Special Report 16 November 2007

Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects

Appendices B, C, D, and E

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Introduction to Appendices B, C, D, and E

Appendices B, C, D, and E contain supplemental material not included in the printed report. These appendices are available on the HEI Web site (*www.healtheffects.org*) and on a compact disk (CD) that accompanies the printed version of the main text and Appendix A.

In beginning its review of mobile-source air toxics (MSATs), the HEI Air Toxics Review Panel sought to identify the MSATs likely to pose the greatest risk to humans at ambient exposure concentrations. The panel elected to focus on the following 21 MSATs listed by the U.S. Environmental Protection Agency (EPA) in its 2001 rule: acetaldehyde, acrolein, arsenic compounds, benzene, 1,3-butadiene, chromium compounds, diesel exhaust (particulate matter and organic gases), dioxin and furan compounds, ethylbenzene, formaldehyde, *n*-hexane, lead compounds, manganese compounds, mercury compounds, methyl *tert*-butyl ether, naphthalene, nickel compounds, polycyclic organic matter (POM), styrene, toluene compounds, and xylene.

Gradient Corporation of Cambridge, Mass., was engaged to conduct a literature survey to identify and summarize published information on exposure and toxicity for these 21 MSATs. The information resulting from this survey (undertaken the winter of 2004–2005) was used by the panel in its evaluation of MSATs and is presented in Appendices B and C of this report. Appendix B consists of the tables summarizing information on exposure to the MSATs, and Appendix C the tables summarizing information on toxicity and health effects.

Further information was collected for six of the seven priority MSATs identified by the panel as meriting special attention (acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, and POM). Additional information both on toxicity and health and on indoor exposures was collected. The toxicity and health information was incorporated into the tables in Appendix C; the information on indoor air concentrations is presented in Appendix D. Abbreviations and other terms used in the tables that make up Appendices B, C, and D are defined in Appendix E.

In preparing the tables for publication, HEI merged and reformatted information from Gradient Corporation's original literature searches. HEI also corrected typographical errors, updated expired hyperlinks, and made minor editorial changes. In addition, shortly before publication of the report, Tables C.1 and C.2 were updated by HEI to reflect changes in regulatory values. However, HEI has not attempted to verify the accuracy of all the information in the tables or their corresponding reference lists. Although the hyperlinks from the tables to Web sites were active shortly before publication, HEI cannot be responsible for any subsequent changes in the Web sites referred to.

APPENDIX B. AMBIENT AND OUTDOOR EXPOSURE TABLES

Table B.1 is a summary of key information on the exposure studies for each MSAT, including brief descriptions of each study and details of time periods, locations, and types of location (i.e., urban, suburban, rural, in-vehicle, roadside, and tunnel).

Table B.2 is a matrix of data sources for exposure studies, showing the MSATs investigated in each study.

Tables B.3 through B.23 summarize the data for exposure information on each of the MSATs. Certain MSATs are represented by one or more surrogate compounds. POM, for example, is represented by data both for all polycyclic aromatic hydrocarbons (PAHs) combined and for the seven specific PAHs identified by the EPA as probable human carcinogens—benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*a*]pyrene, chrysene, 7,12-dimethylbenz[*a*]-anthracene, and indeno[1,2,3-*cd*]pyrene.

APPENDIX C. TOXICITY AND HEALTH EFFECTS TABLES

In the toxicity and health portions of the literature survey, information on acute, chronic, and subchronic health effects (including cancer and noncancer endpoints) was collected from peer-reviewed secondary sources, such as the EPA's Health Assessment Documents, U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reports, and the International Agency for Research on Cancer (IARC) monographs. The primary sources that served as the basis for key toxicity criteria were also obtained. For the seven priority MSATs (acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, naphthalene, and POM), the survey was augmented with recent information from primary sources. The survey was also augmented for the nonpriority MSATs in cases in which the secondary sources were out of date (i.e., 2001 or earlier).

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Tables C.1 and C.2 summarize the toxicity criteria that were readily available in the secondary sources and online, showing whether a given MSAT is considered a carcinogen, how toxic or potent it is, and the date of the most recent evaluation. The principal focus is on inhalation, because this is the predominant route of exposure to MSATs. To facilitate the comparison of criteria, all cancer and noncancer toxicity criteria are expressed in units per µg/m^3 for the inhalation route and mg/kg-day for the oral route. These tables were updated shortly before publication to reflect changes in regulatory values.

Table C.3 provides information on chronic noncancer health effects at the time the literature survey was completed (winter 2004–2005). For each MSAT, the details of the key chronic-toxicology studies that formed the basis of the toxicity criteria are summarized, starting with the Integrated Risk Information System (IRIS) and adding other sources if they were more recent. In addition, the studies on which the toxicity criteria were based are listed in the last column of the table. Criteria based on oral-route studies are included in the table only when no toxicity criteria were identified for the inhalation route.

Table C.4 provides information on chronic cancer health effects at the time the literature survey was completed. In addition, the studies on which the toxicity criteria were based are listed in the last column of the table. Criteria based on oral-route studies are included in the table only when the inhalation unit risk was not provided and the compound was classified as a carcinogen when inhaled; in these cases, the oral unit risk and associated critical study are provided.

For classes of compounds (e.g., POM and dioxins), information on the individual compounds is provided in the summary table (Table C.1), but detailed information is provided only for those that are the most toxic or the most studied. For POM, for example, detailed information was provided for benzo[*a*]pyrene; for dioxins, detailed information was provided for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin.

Table C.5 summarizes the acute-toxicity criteria available for each MSAT at the time the literature survey was completed. This report does not include level 3 (in the acute exposure guideline levels and the *Emergency Response Planning Guidelines*), which pertains to life-threatening effects, because it was deemed too extreme to be useful in the report.

Table C.6 summarizes the studies that served as the basis for the acute-toxicity criteria for each MSAT at the time the literature survey was completed. The literature searches in this table were updated, like the literature searches in Tables C.3 and C.4, although to a lesser extent, because most of the exposure guidelines were of recent origin.

APPENDIX D. INDOOR EXPOSURE TABLES

The tables in Appendix D summarize information on indoor air concentrations for six of the seven priority MSATs (not including naphthalene).

Table D.1 is a summary of the sources of data on indoor air concentrations for each MSAT, including brief descriptions of each study and details of study time periods, locations, and types of location (e.g., residences, office buildings, and schools), as well as a description of each location and notes.

Table D.2 is a matrix of data sources showing the MSATs investigated in each study used for indoor air concentration information.

Tables D.3 through D.8 are data summaries for each MSAT. Certain MSATs are represented by one or more surrogate compounds.

APPENDIX E. ABBREVIATIONS AND OTHER TERMS

This appendix defines abbreviations and other terms used in the tables in Appendices B, C, and D.

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Appendix B. Ambient and Outdoor Exposure Tables

INTRODUCTION

Table B.1 is a summary of key information on the exposure studies for each MSAT, including brief descriptions of each study and details of time periods, locations, and types of location (i.e., urban, suburban, rural, in-vehicle, roadside, and tunnel).

Table B.2 is a matrix of data sources for exposure studies, showing the MSATs investigated in each study.

Tables B.3 through B.23 summarize the data for exposure information on each of the MSATs. Certain MSATs are represented by one or more surrogate compounds. POM, for example, is represented by data both for all polycyclic aromatic hydrocarbons (PAHs) combined and for the seven specific PAHs identified by the EPA as probable human carcinogens—benz[*a*]anthracene, benzo[*b*]fluoranthene, benzo[*k*]-fluoranthene, benzo[*a*]pyrene, chrysene, 7,12-dimethylbenz[*a*]anthracene, and indeno[1,2,3-*cd*]pyrene.

Although the hyperlinks from the tables to Web sites were active shortly before publication, HEI cannot be responsible for any subsequent changes in the Web sites referred to.

For more information about this appendix, see Introduction to Appendices B, C, D, and E.

Table B.1. Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
EPA Ambient Air Quality Databases or Monitoring Programs						
Cleverly et al. (2002)	Journal article summarizing calendar year 2000 ambient air data from EPA National Dioxin Air Monitoring Network (NDAMN)	2000	Washington DC and San Francisco CA	Suburban	Considered by authors to be the two NDAMN stations of more urban character that can serve as indicator of dioxin/furan levels in more populated areas	Data compilation excludes data from majority of NDAMN sites that are located in rural and remote locations (additional 19 nationwide sites in 2000).
Eastern Research Group (ERG 2004) www.epa.gov/ttn/amtic/airtxfil.html	Final report submitted to EPA summarizing ambient air monitoring conducted as part of the 2003 Urban Air Toxics Monitoring Program (UATMP)	2003	53 monitoring sites nationwide in or near 32 urban and rural locations	Urban, suburban, rural	Includes sites in or near urban centers within 18 states, and Puerto Rico	Data also available in electronic form from EPA AirData web site, although data appear to be incomplete for some sites when compared to UATMP data tables.
McCarty et al. (2004) www.epa.gov/glnpo/lmmb/results/mercury/index.html	Final report submitted to EPA summarizing ambient air mercury data collected during Lake Michigan Mass Balance Study	June 1994–Oct 1995	WI, MI, IL, and IN, with 4 locations along Lake Michigan and a fifth at an inland location	Mix with urban, urban-influenced, and rural locations	Included urban Chicago station	Additional site in Chicago excluded from the data compilation due to the collection of only 1 gaseous and 2 particulate Hg samples at this site.
EPA Air Quality System (AQS) Database (via AIR-Data website) www.epa.gov/air/data/index.html	Comprehensive EPA database of ambient air monitoring data; 2003 data query	2003	Multiple locations nationwide	Urban, suburban, rural	Comprehensive database covers variety of national, state, and local monitoring networks	Includes UATMP data (see note above). Majority of data are for 24-hr samples, although 1-hr and 3-hr data available for many MSATs.
Recent In-Vehicle Roadway Measurement Studies						
Batterman et al. (2002)	Journal article summarizing VOC samples collected from ambient air near cars and in bus interiors during 40 trips along Detroit commuting routes for 4 days in Oct and Nov 1999	10/20/99–11/10/99 (1 day/week for 4 weeks)	Detroit MI	In-vehicle, urban	Primarily along 3 bus routes selected to include residential, commercial, and heavily industrialized areas	Samples collected outside of cars on only 1 of the 4 sampling days—majority of samples thus collected from bus interiors.
Borak et al. (2003)	Journal article summarizing series of ambient and occupational diesel PM exposure measurements that included school bus survey of three diesel school buses	Not provided	Not provided	In-vehicle	Inside 3 buses, windows primarily closed	
Chellam et al. (2005)	Journal article summarizing fine PM samples collected in highway tunnel in Houston TX	8/29/00–9/1/00	Washburn Tunnel in Houston TX	Tunnel, urban	Tunnel runs under highly industrialized eastern Harris County and is only vehicular tunnel currently in operation in TX	

Table continues on next page

Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent In-Vehicle Roadway Measurement Studies (*Continued*)						
Destaillats et al. (2002)	Journal article summarizing carbonyl measurements made at San Francisco Bay Bridge toll plaza during rush hour traffic	4/23/01–4/24/01	Oakland-SF Bay Bridge Toll Plaza CA	Roadside, urban	Bay Bridge characterized by busiest commuter traffic in northern CA with nearly a quarter million vehicles traveling across bridge/day	Samples collected during three periods of rush hour traffic.
Fedoruk and Kerger (2003)	Journal article summarizing in-vehicle measurement study conducted to examine the pattern and magnitude of VOC exposures in a survey of selected "new" and "used" vehicles under different conditions.	June–July 1997	Los Angeles CA and Foxboro MA	In-vehicle, urban and suburban	Included sampling inside five different passenger sedan vehicles from three different manufacturers under variable conditions (i.e., static vs. driving, in-cabin temp., ventilation mode, traffic conditions)	
Fitz et al. (2003) www.arb.ca.gov/research/schoolbus/schoolbus.htm	Final report submitted to California Air Resources Board (ARB) summarizing comprehensive in-vehicle bus measurement study conducted as part of Children's School Bus Exposure Study	4/22/02–6/12/02	Los Angeles CA	In-vehicle, primarily urban	Included 3 different routes: an urban route from S Central LA to W Side of LA with freeway travel, a different urban route exclusively on surface streets, and a rural/suburban route	Study included measurements on 5 conventional diesel school buses, manufactured from 1975 to 1998, and a 1998 diesel bus outfitted with a particulate trap, all operating on low sulfur "green" diesel fuel.
Gertler et al. (1996, 1998)	Journal article (1998) and final report (1996) summarizing 10 24-hour day/day or night/night sampling periods conducted in Oct and Nov 1995 where dioxin/furan air concentrations were measured at inlets, vents, and outlets at Baltimore's Fort McHenry Tunnel	Oct–Nov 1995	Baltimore MD	Tunnel, urban	Fort McHenry Tunnel with four bores, two lanes/bore, carrying Interstate 95 east-west under Baltimore Harbor	Sampling occurred in two eastbound bores with exhaust fans shut off: Bore 3, consisting of primarily light-duty vehicles (<2% heavy-duty diesel vehicles); and Bore 4, where trucks are directed (on average 24–25% heavy-duty diesel vehicles during sampling runs).
Grosjean and Grosjean (2002) www.pubs.healtheffects.org/view.php?id=107	Final report submitted to Health Effects Institute summarizing carbonyl (i.e., aldehyde) air sampling at the inlet and outlet of two large highway tunnels	5/18/99–5/21/99 and 7/20/99–8/5/99	Tuscarora Mountain Tunnel in PA (on Pennsylvania Turnpike), and Caldecott Tunnel in CA (near San Francisco)	Tunnel, urban	Ventilation systems turned off in both tunnels; Tuscarora Mountain Tunnel with characteristic fleet of both light-duty vehicles and heavy-duty diesel trucks, and Caldecott Tunnel fleet consisting primarily of light-duty vehicles using California Phase 2 reformulated gasoline	
Hunt et al. (1997)	Journal article summarizing one week of ambient dioxin/furan measurements at metropolitan Phoenix AZ site in Dec 1994	12/15/94–12/20/94	Phoenix AZ	Roadside, urban	Sampling site situated near a heavily traveled road in order to assess the influences of motor vehicle emissions	

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Table B.1 (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent In-Vehicle Roadway Measurement Studies (*Continued*)						
Kinney et al. (2000)	Journal article summarizing $PM_{2.5}$ and elemental carbon air sampling conducted for five days in July 1996 along Harlem sidewalks	July 1996 (5 week days within 13-day period)	Harlem, New York City	Roadside, urban	3 sites at high-traffic intersections and 1 in quiet residential area (control site)	
Lena et al. (2002)	Journal article summarizing sidewalk measurements of $PM_{2.5}$ and EC in Hunts Point, a section of the South Bronx, New York City that serves as a regional hub for the freight transportation system	July–Aug 1999: 9 week days over 3-week period	Hunts Point Section of the South Bronx, New York City	Roadside, urban	6 sites near high-traffic intersections, and 1 in no-truck-traffic zone (control)	
Levy et al. (2003)	Journal article summarizing continuous $PM_{2.5}$, ultrafine particle, and particle-bound PAH measurements made in Summer 2001 at several sites in Roxbury, a section of Boston MA with high traffic levels	12 days in July–Aug 2001	Roxbury neighborhood of Boston MA	Roadside, urban	9 sites within high-traffic urban neighborhood with multiple bus routes and bus and truck depots	
Marr et al. (1999)	Journal article summarizing comprehensive study characterizing PAHs in motor vehicle fuels and exhaust emissions that included fine particle-phase PAH measurements in two bores of a roadway tunnel.	7/21/97–8/5/97	Caldecott Tunnel in Northern CA (near San Francisco)	Tunnel, urban	Sampling in both truck-influenced bore and light-duty bore	Sampling occurred from 12:30–3:30 PM in Bore 1 when heavy-duty truck fraction was high, and from 3:30 to 6:30 PM in Bore 2 when light-duty traffic volumes peaked.
Martuzevicius et al. (2004)	Journal article summarizing $PM_{2.5}$ concentration and composition measurements made at 11 locations in Cincinnati metropolitan area during 1-year measurement campaign	Dec 2001–Nov 2002	Cincinnati OH	Roadside, urban	Many sites adjacent to freeways	Sampling conducted during 9 measurement cycles, with durations ranging from 5-23 days, where typically 2-4 sites were operated simultaneously.
Riediker et al. (2003)	Journal article summarizing suite of in-vehicle, roadside, and fixed ambient site measurements collected over 25 days in Autumn 2001 as part of occupational exposure study of NC State Highway Patrol Troopers	8/13/01–10/11/01	Wake County NC	In-vehicle and roadside, urban	Included sampling inside highway patrol vehicles, at roadside locations near major traffic routes, and at fixed ambient site in northern Raleigh	Two patrol cars studied each day for a total of 50 sampled late-shift patrols (3 PM to midnight).

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Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent In-Vehicle Roadway Measurement Studies (*Continued*)						
Rodes et al. (1998) www.arb.ca.gov/research/abstracts/95-339.htm	Final report submitted to California Air Resources Board (ARB) summarizing comprehensive suite of measurements made during 32 driving trips in Los Angeles and Sacramento	Sept–Oct 1997	Los Angeles and Sacramento CA	In-vehicle and roadside, urban	Samples collected concurrently inside 2 vehicles, just outside vehicles, along roadway, and at ambient monitoring sites during driving trips	Commute types listed to include arterial rush, arterial non-rush, freeway rush, freeway non-rush, rural, school bus, freeway rush carpool, and maximum commute.
Sapkota and Buckley (2003)	Journal article summarizing 1,3-butadiene, benzene, and particle-bound PAH measurements made at Baltimore Harbor Tunnel tollbooth	6/18/01 – 6/28/01	Baltimore MD	Roadside, urban	Baltimore Harbor Tunnel tollbooth	Samples collected on seven weekdays.
Recent Large-Scale Modeling Analyses						
Seigneur et al. (2003)	Journal article summarizing modeling study conducted to simulate atmospheric fate and transport of benzene and diesel PM for one-week period in July 1995 in northeastern US	7/11/95–7/15/95	Regional modeling domain encompassing northeastern US	Varied, including urban, suburban, rural, and remote locations.	Finer modeling grid (4 km versus 12 km for remainder of domain) employed over part of northeastern US including New York City and Washington DC	Modeled time period noted to have high ozone pollution and low mixing height.
EPA National Air Toxics Assessment (NATA) (EPA 2002a) www.epa.gov/ttn/atw/nata/	EPA website summarizing comprehensive modeling analysis conducted as part of nation-scale assessment of 33 air pollutants	1996	Counties nationwide	Varied, including urban and rural counties	Annual average ambient concentrations reported on nationwide basis, statewide basis, individual-county basis, and for all rural and all urban counties combined	Only modeled ambient concentrations reported for this data compilation, although analysis also yielded modeled human exposure concentrations that account for movement of people outdoors and indoors.
Recent, Peer-Reviewed Urban Air Monitoring Studies						
Adgate et al. (2004a)	Journal article summarizing screening-phase indoor measurements collected in 284 households and intensive-phase personal, indoor, and outdoor measurements for 10 VOCs collected in a probability sample of 72 households as part of the Minnesota Children's Pesticide Exposure Study (MNCPES)	May–Sept 1997	Multiple locations, MN	Urban and non-urban	Households recruited from cities of Minneapolis and St Paul (designated urban households) and Rice and Goodhue Counties (south of Minneapolis-St Paul metropolitan area and designated nonurban households)	Weighted distributions from intensive-phase sampling stated to be representative of more than 58,000 urban and 4,000 nonurban households. Only outdoor data compiled in data tables.

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Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Urban Air Monitoring Studies (*Continued*)						
Adgate et al. (2004b)	Journal article summarizing exposure measurements for 15 VOCs conducted in multiple locations (outdoors, indoors at school, indoors at home, and personal samples) among a study population of 113 children attending two inner-city schools in Minneapolis	Winter (1/24/00–2/18/00) and Spring (4/9/00–5/12/00)	Minneapolis MN	Urban	Two inner-city Minneapolis schools serving predominantly low-income households	Children were participants in School Health Initiative: Environment, Learning, and Disease (SHIELD) study, which consisted of a randomly-selected ethnically and racially diverse sample of inner-city children in Minneapolis. Only outdoor data compiled in data tables.
Carpi and Chen (2002)	Journal article summarizing ambient elemental Hg monitoring at six locations in New York City for approximately weeklong periods from June to Nov 2000	June–Nov 2000	New York City NY	Urban	6 locations in city, with 4 in Manhattan and 1 each in Queens and Brooklyn	Authors describe data as background mercury concentrations in New York City.
Chen et al. (2004)	Journal article summarizing ambient total gaseous mercury (TGM) monitoring conducted as part of a three-year study of atmospheric mercury levels in state of Connecticut between 1997 to 1999	Jan 1997–Dec 1999	8 locations in CT	Urban and rural	Includes 4 urban and 4 rural sites representing both coastal and interior locations	
Dachs et al. (2002)	Journal article summarizing PAH measurement study conducted in Baltimore and adjacent Chesapeake Bay in 1997 to evaluate processes driving the short-term variability of PAHs in these areas.	Feb 1997 and July 1997	Baltimore and adjacent Chesapeake Bay site, MD	Urban and coastal	One site in urban Baltimore and second site about 15 km east of Baltimore in Chesapeake Bay	Only Chesapeake Bay site sampled in Feb 1997, while both sites sampled in July 1997.
Eiguren-Fernandez et al. (2004)	Journal article summarizing PAHs in vapor-phase and $PM_{2.5}$ samples for one year of sampling in Southern California urban and rural communities	May 2001–July 2002	6 locations in Southern California	Urban and rural	Includes 2 rural communities (Atascadero and Lompoc) and 4 urban communities (San Dimas, Upland, Mira Loma, and Riverside)	Authors conclude that data suggest that in Southern California vehicular exhaust emissions are major contributor to particle-phase PAHs.
Gigliotti et al. (2000)	Journal article summarizing PAH measurement study conducted at a suburban site near New Brunswick NJ and a coastal site at Sandy Hook NJ	Oct 1997–Oct 1998	New Brunswick and Sandy Hook NJ	Suburban / coastal	New Brunswick site in close proximity to major traffic arteries, while Sandy Hook located at tip of peninsula extending into Lower Hudson River Estuary/Atlantic Ocean	Authors note that seasonal trends of particulate PAH concentrations are likely indicative of PAH sources such as fuel consumption for domestic heating and vehicular traffic.

