Appendix B. Acute, 8-Hour, and Chronic Reference Exposure Levels (RELs) Summary Table

(Revised October 2013 to reflect adoption of additional new or revised RELs)

B.1 Introduction to Reference Exposure Levels Summary Table

A number of acute noncancer Reference Exposure Levels (RELs) originally appeared in the "*Air Toxics Hot Spots Program Risk Assessment Guidelines Part I: The Determination of Acute Reference Exposure Levels for Airborne Toxicants*" March 1999 (OEHHA 1999a). Chronic noncancer RELs were presented in a subsequent publication: "*Air Toxics Hot Spots Program Risk Assessment Guidelines Part III: Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels*" (OEHHA 2000). These earlier acute and chronic RELs underwent public review and peer review by the State's Scientific Review Panel (SRP) on Toxic Air Contaminants (TACs). The development of 8-hour RELs is presented for the first time in this document.

OEHHA develops inhalation RELs for chemicals on the list of substances for which emissions need to be quantified (see Appendix C) under the Air Toxics Hot Spots Program. These substances are selected primarily based on:

(1) the magnitude of current known emissions in California and
(2) the availability of a scientific database on which to estimate RELs.

RELs for acrolein, acetaldehyde, arsenic, butadiene, formaldehyde, manganese, mercury and nickel have been developed using these new guidelines, and were approved by the SRP and adopted by OEHHA. These new RELs are listed here. This table also lists RELs developed using the original (OEHHA 1999a and 2000) methodologies. In addition, the California Air Resources Board (ARB) previously adopted chronic RELs for acetaldehyde, diesel exhaust particulates, and perchloroethylene during the identification of these substances as TACs. Risk assessors should continue to use these existing values, until such time as they are replaced by newly developed values. Prioritization for updating these original values will follow the scheme presented in the *Prioritization of Toxic Air contaminants under the Children's environmental Health Protection Act* (OEHHA, 2001).

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Acetaldehyde (75-07-0)	**A**	470[5]		Eyes; respiratory system (sensory irritation)	H
	8	300[4,5]		Respiratory system	R
	C	140[4,5]		Respiratory system	R
Acrolein (107-02-8)	**A**	2.5[5]		Eyes; respiratory system (sensory irritation)	H
	8	0.7[5]		Respiratory system	R
	C	0.35[5]		Respiratory system	R
Acrylic Acid (79-10-7)	**A**	6,000		Respiratory system; eyes	R
Acrylonitrile (107-13-1)	**C**	5[4]		Respiratory system	R
Ammonia (7664-41-7)	**A**	3200[4]		Respiratory system; eyes	H
	C	200		Respiratory system	H
Arsenic (7440-38-2) **& inorganic arsenic compounds (including arsine)**	**A**	0.20[5]		Development; cardiovascular system; nervous system	M
	8	0.015[5]		Development; cardiovascular system; nervous system; respiratory system; skin	H
	C	0.015[5]	0.0035[5]	*Inhalation and Oral:* Development; cardiovascular system; nervous system; respiratory system; skin	H
Benzene (71-43-2)	**A**	1,300		Reproductive/development; immune system; hematologic system	R
	C	60		Hematologic and nervous systems; development	H
Benzyl Chloride (100-44-7)	**A**	240		Respiratory system; eyes	M, R
Beryllium& beryllium compounds (7440-41-7)	**C**	0.007	2.0	*Inhalation:* Respiratory system; immune system *Oral:* Alimentary system (gastrointestinal tract)	H
Butadiene (106-99-0)	**A**	660[4,5]		Development	M
	8	9[4,5]		Reproductive system	M
	C	2[4,5]		Reproductive system	M

