ANNEX I

Summary tables of air pollution exposure research for

Chapter 1. INTRODUCTION

Annex I. Table 1. Key design characteristics of past personal exposure and microenvironmental concentration studies

Pollutant(s)	exposure time frame	sampling time(s)	exposure data	target population	sampling frame	population sample	reference
NO_2	long term	7 d 7 d 7 d 7 d	PPS PMSS POSS TAD MoPE MePE	families of Portage WI with school aged children	volunteer families	19 families 66 individuals	Quackenboss *et al.* 1982
CO	short term	continuous	PEM SAM TAD	nonsmoking residents (18-70 y) Washington, DC and Denver, CO	stratified probability sample	712 + 808	Ackland *et al.* 1985 Jungers *et al.* 1985
NO_2	long term	7 d 7 d 7 d 7 d	PPS PMSS POSS TAD MoPE	families of Portage Wi with school aged children	stratified cluster sample	350	Quackenboss *et al.* 1986
VOC	full year	2 x 12 h	PAS BME EI BI	population of California over 7 y.	stratified probability sample	188	Hartwell *et al.* 1987
CO	short term	continuous	PEM TAD	Washington commuters	8 high exposure routes for autos 4 for busses 3 for rail	213 trips 35 trips 8 trips	Flashbart *et al.* 1987
CO	long term	2 x 1 d	PEM SAM SPE (MC)	urban non-smoking population of Denver, CO	random sample	336	Ott *et al,* 1988
CO	short term	continuous	PEM SAM BME	non-smoking populations of Denver, CO, and Washington, DC	stratified probability sample	454 + 625	Wallace *et al.* 1988
CO	short-term	continuous	PEM SAM BME TAD SPE	non-smoking populations of Denver CO and Washington DC	random sample	555	Mage *et al.* 1989
NO2	short-term	2 x 0-24 h	PISS PPS TAD	population of Boston, MA	stratified probability sample	313	Ryan *et al.* 1989
PM10	short-term	14 x 24 h	PEM SIM SAM REQ	14 non-smoking adult individuals in Phillipsburg NJ	selected sample	14	Lioy *et al.* 1990
CO NO_x	short term	cont -4 h cont -4 h	MAQM MAQM	highway commuters in Germany	field sampling on highway	-	Rudolf 1990

Table 1.(Cont) Key design characteristics of past personal exposure and microenvironmental concentration studies

Pollutant(s)	exposure time frame	sampling time(s)	exposure data	target population	sampling frame	population sample	reference
CO NO_x	short term	continuous continuous	MAQM MAQM	commuters of Jerusalem	field sampling on street	-	Luria *et al.* 1990
PM10 NO_2	short term	24 h (?) 24 h 2 x 1 wk continuous	AISS SAM PMSS SAM MIAQ TAD MoPE	children (6-15 y) in Tucson, AZ	stratified cluster sample of county employees and their families	400	Quackenboss *et al.* 1991
VOC CO O_3 NO_2	short term	1 h 1 h 1 h 1 h continuous	AMSS AMSS AMSS AMSS SAM MMAQ	selected driving routes in Raleigh, NC during rush hours	field experim with 2 automobiles	-	Chan *et al.* 1991
NO_x SO_2 CO	short term	1 h 1 h 1 h continuous	AMSS AMSS AMSS SAM MMAQ	bus commuters and pedestrians of Hong kong	selected bus lines	-	Chan *et al.* 1993
CO NO_2 (car exch)	full year	20 h 1 wk continuous	PEM PPS SAM REQ HD TQ	day care center children in Helsinki	all children in 8 day care centers	250	Alm *et al.* 1993 Alm *et al.* 1997
NO_2	full year	8 h 24 h (?)	PPS SPE (MC) TAD REQ	people living in gas range homes in Los Angeles, CA	see Spengler et al. 1992	400	Özkaynak *et al.* 1993
TVOC SO_2 NO_2 CO TSP	cross sect	1 wk -"- 8 h 8 h 8 h 12 h	PISS POSS SIM SIM SIM PAS	rural South African population in cold winter regions using wood fuel	among the households in a farm in Transvaal Highveld	7 12 18 18 18	Terblanche *et al.* 1993
NO_2	cross sect	7 x 24 h -"- -"- -"-	PPS PISS POSS TAD REQ OEQ	Moscovites (pilot)	non-smoking volunteers from the Institute	10	Avaliani *et al.* 1993

Table 1.(Cont) Key design characteristics of past personal exposure and microenvironmental concentration studies

Pollutant(s)	exposure time frame	sampling time(s)	exposure data	target population	sampling frame	population sample	reference
NO_2	cross sect	continuous	SAM	infants in Berlin	infants	10	Dörre & Knauer 1993
		continuous	SIM		attending one		
			MoPE		day care facility		
		24 h	TAD				
			REQ				
NO_2	May-July	3 x 24 h	PPS	adult residents of Zürich	residents in	13	Monn et al. 1993
		-"-	POSS	and its suburban towns	Zürich		
		-"-	PISS		residents in	13	
			MoPE		suburbs		
O_3		3 x 24 h	PPS		(volunteers?)		
		-"-	POSS				
		-"-	PISS				
			MoPE				
		3 x 24 h	TAD				
			REQ				
NO_2	winter	? x 24 h	PPS	schoolchoildren in Tokyo	children in	?	Muramatsu et al. 1993
		continuous	SAM	and suburbs	3 urban and		
		?	SIM (?)		2 rural schools		
HCHO		? x 24 h	PSD				
		?	SAM (?)				
		?	SIM (?)				
		? x 24 h	TAD				
			REQ				
			HD				
NO_2	cross sect	24 h (?)	PAS	residents of Berlin (?)	?	?	Schauer & Dörre 1993
		continuous	SAM				
			MMAQ				
			MoPE				
			MePE				
		24 h	TAD				
			REQ				
NO_2	full year	24 h	PPS	30-60 year old housewives	cluster	59	Song *et al.* 1993
		-"-	PMSS	in Beijing	random		
		-"-	POSS		sampling		
		-"-	TAD				
			REQ				
NO_2	full year	48 h	PPS	residents of Los Angeles, CA	random	700	Xue *et al.* 1993
		48 h & 2 wk	POSS		representation		
		48 h & 2 wk	PMSS		sample		
		48 h	TAD				
			REQ				
			MePE				
			MoPE				
			MIAQ				