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Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Urban Air Monitoring Studies (*Continued*)						
Kinney et al. (2002)	Journal article summarizing personal, indoor, and outdoor sampling conducted in 1999 as part of the Toxic Exposure Assessment, a Columbia/ Harvard (TEACH) study, an urban air toxics study of inner-city New York City neighborhoods	Winter and summer 1999, 8 weeks per season	New York City	Urban	Inner-city neighborhoods primarily in northern Manhattan and the South Bronx, but also including the boroughs of Queens and Brooklyn.	Only outdoor data compiled in data tables
Manchester-Neesvig et al. (2003)	Journal article summarizing distribution of particle-phase organic compounds in atmospheric particulate matter (PM_{10}) samples collected from 12 sites in southern California in 1995 as part of the Southern California Children's Health Study (SCCHS)	1995	12 Southern California communities	Urban and rural	Includes 5 urban sites, 3 rural coastal sites, 1 rural inland site, 1 desert site, and 2 mountainous sites.	
Mohamed et al. (2002)	Journal article summarizing ambient VOC data collected from 13 urban US locations as part of 1996 EPA Urban Air Toxics Monitoring Program (UATMP)	Sept 1996–Aug 1997	Multiple locations in LA, TX, VT, and NJ (13 in all)	Urban, near-urban	Baton Rouge LA; Brownsville TX; Brattleboro VT; Burlington VT; Camden NJ; El Paso TX; Garyville LA; Galveston TX; Hahnville LA; Port Neches TX; Rutland VT; Underhill VT; Winooski VT.	
Naumova et al. (2002)	Journal article summarizing indoor and outdoor PAH measurements collected in 55 nonsmoking residences in three urban areas during June 1999–May 2000 as part of Relationship of Indoor, Outdoor, and Personal Air study (RIOPA)	June 1999–May 2000	Los Angeles CA, Houston TX, and Elizabeth NJ	Urban	Nonsmoking residences in urban areas near dominant emission sources, with LA and Elizabeth homes near high-traffic roadways.	Only outdoor data compiled in data tables.
Odabasi et al. (1999)	Journal article summarizing ambient air sampling conducted in Chicago between June and Oct 1995 as part of study to investigate the dry deposition and air-water exchange of PAHs	June–Oct 1995	Chicago IL	Urban	Sampling site in mixed institutional, residential, and commercial area	

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Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Urban Air Monitoring Studies (*Continued*)						
Payne-Sturges et al. (2004)	Journal article summarizing personal, indoor, and outdoor sampling of 33 nonsmoking adult residents conducted as part of a community-based exposure assessment conducted in Baltimore.	Jan 2000–June 2001	Baltimore MD	Urban	South Baltimore communities in close proximity to large chemical industries as well as nearby interstate highways and local truck traffic servicing industry	Only outdoor data compiled in data tables.
Pratt et al. (2000)	Journal article summarizing comprehensive air toxics assessment conducted for the state of Minnesota using monitoring data collected at 25 sites throughout the state for varying periods of time	1991–1999, with up to 9 years of data/site	25 sites throughout MN	Varied, including urban, rural, small town, and industrial sites	Some monitoring sites established to measure concentrations in vicinity of specific point sources, others to collect baseline data in Minneapolis-St Paul metropolitan area, and others as part of randomly selected statewide monitoring network.	Article also summarizes Minnesota results from EPA Cumulative Exposure Project, a modeling analysis based on 1990 data that was a predecessor to the NATA study.
Sexton et al. (2004)	Journal article summarizing personal, indoor, and outdoor sampling for 15 VOCs conducted over 3 seasons in 1999 among population of 71 nonsmoking adults in three Minneapolis-St Paul urban neighborhoods	Apr–Nov 1999	Minneapolis-St Paul MN	Urban	3 urban neighborhoods (Phillips, East St Paul, Battle Creek) with different outdoor VOC concentration profiles, including large manufacturing plant located near East St Paul neighborhood	Only outdoor data compiled in data tables.
Zielinska et al. (1998)	Journal article summarizing hazardous air pollutants monitoring program conducted in 1994–1996 in several representative urban and rural areas of Arizona.	Apr 1994–Apr 1996	Multiple locations in AZ, including Phoenix and Tucson	Urban and rural	4 permanent sites selected to represent typical communities in AZ; 4 temporary sites selected in areas impacted by particular emission source types	Temporary sites included a motor-vehicle-impacted site in Phoenix, a site in Phoenix in vicinity of the International airport, and 2 sites in Tuscon near bus yards, garages, railroad tracks.
Special Purpose California State Monitoring Programs						
California Ambient Dioxin Air Monitoring Program (CADAMP) www.arb.ca.gov/aaqm/qmosopas/dioxins/dioxins.htm	California Air Resources Board (ARB) ambient air monitoring program implemented to provide information on ambient levels of dioxins and dioxin-like compounds in urban, populated areas, with monitoring to continue for approximately three years (2002–2004) at ten sites	2002–2004	California urban centers	Urban	10 sampling sites with 5 in San Francisco Bay Area, 4 in Los Angeles basin, and 1 in Sacramento (added for 2003 sampling)	Several of dioxin monitors operated in parallel with new monitoring stations installed as part of ARB Children's Environmental Health Protection Program.

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Table B.1. (*Continued*). Ambient and Outdoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Special Purpose California State Monitoring Programs (*Continued*)						
Children's Environmental Health Protection Program (SB 25) Statewide Air Monitoring Network www.arb.ca.gov/ch/programs/sb25/sb25.htm	California special monitoring program that expanded existing ambient air toxics monitoring program in six communities around the state, with locations selected where children are typically present (i.e., schools, daycare centers) and near sources of air pollution, including busy highways and industry	Approx. one year periods within 2000–2003	California urban centers	Urban	Barrio Logan (San Diego), Boyle Heights (Los Angeles), Crockett (Contra Costa), Fresno, Fruitvale (Oakland), Wilmington (Los Angeles)	
South Coast Air Quality Management District (AQMD) 2000 www.aqmd.gov/matesiidf/matestoc.htm	California-based comprehensive urban air toxic modeling and monitoring study that included fixed-site "neighborhood scale" and microscale "local conditions" monitoring programs and regional air modeling analysis for 30+ air pollutants	Apr 1998–Mar 1999	Multiple locations in South Coast Air Basin, CA	Urban	7 fixed monitoring sites in LA County, and one each in the other three counties in the Basin	Only sampling data for 10 fixed monitoring locations have been compiled due to unavailability of microscale site data in final report. EPA's Urban Airshed Model (UAM) model used in modeling analysis of emissions from on-road mobile, area and off-road mobile, and major point sources. Reports concludes that mobile sources are dominant source types.
Recent EPA Comprehensive Review Documents						
EPA 2002b http://cfpub2.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060&CFID=1048605&CFTOKEN=13395006	Comprehensive EPA review document summarizing the state of the science regarding the possible health hazards associated with exposure to diesel engine exhaust (DE).	1990s	Multiple US urban and suburban locations	Urban and suburban	Among studies considered by EPA are those conducted in Phoenix AZ; Welby and Brighton CO; Boston MA; New York City NY (Manhattan bus stop); Washington DC; and Southern California	EPA provides "typical range" for ambient DPM averaged over at least a season that is based on post-1990 chemical mass balance (CMB) studies and EC measurements for urban and suburban areas.
EPA 2003 www.epa.gov/ncea/pdfs/dioxin/nas-review/	Latest draft of EPA review document summarizing EPA's comprehensive reassessment of dioxin exposure and human health effects	1988–1995	Multiple US urban locations	Urban	EPA summary statistics based on measurements in CT, CA, OH, and NY	Table 3-9 in Part I, Volume 2 contains summary statistics of TEQ_{DF}-WHO_{98} concentrations for studies considered by EPA to be representative of urban background.
EPA 2004 http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=87903 Part I http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=435945 Part II http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=435946	EPA Criteria Document (CD) summarizing the latest available scientific information on nature and effects of ambient exposure to particulate matter (PM). Appendix 3B provides initial ambient $PM_{2.5}$ speciation data from pilot method evaluation study for the national speciation network	Oct 2001–Sept 2002	Multiple US urban locations (13 in all summarized in PM CD)	Urban	Burlington VT; Philadelphia PA; Atlanta GA; Detroit MI; Chicago IL; St. Louis MO; Houston TX; Minneapolis MN; Boulder CO; Phoenix AZ; Seattle WA; Sacramento CA; Riverside-Rubidoux CA	For the time period 10/01 to 9/02, 51 sites have complete data for this time period. Thirteen sites were selected for summary in PM CD, and are "included for various reasons and representing a cross section of the country."

Table B.2. Ambient and Outdoor Exposure Data Sources for Each MSAT[a]

	Acetaldehyde	Acrolein	Arsenic Compounds	Benzene	1,3-Butadiene	Chromium Compounds	Dioxins/Furans	DPM + DEOG (diesel)[b]	Ethylbenzene	Formaldehyde	*n*-Hexane	Lead Compounds	Manganese Compounds	Mercury Compounds	MTBE	Naphthalene	Nickel Compounds	POM[c]	Styrene	Toluene	Xylene
EPA Ambient Air Quality Databases or Monitoring Programs																					
National Dioxin Air Monitoring Network (NDAMN)—Cleverly et al. (2002)							✓														
2003 Urban Air Toxics Monitoring Program (UATMP)—Eastern Research Group (ERG 2004)[d,e]	✓			✓	✓				✓	✓					✓				✓	✓	✓
Lake Michigan Mass Balance Study—McCarty et al. (2004)														✓							
EPA Air Quality System (AQS) Database (via AIRData website)	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Recent In-Vehicle, Roadway Measurement Studies																					
Batterman et al. (2002)				✓					✓		✓					✓			✓	✓	✓
Borak et al. (2003)								✓													
Chellam et al. (2005)			✓									✓	✓				✓	✓			
Destaillats et al. (2002)		✓																			
Fedoruk and Kerger (2003)				✓					✓		✓				✓				✓	✓	✓
Fitz et al. (2003)	✓	✓		✓	✓			✓	✓	✓								✓		✓	✓
Gertler et al. (1996, 1998)							✓														
Grosjean and Grosjean (2002)	✓	✓								✓											
Hunt et al. (1997)							✓														
Kinney et al. (2000)								✓													
Lena et al. (2002)								✓													
Levy et al. (2003)																		✓			
Marr et al. (1999)																		✓			
Martuzevicius et al. (2004)								✓				✓	✓				✓				
Riediker et al. (2003)	✓[f]	✓[f]	✓	✓	✓[f]	✓			✓	✓[f]	✓[f]	✓	✓	✓			✓	✓		✓	✓
Rodes et al. (1998)				✓	✓	✓		✓	✓	✓		✓	✓		✓		✓			✓	✓
Sapkota and Buckley (2003)				✓	✓													✓			
Recent Large-Scale Modeling Analyses																					
Seigneur et al. (2003)				✓				✓													
EPA National Air Toxics Assessment (NATA)[g]	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓	✓			✓	✓			
Recent, Peer-Reviewed Urban Air Monitoring Studies																					
Adgate et al. (2004b)				✓					✓										✓	✓	✓
Adgate et al. (2004a)				✓															✓	✓	✓
Carpi and Chen (2002)														✓							

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[a] See end of table all for footnotes.

Table B.2. (*Continued*). Ambient and Outdoor Exposure Data Sources for Each MSAT[a]

	Acetaldehyde	Acrolein	Arsenic Compounds	Benzene	1,3-Butadiene	Chromium Compounds	Dioxins/Furans	DPM + DEOG (diesel)[b]	Ethylbenzene	Formaldehyde	*n*-Hexane	Lead Compounds	Manganese Compounds	Mercury Compounds	MTBE	Naphthalene	Nickel Compounds	POM[c]	Styrene	Toluene	Xylene
Recent, Peer-Reviewed Urban Air Monitoring Studies (*Continued*)																					
Chen et al. (2004)														✓							
Dachs et al. (2002)																		✓			
Eiguren-Fernandez et al. (2004)																✓		✓			
Gigliotti et al. (2000)																		✓			
Kinney et al. (2002)	✓		✓	✓	✓	✓			✓	✓		✓	✓		✓		✓		✓	✓	✓
Manchester-Neesvig et al. (2003)								✓										✓			
Mohamed et al. (2002)				✓					✓										✓	✓	✓
Naumova et al. (2002)																		✓			
Odabasi et al. (1999)																		✓			
Payne-Sturges et al. (2004)				✓					✓						✓				✓	✓	✓
Pratt et al. (2000)	✓		✓	✓		✓			✓	✓		✓	✓	✓			✓		✓	✓	✓
Sexton et al. (2004)				✓					✓										✓	✓	✓
Zielinska et al. (1998)	✓			✓	✓				✓	✓	✓					✓		✓	✓	✓	✓
Special Purpose California State Monitoring Programs																					
California Ambient Dioxin Air Monitoring Program (CADAMP)							✓														
Children's Environmental Health Protection Program (SB 25)	✓		✓	✓	✓	✓	✓ [h]	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓
South Coast Air Quality Management District (AQMD) MATES-II (2000) (Also included modeling analysis)	✓		✓	✓	✓	✓	✓ [f]	✓	✓ [f]	✓		✓	✓ [f]			✓ [f]	✓	✓ [f]	✓	✓	✓ [f]
Recent EPA Comprehensive Review Documents																					
Diesel HAD (2002)								✓													
Dioxin Reassessment (2003)							✓														
PM Criteria Document (2004)			✓			✓		✓				✓	✓				✓				

[b] Data sources include studies measuring black carbon and elemental carbon, two commonly used surrogates for diesel PM.

[c] Surrogates used for POM include total polycylic aromatic hydrocarbons (Total PAHs) as well as seven PAHs identified by EPA as probable human carcinogens and used as surrogates for the larger group of POM compounds in EPA air toxics evaluations.

[d] TSP samples were also analyzed for metals at selected UATMP sites; these data are not reported in data compilation tables due to availability of $PM_{2.5}$ metals data from numerous other sources.

[e] PAH data available for one UATMP site (Sault Sainte Marie MI) are not reported in data compilation tables due to discrepancies in the data provided in the UATMP report.

[f] Included within sampling program, but data not provided in final report.

[g] Based on 1996 emissions data.

[h] Some sites included in CADAMP; data are reported by CADAMP and are thus attributed to CADAMP in data compilation tables.

Table B.3. Ambient and Outdoor Exposure Data Summaries. Acetaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Min	Max
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, subur-ban, rural	2003	24 hrs	1,875	70%	µg/m³ (converted from ppb)	Directly from reference	7.2×10^{-2}	1.7×10^{1}
EPA Air Quality System (AQS) Database (via AIRData web-site)	HAP monitor values report data summary	Nation-wide	US	Urban, subur-ban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hrs	10,515		µg/m³ (converted from ppbC)	Calculated from annual summary report		1.8×10^{2}
Children's Environmental Health Protec-tion Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	68	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	2.7×10^{-1}	3.8
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	73	97%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 1.8 \times 10^{-1}$	8.5
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	82	98%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 1.8 \times 10^{-1}$	2.7
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	67	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	6.7×10^{-1}	1.0×10^{1}
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	76	97%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 1.8 \times 10^{-1}$	3.6

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Table B.3. Ambient and Outdoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	2.5			2.0			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	2.7	0	2.5×10^{1}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 24-hr sampling period.
Children's Environmental Health Protection Program	17 months	1.5						
	~ 15 months	2.8						
	~ 1.5 yrs	7.2×10^{-1}						
	1 yr	2.9						
	6 months	1.2						

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Table B.3. Ambient and Outdoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Children's Environmental Health Protection Program (*Continued*)	Wilmington Monitoring data summary	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	71	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	3.2×10^{-1}	6.1
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	20 bus commute runs		µg/m³	Directly from reference		
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Provided by author in email	0.0	3.1×10^{1}
Grosjean and Grosjean (2002)	Caldecott Tunnel Measurements	Near San Francisco	CA	Roadside, urban	7/20/99–8/5/99	2 hrs	8 at both inlet and outlet		µg/m³	Directly from reference		
	Tuscarora Mountain Tunnel measurements	Pennsylvania Turnpike	PA	Roadside, urban	5/18/99–5/21/99	1 hr	10 at inlet, 9 at outlet		µg/m³	Directly from reference		
Kinney et al. (2002)	Summary of summer residential outdoor sampling data	New York	NY	Urban	Summer 1999 (over 8 wks)	2 days	36		µg/m³	Directly from reference		
	Summary of winter residential outdoor sampling data	New York	NY	Urban	Winter 1999 (over 8 wks)	2 days	36		µg/m³	Directly from reference		

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Table B.3. Ambient and Outdoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (Continued)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Children's Environmental Health Protection Program (*Continued*)	~ 15 months	1.8						
Fitz et al. (2003)	over all exposure runs grouped by route and window position		2.8×10^1	6.3×10^1				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban routes: one exposure ran with windows closed (morning) and with windows open (afternoon).
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	9.0						Acetaldehyde data not reported in journal article; data obtained through email communication with Ron Williams of EPA, with minimum concentration of 0 as reported in email correspondence.
Grosjean and Grosjean (2002)	8 2-hr measurements		1.5	5.5				Fleet consisted primarily of light-duty vehicles using California Phase 2 reformulated gasoline; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements.
	9–10 hrly measurements		1.1	2.3				Fleet included both light-duty vehicles and heavy-duty diesel trucks; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements.
Kinney et al. (2002)	8 wks	4.2						
	8 wks	2.8						

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Table B.3. Ambient and Outdoor Exposure Data Summaries Data Summaries (*Continued*). Acetaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	2479	100%	µg/m³	Directly from reference		8.8
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results	Nationwide	USA	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results	Nationwide	USA	Urban	1996				µg/m³	Directly from reference		
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	2.0×10^{-1}	1.5×10^{1}
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 wk to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	1.2	1.2×10^{1}

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Table B.3. Ambient and Outdoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Pratt et al. (2000)	1–9 yrs	1.1			9.9×10^{-1}			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	3.2						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	5.2						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	1.7×10^{-1}			1.3×10^{-1}			Mobile sources estimated to account for 73% of nationwide mean.
	1 yr (annual average)	9.7×10^{-1}			7.4×10^{-1}			Mobile sources estimated to account for 91% of nationwide mean.
Zielinska et al. (1998)	1 yr		1.3	5.0				
	~ 1 wk to 2 months		1.9	5.4				

Table B.4. Ambient and Outdoor Exposure Data Summaries Data Summaries. Acrolein (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP Monitor Values Report Data Summary	Nation-wide	US	Urban, sub-urban, rural	2003	Both 24 hrs and 3 hrs	2,574		µg/m³ (converted from ppbC)	Calculated by Gradient Corp. from annual summary report		5.7
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02 – 6/12/02	1–1.5 hrs	31 bus commute runs	0%	µg/m³ (converted from ppb)	Directly from reference	< ~ 0.5	< ~ 0.5
Destaillats et al. (2002)	SF Bay Bridge toll plaza air sampling data summary	Oakland	CA	Roadside, urban	4/23/01–4/24/01	4 hrs	6 (replicate samples for 3 sampling events)	100%	µg/m³	Directly from reference	3.1×10^{-2}	1.4×10^{-1}
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	< 25%	µg/m³	Provided by author in email	$< 5.0 \times 10^{-1}$	9.9×10^{-1}
Grosjean and Grosjean (2002)	Caldecott Tunnel data summary	Near San Francisco	CA	Tunnel, urban	7/20/99–8/5/99	2 hrs	8 at both inlet and outlet		µg/m³	Directly from reference		
	Tuscarora Mountain Tunnel data summary	Pennsylvania Turn-pike	PA	Tunnel, urban	5/18/99–5/21/99	1 hr	10 at inlet, 9 at outlet		µg/m³	Directly from reference		
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results	Nation-wide—all rural counties	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results	Nation-wide—all urban counties	US	Urban	1996				µg/m³	Directly from reference		

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Table B.4. Ambient and Outdoor Exposure Data Summaries (*Continued*). Acrolein (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	7.6×10^{-1}	0.0	2.3				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 24-hr sampling period.
Fitz et al. (2003)								All measurements were below the detection limit, which is reported to be 0.03 µg/sample (approx. 0.5 µg/m^3).
Destaillats et al. (2002)								
Riediker et al. (2003)	50 Late-shift patrols (3 PM to midnight) over 25 days	3.8×10^{-2}						Summary statistics obtained through email communication with Ron Williams of EPA who indicated that large number of non-detects was related to failure of methodology for this pollutant.
Grosjean and Grosjean (2002)	8 2-hr measurements		8.0×10^{-2}	6.0×10^{-1}				Fleet consisted primarily of light-duty vehicles using California Phase 2 reformulated gasoline; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements.
	9–10 hrly measurements		1.0×10^{-1}	3.2×10^{-1}				Fleet included both light-duty vehicles and heavy-duty diesel trucks; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	4.4×10^{-2}			3.7×10^{-2}			Mobile sources estimated to account for 38% of nationwide mean.
	1 yr (annual average)	1.4×10^{-1}			1.0×10^{-1}			Mobile sources estimated to account for 79% of nationwide mean.