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Cadmium & cadmium compounds (7440-43-9)	**C**	0.02	0.5	*Inhalation:* Kidney; respiratory system *Oral:* Kidney	H
Caprolactam (105-60-2)	**A**	50		Eyes (sensory irritation)	H
	8	7		Respiratory system	R
	C	2.2		Respiratory system	R
Carbon disulfide (75-15-0)	**A**	6,200		Reproductive/development; nervous system	R
	C	800[4]		Nervous system; reproductive system	H
Carbon monoxide (630-08-0)	**A**	23,000		Cardiovascular system	H
Carbon tetrachloride (56-23-5)	**A**	1,900		Alimentary system (liver); reproductive/development; nervous system	R
	C	40		Alimentary and nervous systems; development	GP
Chlorinated dibenzo-p-dioxins and dibenzofurans Unspeciated mixtures treated as 2,3,7,8-tetrachlorodibenzo-p-dioxin (1746-01-6)	**C**	0.00004	1×10^{-5}	*Inhalation and oral:* Alimentary (liver) reproductive, endocrine, respiratory and hematologic systems; development	R
Chlorine (7782-50-5)	**A**	210		Respiratory system; eyes	H
	C	0.2[4]		Respiratory system	R
Chlorine dioxide (10049-04-4)	**C**	0.6		Respiratory system	R
Chlorobenzene (108-90-7)	**C**	1,000		Alimentary system (liver); kidney; reproductive system	R
Chloroform (67-66-3)	**A**	150		Reproductive/development; respiratory system; nervous system	R
	C	300		Alimentary system (liver); kidney; development	R

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Chloropicrin (76-06-2)	**A**	29		Respiratory system; eyes	M
	C	0.4[4]		Respiratory system	M
Chromic trioxide (as chromic acid mist)	**C**	0.002	20	*Inhalation:* Respiratory system *Oral:* Hematologic system	H
Chromium hexavalent: (18540-29-9) and soluble hexavalent chromium compounds (except chromic trioxide)	**C**	0.2[4]	20	*Inhalation:* Respiratory system *Oral:* Hematologic system	R
Copper and compounds	**A**	100		Respiratory system	H
Cresol mixtures (1319-77-3)	**C**	600		Nervous system	R
Dichlorobenzene (1,4-) (106-46-7)	**C**	800		Nervous system; respiratory system; alimentary system (liver); kidney	R
Dichloroethylene (1,1-) (75-35-4)	**C**	70		Alimentary system (liver)	GP
Diesel Exhaust	**C**	5[3,4]		Respiratory system	R
Diethanolamine (111-42-2)	**C**	3		Respiratory system; hematologic system	R
Dimethylformamide (N,N-) (68-12-2)	**C**	80		Alimentary system (liver); respiratory system	H
Dioxane (1,4-) (123-91-1)	**A**	3,000		Respiratory system; eyes	H
	C	3,000		Alimentary system; kidney; cardiovascular system	R
Epichlorohydrin (106-89-8)	**A**	1,300		Respiratory system; eyes	H
	C	3		Respiratory system; eyes	R
Epoxybutane (1,2-) (106-88-7)	**C**	20		Respiratory system; cardiovascular system	M
Ethylbenzene (100-41-4)	**C**	2,000		Development; alimentary system (liver); kidney; endocrine system	M, R
Ethyl chloride (75-00-3)	**C**	30,000		Development; alimentary system (liver)	M
Ethylene dibromide (106-93-4)	**C**	0.8		Reproductive system	H

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Ethylene dichloride (107-06-2)	**C**	400		Alimentary system (liver)	R
Ethylene glycol (107-21-1)	**C**	400		Respiratory system; kidney; development	H
Ethylene glycol monobutyl ether (111-76-2)	**A**	14,000		Respiratory system; eyes	H
Ethylene glycol monoethyl ether (110-80-5)	**A**	370		Reproductive/development	R
	C	70		Reproductive system; hematologic system	Rb
Ethylene glycol monoethyl ether acetate (111-15-9)	**A**	140		Reproductive/development; nervous system	R
	C	300		Development	Rb
Ethylene glycol monomethyl ether (109-86-4)	**A**	93		Reproductive/development	R
	C	60		Reproductive system	Rb
Ethylene glycol monomethyl ether acetate (110-49-6)	**C**	90		Reproductive system	Rb
Ethylene oxide (75-21-8)	**C**	30		Nervous system	R
Fluorides (except Hydrogen Fluoride - listed here separately)	**C**	13[4]	40	*Inhalation:* Bone and teeth; respiratory system *Oral:* Bone and teeth	H
Formaldehyde (50-00-0)	**A**	55[4,5]		Eyes (sensory irritation)	H
	8	9[5]		Respiratory system	H
	C	9[5]		Respiratory system	H
Glutaraldehyde (111-30-8)	**C**	0.08[5]		Respiratory system	M
Hexane (n-) (110-54-3)	**C**	7000		Nervous system	H
Hydrazine (302-01-2)	**C**	0.2		Alimentary system (liver); endocrine system	Ha
Hydrogen chloride (7647-01-0)	**A**	2,100		Respiratory system; eyes	H
	C	9		Respiratory system	H
Hydrogen cyanide (74-90-8)	**A**	340		Nervous system	H
	C	9		Nervous system; endocrine system; cardiovascular system	H