Table 1.(Cont) Key design characteristics of past personal exposure and microenvironmental concentration studies

Pollutant(s)	**exposure time frame**	**sampling time(s)**	**exposure data**	**target population**	**sampling frame**	**population sample**	**reference**
Nicotine (ETS)	cross sect	2 x 48 h -"- -"-	PPS PMSS TAD REI	schoolchildren in Taipei	stratified sampling of schools and classes random sampling of children	39	Chan *et al* 1993
ETS	cross sect	1991	PAS EQ	homes in Atlanta GA	?	45 homes	Fisher 1993
ETS	long term	1984-90	EQ BQ BME	(self reported) non-smoking residents of Southern Germany	random sample	3036	Heller *et al.* 1993
ETS	cross sect	1991	BQ SEQ HSQ	children of (self reported) smoking parents in Espoo, Finland	random sample	1003	Jaakkola *et al.* 1993
ETS Nicotine	cross sect	7 d	EQ PPS BME	(self reported) non-smoking pregnant women in the U.S.	random sample minus dropouts	415	O'Connor *et al.* 1993
PM_{10} $PM_{2.5}$ Nicotine	48 d	2 x 12 h 2 x 12 h 2 x 12 h 48 x 1 d 2 x 12 h 2 x 12 h	PEM SIM SAM AOSS TAD EQ	Non-smoking residents of Riverside, CA	stratified probability sample	178	Wallace *et al.* 1993 Thomas *et al.* 1994
PM_{10} $PM_{2.5}$ Nicotine	long term	2 x 12 h 2 x 12 h 2 x 12 h 48 x 1 d 2 x 12 h 2 x 12 h	PEM SIM SAM AOSS TAD EQ	Residents of Riverside, CA	stratified probability sample	175	Özkaynak *et al.* 1993 Clayton *et al.* 1994 Özkaynak *et al.* 1996
CO	short term	1-8 h	PEM SAM	residents near main roads in Oslo Vålerenga Gammelbye area	?	10	Larsen *et al.* 1993
NO_2		1-24 h	PPS SAM			15	
PM_{10} Black smoke		24 h 24 h	AOSS AOSS BME TAD REQ HSQ HD MoPE			 153 1028 1028 153	
VOC		short term	PAS AISS TQ	commuters of Taipei, bus and MC	random sample	3+3 1694	Chan *et al.* 1993

Table 1.(Cont) Key design characteristics of past personal exposure and microenvironmental concentration studies

Pollutant(s)	exposure time frame	sampling time(s)	exposure data	target population	sampling frame	population sample	reference
NO_2	short-term	48 h	PPS PISS POSS TAD	population of the Los Angeles Basin	population representative sample	682	Spengler *et al.* 1994
PM_{10}	short term	24 h	PAS SAM AOSS EQ	Schoolchildren in Wageningen and Amsterdam, the Netherlands	children from four schools	45	Janssen *et al.* 1997

Abreviations used

AISS = active indoor stationary sampler
AMSS = active microenvironmental stationary sampler
AOSS = active outdoor stationary sampler
ASD = active stationary sampler
ASD = active sampling device
BI = behaviour interview
BME = biomarker of exposure
BQ = behaviour questionnaire
EI = exposure interview
EQ = exposure questionnaire
HD = health diary
HSI = health status interview
HSQ = health status questionnaire
MAQM = mobile air quality monitor
MEM = microenvironmental monitor
MePE = measurement of personal exposure
MoIAQ = modeling of indoor air quality
MoMAQ = modeling of microenvironmental air quality
MoOAQ = modeling of outdoor air quality
MoPE = modeling of personal exposures
MoTPE = modeling of total personal exposure
OEI = occupational exposure interview
OEQ = occupational exposure questionnaire
PAS = personal active sampler
PEM = personal exposure monitor
PISS = passive indoor stationary sampler
PMSS = passive microenvironm.. stationary sampler
POSS = passive outdoor stationary sampler
PPS = personal passive sampler
PSD = passive sampling device
PSS = passive stationary sampler
REI = residential environmental interview
REQ = residential environmental questionnaire
SAM = stationary ambient air monitor
SEI = socioeconomic interview
SEQ = socioeconomic questionnaire
SIM = stationary indoor air monitor
SPE = simulation of population exposure
TAD = time activity diary
TI = transportation interview
TQ = transportation questionnaire