Table B.5. Ambient and Outdoor Exposure Data Summaries. Arsenic Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP Monitor Values Report data summary—$PM_{2.5}$ As	Nationwide	US	Urban, suburban, rural	2003	24 hrs	13,927		µg/m³	Calculated by Gradient Corp. from annual summary report		4.7×10^{-2}
Children's Environmental Health Protection Program	Barrio Logan Monitoring data summary—TSP As	San Diego	CA	Urban	Oct–Nov 1999, Mar–Aug 2000	24 hrs	19	26%	µg/m³	Calculated by Gradient Corp. from study data set	$< 1.4 \times 10^{-3}$–4.7×10^{-3}	3.6×10^{-3}
	Boyle Heights Monitoring data summary—TSP As	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	7%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3.0 \times 10^{-3}$	5.2×10^{-3}
	Crockett Monitoring data summary—TSP As	Crockett	CA	Urban	Oct 2001–Feb 2003	24 hrs	60	2%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3.0 \times 10^{-3}$	3.7×10^{-3}
	Fresno Monitoring data summary—PM_{10} As	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	47%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	1.0×10^{-2}
	Fruitvale Monitoring data summary—TSP As	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	4%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3.0 \times 10^{-3}$	6.0×10^{-3}
	Wilmington Monitoring data summary—TSP As	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	68	4%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3.0 \times 10^{-3}$	4.2×10^{-3}
EPA (2004)	Atlanta GA—$PM_{2.5}$ As	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.4×10^{-2}

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Table B.5. Ambient and Outdoor Exposure Data Summaries (*Continued*). Arsenic Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
EPA Air Quality System (AQS) Database (via AIRData website)	typically 1 yr (annual average)	1.7×10^{-3}	5.0×10^{-4}	8.7×10^{-3}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	8 months	1.7×10^{-3}						
	~ 15 months	1.7×10^{-3}						
	~ 1.5 yrs	1.3×10^{-3}						
	6 months	2.4×10^{-3}						
	6 months	1.4×10^{-3}						
	~ 15 months	1.6×10^{-3}						
EPA (2004)	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.5. Ambient and Outdoor Exposure Data Summaries (*Continued*). Arsenic Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA (2004) (*Continued*)	Boulder CO—$PM_{2.5}$ As	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	5.0×10^{-3}
	Burlington VT—$PM_{2.5}$ As	Burlington	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	5.0×10^{-3}
	Chicago IL—$PM_{2.5}$ As	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	1.0×10^{-3}	6.0×10^{-3}
	Detroit MI—$PM_{2.5}$ As	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.0×10^{-2}
	Houston TX—$PM_{2.5}$ As	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	1.0×10^{-3}	6.0×10^{-3}
	Minneapolis MN—$PM_{2.5}$ As	Minnea-polis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.2×10^{-2}
	Philadelphia, PA—$PM_{2.5}$ As	Philadel-phia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	6.0×10^{-3}
	Phoenix AZ—$PM_{2.5}$ As	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	9.0×10^{-3}
	Riverside-Rubidoux CA—$PM_{2.5}$ As	Riverside-Rubidoux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	6.0×10^{-3}
	Sacramento CA—$PM_{2.5}$ As	Sacramento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	6.0×10^{-3}
	Seattle WA—$PM_{2.5}$ As	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	1.0×10^{-3}	7.0×10^{-3}
	St Louis MO—$PM_{2.5}$ As	St Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	1.0×10^{-3}	1.1×10^{-2}

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Table B.5. Ambient and Outdoor Exposure Data Summaries (*Continued*). Arsenic Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
EPA (2004) (*Continued*)	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.5. Ambient and Outdoor Exposure Data Summaries (*Continued*). Arsenic Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Riediker et al. (2003)	Ambient air data summary—$PM_{2.5}$ As	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	5.0×10^{-3}
	In-vehicle data summary for NC State police patrol cars—$PM_{2.5}$ As	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	4.4×10^{-3}
	Roadside sample data summary—$PM_{2.5}$ As	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		g/m³	Directly from reference	0.0	4.4×10^{-3}
Chellam et al. (2005)	Tunnel data summary—$PM_{2.5}$ As	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	0%	µg/m³	Directly from reference	$< 3.12 \times 10^{-3}$	$< 3.12 \times 10^{-3}$
Kinney et al. (2002)	Summary of summer residential outdoor data—$PM_{2.5}$ As	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary—PM_{10} As	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	717	4%	µg/m³	Directly from reference	$< 5 \times 10^{-3}$	1.5×10^{-2}
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary—TSP As	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated As	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—arsenic compounds	Nationwide	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—arsenic compounds	Nationwide	US	Urban	1996				µg/m³	Directly from reference		

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Table B.5. Ambient and Outdoor Exposure Data Summaries (*Continued*). Arsenic Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	1.5×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	1.0×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	1.2×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
Chellam et al. (2005)								
Kinney et al. (2002)	8 weeks	3.7×10^{-4}						
Pratt et al. (2000)	1–9 yrs	2.0×10^{-3}			1.0×10^{-3}			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	1.6						Concentration extremely elevated compared to other data sources, possibly reflecting typo in Table 5-1 in report; report concluded that mobile sources were dominant pollutant sources.
	1 yr	1.7						Concentration extremely elevated compared to other data sources, possibly reflecting typo in Table 5-1 in report; report concluded that mobile sources were dominant pollutant sources.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	5.8×10^{-5}			1.3×10^{-5}			Mobile sources estimated to account for 1% of nationwide mean.
	1 yr (annual average)	1.7×10^{-4}			8.1×10^{-5}			Mobile sources estimated to account for 6% of nationwide mean.

Table B.6. Ambient and Outdoor Exposure Data Summaries. Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	75%	µg/m³ (con-verted from ppb)	Directly from reference	1.3×10^{-1}	8.8
EPA Air Quality System (AQS) Database (via AIRData web-site)	HAP Monitor Values Report data summary	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hrs	113,343		µg/m³ (con-verted from ppbC)	Calculated by Gradient Corp. from annual summary report		2.3×10^{2}
Children's Environmental Health Protection Program	Barrio Logan Monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	90%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 6.5 \times 10^{-1}$	1.0×10^{1}
	Boyle Heights Monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	74	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	9.5×10^{-1}	2.2×10^{1}
	Crockett Monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	2.7×10^{-1}	1.9
	Fresno Monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	3.3×10^{-1}	8.2
	Fruitvale Monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	2.6×10^{-1}	7.5
	Wilmington Monitoring data summary	Wilming-ton	CA	Urban	July 2001–July 2002	24 hrs	60	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	3.6×10^{-1}	9.5

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	1.5			1.1			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.4	1.3×10^{-1}	8.6				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1-hr sampling period.
Children's Environmental Health Protection Program	17 months	3.2						
	16 months	3.9						
	~ 1.5 yrs	7.8×10^{-1}						
	1 yr	1.8						
	~ 1.5 yrs	2.0						
	~ 1 yr	2.2						

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	20 bus commute runs		µg/m³ (converted from ppb)	Directly from reference		
Payne-Sturges et al. (2004)	Baltimore Outdoor Air data summary	Baltimore	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		3.1 (P90)
Riediker et al. (2003)	Ambient Air data summary	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³ (converted from ppb)	Directly from reference	0.0	2.0
	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46 (4 excluded by authors)		µg/m³ (converted from ppb)	Directly from reference	1.3	4.4×10^1
	Roadside Sample data summary	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³ (converted from ppb)	Directly from reference	0.0	2.6
Sapkota and Buckley (2003)	Baltimore Harbor Tunnel Tollbooth data summary	Baltimore	MD	Roadside, urban	7 weekdays between 6/18/01–6/28/01	3 hrs	8 samples per day on 7 weekdays (56)		µg/m³	Directly from reference	7.0×10^{-1}	3.3×10^1
Adgate et al. (2004b)	Minneapolis Spring Outdoor School data summary	Minneapolis	MN	Urban	4/9/00–5/12/00	5 days	10	100%	µg/m³	Directly from reference		1.6 (P90)
	Minneapolis Winter Outdoor School data summary	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	100%	µg/m³	Directly from reference		2.2 (P90)
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	100%	µg/m³	Directly from reference		1.1×10^1

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		2.9	9.5				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban routes: one exposure ran with windows closed (morning) and with windows open (afternoon).
Payne-Sturges et al. (2004)	18 months	1.8			1.8			
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	3.3×10^{-1}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	1.3×10^{1}						Four excluded samples were from one car that had extreme values, which increased from shift to shift.
	50 late-shift patrols (3 PM to midnight) over 25 days	6.5×10^{-1}						Minimum concentration of 0.0 is as reported in publication.
Sapkota and Buckley (2003)	7 days of 3-hr integrated samples					2.7	2.2×10^{1}	Range in median concentrations represent daily 3-hr time blocks over the week of sampling with minimum and maximum median concentrations.
Adgate et al. (2004b)	5 weeks				1.1			
	4 weeks				1.3			
Batterman et al. (2002)	4 days (over 4 weeks)	4.5						

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	35		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	3650	99%	µg/m³	Directly from reference	$< 2.5 \times 10^{-1}$	2.6×10^{1}
Sexton et al. (2004)	Minneapolis-St Paul outdoor air data summary	Minneapolis-St Paul	MN	Urban	Apr–Nov 1999	2 days	132	100%	µg/m³	Directly from reference		3.3 (P90)
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24 hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Adgate et al. (2004a)	Minnesota residential outdoor air data summary	Statewide	MN	Urban, nonurban	May–Sept 1997	6 days	100	100%	µg/m³	Directly from reference	5.0×10^{-1}	4.6 (P95)
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 minutes	1	100%	µg/m³	Directly from reference	2.4	2.4

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Kinney et al. (2002)	8 weeks	1.3						
	8 weeks	2.6						
Pratt et al. (2000)	1-9 yrs	1.8			1.3			
Sexton et al. (2004)	7 months	1.6				1.3		Authors note that manufacturing plant located near East St Paul neighborhood.
South Coast Air Quality Management District (AQMD) (2000)	1 yr	3.5						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	3.1						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Adgate et al. (2004a)	5 months	3.3						
Fedoruk and Kerger (2003)	90 minutes	2.4						Testing conducted for used 1993 Toyota Camry.

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Fedoruk and Kerger (2003) (*Continued*)	Data summary for in-vehicle measurements during extreme heat/ static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference	1.7	1.4×10^1
	Data summary for in-vehicle measurements during moderate heat/ static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	33%	µg/m³	Directly from reference	$< 9 \times 10^{-1}$	1.9
Mohamed et al. (2002)	1996 UATMP data summary	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	79%>MDL reported for all Sacramento samples	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	100%	µg/m³	Directly from reference	9.8	2.2×10^1
	In-vehicle data summary, Sacramento	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	79%>MDL reported for all Sacramento samples	µg/m³	Directly from reference	2.0	1.6×10^1
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Directly from reference	< 1.1	2.0×10^1

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Fedoruk and Kerger (2003) (*Continued*)	3 90-minute tests	1.0×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests							Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry. Benzene detected only during testing of used 1993 Toyota Camry.
Mohamed et al. (2002)	1 yr		7.8×10^{-1}	4.1				Samples collected every 12 days.
Rodes et al. (1998)	2–4 commutes		3.0	6.6				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.1	2.9				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		1.3×10^{1}	1.7×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		2.0	1.4×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		5.2	1.2×10^{1}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	Roadside sampling data summary, Sacramento	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	79%>MDL reported for all Sacramento samples	µg/m³	Directly from reference	6.0×10^{-1}	5.9
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results	Nationwide—all rural counties	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results	Nationwide—all urban counties	US	Urban	1996				µg/m³	Directly from reference		
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	2.4×10^{1}
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	2.0	3.9×10^{1}
Seigneur et al. (2003)	Suburban/rural modeling results	Regional modeling grid encompassing northeastern US	US	Urban, suburban/rural, remote	7/11/95–7/15/95				µg/m³ (converted from ppb)	Directly from reference		
	Urban modeling results	Regional modeling grid encompassing northeastern US	US	Urban, suburban/rural, remote	7/11/95–7/15/95				µg/m³ (converted from ppb)	Directly from reference		

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Table B.6. Ambient and Outdoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998) (*Continued*)	1–4 commutes		1.0	5.0				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	7.3×10^{-1}			6.6×10^{-1}			Mobile sources estimated to account for 24% of nationwide mean.
	1 yr (annual average)	1.6			1.4			Mobile sources estimated to account for 60% of nationwide mean.
Zielinska et al. (1998)	1 yr		2.9×10^{-1}	7.9				
	1 yr		2.6	1.4×10^{1}				
Seigneur et al. (2003)	1 hr		3.3×10^{-1}	1.6				Modeled time period noted to have high ozone pollution and low mixing height.
	1 hr		3.3	1.6×10^{1}				Modeled time period noted to have high ozone pollution and low mixing height.

Table B.7. Ambient and Outdoor Exposure Data Summaries. 1,3-Butadiene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	26%	µg/m³ (con-verted from ppb)	Directly from reference	$< 2.2 \times 10^{-2}$	1.4
EPA Air Quality System (AQS) Database (via AIRData web-site)	HAP monitor values report data summary	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hr	56,919		µg/m³ (con-verted from ppbC)	Calculated by Gradient Corp. from annual sum-mary report		1.6×10^{2}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	99%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 9 \times 10^{-2}$	2.2
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	74	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	1.5×10^{-1}	4.0
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	49%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 9 \times 10^{-2}$	5.5×10^{-1}
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	52%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 9 \times 10^{-2}$	1.6
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	78%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 9 \times 10^{-2}$	2.2
	Wilmington monitoring data summary	Wilming-ton	CA	Urban	July 2001–July 2002	24 hrs	60	85%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 9 \times 10^{-2}$	3.3

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Table B.7. Ambient and Outdoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) 2004	Typically 1 yr (annual average)	2.9×10^{-1}			2.0×10^{-1}			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	2.7×10^{-1}	2.4×10^{-2}	7.1				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1-hr sampling period.
Children's Environmental Health Protection Program	17 months	2.2						
	~ 15 months	9.3×10^{-1}						
	~ 1.5 yrs	1.1×10^{-1}						
	1 yr	2.7×10^{-1}						
	~ 1.5 yrs	4.0×10^{-1}						
	~ 1 yr	6.2×10^{-1}						

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Table B.7. Ambient and Outdoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	31 bus commute runs	26%	µg/m³ (converted from ppb)	Directly from reference	1.3	2.9
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	0%	µg/m³	Provided by author in email	< 6.5	< 6.5
Sapkota and Buckley (2003)	Baltimore Harbor tunnel tollbooth data summary	Baltimore	MD	Roadside, urban	7 weekdays between 6/18/01–6/28/01	3 hrs	8 samples per day on 7 weekdays (56)		µg/m³	Directly from reference	8.0×10^{-1}	1.9×10^{1}
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	35		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
South Coast Air Quality Management District (AQMD) (2000)	Fixed Site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	one 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	97%>MDL reported for all LA samples	µg/m³	Directly from reference		

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Table B.7. Ambient and Outdoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Fitz et al. (2003)	Over 8 commute runs with detects	2.0						1,3-butadiene detected for only eight morning runs out of 31 bus commute runs.
Riediker et al. (2003)								Authors report that 1,3-butadiene not detectable throughout study; in email communication, Ron Williams of EPA indicated that large number of non-detects is recognized as failure of technique.
Sapkota and Buckley (2003)	7 days of 3-hr integrated samples					2.0	1.4×10^{1}	Range in median concentrations represent daily 3-hr time blocks over the week of sampling with minimum and maximum median concentrations.
Kinney et al. (2002)	8 weeks	1.4×10^{-1}						
	8 weeks	1.3×10^{-1}						
South Coast Air Quality Management District (AQMD) (2000)	1 yr	7.9×10^{-1}						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	3.4×10^{-1}						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Rodes et al. (1998)	2–4 commutes		4.0×10^{-1}	7.0×10^{-1}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.7. Ambient and Outdoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continue on next page*)

		Study Location(s)									Individual Sample Measurement Range	
Source	Data Description	City or County	State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Minimum	Maximum
Rodes et al. (1998) (*Continued*)	Ambient air station data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	67%>MDL reported for all Sacramento samples	$\mu g/m^3$	Directly from reference		
	In-vehicle data summary, Los Angeles	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	97%>MDL reported for all LA samples	$\mu g/m^3$	Directly from reference	2.1	5.7
	In-vehicle data summary, Sacramento	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	67%>MDL reported for all Sacramento samples	$\mu g/m^3$	Directly from reference	2.0×10^{-1}	4.4
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	97%>MDL reported for all LA samples	$\mu g/m^3$	Directly from reference	0.0	4.9
	Roadside sampling data summary, Sacramento	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	67%>MDL reported for all Sacramento samples	$\mu g/m^3$	Directly from reference	0.0	1.1
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results	Nationwide—all rural counties	US	Rural	1996				$\mu g/m^3$	Directly from reference		
	Summary of urban modeling results	Nationwide—all urban counties	US	Urban	1996				$\mu g/m^3$	Directly from reference		
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		$\mu g/m^3$ (converted from ppb)	Directly from reference	0.0	2.8
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 wk to 2 months at each site)	24 hrs	4–17 per site		$\mu g/m^3$ (converted from ppb)	Directly from reference	9.0×10^{-2}	4.8

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Table B.7. Ambient and Outdoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998) (*Continued*)	1–4 commutes		1.0×10^{-1}	5.0×10^{-1}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		2.4	4.7				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		2.0×10^{-1}	2.8				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		1.0	2.9				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		2.0×10^{-1}	1.0				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	2.5×10^{-2}			1.4×10^{-2}			Mobile sources estimated to account for 54% of nationwide mean.
	1 yr (annual average)	8.4×10^{-2}			6.7×10^{-2}			Mobile sources estimated to account for 88% of nationwide mean.
Zielinska et al. (1998)	1 yr		2.0×10^{-2}	7.0×10^{-1}				
	~ 1 week to 2 months		1.8×10^{-1}	1.6				

Table B.8a. Ambient and Outdoor Exposure Data Summaries. Chromium Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—$PM_{2.5}$ Cr	Nationwide	US	Urban, suburban, rural	2003	24 hrs	13,927		µg/m³	Calculated by Gradient Corp. from annual summary report		5.6×10^{-1}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—TSP Cr	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	61	100%	µg/m³	Calculated by Gradient Corp. from study data set	2.3×10^{-3}	3.1×10^{-2}
	Boyle Heights monitoring data summary—TSP Cr	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	91%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	1.5×10^{-2}
	Crockett monitoring data summary—TSP Cr	Crockett	CA	Urban	Oct 2001–Feb 2003	24 hrs	60	57%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	8.7×10^{-3}
	Fresno monitoring data summary—PM_{10} Cr	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	79%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	1.7×10^{-2}
	Fruitvale monitoring data summary—TSP Cr	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	85%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	1.0×10^{-2}
	Wilmington monitoring data summary—TSP Cr	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	68	78%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	2.2×10^{-2}
EPA (2004)	Atlanta GA—$PM_{2.5}$ Cr	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	3.0×10^{-3}
	Boulder CO—$PM_{2.5}$ Cr	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	9.0×10^{-3}

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (Continued)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.8×10^{-3}	4.0×10^{-4}	3.5×10^{-2}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	17 months	6.5×10^{-3}						Barrio Logan is located near two chrome plating facilities.
	~ 15 months	5.7×10^{-3}						
	~ 1.5 yrs	2.6×10^{-3}						
	6 months	5.5×10^{-3}						
	~ 16 months	4.1×10^{-3}						
	~ 1 yr	4.7×10^{-3}						
EPA (2004)	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continue on next page*)

		Study Location(s)									Individual Sample Measurement Range	
Source	Data Description	City or County	State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Minimum	Maximum
EPA (2004) (*Continued*)	Burlington VT—$PM_{2.5}$ Cr	Burlington	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	6.0×10^{-2}
	Chicago IL—$PM_{2.5}$ Cr	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	5.0×10^{-3}
	Detroit MI—$PM_{2.5}$ Cr	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	3.3×10^{-2}
	Houston TX—$PM_{2.5}$ Cr	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	9.0×10^{-3}
	Minneapolis MN—$PM_{2.5}$ Cr	Minneapolis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.6×10^{-2}
	Philadelphia PA—$PM_{2.5}$ Cr	Philadelphia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.8×10^{-2}
	Phoenix AZ—$PM_{2.5}$ Cr	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	2.1×10^{-2}
	Riverside-Rubidoux CA—$PM_{2.5}$ Cr	Riverside-Rubidoux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	2.4×10^{-2}
	Sacramento CA—$PM_{2.5}$ Cr	Sacramento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	4.3×10^{-2}
	Seattle WA—$PM_{2.5}$ Cr	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.6×10^{-2}
	St Louis MO—$PM_{2.5}$ Cr	St Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	3.4×10^{-2}
Riediker et al. (2003)	Ambient air data summary—$PM_{2.5}$ Cr	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	4.6×10^{-3}
	In-vehicle data summary for NC state police patrol cars—$PM_{2.5}$ Cr	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	7.0×10^{-3}
	Roadside sample data summary—$PM_{2.5}$ Cr	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	2.6×10^{-3}

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
EPA (2004) (*Continued*)	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	1.2×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	1.9×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	1.1×10^{-3}						Minimum concentration of 0.0 is as reported in publication.

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Kinney et al. (2002)	Summary of summer residential outdoor data—$PM_{2.5}$ Cr	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	34		µg/m³	Directly from reference		
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary—TSP Cr	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated Cr	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles —$PM_{2.5}$ Cr	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	12 (invalid samples for 4 commutes)	Reported as 0%> MDL	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento —$PM_{2.5}$ Cr	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	Reported as 0%>MDL	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles—$PM_{2.5}$ Cr	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	4.0×10^{-2}
	In-vehicle data summary, Sacramento—$PM_{2.5}$ Cr	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	5.0×10^{-2}

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Kinney et al. (2002)	8 weeks	4.6×10^{-4}						
South Coast Air Quality Management District (AQMD) (2000)	1 yr	4.9×10^{-3}						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	1.4×10^{-2}						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Rodes et al. (1998)	2–4 commutes		0.0	3.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types. Minimum concentration of 0.0 is as reported in publication.
	1–4 commutes		0.0	3.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types. Minimum concentration of 0.0 is as reported in publication.
	2–4 commutes		0.0	3.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car. Minimum concentration of 0.0 is as reported in publication.
	1–4 commutes		0.0	4.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car. Minimum concentration of 0.0 is as reported in publication.

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	Roadside sampling data summary, Los Angeles—$PM_{2.5}$ Cr	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	5.0×10^{-2}
	Roadside sampling data summary, Sacramento—$PM_{2.5}$ Cr	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	5.0×10^{-2}
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—chromium compounds	Nationwide	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—chromium compounds	Nationwide	US	Urban	1996				µg/m³	Directly from reference		

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Table B.8a. Ambient and Outdoor Exposure Data Summaries (*Continued*). Chromium Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (Continued)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Rodes et al. (1998) (*Continued*)	2–4 commutes		1.0×10^{-2}	3.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.0×10^{-2}	3.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	6.5×10^{-4}			7.5×10^{-5}			Mobile sources estimated to account for 4% of nationwide mean.
	1 yr (annual average)	2.8×10^{-3}			1.3×10^{-3}			Mobile sources estimated to account for 8% of nationwide mean.

Table B.8b. Ambient and Outdoor Exposure Data Summaries Hexavalent Chromium Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—TSP Cr-VI	Nation-wide	US	Urban, suburban, rural	2003	24 hrs (with some composite samples)	146		µg/m³	Calculated by Gradient Corp. from annual summary report		1.6×10^{-3}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—TSP Cr-VI	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	45	9%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	3.0×10^{-4}
	Boyle Heights monitoring data summary—TSP Cr-VI	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	73	9.6%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	3.5×10^{-4}
	Crockett monitoring data summary—TSP Cr-VI	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	83	1%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	2.2×10^{-4}
	Fresno monitoring data summary—PM_{10} Cr-VI	Fresno	CA	Urban	Aug 2002–Aug 2003	24 hrs	61	12%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	2.9×10^{-4}
	Fruitvale monitoring data summary—TSP Cr-VI	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	8%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	5.4×10^{-4}
	Wilmington monitoring data summary—TSP Cr-VI	Wilming-ton	CA	Urban	May 2001–July 2002	24 hrs	72	8%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-4}$	3.2×10^{-4}
Pratt et al. (2000)	Minnesota monitoring data—PM_{10} Cr-VI	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	855	75%	µg/m³	Directly from reference	$< 2 \times 10^{-3}$	7.0×10^{-3}
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary—TSP Cr-VI	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated Cr-VI	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		

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Table B.8b. Ambient and Outdoor Exposure Data Summaries (*Continued*). Hexavalent Chromium Compounds (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	2.2×10^{-5}	0.0	2.3×10^{-4}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	17 months	1.1×10^{-4}						Barrio Logan is located near two chrome plating facilities.
	~ 15 months	1.2×10^{-4}						
	~ 1.5 yrs	1.0×10^{-4}						
	6 months	1.2×10^{-4}						
	~ 16 months	1.2×10^{-4}						
	~ 1 yr	1.1×10^{-4}						
Pratt et al. (2000)	1–9 yrs	1.0×10^{-3}			1.0×10^{-3}			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	1.8×10^{-4}						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	2.4×10^{-4}						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.