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Hydrogen fluoride (7664-39-3)	**A**	240		Respiratory system; eyes	H
	C	14[4]	40	*Inhalation:* Bone and teeth; respiratory system *Oral:* Bone and teeth (See "fluorides" summary)	H
Hydrogen selenide (7783-07-5)	**A**	5		Respiratory system; eyes	GP
Hydrogen sulfide (7783-06-4)	**A**	42		Nervous system	H
	C	10		Respiratory system	M
Isophorone (78-59-1)	**C**	2,000		Development; alimentary system (liver)	R, M
Isopropanol (67-63-0)	**A**	3,200		Respiratory system; eyes	H
	C	7,000		Kidney; development	R, M
Maleic anhydride (108-31-6)	**C**	0.7		Respiratory system	R,Ha, Mk
Manganese (7439-96-5) **& manganese compounds**	**8**	0.17[4,5]		Nervous system	H
	C	0.09[4,5]		Nervous system	H
Mercury (7439-97-6) **& inorganic mercury compounds**	**A**	0.6[5]		Nervous system; development	R
	8	0.06[5]		Nervous system, kidney, development	H
	C	0.03[5]	0.16[5]	*Inhalation & Oral:* Nervous system, kidney, development	H
Methanol (67-56-1)	**A**	28,000		Nervous system	H
	C	4,000[4]		Development	M
Methyl bromide (74-83-9)	**A**	3900		Nervous system; respiratory system; reproductive/ development	H
	C	5		Nervous system; respiratory system; development	R
Methyl chloroform (71-55-6)	**A**	68,000		Nervous system	H
	C	1000		Nervous system	Gb

TABLE B.1.1. OEHHA ACUTE, 8-HOUR AND CHRONIC REFERENCE EXPOSURE LEVEL (REL) SUMMARY[1]

Substance	REL type [1]	Inhalation REL (μg/m^3)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Methylene chloride (75-09-2)	**A**	14,000		Cardiovascular system; nervous system	H
	C	400		Cardiovascular system; nervous system	H
Methylene dianiline (4,4'-) (101-77-9)	**C**	20		Eyes; alimentary system (liver)	GP
Methylene diphenyl isocyanate (101-68-8)	**C**	0.7[4]		Respiratory system	R
Methyl ethyl ketone (78-93-3)	**A**	13,000		Respiratory system; eyes	H
Methyl isocyanate (624-83-9)	**C**	1		Respiratory system; reproductive system	R
Methyl *t*-butyl ether (1634-04-4)	**C**	8,000		Kidney; eyes; alimentary system (liver)	R
Naphthalene (91-20-3)	**C**	9		Respiratory system	H
Nickel & nickel compounds (except nickel oxide for chronic inhalation exposures) (Inhalation concentrations as μg Ni/m^3: oral dose as μg Ni/kg-day)	**A**	0.2[4,5]		Immune system	M
	8	0.06[5]		Respiratory system, immune system	R
	C	0.014[4,5]	11[5]	*Inhalation:* Respiratory system; hematologic system *Oral:* Development	R R
Nickel oxide (1313-99-1) (Inhalation concentration as μg Ni/m^3: oral dose as μg Ni/kg-day)	**C**	0.02[4,5]	11[5]	*Inhalation:* Respiratory system *Oral:* Development	M R
Nitric acid (7697-37-2)	**A**	86		Respiratory system	H
Nitrogen dioxide (10102-44-0)	**A**	470		Respiratory system	H
Ozone (10028-15-6)	**A**	180		Respiratory system; eyes	H
Perchloroethylene (127-18-4) (*syn.* **Tetrachloroethylene**)	**A**	20,000		Nervous system; respiratory system; eyes	H
	C	35[3]		Kidney; alimentary system (liver)	M