Table 2. Microenvironmental characterizations used in personal exposure studies

home indoor	home outdoor	work	traffic	other indoor	other outdoor	reference
inside home cooking/helping near smoking	outside		inside a vehicle	other indoors near smoking	outside	Quackenboss & Kanarek 1982
residence			car other Walking	parking garage restaurant office Store, mall	near roadway	Ackland *et al.* 1985
inside home	outside/any	inside/work inside school	inside a vehicle	inside/other	outside/any	Quackenboss *et al.* 1986
cooking/no gas residence/no smokers sleeping cooking with gas residence with smokers		office/no smokers store, shop indoor restaurant indoor health care facility school	automobile bus truck motorcycle	office/no smokers store, shop indoor restaurant indoor health care facility church Other public building Other indoor Office w.smokers	other outdoor open air excercise walking, cycling	Ott *et al.* 1988 (*
home		work/school	out-roads	other indoors	out-any	Quackenboss *et al.* 1991
no gas stove gas stove no smoke smoke	outdoor	day care centre/no gas day care centre/gas day care/outdoor	walk/bike car bus/tram metro/train			Alm *et al.* 1995
kitchen other rooms	outdoor	work school	in-vehicle		outdoor	Özkaynak *et al.* 1993
kitchen bedroom	outdoor	indoor outdoor cooking			outdoor	Avaliani *et al.* 1993
living and sleeping rooms kitchen		child care facility	traffic		outdoors	Dörre & Knauer 1993
indoor		indoor		indoor	outdoor	Monn *et al.* 1993
living room kitchen bathroom sleeping room		workplace recreation room	traffic	indoor-other	outdoor	Schauer & Dörre 1993
kitchen living room bedroom	home outdoor					Song *et al.* 1993
kitchen/gas kitchen/no gas home/other		inside/work inside/school	outside/major road		outside other	Xue *et al.* 1993

*) one more microenvironment for “high exposure”

Table 3. Personal fine PM exposures and microenvironmental levels in a number of studies.

Reference	Mean (geom) PM exposure or microenvironmental concentration [µg/m3]							
		personal	indoor, home	indoor, work	outdr, home	outdr, work	outdr, central site	
* PTEAM								
Clayton et al. 1993	PM2.5		35		38		33	probability day sample of 178 non smoking residents >10 yr in Riverside, CA
			27		37		33	probability night sample of 178 non smoking residents >10 yr in Riverside, C
	PM10	129	78		83		76	probability day sample of 178 non smoking residents >10 yr in Riverside, CA
		68	53		74		61	probability night sample of 178 non smoking residents >10 yr in Riverside, C
* Six Cities								
Spengler et al. 1981	PM3.5		24		21			non smokers in six cities
Sexton et al. 1884	RSP	36	25		19			Waterbury VA, 24 homes, 2 weeks
Spengler et al. 1985	PM3.5	44	42				18	Kingston-Harriman, 101 participants, home indoor
Santanna et al. 1990 (*	PM2.5		20		19			70 nonsmoking homes in Steubenville, winter
			25		30			70 nonsmoking homes in Steubenville, summer
			15		10			70 nonsmoking homes in Portage, winter
			14		14			70 nonsmoking homes in Portage, summer
* New York State								
Sheldon et al. 1989 (*	PM2.5		26		16			Onondaga county, 224 homes
	PM2.5		36		19			Suffolk county, 209 homes
* Other studies								
Lebret et al. 1985, 1990 (*	RSP		58				45	
Diemel et al. 1981 (*	RSP		120				64	101 residences near a lead smelter in Arnhem, NL
Kulmala et al. 1987 (*	PM1.0		16				20	100 dwellings and office buildings in Helsinki
	PM>1.0		13				16	
Janssen et al. 1995 (*	PM10	61	35		42			37 nonsmoking adults in Amsterdam
		104		126		33	38	13 children in Amsterdam and 32 in Wageningen
Kim & Stock 1986 (*	PM2.5		33		25			5 smoking homes in Houston TX
			11		12			6 nonsmokuing homes in Houston, TX
Bahadori et al. 1995 (*	PM2.5	22	16		23			10 nonsmoking COPD patients in Nashville TN, daytime samples
	PM10	33	22		33			10 nonsmoking COPD patients in Nashville TN, daytime samples
	PM2.5		12		22			10 nonsmoking COPD patients in Nashville TN, nighttime samples
	PM10		15		32			10 nonsmoking COPD patients in Nashville TN, nighttime samples
Colome et al. 1990 (*	PM10		43		61			10 nonsmoking asthmatics in Orange County, CA
Mumford et al. 1991 (*	PM10		56		18			8 mobile homes with kerosene heaters
Lioy et al. 1990 (THEES)	PM10	86	54		60			8 nonsmoking homes for 14 winter days in Phillipsburg, NJ
Turk et al. 1987 (*	PM3.0			24		14		38 commercial buildings in NW USA
Boudet et al. 1997	PM2.5	9	mean					40 nonsmoking asthmatic adult volunteers in Grenoble, France
		7	indoor exposure					
		30	outdoor exposure					
*) In Wallace 1996								

Table 4. Impacts of the presence of different sources on personal PM exposures and microenvironmental levels according to a number of studies..