Table B.9. Ambient and Outdoor Exposure Data Summaries . Dioxins-Furans (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units[1]	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
California Ambient Dioxin Air Monitoring Program (CADAMP)	2003 Data summary	Multiple (10) locations	CA	Urban	2003	20–24 days over 4 weeks	11–13 per site	100%	TEQ pg/m^3	Directly from reference	4.4×10^{-3}	7.1×10^{-2}
	2002 Data summary	Multiple (9) locations	CA	Urban	2002	20–24 days over 4 weeks	7–12 per site	100%	TEQ pg/m^3	Directly from reference	6.1×10^{-3}	1.9×10^{-1}
Cleverly et al. (2002)	Data summary for Washington DC and San Francisco NDAMN sites	Washington, San Francisco	DC, CA	Suburban	2000	24 days over 4 weeks	4 per site		TEQ pg/m^3	Directly from reference		
Gertler et al. (1996 1998)	Fort McHenry Tunnel inlet/vent (air intake) data summary	Baltimore	MD	Tunnel, urban	10/25/95–11/6/95	24 hrs (on day/day, night/night basis)	10 sampling runs (34 total inlet/vent samples)	100%	TEQ pg/m^3	Calculated by grouping data for different runs	1.1×10^{-2}	1.1×10^{-1}
	Fort McHenry Tunnel bore 3 outlet data summary	Baltimore	MD	Tunnel, urban	10/25/95–11/6/95	24 hrs (day/day samples only)	5	100%	TEQ pg/m^3	Directly from reference	2.1×10^{-2}	8.5×10^{-2}
	Fort McHenry Tunnel bore 4 outlet data summary	Baltimore	MD	Tunnel, urban	10/25/95–11/6/95	24 hrs (on day/day, night/night basis)	10	100%	TEQ pg/m^3	Directly from reference	3.2×10^{-2}	1.6×10^{-1}
EPA (2003)	Literature survey data summary for urban background	Multiple (14) locations	CT, CA, OH, NY	Urban	1988–1995		106 (from 14 studies)		TEQ pg/m^3	Directly from reference		
Hunt et al. (1997)	Phoenix AZ data summary	Phoenix	AZ	Urban	12/15/94–12/20/94	24 hrs	4	100%	TEQ pg/m^3	Directly from reference	9.2×10^{-2}	4.5×10^{-1}

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Table B.9. Ambient and Outdoor Exposure Data Summaries (*Continued*). Dioxins-Furans (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
California Ambient Dioxin Air Monitoring Program (CADAMP)	1 yr (annual average)		1.8×10^{-2}	2.6×10^{-2}				Concentration reported as TEQ_{DF}-WHO_{97}. Range of means represent sites with minimum and maximum annual averages among all sites meeting ARB completeness criteria.
	1 yr (annual average)		1.3×10^{-2}	4.3×10^{-2}				Concentration reported as TEQ_{DF}-WHO_{97}. Range of means represent sites with minimum and maximum annual averages among all sites meeting ARB completeness criteria.
Cleverly et al. (2002)	1 yr (annual average)	1.6×10^{-2}						Concentration reported as TEQ_{DF}-WHO_{98}. SF and DC considered by authors to be the two NDAMN stations of more urban character that can serve as indicator of dioxin/furan levels in more populated areas. Data from other NDAMN sites located in rural and remote areas are not included since they are intended to represent atmospheric background levels.
Gertler et al. (1996 1998)	10 24-hr sampling periods	3.9×10^{-2}						Concentration reported as TEQ_{DF}-$NATO_{89}$
	5 24-hr sampling periods	4.9×10^{-2}						Concentration reported as TEQ_{DF}-$NATO_{89}$. Primarily light-duty vehicles, less than 2% heavy-duty diesel vehicles
	10 24-hr sampling periods	7.6×10^{-2}						Concentration reported as TEQ_{DF}-$NATO_{89}$. Trucks directed into this bore, on average 24–25% heavy-duty diesel vehicles
EPA (2003)	Weighted mean across 14 studies	8.1×10^{-2}						Concentration reported as TEQ_{DF}-WHO_{98}. EPA assumed that non-detects equal to one-half the limit of detection. Individual study means shown to range from 0.029 to 0.232 TEQ pg/m^3.
Hunt et al. (1997)	4 days	2.5×10^{-1}						TEQ source not reported; appears to be NATA/80 TEQs.

Table B.10. Ambient and Outdoor Exposure Data Summaries. DPM + DEOG (EC + BC as Surrogates) (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Borak et al. (2003)	School bus survey data summary—NIOSH 5040 EC	Not provided		In-vehicle	Not specified (likely in 2002)	13.7–20.1 hrs	27		µg/m³	Directly from reference	$< 1.0 \times 10^{1}$	1.9
Children's Environmental Health Protection Program	Boyle Heights monitoring data summary—continuous Black Carbon	Los Angeles	CA	Urban	1/9/02–2/28/02	1 hr	400	90%	µg/m³	Calculated by Gradient Corp. from study data set	0.0	7.8×10^{-1}
	Boyle Heights monitoring data summary—PM_{10} EC	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	144	10%	µg/m³	Calculated by Gradient Corp. from study data set	< 1	4.0
	Crockett monitoring data summary—continuous Black Carbon	Crockett	CA	Urban	10/2/01–2/28/02	1 hr	2,381	100%	µg/m³	Calculated by Gradient Corp. from study data set	3.5×10^{-2}	5.8
	Crockett monitoring data summary—PM_{10} EC	Crockett	CA	Urban	Nov 2001–May 2003	24 hrs	78	0%	µg/m³	Calculated by Gradient Corp. from study data set	< 1	< 1
	Fresno monitoring data summary—continuous Black Carbon	Fresno	CA	Urban	June 2002–Aug 2003	1 hr	10,388	100%	µg/m³	Calculated by Gradient Corp. from study data set	2.0×10^{-3}	1.3×10^{1}
	Fresno monitoring data summary—continuous EC	Fresno	CA	Urban	June 2002–Aug 2003	1 hr	9,008	99%	µg/m³	Calculated by Gradient Corp. from study data set	$< 1 \times 10^{-1}$	1.5×10^{1}
	Fruitvale monitoring data summary—continuous Black Carbon	Fruitvale area of Oakland	CA	Urban	12/11/01–2/28/02	1 hr	1,030	100%	µg/m³	Calculated by Gradient Corp. from study data set	7.3×10^{-2}	8.9
	Fruitvale monitoring data summary—PM_{10} EC	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	71	8%	µg/m³	Calculated by Gradient Corp. from study data set	< 1	2.5
	Wilmington monitoring data summary—continuous Black Carbon	Wilmington	CA	Urban	1/30/02–2/28/02	1 hr	379	100%	µg/m³	Calculated by Gradient Corp. from study data set	0.0	6.7×10^{-1}

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (Continued)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Borak et al. (2003)								Aethalometer also used to measure BC, although authors identified technical limitations associated with this methodology.
Children's Environmental Health Protection Program	~ 2 months	2.0×10^{-1}						Black carbon measured using aethalometer; 0 reported for 41 hrs, with 0.008 µg C/m^3 as next lowest concentration
	~ 15 months	6.6×10^{-1}						PM_{10} EC method derived from NIOSH method.
	~ 5 months	8.9×10^{-1}						Black carbon measured using aethalometer.
	~ 1.5 yrs							PM_{10} EC method derived from NIOSH method.
	~ 1 yr	1.2						Black carbon measured using aethalometer.
	~ 1 yr	7.2×10^{-1}						EC instrument type not provided; 0 reported for 55 hrs, with 0.1 µg C/m^3 as next lowest concentration
	~ 3 months	1.8						Black carbon measured using aethalometer.
	15 months	6.1×10^{-1}						PM_{10} EC method derived from NIOSH method.
	1 month	1.9×10^{-1}						Black carbon measured using aethalometer. Only 1 record out of 379 had a concentration of 0 and was not flagged, with the next lowest concentration being 0.02 µg C/m^3

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Children's Environmental Health Protection Program (*Continued*)	Wilmington monitoring data summary—PM_{10} EC	Wilming-ton	CA	Urban	May 2001–July 2002	24 hrs	96	84%	µg/m³	Calculated by Gradient Corp. from study data set	< 1	4.9
Fitz et al. (2003)	In-vehicle data summary for school bus study—continuous Black Carbon	Los Angeles	CA	In-vehicle, urban and rural/ sub-urban	4/22/02–6/12/02	1–1.5 hrs	32 bus commute runs		µg/m³	Directly from reference		
Martuzevicius et al. (2004)	Greater Cincinnati $PM_{2.5}$ monitoring study data summary—$PM_{2.5}$ EC	Cincin-nati	OH	Roadside, urban	Dec 2001–Nov 2002	24 hrs	total of 219 daily $PM_{2.5}$ samples		µg/m³	Directly from reference	1.0	1.3×10^{1}
EPA (2004)	Atlanta GA—$PM_{2.5}$ EC	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		µg/m³	Directly from reference	$< 1.3 \times 10^{-1}$	3.5
	Boulder CO—$PM_{2.5}$ EC	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161	100%	µg/m³	Directly from reference	1.5×10^{-1}	4.4
	Burlington VT—$PM_{2.5}$ EC	Burling-ton	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	8.4×10^{-1}
	Chicago IL—$PM_{2.5}$ EC	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	$< 5.9 \times 10^{-2}$	1.6
	Detroit MI—$PM_{2.5}$ EC	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	3.7
	Houston TX—$PM_{2.5}$ EC	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	$< 5.9 \times 10^{-2}$	1.1
	Minneapolis MN—$PM_{2.5}$ EC	Minne-apolis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	1.8
	Philadelphia PA—$PM_{2.5}$ EC	Philadel-phia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	2.3

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Children's Environmental Health Protection Program (*Continued*)	~ 1 yr	8.7×10^{-1}						PM_{10} EC method derived from NIOSH method. ARB summary data spreadsheet has units incorrectly labeled as mg C/m^3.
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		2.7	1.0×10^{1}				Black carbon measured using aethalometer. Range in mean concentrations reflects mean concentrations presented in report for three groups of exposure runs: urban route one with windows closed (morning), urban route one with windows open (afternoon), and rural/suburban route with windows open (afternoon).
Martuzevicius et al. (2004)								$PM_{2.5}$ EC concentration via NIOSH method
EPA (2004)	1 yr	9.0×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.6×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.1×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.8×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.9×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.6×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
EPA (2004) (*Continued*)	Phoenix AZ—$PM_{2.5}$ EC	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	5.0
	Riverside-Rubidoux CA—$PM_{2.5}$ EC	River-side-Rubid-oux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161	100%	µg/m³	Directly from reference	1.2×10^{-1}	4.3
	Sacramento CA—$PM_{2.5}$ EC	Sacra-mento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	$< 1.5 \times 10^{-1}$	8.4
	Seattle WA—$PM_{2.5}$ EC	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	$< 5.9 \times 10^{-2}$	2.7
	St Louis MO — $PM_{2.5}$ EC	St Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	$< 1.3 \times 10^{-1}$	2.7
Lena et al. (2002)	Hunts Point, NY sidewalk monitoring data summary—$PM_{2.5}$ EC	New York City	NY	Roadside, urban	July–Aug 1999: 9 weekdays over 3-week period	10–12 hrs	33	100%	µg/m³	Directly from reference		
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary—PM_{10} EC	South-ern Cali-fornia South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998-Mar 1999	24 hrs	one 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated EC	Southern Califor-nia South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998-Mar 1999				µg/m³	Directly from reference		

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA (2004) (*Continued*)	1 yr	7.5×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.2						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.6×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.0×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	7.2×10^{-1}						$PM_{2.5}$ EC concentration via NIOSH method; 1 of 13 sites featured in PM CD to represent cross-section of US.
Lena et al. (2002)	Varies (between 2–9 10–12 hr samples)	3.8	2.6	7.3				For 13 of 33 samples, $PM_{2.5}$ EC concentration measured via NIOSH method; for remaining samples, EC estimated from reflectance measurements of $PM_{2.5}$ filters.
South Coast Air Quality Management District (AQMD) (2000)	1 yr	3.4						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	3.4						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.

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Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Rodes et al. (1998)	In-vehicle data summary, Los Angeles—continuous Black Carbon	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 1 car (16 total sampling events)		µg/m³	Directly from reference	3.3	2.3×10^{1}
	In-vehicle data summary, Sacramento—continuous Black Carbon	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 1 car (13 total sampling events)		µg/m³	Directly from reference	-3.0×10^{-1}	9.5
Kinney et al. (2000)	Harlem sidewalk monitoring data summary—$PM_{2.5}$ EC	New York City	NY	Roadside, urban	July 1996 (5 weekdays within 13-day period)	8 hrs	40 (20 replicates)	100%	µg/m³	Directly from reference	1.1	7.9
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—diesel PM	Nationwide—all rural counties	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—diesel PM	Nationwide—all urban counties	US	Urban	1996				µg/m³	Directly from reference		
Manchester-Neesvig et al. (2003)	Southern California diesel exhaust PM_{10} source contributions—diesel PM	Multiple (12) Southern California communities	CA	Urban and rural	1995				µg/m³	Directly from reference		
	Southern California PM_{10} organics measurement data summary—PM_{10} EC	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		µg/m³	Directly from reference		
Seigneur et al. (2003)	Suburban and rural modeling results—diesel PM	Regional modeling grid encompassing northeastern US	US	Urban, suburban and rural remote	7/11/95-7/15/95				µg/m³	Directly from reference		
Seigneur et al. (2003)	Urban modeling results—diesel PM	Regional modeling grid encompassing northeastern US	US	Urban, suburban and rural remote	7/11/95–7/15/95				µg/m³	Directly from reference		
EPA (2002)b	Literature survey data summary—diesel PM	Multiple US metropolitan areas	US	Urban and suburban locations	post-1990	Typically 24 hrs			µg/m³	Directly from reference	0.0	4.7×10^{1}

Table B.10. Ambient and Outdoor Exposure Data Summaries (*Continued*). DPM + DEOG (EC + BC as Surrogates) (*Columns continued from previous page*)

Source (Continued)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998)	2–4 commutes		4.4	2.1×10^{1}				Black Carbon measured with aethalometer. Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		-3.0×10^{-1}	8.3				Black Carbon measured with aethalometer. Range in average concentrations represents averages reported by commute type and car.
Kinney et al. (2000)	5 days	3.4	1.5	6.2				$PM_{2.5}$ EC concentration via NIOSH method.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	7.4×10^{-1}			6.7×10^{-1}			Mobile sources estimated to account for 100% of nationwide mean.
	1 yr (annual average)	2.4			1.9			Mobile sources estimated to account for 100% of nationwide mean.
Manchester-Neesvig et al. (2003)	Seasonal averages		3.0×10^{-1}	5.6				PM_{10} mass concentration source contributions for DPM based on molecular-marker source apportionment model.
	1 yr (annual average)		1.5×10^{-1}	1.7				PM_{10} EC concentration measured via NIOSH method; range represents sites with minimum and maximum annual average concentrations among 11 sites with measurable levels.
Seigneur et al. (2003)	1 hr		1.0	4.0				Simulated DPM concentration; modeled time period noted to have high ozone pollution and low mixing height.
Seigneur et al. (2003)	1 hr		2.0	4.1×10^{1}				Simulated DPM concentration; modeled time period noted to have high ozone pollution and low mixing height.
EPA (2002)	Annual/seasonal average		1.0	4.0				Typical range based on review of post-1990 chemical mass balance (CMB) studies and EC measurement studies.

Table B.11. Ambient and Outdoor Exposure Data Summaries. Ethylbenzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, subur-ban, rural	2003	24 hrs	1,550	61%	µg/m³ (con-verted from ppb)	Directly from reference	4.3×10^{-2}	1.2×10^{1}
EPA Air Quality System (AQS) Data-base (via AIR-Data website)	HAP monitor values report data summary	Nation-wide	US	Urban, subur-ban, rural	2003	primarily 24 hrs, some 1 hr and 3 hr	111,942		µg/m³ (con-verted from ppbC)	Calculated by Gradient Corp. from annual sum-mary report		6.4×10^{1}
Children's Environmen-tal Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	10%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	< 2.6	3.9
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	64	73%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 8.7 \times 10^{-1}$	4.3
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	80	0%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 8.7 \times 10^{-1}$	$< 8.7 \times 10^{-1}$
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	35%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 8.7 \times 10^{-1}$	4.8
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	46%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 8.7 \times 10^{-1}$	9.1
	Wilmington monitoring data summary	Wilming-ton	CA	Urban	July 2001–July 2002	24 hrs	58	40%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	$< 8.7 \times 10^{-1}$	3.8
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehi-cle, urban	4/22/02–6/12/02	1–1.5 hrs	20 sam-pling runs		µg/m³ (con-verted from ppb)	Directly from reference		
Payne-Sturges et al. (2004)	Baltimore outdoor air data summary	Balti-more	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		2.0 (P90)

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	1.0			6.5×10^{-1}			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	5.4×10^{-1}	8.2×10^{-3}	3.4				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1 hr sampling period.
Children's Environmental Health Protection Program	17 months	1.5						
	~ 15 months	1.5						
	~ 1.5 yrs							
	1 yr	9.1×10^{-1}						
	6 months	1.2						
	~ 1 yr	9.1×10^{-1}						
Fitz et al. (2003)	Overall exposure runs grouped by route and window position		1.7	4.8				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban route one exposure runs: with windows closed (morning), and with windows open (afternoon).
Payne-Sturges et al. (2004)	18 months	1.3			1.0			

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Riediker et al. (2003)	Ambient air data summary	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	100%	µg/m³ (converted from ppb)	Directly from reference	4.3×10^{-1}	2.2
	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46 (4 excluded by authors)	100%	µg/m³ (converted from ppb)	Directly from reference	1.3	1.1×10^{1}
	Roadside sample data summary	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	100%	µg/m³ (converted from ppb)	Directly from reference	4.3×10^{-1}	2.2
Adgate et al. (2004b)	Minneapolis spring outdoor school data summary	Minneapolis	MN	Urban	4/9/00–5/12/00	5 days	10	100%	µg/m³	Directly from reference		7.0×10^{-1} (P90)
	Minneapolis winter outdoor school data summary	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	100%	µg/m³	Directly from reference		8.0×10^{-1} (P90)
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	95%	µg/m³	Directly from reference	$< 1.0 \times 10^{-1}$	6.1
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	29		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	3,650	80%	µg/m³	Directly from reference	$< 3.2 \times 10^{-1}$	2.1×10^{1}
Sexton et al. (2004)	Minneapolis-St Paul outdoor air data summary	Minneapolis-St Paul	MN	Urban	Apr–Nov 1999	2 days	132	98.5%	µg/m³	Directly from reference		1.4 (P90)

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	8.7×10^{-1}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	3.9						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	8.7×10^{-1}						Four excluded samples were from one car that had extreme values, which increased from shift to shift.
Adgate et al. (2004b)	5 weeks				5.0×10^{-1}			
	4 weeks				6.0×10^{-1}			
Batterman et al. (2002)	4 days (over 4 weeks)	2.0						
Kinney et al. (2002)	8 weeks	1.9						
	8 weeks	1.3						
Pratt et al. (2000)	1–9 yrs	7.4×10^{-1}			4.6×10^{-1}			
Sexton et al. (2004)	7 months	7.0×10^{-1}			5.0×10^{-1}			Authors note that manufacturing plant located near East St Paul neighborhood.

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 minutes	1	100%	µg/m³	Directly from reference	2.0	2.0
	Data summary for in-vehicle measurements during extreme heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference	4.7	3.2×10^{1}
	Data summary for in-vehicle measurements during moderate heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference	2.5	7.5
Mohamed et al. (2002)	1996 UATMP data summary	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Directly from reference		
Rodes et al. (1998)	Ambient Air Station Data Summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Directly from reference		
	Ambient air station data summary, sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	73%>MDL for all Sacramento samples	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	100%	µg/m³	Directly from reference	4.5	1.2×10^{1}
	In-vehicle data summary, Sacramento	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	73%>MDL for all Sacramento samples	µg/m³	Directly from reference	6.0×10^{-1}	1.0×10^{1}
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Directly from reference	1.2	9.7
	Roadside sampling data summary, Sacramento	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	73%>MDL for all Sacramento samples	µg/m³	Directly from reference	3.0×10^{-1}	3.3

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Fedoruk and Kerger (2003)	90 minutes	2.0						Testing conducted on used 1993 Toyota Camry.
	3 90-minute tests	1.6×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests	4.2						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
Mohamed et al. (2002)	1 yr		8.0×10^{-2}	4.1×10^{-1}				Samples collected every 12 days.
Rodes et al. (1998)	2–4 commutes		1.6	3.5				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		6.0×10^{-1}	1.8				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		5.7	9.7				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		6.0×10^{-1}	8.2				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		2.7	5.6				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		6.0×10^{-1}	3.0				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	1.1×10^{1}
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	8.7×10^{-1}	1.9×10^{1}

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Table B.11. Ambient and Outdoor Exposure Data Summaries (*Continued*). Ethylbenzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Zielinska et al. (1998)	1 yr		4.0×10^{-2}	3.5				
	~ 1 week to 2 months		1.1	1.2×10^{1}				

Table B.12. Ambient and Outdoor Exposure Data Summaries. Formaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nationwide	US	Urban, suburban, rural	2003	24 hrs	1,875	70%	µg/m³ (converted from ppb)	Directly from reference	9.8×10^{-2}	4.9×10^{1}
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary	Nationwide	US	Urban, suburban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hr	16,578		µg/m³ (converted from ppb)	Calculated by Gradient Corp. from annual summary report		1.8×10^{2}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	68	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	6.5×10^{-1}	6.8
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	73	99%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 1.2 \times 10^{-1}$	1.4×10^{1}
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	82	98%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 1.2 \times 10^{-1}$	6.3
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	67	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	9.5×10^{-1}	1.2×10^{1}
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	76	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	2.0×10^{-1}	1.5×10^{1}
	Wilmington monitoring data summary	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	71	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	4.9×10^{-1}	8.4
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	32 bus commute runs		µg/m³	Directly from reference	3.4×10^{-1}	4.8
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Provided by author in email	0.0	6.5×10^{1}

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Table B.12. Ambient and Outdoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	3.2			2.4			
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	4.3	0.0	4.9×10^{1}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 24-hr sampling period.
Children's Environmental Health Protection Program	17 months	2.8						
	~ 16 months	4.7						
	~ 1.5 yrs	1.9						
	1 yr	4.5						
	6 months	2.4						
	~ 15 months	3.1						
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		9.3×10^{-1}	2.1				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban route one exposure runs: with windows closed (morning), and with windows open (afternoon).
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	2.1×10^{1}						Formaldehyde data not reported in journal article; data obtained through email communication with Ron Williams of EPA, with minimum concentration of 0 as reported in email correspondence.