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Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Phenol (108-95-2)	**A**	5,800		Respiratory system; eyes	H
	C	200		Alimentary system (liver); cardiovascular system; kidney; nervous system	R
Phosgene (75-44-5)	**A**	4		Respiratory system	R
Phosphine (7803-51-2)	**C**	0.8		Respiratory system; alimentary system (liver); nervous system; kidney; hematologic system	M
Phosphoric acid (7664-38-2)	**C**	7[4]		Respiratory system	R
Phthalic anhydride (85-44-9)	**C**	20		Respiratory system	H
Polychlorinated biphenyls (PCBs) **Individual congeners evaluated using TEF methodology, relative to as 2,3,7,8-tetrachlorodibenzo-p-dioxin (see Appendix C in the TSD for Cancer Potency Factors – online at: http://oehha.ca.gov/air/hot_spots/tsd052909.html**	**C**	-	–	*Inhalation & oral*: Alimentary (liver), reproductive, endocrine, respiratory, and hematologic systems; development	R
Propylene (115-07-1)	**C**	3,000		Respiratory system	R
Propylene glycol mono-methyl ether (107-98-2)	**C**	7,000		Alimentary system (liver)	R
Propylene oxide (75-56-9)	**A**	3,100		Respiratory system; eyes; reproductive/development	H
	C	30		Respiratory system	R
Selenium and selenium compounds (other than hydrogen selenide)	**C**	20	5	*Inhalation and Oral:* Alimentary system (liver); cardiovascular system; nervous system	H
Silica (crystalline, respirable)	**C**	3[4]		Respiratory system	H
Sodium hydroxide (1310-93-2)	**A**	8		Respiratory system; eyes; skin	H
Styrene (100-42-5)	**A**	21,000		Respiratory system; eyes; reproductive/development	H
	C	900[4]		Nervous system	H
Sulfates	**A**	120		Respiratory system	H

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Substance	REL type [1]	Inhalation REL ($\mu g/m^3$)	Oral REL (μg/kg BW-day)	Hazard Index Target Organs	Species [2]
Sulfur dioxide (7446-09-5)	**A**	660		Respiratory system	H
Sulfuric acid (7664-93-9) [**& oleum,** *acute only***]**	**A**	120		Respiratory system	H
	C	1		Respiratory system	Mk
Toluene (108-88-3)	**A**	37,000		Respiratory system; nervous system; eyes; reproductive/ development	H
	C	300		Nervous system; respiratory system; development	R
Toluene diisocyanates (2,4- & 2,6-)	**C**	0.07		Respiratory system	H
Trichloroethylene (79-01-6)	**C**	600		Nervous system; eyes	H
Triethylamine (121-44-8)	**A**	2,800		Nervous system; eyes	H
	C	200		Eyes	R
Vanadium pentoxide (1314-62-1)	**A**	30		Respiratory system; eyes	H
Vinyl acetate (108-44-8)	**C**	200		Respiratory system	R, M
Vinyl chloride (75-01-4)	**A**	180,000		Nervous system; respiratory system; eyes	H
Xylenes: technical mixture (1330-20-7) and o-xylene (95-47-6), m-xylene (108-38-3) and p-xylene (106-42-3).isomers	**A**	22000		Nervous system; respiratory system; eyes	H
	C	700		Nervous system; respiratory system; eyes	H

Footnotes:

[1] REL types: **A** = acute, **8** = 8-hour, **C** = chronic. Exposure averaging time for acute RELs is 1 hour. For 8-hour RELs, the exposure averaging time is 8 hours, which may be repeated. Chronic RELs are designed to address continuous exposures for up to a lifetime: the exposure metric used is the annual average exposure.

[2] Species used in key study for REL development: D = dog; Gb = gerbil; GP = guinea pig: H = human; Ha = hamster; M = mouse; Mk = monkey; R = rat; Rb = rabbit

[3] These peer-reviewed chronic REL values were developed under the Toxic Air Contaminant (TAC) Program mandated by AB1807.

[4] REL based on benchmark dose (BMC) approach.

[5] REL developed using the revised methodology (OEHHA, 2008)]