Reference	Mean (geom) PM exposure or microenvironmental concentration [µg/m3]									
		no smoke	smoke	smoke +	cook +	gasstove+	kerosnhtr+	woodstv+	humif+	
* PTEAM										
Clayton et al. 1993	PM2.5			27	13					Riverside CA, 178 homes, indoor air daytime samples
				32						Riverside CA, 178 homes, indoor air nighttime samples
	PM10	72	114	29	26					Riverside CA, 178 homes, indoor air daytime samples
		47	84	38	12					Riverside CA, 178 homes, indoor air nighttime samples
	PM10	131	127							Riverside CA, 178 homes, personal exposure, daytime sampl
		63	97							Riverside CA, 178 homes, personal exposure, nighttime sam
* Six Cities										
Spengler et al. 1981	PM3.5	24	37	1 smoker						non smokers
			70	> 1 smoker						
Neas et al. 1995 (*	PM2.5	17	49							home indoor concentrations of 1050 children in the 6 cities st
Spengler et al. 1985	PM3.5	28	74							Kingston-Harriman, 101 participants, home indoor
Spengler et al. 1987 (*	PM2.5			30						Watertown, St. Louis, Kingston-Harriman, 3x300 children, ho
Santanna et al. 1990 (*	PM2.5	20	44							70 nonsmoking homes in Steubenville, winter
		25	50							70 nonsmoking homes in Steubenville, summer
		15	35							70 nonsmoking homes in Portage, winter
		14	25							70 nonsmoking homes in Portage, summer
* New York State										
Sheldon et al. 1989 (*	PM2.5	14	37	45		5	5	8		Onondaga county, 224 homes
Sheldon et al. 1989 (*	PM2.5	17	49	47			30	10		Suffolk county, 209 homes
Leaderer&Hammond 1991	PM2.5	15	44							subset of 96 homes with nicotine controlled smoking status
* other studies										
Jenkins et al. 1994, 1995 (	PM3.5	15	20	ETS at work						personal exposures of 16 x 100 nonsmoking individuals
			23	ETS at home						
			34	ETS at work and home						
Lebret et al. 1985, 1990 (*	RSP	30	70							260 homes in Ede and Rotterdam
Heavner et al. 1995 (*	PM3.5	28	87							homes of 104 NJ females
		30	67							workplaces of 104 NJ females
Quackenboss et al. 1989 (*	PM2.5	15	27	< 1 pack per day						98 homes in Tucson, AZ
			61	> 1 pack per day						
Highsmith et al. 1988, 199	PM2.5	18						8		11 homes in Houston TX
Kim & Stock 1986 (*	PM2.5	11	33							13 Houston homes
Morandi et al. 1986 (*	PM3.5	19	89	active smo	7					
Mumford et al. 1991 (*	PM10	56					27			8 mobile homes with kerosene heaters
Highsmith et al. 1988 (*	PM2.5	11							542	test of ultrasonic humidifiers in homes using tapwater
									27	test of ultrasonic humidifiers in homes using distilled water
Turk et al. 1987 (*	PM3.0	15	44							38 commercial buildings in NW USA
*) in Wallace 1996										

Table 5. Source apportionment of PM in personal exposures, indoor air and ambient air according to a number of studies.

Reference		Source apportionment outdoor air (1		ETS		woodburning		cooking		soil related (2		industry&heating(3		all traffic (4		diesel		secondary (5		Additional specifications
		µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	µg/m3	%	
* Personal exposure																				
		There exists no published data																		
* Indoor air																				
Koutrakis et al.1992 (*	PM2.5	9	60	non smoking																NYS data, 178 indoor air samples
		15	30	26	54															
Santanna et al. 1990 (*	PM2.5			20	46	4	10			3	8	4	10	<<-- (6	<<--	<<--	<<--			Six Cities data, 70 smoking homes in Steubenville, winter
						4	21			3	18	4	23	<<--	<<--	<<--	<<--			Six Cities data, 70 nonsmoking homes in Steubenville, winter
				27	54					13	27	<<--	<<--	4	7	<<--	<<--			Six Cities data, 70 smoking homes in Steubenville, summer
										12	50	<<--	<<--	4	15	<<--	<<--			Six Cities data, 70 nonsmoking homes in Steubenville, summe
				25	71	1	3			1	4	5	13	2	5	<<--	<<--			Six Cities data, 70 smoking homes in Portage, winter
						1	6			1	9	5	31	2	12	<<--	<<--			Six Cities data, 70 nonsmoking homes in Portage, winter
				10	40					2	8	6	23	5	18	<<--	<<--			Six Cities data, 70 smoking homes in Portage, summer
										2	13	5	38	4	30	<<--	<<--			Six Cities data, 70 nonsmoking homes in Portage, summer
Özkaynak et al. 1996	PM2.5		60		30				3											PTEAM 178 Riverside homes data, with smoking
			62		5				25											PTEAM 178 Riverside homes data, with cooking
	PM10		56		24				3											PTEAM 178 Riverside homes data, with smoking
			58		4				25											PTEAM 178 Riverside homes data, with cooking
* Ambient air																				
Santanna et al. 1990 (*	PM2.5					4	23			2	10	5	25							Six Cities data, Steubenville, winter
										23	79	<<--	<<--	2	5	<<--	<<--			Six Cities data, Steubenville, summer
						1	13			1	13	4	39	•2	17	<<--	<<--			Six Cities data, Portage, winter
										2	17	6	46	5	37	<<--	<<--			Six Cities data, Portage, summer
Vega et al. 1997	PM2.5										14		19		41		6		15	Mexico City, 33 suburban daytime samples in winter
											15		24		36		4		15	Mexico City, 33 suburban nighttime samples in winter
Schauer et al. 1995	PM3.5					3		3		4				2		5		11		Los Angeles, 1982, Pasadena
						2		2		4				3		12		13		Los Angeles, 1982, Downtown
						3		2		3				2		4		10		Los Angeles, 1982, West LA
						1		2		5				1		5		22		Los Angeles, 1982, Rubidoux
Ruuskanen 1996	PM10						11				48		12		14					Kuopio winter 1994