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Table B.12. Ambient and Outdoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Grosjean and Grosjean (2002)	Caldecott Tunnel data summary	Near San Francisco	CA	Urban	7/20/99–8/5/99	2 hrs	8 at both inlet and outlet		µg/m³	Directly from reference		
	Tuscarora Mountain Tunnel data summary	Pennsylvania Turnpike	PA	Urban	5/1/99–5/21/99	1 hr	10 at inlet, 9 at outlet		µg/m³	Directly from reference		
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	2494	99%	µg/m³	Directly from reference	$< 4.8 \times 10^{-2}$	2.1×10^{1}
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	one 24 hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	15 (invalid sample for 1 commute)	98%>MDL for all LA samples	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	10 (invalid samples for 2 commutes)	96%>MDL for all Sacramento samples	µg/m³	Directly from reference		

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Table B.12. Ambient and Outdoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Grosjean and Grosjean (2002)	8 2-hr measurements		5.0	2.1×10^1				Fleet consisted primarily of light-duty vehicles using California Phase 2 reformulated gasoline; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements
	9–10 hrly measurements		1.7	4.6				Fleet included both light-duty vehicles and heavy-duty diesel trucks; average concentration range presented is average concentrations across inlet (minimum) and outlet (maximum) measurements
Kinney et al. (2002)	8 weeks	5.3						
	8 weeks	2.1						
Pratt et al. (2000)	1–9 yrs	1.7			1.4			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	4.8						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	5.5						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Rodes et al. (1998)	2–4 commutes		6.7	2.1×10^1				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		2.0	4.1				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.12. Ambient and Outdoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	In-vehicle data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	15 for vehicle 1 and 14 for vehicle 2 (29 total)	98%>MDL for all LA samples	µg/m³	Directly from reference	0.0	2.4×10^1
	In-vehicle data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	96%>MDL for all Sacramento samples	µg/m³	Directly from reference	4.6	1.9×10^1
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	10 of the 16 commutes at 2 locations (19 total due to 1 invalid sample)	98%>MDL for all LA samples	µg/m³	Directly from reference	0.0	2.0×10^1
	Roadside sampling data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	96%>MDL for all Sacramento samples	µg/m³	Directly from reference	3.0	8.3
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results	Nationwide	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results	Nationwide	US	Urban	1996				µg/m³	Directly from reference		
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	2.0×10^{-2}	2.5×10^1
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	1.8×10^{-1}	7.8

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Table B.12. Ambient and Outdoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Rodes et al. (1998) (*Continued*)	2–4 commutes		7.2	2.0×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		4.9	1.2×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		1.1×10^{1}	1.5×10^{1}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		4.6	6.3				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	5.5×10^{-1}			4.7×10^{-1}			Mobile sources estimated to account for 25% of nationwide mean.
	1 yr (annual average)	1.4			1.1			Mobile sources estimated to account for 72% of nationwide mean.
Zielinska et al. (1998)	1 yr		1.1	4.4				
	~ 1 week to 2 months		7.7×10^{-1}	5.1				

Table B.13. Ambient and Outdoor Exposure Data Summaries. *n*-Hexane (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary	Nationwide	US	Urban, suburban and rural	2003	Primarily 24 hrs, some 1 hr and 3 hrs	108,288		µg/m³ (converted from ppbC)	Calculated from annual summary report		1.0×10^{3}
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	47	> 75%	µg/m³ (converted from ppb)	Provided by author in email	1.9	1.1×10^{2}
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	100%	µg/m³	Directly from reference		2.5×10^{1}
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 minutes	1	100%	µg/m³	Directly from reference	1.8	1.8
	Data summary for in-vehicle measurements during extreme heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference	4.8	4.1×10^{1}
	Data summary for in-vehicle measurements during moderate heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference	1.7	1.1×10^{1}
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	1.1×10^{2}
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	9.5×10^{-1}	2.9×10^{3}

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Table B.13. Ambient and Outdoor Exposure Data Summaries (*Continued*). *n*-Hexane (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.2	2.4×10^{-2}	9.1				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1-hr sampling period.
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	2.5×10^{1}						*n*-hexane data not reported in journal article; data obtained through email communication with Ron Williams of EPA.
Batterman et al. (2002)	4 days (over 4 weeks)	1.6×10^{1}						
Fedoruk and Kerger (2003)	90 minutes	1.8						Testing conducted on used 1993 Toyota Camry.
	3 90-minute tests	2.4×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests	5.2						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry. Benzene detected only during testing of used 1993 Toyota Camry.
Zielinska et al. (1998)	1 yr		3.5×10^{-1}	7.5				
	~ 1 week to 2 months		1.6	1.9×10^{3}				

Table B.14. Ambient and Outdoor Exposure Data Summaries. Lead Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—$PM_{2.5}$ Pb	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	13,927		µg/m³	Calculated from annual summary report		9.6×10^{-1}
Children's Environ-mental Health Protection Program	Barrio Logan monitoring data summary —TSP Pb	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	61	100%	µg/m³	Calculated by Gradi-ent Corp. from study data set	1.4×10^{-3}	6.5×10^{-2}
	Boyle Heights monitoring data summary —TSP Pb	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	99%	µg/m³	Calculated by Gradi-ent Corp. from study data set	$< 4 \times 10^{-3}$	6.3×10^{-2}
	Crockett monitoring data summary —TSP Pb	Crockett	CA	Urban	Oct 2001–Feb 2003	24 hrs	60	82%	µg/m³	Calculated by Gradi-ent Corp. from study data set	$< 4 \times 10^{-3}$	6.1×10^{-2}
	Fresno monitoring data summary —PM_{10} Pb	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	94%	µg/m³	Calculated by Gradi-ent Corp. from study data set	$< 3 \times 10^{-3}$	2.3×10^{-2}
	Fruitvale monitoring data summary —TSP Pb	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	98%	µg/m³	Calculated by Gradi-ent Corp. from study data set	2.0×10^{-3}	8.2×10^{-2}
	Wilmington monitoring data summary —TSP Pb	Wilming-ton	CA	Urban	May 2001–July 2002	24 hrs	68	96%	µg/m³	Calculated by Gradi-ent Corp. from study data set	$< 4 \times 10^{-3}$	4.0×10^{-2}
Martuzevi-cius et al. (2004)	Greater Cincinnati $PM_{2.5}$ monitoring study data summary —$PM_{2.5}$ Pb	Cincinnati	OH	Roadside and urban	Dec 2001–Nov 2002	24 hrs	Total of 219 daily $PM_{2.5}$ samples		µg/m³	Directly from reference		
EPA (2004)	Atlanta GA —$PM_{2.5}$ Pb	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	8.0×10^{-3}
	Boulder CO —$PM_{2.5}$ Pb	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	3.6×10^{-2}

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	4.8×10^{-3}	1.0×10^{-3}	5.5×10^{-2}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	~ 1.5 yrs	1.9×10^{-2}						
	~ 14 months	2.7×10^{-2}						
	~ 1.5 yrs	7.9×10^{-3}						
	8 months	9.2×10^{-3}						
	~ 1.5 yrs	1.4×10^{-2}						
	~ 1 yr	1.3×10^{-2}						
Martuzevicius et al. (2004)	5–23 days, ranges across sites		1.8×10^{-3}	2.8×10^{-2}				
EPA (2004)	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	5.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA (2004) (*Continued*)	Burlington VT —$PM_{2.5}$ Pb	Burlington	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Calculated by Gradient Corp. from annual summary report	$< 6 \times 10^{-3}$	1.6×10^{-2}
	Chicago IL —$PM_{2.5}$ Pb	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	4.0×10^{-2}
	Detroit MI —$PM_{2.5}$ Pb	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	3.4×10^{-2}
	Houston TX —$PM_{2.5}$ Pb	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	7.0×10^{-3}
	Minneapolis MN—$PM_{2.5}$ Pb	Minneapolis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	6.6×10^{-2}
	Philadelphia PA—$PM_{2.5}$ Pb	Philadelphia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	2.5×10^{-2}
	Phoenix AZ —$PM_{2.5}$ Pb	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	2.0×10^{-2}
	Riverside-Rubidoux CA—$PM_{2.5}$ Pb	Riverside-Rubidoux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	2.6×10^{-2}
	Sacramento CA—$PM_{2.5}$ Pb	Sacramento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	$< 5 \times 10^{-3}$	4.4×10^{-2}
	Seattle WA —$PM_{2.5}$ Pb	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	7.8×10^{-2}
	St Louis MO —$PM_{2.5}$ Pb	St Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	9.0×10^{-2}
Riediker et al. (2003)	Ambient air data summary —$PM_{2.5}$ Pb	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	7.2×10^{-3}
	In-vehicle data summary for NC state police patrol cars —$PM_{2.5}$ Pb	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	1.2×10^{-2}

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
EPA (2004) (*Continued*)	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	5.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	5.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	4.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.4×10^{-2}						1 of 13 sites featured in PM CD to represent cross-section of US.
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	2.0×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 PM to midnight) over 25 days	2.4×10^{-3}						Minimum concentration of 0.0 is as reported in publication.

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Riediker et al. (2003) (*Continued*)	Roadside sample data summary —$PM_{2.5}$ Pb	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	2.7×10^{-2}
Chellam et al. (2005)	Tunnel data summary —$PM_{2.5}$ Pb	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	µg/m³	Directly from reference	5.9×10^{-3}	3.8×10^{-2}
Kinney et al. (2002)	Summary of summer residential outdoor data—$PM_{2.5}$ Pb	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
	Summary of winter residential outdoor data—$PM_{2.5}$ Pb	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary —PM_{10} Pb	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	typically 24 hrs	1081	86%	µg/m³	Directly from reference	$< 1 \times 10^{-4}$	5.8×10^{-2}
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary —TSP Pb	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated Pb	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles—$PM_{2.5}$ Pb	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	12 (invalid samples for 4 commutes)	2%>MDL for all LA samples	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento—$PM_{2.5}$ Pb	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	1%>MDL for all Sacramento samples	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles—$PM_{2.5}$ Pb	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	2%>MDL for all LA samples	µg/m³	Directly from reference	0.0	6.0×10^{-2}
	In-vehicle data summary, Sacramento—$PM_{2.5}$ Pb	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	1%>MDL for all Sacramento samples	µg/m³	Directly from reference	0.0	5.0×10^{-2}

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Riediker et al. (2003) (*Continued*)	50 late-shift patrols (3 PM to midnight) over 25 days	4.3×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
Chellam et al. (2005)								
Kinney et al. (2002)	8 weeks	6.6×10^{-3}						
	8 weeks	7.0×10^{-3}						
Pratt et al. (2000)	1–9 yrs	5.0×10^{-3}			4.0×10^{-3}			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	2.0×10^{-2}						Report concluded that mobile sources were dominant pollutant sources.
	1 yr		2.9×10^{-3}	4.8×10^{-2}				Range represents separate modeling estimates for point sources and area sources. Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Rodes et al. (1998)	2–4 commutes		0.0	2.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.0×10^{-2}	2.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		0.0	3.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		0.0	4.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.

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Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	Roadside sampling data summary, Los Angeles—$PM_{2.5}$ Pb	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	2%> MDL for all LA samples	µg/m³	Directly from reference	0.0	6.0×10^{-2}
	Roadside sampling data summary, Sacramento—$PM_{2.5}$ Pb	Sacra-mento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	1%> MDL for all Sacramento samples	µg/m³	Directly from reference	0.0	4.0×10^{-2}
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—Lead Compounds	Nation-wide—all rural counties	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—Lead Compounds	Nation-wide—all urban counties	US	Urban	1996				µg/m³	Directly from reference		

Table B.14. Ambient and Outdoor Exposure Data Summaries (*Continued*). Lead Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Rodes et al. (1998) (*Continued*)	2–4 commutes		1.0×10^{-2}	2.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.0×10^{-2}	2.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	9.7×10^{-4}			1.7×10^{-4}			Mobile sources estimated to account for 17% of nationwide mean.
	1 yr (annual average)	7.3×10^{-3}			3.0×10^{-3}			Mobile sources estimated to account for 57% of nationwide mean.

Table B.15. Ambient and Outdoor Exposure Data Summaries. Manganese Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—$PM_{2.5}$ Mn	Nationwide	US	Urban, suburban, rural	2003	24 hrs	13,927		µg/m³	Calculated by Gradient Corp. from annual summary report		1.2
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—TSP Mn	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	61	100%	µg/m³	Calculated by Gradient Corp. from study data set	4.6×10^{-3}	1.7×10^{-1}
	Boyle Heights monitoring data summary—TSP Mn	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	99%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	6.1×10^{-2}
	Crockett monitoring data summary—TSP Mn	Crockett	CA	Urban	Oct 2001–Feb 2003	24 hrs	60	98%	µg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	7.0×10^{-2}
	Fresno monitoring data summary—PM_{10} Mn	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	100%	µg/m³	Calculated by Gradient Corp. from study data set	6.0×10^{-3}	1.2×10^{-1}
	Fruitvale monitoring data summary—TSP Mn	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	100%	µg/m³	Calculated by Gradient Corp. from study data set	3.0×10^{-3}	4.9×10^{-2}
	Wilmington monitoring data summary—TSP Mn	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	68	100%	µg/m³	Calculated by Gradient Corp. from study data set	4.4×10^{-3}	9.3×10^{-2}
Martuzevicius et al. (2004)	Greater Cincinnati $PM_{2.5}$ monitoring study data summary—$PM_{2.5}$ Mn	Cincinnati	OH	Roadside and urban	Dec 2001–Nov 2002	24 hrs	Total of 219 daily $PM_{2.5}$ samples		µg/m³	Directly from reference		
EPA (2004)	Atlanta GA—$PM_{2.5}$ Mn	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.1×10^{-2}
	Boulder CO—$PM_{2.5}$ Mn	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.5×10^{-2}

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	3.1×10^{-3}	5.0×10^{-4}	8.7×10^{-2}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	17 months	3.1×10^{-2}						
	~ 15 months	2.6×10^{-2}						
	~ 1.5 yrs	1.9×10^{-2}						
	6 months	3.8×10^{-2}						
	6 months	1.8×10^{-2}						
	~ 15 months	2.9×10^{-2}						
Martuzevicius et al. (2004)	5–23 days, ranges across sites		1.6×10^{-3}	1.1×10^{-2}				
EPA (2004)	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA (2004) (*Continued*)	Burlington VT—$PM_{2.5}$ Mn	Burlington	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	7.0×10^{-3}
	Chicago IL—$PM_{2.5}$ Mn	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.4×10^{-2}
	Detroit MI—$PM_{2.5}$ Mn	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	2.5×10^{-2}
	Houston TX—$PM_{2.5}$ Mn	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.3×10^{-2}
	Minneapolis MN—$PM_{2.5}$ Mn	Minneapolis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	9.0×10^{-3}
	Philadelphia PA—$PM_{2.5}$ Mn	Philadelphia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	9.0×10^{-3}
	Phoenix AZ—$PM_{2.5}$ Mn	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	2.7×10^{-2}
	Riverside-Rubidoux, CA—$PM_{2.5}$ Mn	Riverside-Rubidoux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.5×10^{-2}
	Sacramento CA—$PM_{2.5}$ Mn	Sacramento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	$< 2 \times 10^{-3}$	1.3×10^{-2}
	Seattle WA—$PM_{2.5}$ Mn	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	2.4×10^{-2}
	St. Louis MO—$PM_{2.5}$ Mn	St. Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.3×10^{-1}
Riediker et al. (2003)	Ambient air data summary—$PM_{2.5}$ Mn	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	6.1×10^{-3}
	In-vehicle data summary for NC state police patrol cars—$PM_{2.5}$ Mn	Wake County	NC	In-vehicle and urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	1.34×10^{-2}
	Roadside data summary—$PM_{2.5}$ Mn	Wake County	NC	Roadside and urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	3.0×10^{-4}	9.4×10^{-3}

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
EPA (2004) (*Continued*)	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	4.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	4.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	4.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.4×10^{-2}						1 of 13 sites featured in PM CD to represent cross-section of US.
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	2.9×10^{-3}						
	50 late-shift patrols (3 PM to midnight) over 25 days	4.2×10^{-3}						
	50 late-shift patrols (3 PM to midnight) over 25 days	3.2×10^{-3}						

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Chellam et al. (2005)	Tunnel data summary—$PM_{2.5}$ Mn	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	µg/m³	Directly from reference	2.3×10^{-2}	8.0×10^{-2}
Kinney et al. (2002)	Summary of summer residential outdoor data—$PM_{2.5}$ Mn	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
	Summary of winter residential outdoor data—$PM_{2.5}$ Mn	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary—PM_{10} Mn	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	typically 24 hrs	1112	94%	µg/m³	Directly from reference	$< 5 \times 10^{-5}$	7.1×10^{-2}
Rodes et al. (1998)	Ambient air station data summary, Los Angeles—$PM_{2.5}$ Mn	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	12 (invalid samples for 4 commutes)	Reported as 0%>MDL	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento—$PM_{2.5}$ Mn	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	Reported as 0%>MDL	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles—$PM_{2.5}$ Mn	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	Reported as 0%> MDL	µg/m³	Directly from reference	0.0	4.0×10^{-2}
	In-vehicle data summary, Sacraento—$PM_{2.5}$ Mn	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	Reported as 0%> MDL	µg/m³	Directly from reference	0.0	5.0×10^{-2}
	Roadside sampling data summary, Los Angeles—$PM_{2.5}$ Mn	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	Reported as 0%> MDL	µg/m³	Directly from reference	0.0	3.0×10^{-2}

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chellam et al. (2005)								
Kinney et al. (2002)	8 weeks	2.1×10^{-3}						
	8 weeks	2.4×10^{-3}						
Pratt et al. (2000)	1–9 yrs	7.0×10^{-3}			5.0×10^{-3}			
Rodes et al. (1998)	2–4 commutes		0.0	3.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		0.0	3.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		0.0	3.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		0.0	3.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		0.0	1.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Rodes et al. (1998) (*Continued*)	Roadside sampling data summary, Sacramento—$PM_{2.5}$ Mn	Sacra-mento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	Reported as 0%> MDL	µg/m³	Directly from reference	0.0	4.0×10^{-2}
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—Manganese Compounds	Nation-wide	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—Manganese Compounds	Nation-wide	US	Urban	1996				µg/m³	Directly from reference		

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Table B.15. Ambient and Outdoor Exposure Data Summaries (*Continued*). Manganese Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998) (*Continued*)	1–4 commutes		1.0×10^{-2}	2.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	1.9×10^{-3}			3.2×10^{-4}			Mobile sources estimated to account for 1% of nationwide mean.
	1 yr (annual average)	3.5×10^{-3}			1.8×10^{-3}			Mobile sources estimated to account for 6% of nationwide mean.

Table B.16. Ambient and Outdoor Exposure Data Summaries. Mercury Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—particulate ($PM_{2.5}$) Hg	Nationwide	US	Urban, suburban and rural	2003	24 hrs	13,927		µg/m³	Calculated by Gradient Corp. from annual summary report		2.8×10^{-2}
Children's Environmental Health Protection Program	Boyle Heights monitoring data summary—particulate (TSP) Hg	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	1%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3 \times 10^{-3}$	3.3×10^{-3}
	Crockett monitoring data summary—particulate (TSP) Hg	Crockett	CA	Urban	Oct 2001–Feb 2003	24 hrs	60	12%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3 \times 10^{-3}$	4.7×10^{-3}
	Fresno monitoring data summary—particulate (PM_{10}) Hg	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	9%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3 \times 10^{-3}$	5.0×10^{-3}
	Fruitvale monitoring data summary—particulate (TSP) Hg	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	11%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3 \times 10^{-3}$	5.0×10^{-3}
	Wilmington monitoring data summary—particulate (TSP) Hg	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	68	10%	µg/m³	Calculated by Gradient Corp. from study data set	$< 3 \times 10^{-3}$	6.5×10^{-3}
Riediker et al. (2003)	Ambient air data summary—particulate ($PM_{2.5}$) Hg	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	9.5×10^{-3}
	In-vehicle data summary for NC state police patrol cars—particulate ($PM_{2.5}$) Hg	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	5.3×10^{-3}
	Roadside sample data summary—particulate ($PM_{2.5}$) Hg	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	9.8×10^{-3}

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Table B.16. Ambient and Outdoor Exposure Data Summaries (*Continued*). Mercury Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	2.0×10^{-3}	8.0×10^{-4}	3.0×10^{-3}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	~ 15 months	1.5×10^{-3}						
	~ 1.5 yrs	1.7×10^{-3}						
	8 months	1.7×10^{-3}						
	~ 1.5 yrs	1.8×10^{-3}						
	~ 1 yr	1.8×10^{-3}						
Riediker et al. (2003)	50 late-shift patrols (3 pm to midnight) over 25 days	2.9×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 pm to midnight) over 25 days	1.1×10^{-3}						Minimum concentration of 0.0 is as reported in publication.
	50 late-shift patrols (3 pm to midnight) over 25 days	3.8×10^{-3}						Minimum concentration of 0.0 is as reported in publication.

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Table B.16. Ambient and Outdoor Exposure Data Summaries (*Continued*). Mercury Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Carpi and Chen (2002)	NYC background data summary—gaseous Elemental Hg	New York City	NY	Urban	June–Nov 2000	5 min continuous measurements	967–2551 per site		µg/m³	Directly from reference		1.8×10^{-2}
Chen et al. (2004)	Connecticut statewide monitoring data summary—total gaseous Mercury (TGM)	Multiple locations	CT	Urban and rural	Jan 1997–Dec 1999	Weekly			µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary—particulate (PM_{10}) Hg	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	86	0%	µg/m³	Directly from reference	$< 5.7 \times 10^{-2}$	$< 5.7 \times 10^{-2}$
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—Mercury Compounds	Nationwide—all rural counties	US	Rural	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—Mercury Compounds	Nationwide—all urban counties	US	Urban	1996				µg/m³	Directly from reference		
McCarty et al. (2004)	Lake Michigan long-term particulate-phase Hg data summary	Multiple locations	WI, MI, IL, IN	Urban and rural	June 1994–Oct 1995	Weekly	Total of 397 (between 74 to 83 per site)	100%	µg/m³	Directly from reference	1.1×10^{-6}	4.9×10^{-4}
	Lake Michigan long-term vapor-phase Hg data summary	Multiple locations	WI, MI, IL, IN	Urban and rural	June 1994–Oct 1995	Weekly	Total of 386 (between 73 to 80 per site)	100%	µg/m³	Directly from reference	1.6×10^{-3}	2.2×10^{-2}

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Table B.16. Ambient and Outdoor Exposure Data Summaries (*Continued*). Mercury Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Carpi and Chen (2002)	5–12 days		2.7×10^{-3}	4.6×10^{-3}				
Chen et al. (2004)	3 yr average	2.1×10^{-3}	1.6×10^{-3}	3.8×10^{-3}				
Pratt et al. (2000)								
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	1.6×10^{-3}			1.5×10^{-3}			Mobile sources estimated to account for 0.2% of nationwide mean.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	2.2×10^{-3}			1.8×10^{-3}			Mobile sources estimated to account for 1.7% of nationwide mean.
McCarty et al. (2004)	~ 17 months	3.1×10^{-5}	1.2×10^{-5}	7.4×10^{-5}		1.1×10^{-5}	5.4×10^{-5}	Maximum site average concentration for urban stations near Chicago; statistics exclude 2 samples collected at George Washington HS in East Chicago IN.
	~ 17 months	2.4×10^{-3}	2.1×10^{-3}	3.6×10^{-3}		1.9×10^{-3}	2.9×10^{-3}	Maximum site average concentration for urban stations near Chicago; statistics exclude 1 sample collected at George Washington HS in East Chicago IN.

