) phosphonium chloride-urea condensate (THPC-urea)	67
C2.2	Physical and chemical properties	68
C2.2.1	Technical products	68
C2.3	Conversion factors	68
C2.4	Analytical methods	68
C3.	SOURCES OF HUMAN AND ENVIRONMENTAL EXPOSURE	71
C3.1	Natural occurrence	71
C3.2	Anthropogenic sources	71

	C3.2.1	Production levels and processes	71
	C3.2.2	Uses	71
C4.		ENVIRONMENTAL TRANSPORT, DISTRIBUTION AND TRANSPORTATION	73
	C4.1	Transport and distribution between media	73
	C4.2	Transformation	73
		C4.2.1 Biodegradation	73
		C4.2.2 Abiotic degradation	74
	C4.3	Migration from textiles	74
C5.		ENVIRONMENTAL LEVELS AND HUMAN EXPOSURE	76
C6.		KINETICS AND METABOLISM IN LABORATORY ANIMALS	77
C7.		EFFECTS ON LABORATORY MAMMALS AND <i>IN VITRO</i> TEST SYSTEMS	78
	C7.1	Single exposure	78
		C7.1.1 Oral	78
		C7.1.2 Dermal	78
		C7.1.3 Inhalation	79
	C7.2	Repeated exposure	79
		C7.2.1 Oral	79
		C7.2.1.1 THPC	79
		C7.2.1.2 THPS	80
		C7.2.2 Dermal	82
	C7.3	Long-term exposure	83
		C7.3.1 THPC	83
		C7.3.2 THPS	84
	C7.4	Skin and eye irritation; sensitization	84
		C7.4.1 Skin irritation	84
		C7.4.1.1 THPS	84
		C7.4.1.2 THPC-urea	85
		C7.4.2 Eye irritation	85
		C7.4.3 Skin sensitization	85
		C7.4.3.1 THPS	85
		C7.4.3.2 THPC-urea	85

C7.5	Reproductive toxicity, embryotoxicity and teratogenicity	86
C7.5.1	THPS	86
C7.5.2	THPC-urea	86
C7.6	Mutagenicity and related end-points	87
C7.6.1	THPC-urea	87
	C7.6.1.1 <i>In vitro</i> studies	87
	C7.6.1.2 <i>In vivo</i> studies	87
C7.6.2	THPC	87
C7.6.3	THPS	89
C7.6.4	THPO	90
C7.6.5	Treated fabrics	90
C7.7	Carcinogenicity	90
C7.7.1	Oral studies	90
	C7.7.1.1 Mice	90
	C7.7.1.2 Rats	91
C7.7.2	Dermal studies: initiation and promotion	91
C7.8	Special studies	91
C8.	EFFECTS ON HUMANS	92
C9.	EFFECTS ON OTHER ORGANISMS IN THE LABORATORY AND FIELD	93
C9.1	Laboratory experiments	93
	C9.1.1 Aquatic organisms	93
	C9.1.2 Terrestrial organisms	94
C10.	PREVIOUS EVALUATIONS BY INTERNATIONAL BODIES	95
	REFERENCES	96
	APPENDIX	109
	RÉSUMÉ, EVALUATION ET RECOMMANDATIONS	110
	RESUMEN, EVALUACIÓN Y RECOMENDACIONES	121