1) Contribution to indoor air PM
2) Soil material and resuspended road dust
3) Mostly primary partiicles, sulfates go to secondary
4) Only gasoline if diesel particles presented separately
5) sulfate, nitrate and ammonia particles
6) included in the arrow pointed column

*) in Wallace 1996

Table 6. Health effects of different VOC:s

VOC (µg/m3)	health effect: allergen NKB 1994:03 — airway hypersens initiator	health effect: allergen NKB 1994:03 — skin contact allergen	carcinog IARC	irr	odor	reference values: odor detection USEPA — odor detection (µg/m3)	odor detection Devos 1990 — odor detection (µg/m3)	mucous irritation Scharper 1993 — mucous irritation (µg/m3) x/40	mucous irritation AT 1992 — mucous irritation (µg/m3) x/40	WHO 1987 — mucous irritation (µg/m3) x/40	air quality guideline WHO 1987 — Air Quality Guidelines	indoor guideline USA 1989 — ASHRAE 62	outdoor priority USA 1990 — **CAAA's 189 HAP**
lkanes/cycloalkanes													
isobutane			II B						2694				
1,3-butadiene													x
hexane							79430						x
isoalkane (SUM)								47851					
nonane					x		6760	244258					
decane					x		4370		6656				
cyclohexane							77630	17500					
romatics													
benzene			I		x								x
toluene					x		5880	9510		8000	8000		x
ethylbenzene					x		13	4655	5531				x
m&p-xylene					x		1410	4308	2708				x
o-xylene					x								x
p-xylene					x								x
styrene	II B		II B		x		631	1869	2708		70		x
naphtalene					x								x
propylbenzene						100		5360					
1,2,4-trimethylbenzene							780	3130					
1,4-dimethyl-ethylbenzene								3490	2917				
biphenyl					x								x
aniline					x								x
lcohols													
2-propanol							25700	9199					
2-methyl-1-propanol							2570	4124					
1-butanol				x									
1-pentanol							1510	2876	3859				
2-ethylhexanol							1318	1753					
phenol					x		430	479	98			100	x
lycols/glycol ethers													
1,2-ethandiol									3233				
1,2-propandiol				x									
ethoxyethanol							4570		469				
2-butoxyethanol							1660	10222	3078				
sters													
butyl acetate							930	2597	18150				
butyl phtalates		III							75				
phtalates								75					
methylmetacrylate		III											
lkanals/alkanons													
formaldehyde	I	II B	II A	x	x						100		x
acetaldehyde				x	x								x
butanal					x		28	2240					
benzaldehyde					x		190	1082					
acetone				x			34670	41760				7000	
butanone							23440	19865					
arboxylic acids													
acetic acid							360	300					
iloxanes													
tetraethyl orthosiloxane									2170				
alogenated compounds													
trichloroethene											1000		x
tetrachloroethene											5000	2000	x
1,1,2-trichloroethane													x
tetrachloroethane			II B										x
chloroform			II B										x
chlorobenzene													x
1,4-dichlorobenzene													x
hexachloroethane													x
1,2,4-trichlorobenzene													x
hexachlorobenzene			II B										x
vinyl chloride			I										x
chlorophenols			II B										x
iscellaneous													
butanone oxime		II B					360						
N-ethyl acetamide							360						
methylisocyanate	I	III			x			5	1				x
quinoline					x								x