Table B.17. Ambient and Outdoor Exposure Data Summaries. MTBE (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, suburban and rural	2003	24 hrs	1,550	25%	µg/m³ (converted from ppb)	Directly from reference	7.2×10^{-2}	3.7×10^{1}
EPA Air Quality System (AQS) Data-base (via AIRData website)	HAP monitor values report data summary	Nation-wide	US	Urban, suburban and rural	2003	Primarily 24 hrs	8,102		µg/m³ (converted from ppbC)	Calculated by Gradient Corp. from annual summary report		1.2×10^{2}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	1.6	2.2×10^{1}
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	71	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	2.7	3.6×10^{1}
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	77	68%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	< 1.1	5.4
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	82%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	< 1.1	2.3×10^{1}
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	81	72%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	< 1.1	8.7
	Wilmington monitoring data summary	Wilming-ton	CA	Urban	July 2001–July 2002	24 hrs	57	100%	µg/m³ (con-verted from ppb)	Calculated by Gradient Corp. from study data set	1.7	3.4×10^{1}
Payne-Sturges et al. (2004)	Baltimore outdoor air data summary	Baltimore	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		8.7 (P90)

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Table B.17. Ambient and Outdoor Exposure Data Summaries (*Continued*). MTBE (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	3.2			1.8			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.1	3.6×10^{-2}	1.2×10^{1}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 24-hr sampling period.
Children's Environmental Health Protection Program	17 months	9.0						
	~ 16 months	1.1×10^{1}						
	~ 1.5 yrs	1.6						
	1 yr	3.8						
	~ 1.5 yrs	2.4						
	~ 1 yr	8.3						
Payne-Sturges et al. (2004)	18 months	4.4			4.3			

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Table B.17. Ambient and Outdoor Exposure Data Summaries (*Continued*). MTBE (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	35		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive	Los Angeles	CA	Urban and suburban	June–July 1997	90 minutes	1	100%	µg/m³	Directly from reference	5.8	5.8
	Data summary for in-vehicle measurements during extreme heat/static conditions	Foxboro	MA	Urban and suburban	June–July 1997	90 minutes	3	0%	µg/m³	Directly from reference	$< 9.0 \times 10^{-1}$	$< 9.0 \times 10^{-1}$
	Data summary for in-vehicle measurements during moderate heat/static conditions	Foxboro	MA	Urban	June–July 1997	90 minutes	3	33%	µg/m³	Directly from reference	$< 9.0 \times 10^{-1}$	2.6
Rodes et al. (1998)	Ambient air station data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	92%> MDL for all Sacramento samples	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	100%	µg/m³	Directly from reference	2.0×10^{1}	9.0×10^{1}
	In-vehicle data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	92%> MDL for all Sacramento samples	µg/m³	Directly from reference	1.4	3.6×10^{1}
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Directly from reference	6.9	5.9×10^{1}
	Roadside sampling data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	92%> MDL for all Sacramento samples	µg/m³	Directly from reference	1.1	1.4×10^{1}

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Table B.17. Ambient and Outdoor Exposure Data Summaries (*Continued*). MTBE (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Kinney et al. (2002)	8 weeks	1.3×10^1						
	8 weeks	1.2×10^1						
Fedoruk and Kerger (2003)	90 minutes	5.8						Testing conducted on used 1993 Toyota Camry.
	3 90-minute tests	Not provided						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests	2.6						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
Rodes et al. (1998)	2–4 commutes		9.7	2.6×10^1				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		2.0	6.7				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		3.1×10^1	6.0×10^1				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		1.4	3.0×10^1				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		1.5×10^1	3.2×10^1				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.1	1.1×10^1				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

Table B.18. Ambient and Outdoor Exposure Data Summaries. Naphthalene (*Columns continue on next page*)

		Study Location(s)									Individual Sample Measurement Range	
Source	Data Description	City or County	State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Minimum	Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary	Multiple locations	OR, TX	Urban and suburban	2003	Primarily 24 hrs	190		µg/m³	Calculated by Gradient Corp. from annual summary report		6.9×10^{-1}
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		µg/m³	Directly from reference		
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle and urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	90%	µg/m³	Directly from reference	$< 1 \times 10^{-1}$	3.8
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³	Directly from reference	0.0	2.0
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³	Directly from reference	1.7×10^{-1}	1.8

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Table B.18. Ambient and Outdoor Exposure Data Summaries (*Continued*). Naphthalene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	8.4×10^{-2}	1.2×10^{-3}	3.7×10^{-1}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 24-hr sampling period.
Eiguren-Fernandez et al. (2004)	~ 1 yr		7.4×10^{-2}	5.8×10^{-1}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Batterman et al. (2002)	4 days (over 4 weeks)	1.2						
Zielinska et al. (1998)	1 yr		9.5×10^{-3}	8.2×10^{-1}				
	~ 1 week to 2 months		2.6×10^{-1}	8.9×10^{-1}				

Table B.19. Ambient and Outdoor Exposure Data Summaries. Nickel Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary—$PM_{2.5}$ Ni	Nationwide	US	Urban, suburban, rural	2003	24 hrs	13,927		μg/m³	Calculated by Gradient Corp. from annual summary report		1.1×10^{-1}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—TSP Ni	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	61	93%	μg/m³	Calculated by Gradient Corp. from study data set	$< 4.7 \times 10^{-3}$	2.2×10^{-2}
	Boyle Heights monitoring data summary—TSP Ni	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	68	90%	μg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	3.1×10^{-2}
	Crockett monitoring data summary—TSP Ni	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	60	83%	μg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	4.6×10^{-2}
	Fresno monitoring data summary—PM_{10} Ni	Fresno	CA	Urban	Aug 2002–Feb 2003	24 hrs	34	85%	μg/m³	Calculated by Gradient Corp. from study data set	$< 1.0 \times 10^{-3}$	9.0×10^{-3}
	Fruitvale monitoring data summary—TSP Ni	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	53	89%	μg/m³	Calculated by Gradient Corp. from study data set	$< 2.0 \times 10^{-3}$	1.0×10^{-2}
	Wilmington monitoring data summary—TSP Ni	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	68	100%	μg/m³	Calculated by Gradient Corp. from study data set	2.2×10^{-3}	2.7×10^{-2}
Martuzevicius et al. (2004)	Greater Cincinnati $PM_{2.5}$ monitoring study data summary—$PM_{2.5}$ Ni	Cincinnati	OH	Roadside, urban	Dec 2001–Nov 2002	24 hrs	Total of 219 daily $PM_{2.5}$ samples		μg/m³	Directly from reference		
EPA (2004)	Atlanta GA—$PM_{2.5}$ Ni	Atlanta	GA	Urban	Oct 2001–Sept 2002	24 hrs	183		μg/m³	Directly from reference	$< 1 \times 10^{-3}$	2.0×10^{-3}
	Boulder CO—$PM_{2.5}$ Ni	Boulder	CO	Urban	Oct 2001–Sept 2002	24 hrs	161		μg/m³	Directly from reference	1.0×10^{-3}	1.0×10^{-2}

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.7×10^{-3}	3.0×10^{-4}	1.8×10^{-2}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages).
Children's Environmental Health Protection Program	17 months	5.2×10^{-3}						
	~ 15 months	6.8×10^{-3}						
	~ 1.5 yrs	4.4×10^{-3}						
	6 months	3.1×10^{-3}						
	6 months	3.8×10^{-3}						
	~ 1 yr	1.1×10^{-2}						
Martuzevicius et al. (2004)	5–23 days, ranges across sites		2.3×10^{-4}	4.6×10^{-3}				
EPA (2004)	1 yr	Not provided						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
EPA (2004) (*Continued*)	Burlington VT—$PM_{2.5}$ Ni	Burling-ton	VT	Urban	Oct 2001–Sept 2002	24 hrs	201		µg/m³	Directly from reference	1.0×10^{-3}	2.2×10^{-2}
	Chicago IL—$PM_{2.5}$ Ni	Chicago	IL	Urban	Oct 2001–Sept 2002	24 hrs	139		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	7.0×10^{-3}
	Detroit MI—$PM_{2.5}$ Ni	Detroit	MI	Urban	Oct 2001–Sept 2002	24 hrs	189		µg/m³	Directly from reference	1.0×10^{-3}	2.2×10^{-2}
	Houston TX—$PM_{2.5}$ Ni	Houston	TX	Urban	Oct 2001–Sept 2002	24 hrs	229		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	4.7×10^{-2}
	Minneapolis MN—$PM_{2.5}$ Ni	Minn-eapolis	MN	Urban	Oct 2001–Sept 2002	24 hrs	163		µg/m³	Directly from reference	1.0×10^{-3}	1.4×10^{-2}
	Philadelphia PA—$PM_{2.5}$ Ni	Phila-delphia	PA	Urban	Oct 2001–Sept 2002	24 hrs	262		µg/m³	Directly from reference	1.0×10^{-3}	1.3×10^{-1}
	Phoenix AZ—$PM_{2.5}$ Ni	Phoenix	AZ	Urban	Oct 2001–Sept 2002	24 hrs	275		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	1.3×10^{-1}
	Riverside-Rubidoux CA—$PM_{2.5}$ Ni	River-side-Rubidoux	CA	Urban	Oct 2001–Sept 2002	24 hrs	161		µg/m³	Directly from reference	6.0×10^{-3}	1.4×10^{-2}
	Sacramento CA—$PM_{2.5}$ Ni	Sacra-mento	CA	Urban	Oct 2001–Sept 2002	24 hrs	265		µg/m³	Directly from reference	1.0×10^{-3}	6.1×10^{-1}
	Seattle WA—$PM_{2.5}$ Ni	Seattle	WA	Urban	Oct 2001–Sept 2002	24 hrs	314		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	2.0×10^{-2}
	St Louis MO—$PM_{2.5}$ Ni	St Louis	MO	Urban	Oct 2001–Sept 2002	24 hrs	324		µg/m³	Directly from reference	$< 1 \times 10^{-3}$	4.0×10^{-2}
Riediker et al. (2003)	Ambient air data summary —$PM_{2.5}$ Ni	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	0.0
	In-vehicle data summary for NC state police patrol cars—$PM_{2.5}$ Ni	Wake County	NC	In-vehicle and urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	3.0×10^{-4}

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
EPA (2004) (*Continued*)	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	6.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	3.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	1.0×10^{-2}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
	1 yr	2.0×10^{-3}						1 of 13 sites featured in PM CD to represent cross-section of US.
Riediker et al. (2003)	50 late-shift patrols (3 pm to midnight) over 25 days	0.0						Minimum/maximum/mean concentrations of 0.0 is as reported in publication.
	50 late-shift patrols (3 pm to midnight) over 25 days	0.0						Mean concentration of 0.0 is as reported in publication.

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Riediker et al. (2003) (*Continued*)	Roadside sample data summary—$PM_{2.5}$ Ni	Wake County	NC	Roadside and urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50		µg/m³	Directly from reference	0.0	9.0×10^{-4}
Chellam et al. (2005)	Tunnel data summary—$PM_{2.5}$ Ni	Houston	TX	Tunnel and urban	8/29/00–9/1/00	2 hrs	6	100%	µg/m³	Directly from reference	1.0×10^{-3}	8.4×10^{-2}
Kinney et al. (2002)	Summary of summer residential outdoor data —$PM_{2.5}$ Ni	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
	Summary of winter residential outdoor data—$PM_{2.5}$ Ni	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary—PM_{10} Ni Subsulfide or compounds	State-wide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	typically 24 hrs	1102	5%	µg/m³	Directly from reference	$< 2.2 \times 10^{-3}$	2.0×10^{-2}
South Coast Air Quality Management District (AQMD) (2000)	Fixed Site sampling data summary —TSP Ni	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary—simulated Ni	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles—$PM_{2.5}$ Ni	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	12 (invalid samples for 4 commutes)	Reported as 0%>MDL	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento—$PM_{2.5}$ Ni	Sacra-mento	CA	Urban	9/9/97–9/16/97	2 hrs	12	Reported as 0%>MDL	µg/m³	Directly from reference		

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Riediker et al. (2003) (*Continued*)	50 late-shift patrols (3 pm to midnight) over 25 days	0.0						Minimum/average concentrations of 0.0 is as reported in publication.
Chellam et al. (2005)								
Kinney et al. (2002)	8 weeks	1.2×10^{-2}						
	8 weeks	3.2×10^{-2}						
Pratt et al. (2000)	1–9 yrs	1.0×10^{-3}			0.0			
South Coast Air Quality Management District (AQMD) (2000)	1 yr	8.7×10^{-3}						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	7.8×10^{-3}						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Rodes et al. (1998)	2–4 commutes		0.0	1.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		0.0	1.0×10^{-2}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	In-vehicle data summary, Los Angeles —$PM_{2.5}$ Ni	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	3.0×10^{-2}
	In-vehicle data summary, Sacramento—$PM_{2.5}$ Ni	Sacra-mento	CA	In-vehicle and urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	3.0×10^{-2}
	Roadside sampling data summary, Los Angeles—$PM_{2.5}$ Ni	Los Angeles	CA	In-vehicle and urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	3.0×10^{-2}
	Roadside sampling data summary, Sacramento—$PM_{2.5}$ Ni	Sacra-mento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	Reported as 0%>MDL	µg/m³	Directly from reference	0.0	2.0×10^{-2}
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results—Nickel Compounds	Nation-wide	US	Roadside, urban	1996				µg/m³	Directly from reference		
	Summary of urban modeling results—Nickel Compounds	Nation-wide	US	Urban	1996				µg/m³	Directly from reference		

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Table B.19. Ambient and Outdoor Exposure Data Summaries (*Continued*). Nickel Compounds (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Rodes et al. (1998) (*Continued*)	2–4 commutes		0.0	2.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		0.0	3.0×10^{-2}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		0.0	1.0×10^{-2}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		0.0	0.0				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	5.7×10^{-4}			1.0×10^{-4}			Mobile sources estimated to account for 6% of nationwide mean.
	1 yr (annual average)	2.7×10^{-3}			1.4×10^{-3}			Mobile sources estimated to account for 17% of nationwide mean.

Table B.20a. Ambient and Outdoor Exposure Data Summaries. POM: Total PAH as Surrogate (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Children's Environmental Health Protection Program	Fresno monitoring data summary—continuous particle-bound total PAH	Fresno	CA	Urban	June 2002–Aug 2003	Continuous (reported as hrly average)	10,302	99.99%	ng/m³	Calculated by Gradient Corp. from study data set	0.0	2.9×10^2
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—particle ($PM_{2.5}$) and gas-phase total PAH	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Fitz et al. (2003)	In-vehicle data summary for school bus study—continuous particle-bound total PAH	Los Angeles	CA	In-vehicle, urban and rural/suburban	4/22/02–6/12/02	Continuous readings during 1–1.5 hr commutes	32 bus commute runs		ng/m³	Directly from reference		
Levy et al. (2003)	Boston high-traffic community study data summary—continuous particle-bound total PAH	Boston	MA	Roadside and urban	12 days in July-Aug 2001	Continuous	307		ng/m³	Directly from reference	0.0	1.8×10^2
Riediker et al. (2003)	In-vehicle data summary for NC state police patrol cars—continuous particle-bound total PAH	Wake County	NC	In-vehicle, urban	8/13/01-10/11/01	Continuous	Continuous		ng/m³	Directly from reference		
Sapkota and Buckley (2003)	Baltimore Harbor tunnel tollbooth data summary—continuous particle-bound total PAH	Baltimore	MD	Roadside and urban	7 weekdays between 6/18/01–6/28/01	Continuous	Continuous for 3 of 7 sampling days		ng/m³	Directly from reference		

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Table B.20a. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Total PAH as Surrogate (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Overall Arithmetic Mean and/or Range of Means: Minimum	Overall Arithmetic Mean and/or Range of Means: Maximum	Overall Median and/or Range of Medians: Overall	Overall Median and/or Range of Medians: Minimum	Overall Median and/or Range of Medians: Maximum	Notes
Children's Environmental Health Protection Program	~ 1 yr	1.2×10^1						One zero measurement recorded, with 0.4 ng/m^3 as next lowest reading.
Eiguren-Fernandez et al. (2004)	~ 1 yr		2.6×10^2	6.1×10^2				Approximate range for total PAH levels measured at the various sites, with the exception of Lompoc, a rural community with no major freeways, where the lowest levels were observed.
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		3.6×10^1	2.0×10^2				Range in mean concentrations reflects mean concentrations presented in report for three groups of exposure runs: urban route one with windows closed (morning), urban route one with windows open (afternoon), and rural/suburban route with windows open (afternoon).
Levy et al. (2003)	12 days	1.8×10^1			8.4	4.0	5.7×10^1	Median concentration range represents minimum and maximum median concentrations across all 9 sites.
Riediker et al. (2003)	50 late-shift patrols (3 pm to midnight) over 25 days	2.2×10^1						
Sapkota and Buckley (2003)	3 days of 3-hr averages					9.3	2.0×10^2	1 minute readings averaged over 3-hr time periods reported by authors; median concentration range respresents 3-hour time blocks within day with lowest and highest median concentration.

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Table B.20a. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Total PAH as Surrogate (*Columns continued from previous page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	1.2×10^{1}	1.1×10^{2}
	Houston residential outdoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.0×10^{1}	1.6×10^{2}
	Los Angeles residential outdoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	4.2	6.4×10^{1}
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase total PAH	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Both 12 and 4 hrs			ng/m³	Directly from reference	4.1	1.3×10^{2}
	Baltimore and Chesapeake Bay PAH data summary—particle-phase total PAH	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Both 12 and 4 hrs			ng/m³	Directly from reference	1.4×10^{-1}	8.3
EPA National Air Toxics Assessment (NATA)	Summary of rural modeling results —POM	Nationwide—all rural counties	US	Rural	1996				ng/m³	Directly from reference		
	Summary of urban modeling results —POM	Nationwide—all urban counties	US	Urban	1996				ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data summary—total particle- and gas-phase total PAH	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		

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Table B.20a. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Total PAH as Surrogate (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Overall Arithmetic Mean and/or Range of Means: Minimum	Overall Arithmetic Mean and/or Range of Means: Maximum	Overall Median and/or Range of Medians: Overall	Overall Median and/or Range of Medians: Minimum	Overall Median and/or Range of Medians: Maximum	Notes
Naumova et al. (2002)								
Dachs et al. (2002)	~ 1 week		1.8×10^{1}	3.9×10^{1}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites where PAH levels generally 2–3 fold higher at Baltimore site.
	~ 1 week		7.7×10^{-1}	2.1				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites where PAH levels generally 2–3 fold higher at Baltimore site.
EPA National Air Toxics Assessment (NATA)	1 yr (annual average)	2.6×10^{1}			1.2×10^{1}			Mobile sources estimated to account for 0.4% of nationwide mean.
	1 yr (annual average)	1.1×10^{2}			7.2×10^{1}			Mobile sources estimated to account for 0.4% of nationwide mean.
Odabasi et al. (1999)	5 months	4.3×10^{2}						

Table B.20b. Ambient and Outdoor Exposure Data Summaries. POM: Benz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—gas-phase	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$)	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Chellam et al. (2005)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	8.5×10^{-1}	1.3
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	3.2×10^{-3}	9.4×10^{-2}
	Elizabeth residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	3.5×10^{-2}	5.0×10^{-1}
	Houston residential outdoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	3.5×10^{-3}	5.7×10^{-1}
	Houston residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.4×10^{-3}	1.5×10^{-1}
	Los Angeles residential outdoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	1.0×10^{-3}	2.8×10^{-1}
	Los Angeles residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	8.8×10^{-4}	3.1×10^{-1}

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Table B.20b. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eiguren-Fernandez et al. (2004)	~ 1 yr		< LOD	2.4×10^{-1}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		6.3×10^{-3}	4.1×10^{-2}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Chellam et al. (2005)								
Naumova et al. (2002)	1 yr	1.6×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.4×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	2.2×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.3×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.3×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	4.1×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.

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Table B.20b. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	< LOD	3.0×10^{-2}
	Baltimore and Chesapeake Bay PAH data summary—particle-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	2.0×10^{-3}	2.0×10^{-1}
Marr et al. (1999)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Near San Francisco	CA	Tunnel, urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	3.3	1.0×10^{1}
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data—particle- and gas-phase	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 year at each site)	24 hrs	~ 60 per site		ng/m³	Directly from reference	0.0	7.5
	Summary of AZ HAPs program temporary site monitoring data—particle- and gas-phase	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		ng/m³	Directly from reference	0.0	3.8
Manchester-Neesvig et al. (2003)	Southern California PM_{10} organics measurement data summary—particle-phase (PM_{10})	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data summary—particle- and gas-phase	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		

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Table B.20b. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Dachs et al. (2002)	~ 1 week		2.0×10^{-3}	6.0×10^{-3}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
	~ 1 week		1.9×10^{-2}	8.6×10^{-2}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
Marr et al. (1999)								Minimum from light-duty bore; maximum from truck-influenced bore.
Zielinska et al. (1998)	1 yr		2.0×10^{-2}	1.5				
	~ 1 week to 2 months		1.5×10^{-1}	1.2				
Manchester-Neesvig et al. (2003)	Annual average range across sites		8.0×10^{-3}	1.9×10^{-1}				Not detected at one site (Lompoc, a rural coastal site); range represents sites with minimum and maximum annual average concentrations among 11 sites with measurable levels.
Odabasi et al. (1999)	5 months	2.1						

Table B.20c. Ambient and Outdoor Exposure Data Summaries. POM: Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maxiumum
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—particle-phase (PM_{10}) BbF	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	56	79%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.1
	Barrio Logan monitoring data summary—particle-phase (PM_{10}) BkF	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	56	50%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	4.8×10^{-1}
	Boyle Heights monitoring data summary—particle-phase (PM_{10}) BbF	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	142	93%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	9.1×10^{-1}
	Boyle Heights monitoring data summary—particle-phase (PM_{10}) BkF	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	142	51%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	3.9×10^{-1}
	Crockett monitoring data summary—particle-phase (PM_{10}) BbF	Crockett	CA	Urban	Nov 2001–May 2003	24 hrs	76	41%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	2.4×10^{-1}
	Crockett monitoring data summary—particle-phase (PM_{10}) BkF	Crockett	CA	Urban	Nov 2001–May 2003	24 hrs	76	17%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.1×10^{-1}
	Fruitvale monitoring data summary—particle-phase (PM_{10}) BbF	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	69	62%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.4
	Fruitvale monitoring data summary—particle-phase (PM_{10}) BkF	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	69	46%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	6.0×10^{-1}

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Children's Environmental Health Protection Program	~ 1.5 yrs	2.6×10^{-1}						
	~ 1.5 yrs	1.1×10^{-1}						
	15 months	1.6×10^{-1}						
	15 months	7.0×10^{-2}						
	~ 1.5 yrs	6.0×10^{-2}						
	~ 1.5 yrs	3.0×10^{-2}						
	16 months	2.2×10^{-1}						
	16 months	1.0×10^{-1}						

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maxiumum
Children's Environmental Health Protection Program (*Continued*)	Wilmington monitoring data summary—particle-phase (PM_{10}) BbF	Wilming-ton	CA	Urban	May 2001–July 2002	24 hrs	66	58%	ng/m³	Calculated by Gradi-ent Corp. from study data set	$< 5 \times 10^{-2}$	9.0×10^{-1}
	Wilmington monitoring data summary—particle-phase (PM_{10}) BkF	Wilming-ton	CA	Urban	May 2001–July 2002	24 hrs	66	33%	ng/m³	Calculated by Gradi-ent Corp. from study data set	$< 5 \times 10^{-2}$	4.0×10^{-1}
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—gas-phase BbF	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—gas-phase BkF	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$) BbF	Multiple (6) Southern California Locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$) BkF	Multiple (6) Southern California Locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Chellam et al. (2005)	Tunnel data summary—particle-phase ($PM_{2.5}$) BbF	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	6.0×10^{-1}	3.9
	Tunnel data summary—particle-phase ($PM_{2.5}$) BkF	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	6.8×10^{-1}	3.1
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—gas-phase BbF+BkF	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	4.5×10^{-3}	1.9×10^{-2}

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b,k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Children's Environmental Health Protection Program (*Continued*)	~ 1 yr	1.5×10^{-1}						
	~ 1 yr	7.0×10^{-2}						
Eiguren-Fernandez et al. (2004)	~ 1 yr		< LOD	< LOD				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		< LOD	< LOD				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		1.2×10^{-2}	9.9×10^{-2}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		5.8×10^{-3}	5.3×10^{-2}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Chellam et al. (2005)								
Naumova et al. (2002)	1 yr	8.8×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean.