Table 7. Personal and microenvironmental VOC data from a number of studies

VOC (μg/m3)	PACE 1987-9 Canad	CONC 1987 Europe 13 countries	Hartwell et al 1987 L.A.	L.A.	Chan et al 1991 Raleigh NC	Raleigh NC	Raleigh NC	Raleigh NC	Krause 1991 Germa resider 50%-95%	Chan et al 1993 Taipei streets	Chan e 1993 Taipei school	Faust e 1993 Germa	Faust e 1993 outdoo	Girmar 1993 correct fluid us	Highsn 1993 ground ground	Crump et al 1993 South England indoor	outdoo	Bayer e 1993 microb VOCs	Brown 1994 establi dwellin	Saarel 1993 Finlanc buildin	Saarela 1993 Finland, buildings	Saarel 1993 Finlanc buildings	Fellin a 1993 Canad	Niesloch 1993 residenc and offices	Rothwe 1993 Swiss	Otson 1993 Canadi homes	Perry 1993 London indoor	buildin outdoor	Cottica 1993 Italian	Otson 1994 Canadi resider	Op't Veld 1994 Dutch before	residenc after	Gilli et al 1994 Turin Italy			Weisel et al 1994 traffic suburb	turnpike
microenvironment	gas sta	self-sei	person	outdoo	traffic	outdoo	traffic	street	homes	traffic	school	swimm	outdoo	office	home	home		school	review	offices	homes	offices	homes		homes				offices		homes		person	outdoor	indoor	in auto	in auto
sampling	outdoo	person	pump		vacuum				passive	pump		pump		direct	vacuur	diffusion or pu		pump		pump	pump	pump	diffusion		pump				pump		pump		passive				
medium			Tenax		canister					tenax		charcoal			caniste	Tenax		multisc	WAGN	tenax 1	tenax TA	tenax 1	OVM3500		Tenax TA				multisorb		-		GAC sorbent				
analysis	x1000	x1000	GC/FID		GC/MS				GCFID	GC/MS		GC/ECD		GC/PII	GC/MS	GC/FID		GC/MS		GC/MS	GC/MS (	GC/MS	GC/MSD		GC/MS				GC/MS	GC/FII	GC		GC/FID				
Alkanes/cycloalkanes									87-244																												
propane		0-42								0.235																											
isobutane	1.5	3-149			9.1	3.9	8.5	8																													
n-butane	2.2	2-256			54	17	65	41																													
1,3-butadiene		0-11			3.3	1.2	2.9	1.2																													
pentane	2.5	2-45			31	18	83	16																													
isopentane	1.2	0-152			69	1.2	2.9	53																													
hexane	5	0-16			14	3.3	11	7.4	7-22	35-124	35							x	1-5		-2-20	--4	-2			16			10-43								
isohexane									9-22																												
heptane	0.3				1.3	0.9	4.2	2.9	5-26	62-167	2								1-5		-6-42	--4			--1200				-23								
isoheptane									7-23																												
isoalkane (SUM)									24-80																												
octane			4.1	1.9	1.9	0.4	1.9	1.4	3-15	38-108	8								1-5	-2-11	-2-8	--18															
isooctane	0.04								3-19																				6-41							9-10	11
nonane	0.02				0.6	0.3	0.2	0.9	5-31	29-87	5								1-5		-3-20	--21							-32								
isononane									3-18																												
decane	0.04		2.2	1.1	1.5	0.4	1.4	1.5	8-52	18-79						4	3		5-10	-1-3	-7-40	--43	-48		--7800	54			-23	54							
undecane					1.9	0.4	1.5	1.4	6-28							1	3		1-5	-1-4	-7-36	--25															
dodecane									4-17										1-5	-1-2	-4-23	--13															
tridecane									5-22												-1-5	--4															
tetradecane																			1-5		-2-9	--5															
pentadecane																			1-5		-1-13								-30								
hexadecane																			<1		-2--30																
2-methylpentane	1.2	1-22			25	4.5	23	14																													
3-methylpentane	0.8	1-14																	1-5																	2-4	18
methylcyclopentane		0-4							2-7																												
2-methylhexane	0.2																		1-5																		
3-methylhexane	0.3																		1-5																		
2-methylheptane	0.04																																				
5-methyldecane																													-19								
3-ethylpentane	0.2																																				
2,2,3 trimethylbutane	0.2																																				
2,2,4-trimethylpentane	0.1				17	2.7	16	9.9																													
2,3,3-trimethylpentane		0-14			5.3	0.9	4.9	3.1																													
3,4,4-trimetkyldecane																													-31								
2,2-dimethylbutane		0-18																																			
2,3-dimethylbutane	1.5	0-7																																			
2,3-dimethylhexane					2	0.3	1.8	1.1																													
2,3-dimethylheptane					0.3	0.2	0.2	0.2																													
2,2-dimethylpentane	0.1																																				
2,3-dimethylpentane	0.3																																				
2,4-dimethylpentane	0.2																												-31								
2,5,6-trimethyloctane	2																												-30								
2,2,4,6,6-pentamethylheptane																													-54								
methylcyclopentane	1.1																		1-5																		
cyclopentane	1	0-5							6-18																												
cyclohexane	0.5				1.2	0.2	1.2	0.7											1-5						--10100				7-32								
methylcyclohexane	0.2								4-23										1-5										-33								
diethylcyclohexane																													-37								
Alkenes																																					
trans-2-butene	0.03	0-20																																			
cis-2-butene	0.1	0-16																																			
trans-2-pentene	2.7	0-12																																			
trans-3-methyl-2-pentene	0.2																																				
2,4,4-trimethyl-2-pentene																													-91								
2-methyl-1-butene	0.9																																				
3-methyl-1-butene	0.8																																				
2-methyl-2-butene	0	0-12																																			
1-hexene	0.9																																				
4-phenylcyclohexene																																					
heptene										18-55	4																										
1-heptene	0.2																																				
cis-4,4-dimethylpentene	0.2																																				
Aromatics									135-369																												
benzene	0.44	0-13	15	14	12	1.9	12	6.8	7-22	160-385	38				50-350	8	7	x	5-10		-34-176	--2	-7			12	38	48	-12	5	9-12	1-2	18 ppb	14 ppb	17 ppb	9-11	10
toluene	0.2	0-17			47	8.2	48	31	62-190	445-1054	105					14	11		20-50	-40-121	-31-121	--83	-84	-50-1620	--12200	41	24	35	8-31	41	38-40	21-32	20 ppb	17 ppb	17 ppb	26-40	56
ethylbenzene	0.03		8	7.1	8.8	1.5	9.2	5.9	7-25	124-349	24								5-10	-2-7	-6-25	--19	-14			12	5	7	-32	12	3	2				3-4	8
m&p-xylene	0.002		23	21	31	5	32	20	16-57	358-1009	46					9	7		10-20	-4-13	-14-74	--24	-26	-70-290	--2400	7	14	23	-36	7	3-7	1	19 ppb	15 ppb	16 ppb	16-23	23
o-xylene	0.02		10	7.9	11	1.9	12	7.6	5-18	192-549	26					5	3		5-10	-2-11	-7-33	--7	-8		--	8				8						8-9	9
p-xylene	0.06																		10-20				-9		--	6				6							
styrene			2.3	1.9					1-6									x	1-5	-1-8	-1-274	--6	-1	-31-2440							1	0.4-0.6					
naphtalene									2-5										<1				-8	-14-234	--220	12				12	0.5	0.1-0.3					
propylbenzene										27-165	6								1-5		-1-8	--3							-37		8-17	0.2-0.3					
isopropylbenzene (cumen	0.02								4-13	10-30	1																				0.2	0.1					

VOC (µg/m3)	PACE 1987-9 Canad	CONC 1987 Europe 13 countries	Hartwell et al 1987 L.A.	L.A.	Chan et al 1991 Raleigh NC	Raleigh NC	Raleigh NC	Raleigh NC	Krause 1991 Germa resider 50%-95%	Chan et a 1993 Taipei streets	Chan e 1993 Taipei school	Faust 1993 Germa	Faust 1993 outdoo	Girman 1993 correct fluid us	Highsm 1993 grounc ground	Crump et al 1993 South indoor	Englanc outdoo	Bayer 1993 microb VOCs	Brown 1994 establi dwellin	Saarel 1993 Finlanc buildin	Saarela 1993 Finland, buildings	Saarel 1993 Finlanc buildings	Fellin 1993 Canad	Niesloch 1993 residenc and offices	Rothw 1993 Swiss	Otson 1993 Canad homes	Perry 1993 London indoor	buildir outdoor	Cottica 1993 Italian	Otson 1994 Canad resider	Op't Veld 1994 Dutch before	residen after	Gilli et al 1994 Turin Italy			Weisel et al 1994 traffic suburb	tunpike	tunnel
microenvironment	gas sta	self-se	person	outdoo	traffic	outdoo	traffic	street	homes	traffic	school	swimm	outdoo	office	home	home		school	review	offices	homes	offices	homes		homes				offices		homes		person	outdoo	indoor	in auto	in auto	in auto
sampling	outdoo	person	pump		vacuum				passiv	pump		pump		direct	vacuur	diffusion or pu		pump		pump	pump	pump	diffusion		pump				pump		pump		passive					
medium			Tenax		canister					tenax		charcoal			caniste	Tenax		multisc	WAGN	tenax	tenax T/	tenax	OVM3500		Tenax TA				multisorb		-		GAC sorbent					
analysis	x1000	x1000	GC/FID		GC/MS				GCFID	GC/MS		GC/ECD		GC/PII	GC/MS	GC/FID		GC/MS		GC/MS	GC/MS	GC/MS	GC/MSD		GC/MS				GC/MS	GC/FI	GC		GC/FID					
o-methylpropylbenzene																													-20									
1,3-dimethylbenzene																																						
1,4-dimethylbenzene																																						
1,2-dimethylbenzene																																						
1-ethyl,4-methylbenzene										57-257	13																											
1-ethyl,2-methylbenzene										47-184	8																											
1-ethyl,3-methyl benzene										27-141	6																											
1,2,3-trimethylbenzene									2-9										<1		-1-8	--3			--2500				-23									
1,2,4-trimethylbenzene					16	2.7	17	11	6-27	29-105	6					5	4		5-10	-1-2	-5-25	--15	-16		--	20	6	11	7-23	20	3	1-2						
1,3,5-trimethylbenzene	0.01				4.7	0.9	5.1	3.2	2-11	58-334	11								1-5		-1-7	--10	-5		--	5	2	4	6-29	5	1.5	0.7						
o-methylethylbenzene																													-41									
1,4-dimethyl-ethylbenzene																																						
2,5-dimethylethylbenzene																													-22									
1-ethenyl-3-ethylbenzene																																						
1-ethenyl-4-ethylbenzene																																						
2-ethyltoluene									2-12																													
3-&4-ethyltoluene									6-24																													
biphenyl																										1												
a-methylstyrene																					-1-5	--12																
aniline																										104												
Alcohols																																						
methanol		0-12																																				
ethanol																			>50										-32									
2-propanol																																						
2-methyl-2-propanol																																						
2-methyl-1-propanol																																						
2-ethyl-1-hexanol																					-1-6	--7																
1-butanol									1-4										<1		-6-44	--1		-14-990	-6100													
isobutanol									1-7																--8700													
1-pentanol																					-4-12	--4																
2-pentanol																		x																				
hexanol																													-37									
1-octanol																					-4-37	--6																
2-eythylcyclobutanol																																						
2-ethylhexanol									1-4										1-5		-1-6																	
dimethyloctanols (decanol-ST150)																																						
phenol																								-1-6														
benzyl alcohol																						--3			--5000													
Glycols/glycol ethers																																						
1,2-ethandiol																																						
1,2-propandiol																									--570													
ethoxyethanol																																						
2-butoxyethanol																									--1000				-37									
2-(2-butoxyethoxy)ethanol																									--490													
propyleneglycol																					-4-34																	
Esters																																						
ethyl acetate									6-28									x	5-10		-1-5																	
butyl acetate									3-19										1-5		-4-20	--3			--900													
2-propenyl acetate																		x																				
propylene glycolmethyl etheracetate																									--1100													
1,2-propylene glycoldiacetate																									--2900													
2-(2-butoxyethoxy)ethanol acetate																									--2600													
2-ethoxyethanolacetate																																						
methylethylketone									5-13																													
Texanol 1																																						
Texanol 2																																						
2-butoxyethyl acetate																																						
2,2,4-trimethyl-1,3-pentandiol diisobutyrate, TXIB																					-47-328																	
butyl phtalates																										1												
phtalates																										22												
bis-(1-methylpropyl)malonate																																						
bis-(1-methylpropyl)succinate																																						
bis-(1-methylprpyl) adipate																																						
methylmetacrylate																																						
Alkanals/alkanons																																						
formaldehyde									55-106											20-120					--1300													
acetaldehyde																				10-100																		
butanal																			1-5						--500													
pentanal																				0-250	-4-26	--1			--350													
heptanal																					-2-14				--500													
hexanal									1-4										1-5	0-80	-24-87	--21			--1800													
octanal																									--300				-23									
nonanal																			5-10		-7-57	--2																