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maxiumum
Naumova et al. (2002) (*Continued*)	Elizabeth residential outdoor air data summary—particle-phase ($PM_{2.5}$) BbF+BkF	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	1.1×10^{-1}	1.2
	Houston residential outdoor air data summary—gas-phase BbF+BkF	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	4.5×10^{-3}	9.5×10^{-1}
	Houston residential outdoor air data summary—particle-phase ($PM_{2.5}$) BbF+BkF	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.9×10^{-2}	4.2×10^{-1}
	Los Angeles residential outdoor air data summary—gas-phase BbF+BkF	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	4.8×10^{-3}	4.3×10^{-2}
	Los Angeles residential outdoor air data summary—particle-phase ($PM_{2.5}$) BbF+BkF	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	7.2×10^{-3}	1.7
Gigliotti et al. (2000)	Coastal New Jersey data summary—gas-phase BkF	New Brunswick and Sandy Hook	NJ	Suburban and coastal	Oct 1997–Oct 1998	24 hrs	Samples collected every 6–9 days		ng/m³	Directly from reference		
	Coastal New Jersey data summary—particle-phase BkF	New Brunswick and Sandy Hook	NJ	Suburban and coastal	Oct 1997–Oct 1998	24 hrs	Samples collected every 6–9 days		ng/m³	Directly from reference		
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase BbF+BkF	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	< LOD	1.1×10^{-2}

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Naumova et al. (2002) (*Continued*)	1 yr	4.8×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	2.7×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.1×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	9.8×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	2.0×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
Gigliotti et al. (2000)	~ 1 yr		2.7×10^{-3}	1.2×10^{-2}				Concentrations in New Brunswick generally around 2 times higher than in Sandy Hook
	~ 1 yr		1.2×10^{-1}	3.2×10^{-1}				Concentrations in New Brunswick generally around 2 times higher than in Sandy Hook
Dachs et al. (2002)	~ 1 week		< LOD	1.0×10^{-3}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maxiumum
Dachs et al. (2002) (*Continued*)	Baltimore and Chesapeake Bay PAH data summary—particle-phase BbF+BkF	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	1.8×10^{-2}	6.9×10^{-1}
Marr et al. (1999)	Tunnel data summary—particle-phase ($PM_{2.5}$) BbF	Near San Francisco	CA	Tunnel and urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	3.1	6.8
	Tunnel data summary—particle-phase ($PM_{2.5}$) BkF	Near San Francisco	CA	Tunnel and urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	1.1	3.6
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data—particle- and gas-phase BbF+BkF	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		ng/m³	Directly from reference	0.0	1.2×10^{1}
	Summary of AZ HAPs program temporary site monitoring data—particle- and gas-phase BbF+BkF	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		ng/m³	Directly from reference	2.5×10^{-1}	9.7
Manchester-Neesvig et al. (2003)	Southern California PM_{10} organics measurement data summary—particle-phase (PM_{10}) BbF+BkF	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data summary—particle- and gas-phase BbF	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		
	Chicago PAH data summary—particle- and gas-phase BkF	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		

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Table B.20c. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*b,k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Dachs et al. (2002) (*Continued*)	~ 1 week		8.5×10^{-2}	2.1×10^{-1}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
Marr et al. (1999)								Minimum from light-duty bore; maximum from truck-influenced bore.
								Minimum from light-duty bore; maximum from truck-influenced bore.
Zielinska et al. (1998)	1 yr		2.2×10^{-1}	2.4				
	~ 1 week to 2 months		4.5×10^{-1}	3.1				
Manchester-Neesvig et al. (2003)	Annual average range across sites		2.1×10^{-2}	1.1				Range represents sites with minimum and maximum annual average concentrations among all 12 sites.
Odabasi et al. (1999)	5 months	2.3						
	5 months	1.9						

Table B.20d. Ambient and Outdoor Exposure Data Summaries. POM: Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—particle-phase (PM_{10})	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	56	57%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.2
	Boyle Heights monitoring data summary—particle-phase (PM_{10})	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	142	70%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	7.7×10^{-1}
	Crockett monitoring data summary—particle-phase (PM_{10})	Crockett	CA	Urban	Nov 2001–May 2003	24 hrs	76	18%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.6×10^{-1}
	Fruitvale monitoring data summary—particle-phase (PM_{10})	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	69	51%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.3
	Wilmington monitoring data summary—particle-phase (PM_{10})	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	66	45%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	7.5×10^{-1}
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—gas-phase	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$)	Multiple (6) Southern California Locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Chellam et al. (2005)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Tunnel, urban	8/29/00-9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	2.7×10^{-1}	1.9

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Table B.20d. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Children's Environmental Health Protection Program	~ 1.5 yrs	2.1×10^{-1}						
	15 months	1.0×10^{-1}						
	~ 1.5 yrs	4.0×10^{-2}						
	16 months	1.6×10^{-1}						
	~ 1 yr	1.1×10^{-1}						
Eiguren-Fernandez et al. (2004)	~ 1 yr		< LOD	< LOD				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		9.0×10^{-3}	1.0×10^{-1}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Chellam et al. (2005)								

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Table B.20d. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	$< \sim 3 \times 10^{-3}$	$< \sim 3 \times 10^{-3}$
	Elizabeth residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	4.5×10^{-2}	5.3×10^{-1}
	Houston residential outdoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	4.7×10^{-3}	5.4×10^{-2}
	Houston residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.1×10^{-3}	2.2×10^{-1}
	Los Angeles residential outdoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	5.3×10^{-3}	8.3×10^{-3}
	Los Angeles residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	8.0×10^{-4}	1.0
Gigliotti et al. (2000)	Coastal New Jersey data summary—gas-phase	New Brunswick and Sandy Hook	NJ	Suburban and coastal	Oct 1997–Oct 1998	24 hrs	Samples collected every 6–9 days		ng/m³	Directly from reference		
	Coastal New Jersey data summary—particle-phase	New Brunswick and Sandy Hook	NJ	Suburban and coastal	Oct 1997–Oct 1998	24 hrs	Samples collected every 6–9 days		ng/m³	Directly from reference		

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Table B.20d. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Naumova et al. (2002)	1 yr	$< \sim 3 \times 10^{-3}$						
	1 yr	1.8×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	2.2×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	2.0×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	6.5×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	6.2×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
Gigliotti et al. (2000)	~ 1 yr		2.3×10^{-3}	3.7×10^{-2}				Concentrations in New Brunswick generally around 2 times higher than in Sandy Hook.
	~ 1 yr		3.3×10^{-2}	8.8×10^{-2}				Concentrations in New Brunswick generally around 2 times higher than in Sandy Hook.

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Table B.20d. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs		0%	ng/m³	Directly from reference	< LOD	< LOD
	Baltimore and Chesapeake Bay PAH data summary—particle-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	4.0×10^{-3}	6.4×10^{-1}
Marr et al. (1999)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Near San Francisco	CA	Tunnel, urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	3.2	8.4
Zielinska et al. (1998)	Summary of AZ HAPs Program fixed site monitoring data—particle- and gas-phase	Multiple (5) Locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		ng/m³	Directly from reference	0.0	9.8
	Summary of AZ HAPs Program temporary site monitoring data—particle- and gas-phase	Multiple (4) Locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4-17 per site		ng/m³	Directly from reference	0.0	5.8
Manchester-Neesvig et al. (2003)	Southern California PM_{10} organics measurement data summary—particle-phase (PM_{10})	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data s ummary—particle- and gas-phase	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		

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Table B.20d. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Dachs et al. (2002)	~ 1 week		< LOD	< LOD				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
	~ 1 week		1.9×10^{-2}	1.2×10^{-1}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
Marr et al. (1999)								Minimum from light-duty bore; maximum from truck-influenced bore.
Zielinska et al. (1998)	1 yr		2.0×10^{-2}	1.8				
	~ 1 week to 2 months		1.5×10^{-1}	1.4				
Manchester-Neesvig et al. (2003)	1 yr (annual average)		3.0×10^{-3}	2.8×10^{-1}				Not detected at one site (Lompoc, a rural coastal site); range represents sites with minimum and maximum annual average concentrations among 11 sites with measurable levels.
Odabasi et al. (1999)	5 months	1.6						

Table B.20e. Ambient and Outdoor Exposure Data Summaries. POM: Chrysene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—gas-phase	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$)	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Chellam et al. (2005)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	2.7×10^{-1}	1.9
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	4.9×10^{-3}	5.4×10^{-1}
	Elizabeth residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	9.6×10^{-2}	9.1×10^{-1}
	Houston residential outdoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	3.5×10^{-2}	2.1
	Houston residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.2×10^{-2}	6.2×10^{-1}
	Los Angeles residential outdoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	1.9×10^{-3}	4.7×10^{-1}
	Los Angeles Residential Outdoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	8.3×10^{-3}	4.4×10^{-1}

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Table B.20e. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Chrysene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Eiguren-Fernandez et al. (2004)	~ 1 yr		< LOD	3.8×10^{-1}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		8.0×10^{-3}	5.7×10^{-2}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Chellam et al. (2005)								
Naumova et al. (2002)	1 yr	1.0×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	3.0×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	3.6×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	8.4×10^{-2}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	9.9×10^{-2}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.1×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean.

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Table B.20e. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Chrysene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban/ coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	< LOD	7.5×10^{-2}
	Baltimore and Chesapeake Bay PAH data summary—particle-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban/ coastal	2/19/97-2/22/97 and 7/22/97-7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	3.5×10^{-3}	1.4×10^{-1}
Marr et al. (1999)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Near San Francisco	CA	Tunnel, urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	3.2	8.4
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data—particle- and gas-phase	Multiple (5) Locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 year at each site)	24 hrs	~ 60 per site		ng/m³	Directly from reference	0.0	8.1
	Summary of AZ HAPs program temporary site monitoring data—particle- and gas-phase	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		ng/m³	Directly from reference	1.9×10^{-1}	5.0
Manchester-Neesvig et al. (2003)	Southern California PM_{10} organics measurement data summary—particle-phase (PM_{10})	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data summary—particle- and gas-phase	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hr daytime samples)			ng/m³	Directly from reference		

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Table B.20e. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Chrysene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Overall Arithmetic Mean and/or Range of Means: Minimum	Overall Arithmetic Mean and/or Range of Means: Maximum	Overall Median and/or Range of Medians: Overall	Overall Median and/or Range of Medians: Minimum	Overall Median and/or Range of Medians: Maximum	Notes
Dachs et al. (2002)	~ 1 week		7.0×10^{-3}	2.3×10^{-2}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
	~ 1 week		2.0×10^{-2}	6.3×10^{-2}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
Marr et al. (1999)								Minimum from light-duty bore; maximum from truck-influenced bore
Zielinska et al. (1998)	1 yr		2.0×10^{-2}	1.7				
	~ 1 week to 2 months		3.5×10^{-1}	1.8				
Manchester-Neesvig et al. (2003)	Annual average range across sites		1.7×10^{-2}	3.3×10^{-1}				Reported as chrysene/triphenylene; range represents sites with minimum and maximum annual average concentrations among all 12 sites.
Odabasi et al. (1999)	5 months	3.6						

Table B.20f. Ambient and Outdoor Exposure Data Summaries. POM: 7,12-Dimethylbenz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
No data identified												

Table B.20f. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: 7,12-Dimethylbenz[*a*]anthracene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
No data identified								

Table B.20g. Ambient and Outdoor Exposure Data Summaries. POM: Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary—particle-phase (PM_{10})	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	56	77%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.7
	Boyle Heights monitoring data summary—particle-phase (PM_{10})	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	142	94%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.4
	Crockett monitoring data summary—particle-phase (PM_{10})	Crockett	CA	Urban	Nov 2001–May 2003	24 hrs	76	37%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	2.9×10^{-1}
	Fruitvale monitoring data summary—particle-phase (PM_{10})	Fruitvale area of Oakland	CA	Urban	Nov 2001–Feb 2003	24 hrs	69	57%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.7
	Wilmington monitoring data summary—particle-phase (PM_{10})	Wilmington	CA	Urban	May 2001–July 2002	24 hrs	66	62%	ng/m³	Calculated by Gradient Corp. from study data set	$< 5 \times 10^{-2}$	1.1
Eiguren-Fernandez et al. (2004)	Southern California urban and rural community data summary—gas-phase	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
	Southern California urban and rural community data summary—particle-phase ($PM_{2.5}$)	Multiple (6) Southern California locations	CA	Urban and rural	May 2001–July 2002	24 hrs	Samples collected every 8 days		ng/m³	Directly from reference		
Chellam et al. (2005)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Tunnel, urban	8/29/00–9/1/00	2 hrs	6	100%	ng/m³	Directly from reference	1.4×10^{-1}	2.2
Naumova et al. (2002)	Elizabeth residential outdoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	3.5×10^{-3}	8.7×10^{-3}

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Table B.20g. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Children's Environmental Health Protection Program	~ 1.5 yrs	3.5×10^{-1}						
	15 months	1.9×10^{-1}						
	~ 1.5 yrs	7.0×10^{-2}						
	16 months	2.4×10^{-1}						
	~ 1 yr	1.8×10^{-1}						
Eiguren-Fernandez et al. (2004)	~ 1 yr		< LOD	< LOD				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
	~ 1 yr		1.2×10^{-2}	1.0×10^{-1}				Lowest levels found in Lompoc, a rural community with no major freeways; similar PAH levels observed in Atascadero, also considered a rural area, and in the urban sites.
Chellam et al. (2005)								
Naumova et al. (2002)	1 yr	5.6×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean.

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Table B.20g. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Naumova et al. (2002) (*Continued*)	Elizabeth residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	1.2×10^{-1}	2.2
	Houston residential outdoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.5×10^{-3}	7.8×10^{-2}
	Houston residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.0×10^{-2}	7.8×10^{-1}
	Los Angeles residential outdoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	$< \sim 2 \times 10^{-3}$	$< \sim 2 \times 10^{-3}$
	Los Angeles residential outdoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	4.0×10^{-3}	1.9
Dachs et al. (2002)	Baltimore and Chesapeake Bay PAH data summary—gas-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs		0%	ng/m³	Directly from reference	< LOD	< LOD
	Baltimore and Chesapeake Bay PAH data summary—particle-phase	Baltimore and adjacent Chesapeake Bay	MD	Urban and coastal	2/19/97–2/22/97 and 7/22/97–7/28/97	Either 12 or 4 hrs			ng/m³	Directly from reference	< LOD	1.4
Marr et al. (1999)	Tunnel data summary—particle-phase ($PM_{2.5}$)	Near San Francisco	CA	Tunnel, urban	7/21/97–8/5/97 (4 days of sampling in each of 2 bores)	3 hrs on 2 days	4 (2 per bore)	100%	ng/m³	Directly from reference	3.2×10^{-1}	3.1

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Table B.20g. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Naumova et al. (2002) (*Continued*)	1 yr	5.9×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	1.5×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	9.0×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean.
	1 yr	$< \sim 2 \times 10^{-3}$						
	1 yr	2.0×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean.
Dachs et al. (2002)	~ 1 week		< LOD	< LOD				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
	~ 1 week		3.3×10^{-2}	2.9×10^{-1}				Feb sampling conducted at Chesapeake Bay site only, while July sampling at both sites; average concentration range represents minimum and maximum averages from 2 sampling periods at Chesapeake Bay site and 1 sampling period at Baltimore site.
Marr et al. (1999)								Minimum from light-duty bore; maximum from truck-influenced bore.

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Table B.20g. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data—particle- and gas-phase	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 year at each site)	24 hrs	~ 60 per site		ng/m³	Directly from reference	0.0	5.4
	Summary of AZ HAPs program temporary site monitoring data—particle- and gas-phase	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		ng/m³	Directly from reference	0.0	4.1
Manchester-Neesvig et al. (2003)	Southern California PM_{10} organics measurement data summary—particle-phase (PM_{10})	Multiple (12) Southern California communities	CA	Urban and rural	1995	2 weeks	Nominally 26 per site		ng/m³	Directly from reference		
Odabasi et al. (1999)	Chicago PAH data summary—particle- and gas-phase	Chicago	IL	Urban	June–Oct 1995	24 hrs (2 12-hour daytime samples)			ng/m³	Directly from reference		

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Table B.20g. Ambient and Outdoor Exposure Data Summaries (*Continued*). POM: Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Zielinska et al. (1998)	1 yr		0.0	1.0				
	~ 1 week to 2 months		0.0	1.1				
Manchester-Neesvig et al. (2003)	Annual average range across sites		3.0×10^{-3}	1.6×10^{-1}				Range represents sites with minimum and maximum annual average concentrations among all 12 sites.
Odabasi et al. (1999)	5 months	1.2						

Table B.21. Ambient and Outdoor Exposure Data Summaries. Styrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	30%	µg/m³ (converted from ppb)	Reported	4.3×10^{-2}	1.8×10^{1}
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hr	106,187		µg/m³ (converted from ppb)	Calculated by Gradient Corp. from annual summary report		6.6×10^{1}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–July 2000	24 hrs	52	54%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	4.3
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Mar 2001–May 2002	24 hrs	69	55%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	3.6
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	7%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	9.8×10^{-1}
	Fresno monitoring data summary	Fresno	CA	Urban	July 2003 –Aug 2003	24 hrs	65	25%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	2.1
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001 –Apr 2003	24 hrs	83	34%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	2.7
	Wilmington monitoring data summary	Wilming-ton	CA	Urban	July 2001 –July 2002	24 hrs	60	70%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 4.3 \times 10^{-1}$	4.3
Payne-Sturges et al. (2004)	Baltimore outdoor air data summary	Baltimore	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		1.7 (P90)
Adgate et al. (2004b)	Minneapolis spring outdoor school data summary	Minneap-olis	MN	Urban	4/9/00–5/12/00	5 days	10	0%	µg/m³	Directly from reference		1.0×10^{-1} (P90)

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Table B.21. Ambient and Outdoor Exposure Data Summaries (*Continued*). Styrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	6.4×10^{-1}			3.4×10^{-1}			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	2.7×10^{-1}	3.2×10^{-3}	5.6				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1-hr sampling period.
Children's Environmental Health Protection Program	9 months	6.0×10^{-1}						
	~ 15 months	6.4×10^{-1}						
	~ 1.5 yrs	2.6×10^{-1}						
	1 yr	3.8×10^{-1}						
	~ 1.5 yrs	3.8×10^{-1}						
	~ 1 yr	1.0						
Payne-Sturges et al. (2004)	18 months	5.0×10^{-1}			2.5×10^{-1}			
Adgate et al. (2004b)	5 weeks				0.0			

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Table B.21. Ambient and Outdoor Exposure Data Summaries (*Continued*). Styrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Adgate et al. (2004b) (*Continued*)	Minneapolis winter outdoor school data summary	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	0%	µg/m³	Directly from reference		1.0×10^{-1} (P90)
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	95%	µg/m³	Directly from reference	$< 1.0 \times 10^{-1}$	3.5
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	30		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	2,507	60%	µg/m³	Directly from reference	$< 6.0 \times 10^{-2}$	1.5
Sexton et al. (2004)	Minneapolis-St Paul outdoor air data summary	Minneapolis	MN	Urban	Apr–Nov 1999	2 days	132	43.2%	µg/m³	Directly from reference		4.0×10^{-1} (P90)
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Adgate et al. (2004a)	Minnesota residential outdoor air data summary	Statewide	MN	Urban, nonurban	May–Sept 1997	6 days	100	39%	µg/m³	Directly from reference	$< 6.0 \times 10^{-1}$	9.0×10^{-1} (P95)

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Table B.21. Ambient and Outdoor Exposure Data Summaries (*Continued*). Styrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Adgate et al. (2004b) (*Continued*)	4 weeks				1.0×10^{-1}			
Batterman et al. (2002)	4 days (over 4 weeks)	1.1						
Kinney et al. (2002)	8 weeks	3.2×10^{-1}						
	8 weeks	4.3×10^{-1}						
Pratt et al. (2000)	1–9 yrs	1.0×10^{-1}			8.0×10^{-2}			
Sexton et al. (2004)	7 months	2.0×10^{-1}			1.0×10^{-1}			Authors note that manufacturing plant located near East St Paul neighborhood.
South Coast Air Quality Management District (AQMD) (2000)	1 yr	1.2						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	5.3×10^{-1}						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Adgate et al. (2004a)	5 months	5.0×10^{-1}						

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Table B.21. Ambient and Outdoor Exposure Data Summaries (*Continued*). Styrene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during extreme heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Directly from reference; average concentration calculated by Gradient Corp.	9.4×10^{1}	2.6×10^{2}
Mohamed et al. (2002)	1996 UATMP data summary	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Directly from reference		
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	1.5×10^{1}
	Summary of AZ HAPs program temporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	2.6×10^{-1}	3.2×10^{1}