VOC (µg/m3)	PACE	CONC	Hartwell et al		Chan et al				Krause	Chan et a	Chan e	Faust	Faust	Girmar	Highsr	Crump et al		Bayer	Brown	Saarel	Saarela	Saarel	Fellin a	Niesloch	Rothw	Olson	Perry		Cottica	Olson	Op't Veld		Gilli et al			Weisel et al		
	1987-9	1987	1987		1991				1991	1993	1993	1993	1993	1993	1993	1993		1993	1994	1993	1993	1993	1993	1993	1993	1993	1993		1993	1994	1994		1994			1994		
	Canad	Europe	L.A.	L.A.	Raleigl NC	Raleigl NC	Raleigl NC	Raleigl NC	Germa	Taipei	Taipei	Germa	outdoo	correct	grounc	South	Englanc	microb	establi	Finlanc	Finland,	Finlanc	Canad	residenc	Swiss	Canad	London	buildir	Italian	Canad	Dutch	residen	Turin	Italy		traffic		
		13 countries							resider 50%-95%	streets	school			fluid us	grounc	indoor	outdoo	VOCs	dwellin	buildin	buildings	buildings		and offices		homes	indoor	outdoor		resider	before	after				suburb	tunpike	tunnel
microenvironment	gas st	self-se	person	outdoo	traffic	outdoo	traffic	street	homes	traffic	school	swimm	outdoo	office	home	home		school	review	offices	homes	offices	homes		homes				offices		homes		person	outdoo	indoor	in auto	in auto	in auto
sampling	outdoo	person	pump		vacuum				passiv	pump		pump		direct	vacuur	diffusion or pu		pump		pump	pump	pump	diffusion		pump				pump		pump		passive					
medium			Tenax		canister					tenax		charcoal			caniste	Tenax		multisc	WAGM	tenax	tenax TA	tenax	OVM3500		Tenax TA				multisorb		-		GAC sorbent					
analysis	x1000	x1000	GC/FID		GC/MS				GCFID	GC/MS		GC/ECD		GC/PII	GC/MS	GC/FID		GC/MS		GC/MS	GC/MS	GC/MS	GC/MSD		GC/MS				GC/MS	GC/FI	GC		GC/FID					
decanal																																						
2-nonenal																																						
benzaldehyde																					-2-18	--2			--440				-28									
valeraldehyde																																						
acetone																		x	20-50																			
2-propanone																																						
butanone																			1-5																			
2-pentanone																		x																				
3-methyl-2-butanone																																						
2-hexanone																		x																				
3-heptane																																						
2-heptanone																		x																				
Carboxylic acids																																						
acetic acid																																						
Siloxanes																																						
tetraethyl orthosiloxane																																						
Halogenated compounds									19-119																													
dichloromethane																		x	10-20				-20								3-6	2						
trichloromethane												58-190	1-4													16					2	2						
tetrachloromethane (carbontetrachloride)												1-2	1-2						1-5																			
1,2 dichloroethene																															1-2	0.7						
trichloroethene			2.2	0.46					4-20	-2		-1		300-1000					1-5				-1								12	7-8						
tetrachloroethene			8.2	9					5-27	-2		0-2	0						5-10				-3								7-8	6				-1	-1	1
1,1-dichloroethene																			1-5																			
1,2-dichloroethane										-2									<1				-0,01															
1,1,1-trichloroethane			29	20					5-26				1						10-20						--1600	43			-9		1-2	0.8						
1,1,2-trichloroethane																															0.6-1.4	0.9-1.5						
tetrachloroethane																															1.4	0.9						
chloroform			1	0.28															1-5				-2			9				20								
chlorobenzene																			<1												1-2	0.5						
1,4-dichlorobenzene									27-133	-2													-36								0.8	0.5						
m/p-dichlorobenzene			2.2	0.97						-2									5-10							18			-10									
pentachloroethane										-2													-,03															
hexachloroethane																							-0,05															
p-dichlorobenzene										-2																				18								
1,1,2,2,-tetrachlorobenzene																							-0,03															
1,2,3,5-tetrachlorobenzene																										1												
1,2,4-trichlorobenzene																			<1				-0,03			5				5								
pentachlorobenzene																										1												
hexachlorobenzene																										3												
vinyl chloride																																						
trichlorofluoromethane																													-13									
dibromochloromethane																																						
ethylenedibromide																			1-5																			
chlorophenols																								-6-64														
1-chloronaphtalene																								-41-1660														
Miscellaneous																																						
butanone oxime																																						
N-ethyl acetamide																																						
methylisocyanate																																						
alpha-pinene			1.9	0.25					7-27										1-5		-14-37	--10	-37		--1700					42								
beta-pinene									1-4										<1	-2-4						42												
alpha-terpinene									4-12										1-5																			
beta-carene																																						
delta3-carene																					-2-17																	
d-limonene									13-103										20-50		-3-17		-30		--220	33			-63	33								
p-cymene																							-2			3				3								
camphene																			10-20																			
quinoline																										22												
isoquinoline																										9												
pyridine																										6												
mesitylene																									-2000													