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Table B.21. Ambient and Outdoor Exposure Data Summaries (*Continued*). Styrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Fedoruk and Kerger (2003)	3 90-minute tests	1.9×10^2						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
Mohamed et al. (2002)	1 yr		2.6×10^{-1}	1.3×10^1				Samples collected every 12 days.
Zielinska et al. (1998)	1 yr		4.3×10^{-1}	1.2				
	~ 1 week to 2 months		3.8×10^{-1}	2.4×10^1				

Table B.22. Ambient and Outdoor Exposure Data Summaries. Toulene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP data summary	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	75%	µg/m³ (converted from ppb)	Directly from reference	7.5×10^{-2}	7.9×10^{1}
EPA Air Quality System (AQS) Database (via AIRData website)	HAP monitor values report data summary	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs, some 1 hr and 3 hr	113,218		µg/m³ (converted from ppbC)	Calculated by Gradient Corp. from annual summary report		2.2×10^{2}
Children's Environmental Health Protection Program	Barrio Logan monitoring data summary	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	9.0×10^{-1}	2.5×10^{1}
	Boyle Heights monitoring data summary	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	74	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	2.8	1.0×10^{2}
	Crockett monitoring data summary	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	95%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 7.5 \times 10^{-1}$	6.8
	Fresno monitoring data summary	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	98%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	$< 7.5 \times 10^{-1}$	2.3×10^{1}
	Fruitvale monitoring data summary	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	7.5×10^{-1}	2.5×10^{1}
	Wilmington monitoring data summary	Wilming-ton	CA	Urban	July 2001–July 2002	24 hrs	60	100%	µg/m³ (converted from ppb)	Calculated by Gradient Corp. from study data set	1.2	3.3×10^{1}

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	4.4			2.6			Samples typically collected on a 6-day or 12-day schedule.
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	3.3	1.4×10^{-1}	1.3×10^{1}				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 1-hour sampling period.
Children's Environmental Health Protection Program	17 months	9.0						
	~ 15 months	1.4×10^{1}						
	~ 1.5 yrs	2.0						
	1 yr	5.3						
	~ 1.5 yrs	6.7						
	~ 1 yr	7.5						

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Fitz et al. (2003)	In-vehicle data summary for school bus study	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	20 sampling runs		µg/m³ (converted from ppb)	Directly from reference		
Payne-Sturges et al. (2004)	Baltimore outdoor air data summary	Baltimore	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		6.4 (P90)
Riediker et al. (2003)	Ambient air data summary	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46	100%	µg/m³ (converted from ppb)	Directly from reference	3.0	1.8×10^1
	In-vehicle data summary for NC state police patrol cars	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46	100%	µg/m³ (converted from ppb)	Directly from reference	8.7	4.9×10^2
	Roadside sample data summary	Wake County	NC	Roadside, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46	100%	µg/m³ (converted from ppb)	Directly from reference	2.3	1.2×10^1
Adgate et al. (2004b)	Minneapolis spring outdoor school data summary	Minneapolis	MN	Urban	4/9/00–5/12/00	5 days	10	100%	µg/m³	Directly from reference		3.6 (P90)
	Minneapolis winter outdoor school data summary	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	100%	µg/m³	Directly from reference		4.2 (P90)
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	100%	µg/m³	Directly from reference		3.3×10^1
Kinney et al. (2002)	Summary of summer residential outdoor data	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	31		µg/m³	Directly from reference		
	Summary of winter residential outdoor data	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	Directly from reference		

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		5.4×10^1	6.7×10^1				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban route one exposure runs: with windows closed (morning), and with windows open (afternoon).
Payne-Sturges et al. (2004)	18 months	4.1			3.9			
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	6.4						
	50 late-shift patrols (3 PM to midnight) over 25 days	3.9×10^1						Four excluded samples were from one car that had extreme values, which increased from shift to shift.
	50 late-shift patrols (3 PM to midnight) over 25 days	5.7						
Adgate et al. (2004b)	5 weeks				2.7			
	4 weeks				2.6			
Batterman et al. (2002)	4 days (over 4 weeks)	1.0×10^1						
Kinney et al. (2002)	8 weeks	7.5						
	8 weeks	6.5						

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Pratt et al. (2000)	Minnesota statewide monitoring data summary	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 years per site	typically 24 hrs	3650	98%	µg/m³	Directly from reference	$< 4.3 \times 10^{-1}$	7.5×10^{1}
Sexton et al. (2004)	Minneapolis-St Paul outdoor air data summary	Minneapolis	MN	Urban	Apr–Nov 1999	2 days	132	82.6%	µg/m³	Directly from reference		1.2×10^{1} (P90)
South Coast Air Quality Management District (AQMD) (2000)	Fixed site sampling data summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999	24 hrs	One 24-hr sample every six days		µg/m³	Directly from reference		
	Regional modeling analysis summary	Southern California South Coast Air Basin	CA	Primarily urban, including Los Angeles	Apr 1998–Mar 1999				µg/m³	Directly from reference		
Adgate et al. (2004a)	Minnesota residential outdoor air data summary	Statewide	MN	Varies	May–Sept 1997	6 days	100		µg/m³	Directly from reference	4.6	1.6×10^{1} (P95)
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 min	1	100%	µg/m³	Directly from reference	1.18×10^{1}	1.18×10^{1}
	Data summary for in-vehicle measurements during extreme heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 min	3	100%	µg/m³	Directly from reference	7.9×10^{1}	2.4×10^{2}
	Data summary for in-vehicle measurements during moderate heat/static conditions	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 min	3	100%	µg/m³	Directly from reference	3.8×10^{1}	9.0×10^{1}
Mohamed et al. (2002)	1996 UATMP data summary	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Directly from reference		

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Pratt et al. (2000)	1–9 yrs	3.8			2.6			
Sexton et al. (2004)	7 months	4.8			3.0			Authors note that manufacturing plant located near East St Paul neighborhood.
South Coast Air Quality Management District (AQMD) (2000)	1 yr	1.3×10^1						Report concluded that mobile sources were dominant pollutant sources.
	1 yr	1.2×10^1						Modeling included emissions for on-road mobile, area and off-road mobile, and major point sources.
Adgate et al. (2004a)	5 months	9.7						
Fedoruk and Kerger (2003)	90 min	1.18×10^1						Testing conducted on used 1993 Toyota Camry.
	3 90-min tests	1.7×10^2						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-min tests	7.1×10^1						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
Mohamed et al. (2002)	1 yr		1.4	1.0×10^1				Samples collected every 12 days.

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998)	Ambient air station data summary, Los Angeles	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Directly from reference		
	Ambient air station data summary, Sacramento	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	99%>MDL for all Sacramento samples	µg/m³	Directly from reference		
	In-vehicle data summary, Los Angeles	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	16 commutes in 2 cars (32 total)	100%	µg/m³	Directly from reference	2.3×10^1	5.8×10^1
	In-vehicle data summary, Sacramento	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	99%>MDL for all Sacramento samples	µg/m³	Directly from reference	3.2	4.6×10^1
	Roadside sampling data summary, Los Angeles	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Directly from reference	6.9	7.1×10^1
	Roadside sampling data summary, Sacramento	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	99%>MDL for all Sacramento samples	µg/m³	Directly from reference	2.1	1.5×10^1
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 year at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	6.3×10^1
	Summary of AZ HAPs program emporary site monitoring data	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 wk to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	4.2	1.2×10^2

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Table B.22. Ambient and Outdoor Exposure Data Summaries (*Continued*). Toulene (*Columns continued from previous page*)

		Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			
Source (*Continued*)	Data Averaging Period	Overall	Minimum	Maximum	Overall	Minimum	Maximum	Notes
Rodes et al. (1998)	2–4 commutes		9.6	4.0×10^{1}				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		3.7	8.2				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		3.0×10^{1}	5.1×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		3.2	3.5×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		1.6×10^{1}	4.4×10^{1}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		2.2	1.2×10^{1}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
Zielinska et al. (1998)	1 yr		2.3×10^{-1}	2.0×10^{1}				
	~ 1 week to 2 months		6.2	4.5×10^{1}				

Table B.23. Ambient and Outdoor Exposure Data Summaries. Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Eastern Research Group (ERG) (2004)	2003 UATMP—data summary—*m,p*-Xylene	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	71%	µg/m³ (con-verted from ppb)	Reported	8.7×10^{-2}	3.4×10^{1}
	2003 UATMP data summary—*o*-Xylene	Nation-wide	US	Urban, suburban, rural	2003	24 hrs	1,550	63%	µg/m³ (con-verted from ppb)	Reported	8.7×10^{-2}	1.4×10^{1}
EPA Air Quality System (AQS) Database (via AIRData website)	HAP Monitor values report data summary—*m*-Xylene	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs	2,967		µg/m³ (con-verted from ppbC)	Calculated from annual summary report		1.0×10^{1}
	HAP monitor values report data sum-mary—*o*-Xylene	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs	111,679		µg/m³ (con-verted from ppbC)	Calculated from annual summary report		6.9×10^{1}
	HAP monitor values report data sum-mary—*p*-Xylene	Nation-wide	US	Urban, suburban, rural	2003	Primarily 24 hrs	2,981		µg/m³ (con-verted from ppbC)	Calculated from annual summary report		2.1×10^{1}
Children's Environmental Health Protec-tion Program	Barrio Logan monitoring data summary—*m,p*-Xylene	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	70%	µg/m³ (con-verted from ppb)	Calculated	< 2.6	1.6×10^{1}
	Barrio Logan monitoring data summary—*o*-Xylene	San Diego	CA	Urban	Oct 1999–Feb 2001	24 hrs	69	87%	µg/m³ (con-verted from ppb)	Calculated	$< 4.3 \times 10^{-1}$	5.2
	Boyle Heights monitoring data summary—*m,p*-Xylene	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	74	100%	µg/m³ (con-verted from ppb)	Calculated	1.7	3.6×10^{1}

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Eastern Research Group (ERG) (2004)	Typically 1 yr (annual average)	2.4			1.4			
	Typically 1 yr (annual average)	1.1			6.9×10^{-1}			
EPA Air Quality System (AQS) Database (via AIRData website)	Typically 1 yr (annual average)	1.0	2.7×10^{-1}	2.3				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 3-hour sampling period.
	Typically 1 yr (annual average)	6.4×10^{-1}	6.5×10^{-3}	3.1				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 3-hour sampling period.
	Typically 1 yr (annual average)	2.1	2.7	4.6				Overall mean is the mean of all site average concentrations. Minimum and maximum average concentrations represent range in average concentrations across all sites (i.e., the lowest and highest site averages). Maximum individual sample concentration is for 3-hour sampling period.
Children's Environmental Health Protection Program	17 months	5.6						
	17 months	1.9						
	~ 15 months	1.0×10^{1}						

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Children's Environmental Health Protection Program (*Continued*)	Boyle Heights monitoring data summary—*o*-Xylene	Los Angeles	CA	Urban	Feb 2001–May 2002	24 hrs	74	100%	µg/m³ (converted from ppb)	Calculated	6.1×10^{-1}	9.5
	Crockett monitoring data summary—*m,p*-Xylene	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	69%	µg/m³ (converted from ppb)	Calculated	$< 8.7 \times 10^{-1}$	4.8
	Crockett monitoring data summary—*o*-Xylene	Crockett	CA	Urban	Oct 2001–May 2003	24 hrs	81	44%	µg/m³ (converted from ppb)	Calculated	$< 4.3 \times 10^{-1}$	1.3
	Fresno monitoring data summary—*m,p*-Xylene	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	89%	µg/m³ (converted from ppb)	Calculated	$< 8.7 \times 10^{-1}$	1.7×10^{1}
	Fresno monitoring data summary—*o*-Xylene	Fresno	CA	Urban	July 2002–Aug 2003	24 hrs	65	72%	µg/m³ (converted from ppb)	Calculated	$< 4.3 \times 10^{-1}$	6.5
	Fruitvale monitoring data summary—*m,p*-Xylene	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	92%	µg/m³ (converted from ppb)	Calculated	$< 8.7 \times 10^{-1}$	3.7×10^{1}
	Fruitvale monitoring data summary—*o*-Xylene	Fruitvale area of Oakland	CA	Urban	Nov 2001–Apr 2003	24 hrs	83	81%	µg/m³ (converted from ppb)	Calculated	$< 4.3 \times 10^{-1}$	6.5
	Wilmington monitoring data summary—*m,p*-Xylene	Wilmington	CA	Urban	July 2001–July 2002	24 hrs	60	100%	µg/m³ (converted from ppb)	Calculated	8.7×10^{-1}	2.7×10^{1}
	Wilmington monitoring data summary—*o*-Xylene	Wilmington	CA	Urban	July 2001–July 2002	24 hrs	60	95%	µg/m³ (converted from ppb)	Calculated	$< 4.3 \times 10^{-1}$	6.9

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Children's Environmental Health Protection Program (*Continued*)	~ 16 months	2.7						
	~ 1.5 yrs	1.3						
	~ 1.5 yrs	3.9×10^{-1}						
	1 yr	3.3						
	1 yr	1.2						
	6 months	5.6						
	6 months	1.6						
	~ 1 yr	6.1						
	~ 1 yr	1.7						

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Fitz et al. (2003)	In-vehicle data summary for school bus study—*m,p*-Xylene	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	20 sampling runs		µg/m³ (converted from ppb)	Reported		
	In-vehicle data summary for school bus study—*o*-Xylene	Los Angeles	CA	In-vehicle, urban	4/22/02–6/12/02	1–1.5 hrs	20 sampling runs		µg/m³ (converted from ppb)	Reported		
Payne-Sturges et al. (2004)	Baltimore outdoor air data summary—total Xylenes	Baltimore	MD	Urban	Jan 2000–June 2001	3 days	33		µg/m³	Reported		7.1 (P90)
Riediker et al. (2003)	Ambient air data summary—total xylenes	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	100%	µg/m³ (converted from ppb)	Reported	1.7	1.0×10^1
	In-vehicle data summary for NC state police patrol cars—total Xylenes	Wake County	NC	In-vehicle, urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	46 (4 excluded by authors)	100%	µg/m³ (converted from ppb)	Reported	6.1	5.3×10^1
	Roadside sample data summary—total Xylenes	Wake County	NC	Urban	8/13/01–10/11/01	7.75–14.7 hrs (average 9.1)	50	100%	µg/m³ (converted from ppb)	Reported	1.7	8.2
Adgate et al. (2004b)	Minneapolis spring outdoor school data summary—*m,p*-Xylene	Minneapolis	MN	Urban	4/9/00–5/12/00	5 days	10	100%	µg/m³	Reported		2.8 (P90)
	Minneapolis spring outdoor school data summary—*o*-Xylene	Minneapolis	MN	Urban	4/9/00–5/12/00	5 days	10	100%	µg/m³	Reported		9.0×10^{-1} (P90)
	Minneapolis winter outdoor school data summary—*m,p*-Xylene	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	100%	µg/m³	Reported		3.3 (P90)

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Overall Arithmetic Mean and/or Range of Means: Minimum	Overall Arithmetic Mean and/or Range of Means: Maximum	Overall Median and/or Range of Medians: Overall	Overall Median and/or Range of Medians: Minimum	Overall Median and/or Range of Medians: Maximum	Notes
Fitz et al. (2003)	Over all exposure runs grouped by route and window position		8.7	1.9×10^{1}				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban route one exposure runs: with windows closed (morning), and with windows open (afternoon).
	Over all exposure runs grouped by route and window position		2.6	7.4				Range in mean concentrations reflects the mean concentrations provided in the report for two groups of urban route one exposure runs: with windows closed (morning), and with windows open (afternoon).
Payne-Sturges et al. (2004)	18 months	4.7			4.0			
Riediker et al. (2003)	50 late-shift patrols (3 PM to midnight) over 25 days	4.3						
	50 late-shift patrols (3 PM to midnight) over 25 days	2.0×10^{1}						4 samples out of 50 were excluded from stats = 46 samples.
	50 late-shift patrols (3 PM to midnight) over 25 days	4.3						
Adgate et al. (2004b)	5 weeks				2.0			
	5 weeks				7.0×10^{-1}			
	4 weeks				2.3			

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Adgate et al. (2004b) (*Continued*)	Minneapolis winter outdoor school data summary—*o*-Xylene	Minneapolis	MN	Urban	1/24/00–2/18/00	5 days	8	100%	µg/m³	Reported		1.1 (P90)
Batterman et al. (2002)	Across study roadway and in-bus measurement data summary—*m,p*-Xylene	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	95%	µg/m³	Reported	$< 1.0 \times 10^{-1}$	2.0×10^{1}
	Across study roadway and in-bus measurement data summary—*o*-Xylene	Detroit	MI	In-vehicle, urban	10/20/99–11/10/99 (1 day per week for 4 weeks)	3–4 hrs	74	95%	µg/m³	Reported	$< 1.0 \times 10^{-1}$	6.6
Kinney et al. (2002)	Summary of summer residential outdoor data—*m,p*-Xylene	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	30		µg/m³	Reported		
	Summary of summer residential outdoor data—*o*-Xylene	New York	NY	Urban	Summer 1999 (over 8 weeks)	2 days	30		µg/m³	Reported		
	Summary of winter residential outdoor data—*m,p*-Xylene	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	32.3		
	Summary of winter residential outdoor data—*o*-Xylene	New York	NY	Urban	Winter 1999 (over 8 weeks)	2 days	36		µg/m³	32.3		
Pratt et al. (2000)	Minnesota statewide monitoring data summary—*m,p*-Xylene	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	typically 24 hrs	2,890	98%	µg/m³	Reported	$< 1.8 \times 10^{-1}$	5.9×10^{1}

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Adgate et al. (2004b) (*Continued*)	4 weeks				8.0×10^{-1}			
Batterman et al. (2002)	4 days (over 4 weeks)	6.8						
	4 days (over 4 weeks)	2.2						
Kinney et al. (2002)	8 weeks	5.8						
	8 weeks	2.0						
	8 weeks	4.5						
	8 weeks	1.5						
Pratt et al. (2000)	1–9 yrs	2.1			1.4			

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Pratt et al. (2000) (*Continued*)	Minnesota statewide monitoring data summary—*o*-Xylene	Statewide	MN	Varied: urban, rural, industrial	1991–1999, up to 9 yrs per site	Typically 24 hrs	3650	91%	µg/m³	Reported	$< 1.4 \times 10^{-1}$	1.7×10^{1}
Sexton et al. (2004)	Minneapolis-St Paul outdoor air data summary—*m,p*-Xylene	Minneapolis	MN	Urban	Apr–Nov 1999	2 days	132	98.5%	µg/m³	Reported		5.5 (P90)
	Minneapolis-St Paul outdoor air data summary—*o*-Xylene	Minneapolis	MN	Urban	Apr–Nov 1999	2 days	132	97.0%	µg/m³	Reported		1.7 (P90)
Adgate et al. (2004a)	Minnesota residential outdoor air data summary—*m,p*-Xylene	Statewide	MN	Urban, nonurban	May–Sept 1997	6 days	100	99%	µg/m³	Reported	$< 5.0 \times 10^{-1}$	4.8 (P95)
	Minnesota residential outdoor air data summary—*o*-Xylene	Statewide	MN	Urban, nonurban	May–Sept 1997	6 days	100	98%	µg/m³	Reported	$< 3.0 \times 10^{-1}$	2.4 (P95)
Fedoruk and Kerger (2003)	Data summary for in-vehicle measurements during 90 minute drive—*m,p*-Xylene	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 min	1	100%	µg/m³	Reported	3.8	3.8
	Data summary for in-vehicle measurements during 90 minute drive—*o*-Xylene	Los Angeles	CA	In-vehicle, urban and suburban	June–July 1997	90 min	1	100%	µg/m³	Reported	1.3	1.3
	Data summary for in-vehicle measurements during extreme heat/static conditions—*m,p*-Xylene	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 min	3	100%	µg/m³	Reported	1.6×10^{1}	8.3×10^{1}

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Pratt et al. (2000) (*Continued*)	1-9 yrs	7.9×10^{-1}			5.0×10^{-1}			
Sexton et al. (2004)	7 months	2.5			2.0			Authors note that manufacturing plant located near East St Paul neighborhood.
	7 months	8.0×10^{-1}			7.0×10^{-1}			Authors note that manufacturing plant located near East St Paul neighborhood.
Adgate et al. (2004a)	5 months	3.5						Samples collected every 12 days.
	5 months	1.5						
Fedoruk and Kerger (2003)	90 min	3.8						Testing conducted for used 1993 Toyota Camry.
	90 min	1.3						Testing conducted for used 1993 Toyota Camry.
	3–90 min tests	4.6×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Fedoruk and Kerger (2003) (*Continued*)	Data summary for in-vehicle measurements during extreme heat/ static conditions—*o*-Xylene	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Reported	8.4	2.2×10^1
	Data summary for in-vehicle measurements during moderate heat/ static conditions—*m,p*-Xylene	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Reported	6.6	1.9×10^1
	Data summary for in-vehicle measurements during moderate heat/ static conditions—*o*-Xylene	Foxboro	MA	In-vehicle, urban and suburban	June–July 1997	90 minutes	3	100%	µg/m³	Reported	3.9	9.9
Mohamed et al. (2002)	1996 UATMP data summary—*m,p*-Xylene	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Reported		
	1996 UATMP data summary—*o*-Xylene	Nationwide	US	Urban, near-urban	Sept 1996–Aug 1997	24 hrs	Samples collected every 12 days		µg/m³ (converted from ppb)	Reported		
Rodes et al. (1998)	Ambient air station data summary, Los Angeles—*m,p*-Xylene	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Reported		
	Ambient air station data summary, Los Angeles—*o*-Xylene	Los Angeles	CA	Urban	9/25/97–10/3/97	2 hrs	16	100%	µg/m³	Reported		
	Ambient air station data summary, Sacramento—*m,p*-Xylene	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	92%>MDL reported for all Sacramento samples	µg/m³	Reported		

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Fedoruk and Kerger (2003) (*Continued*)	3 90-minute tests	1.3×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests	1.1×10^{1}						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
	3 90-minute tests	6.2						Three vehicles tested: new 1997 Ford Taurus, new 1997 Chevy Lumina, and used 1993 Toyota Camry.
Mohamed et al. (2002)	1 yr		9.1×10^{-1}	5.6				
	1 yr		4.8×10^{-1}	2.4				Samples collected every 12 days.
Rodes et al. (1998)	2–4 commutes		5.2	9.4				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		2.0	4.0				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1-4 commutes		1.8	5.0				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Rodes et al. (1998) (*Continued*)	Ambient air station data summary, Sacramento—*o*-Xylene	Sacramento	CA	Urban	9/9/97–9/16/97	2 hrs	12	70%>MDL reported for all Sacramento samples	µg/m³	Reported		
	In-vehicle data summary, Los Angeles—*m,p*-Xylene	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	32	100%	µg/m³	Reported	1.7×10^{1}	4.5×10^{1}
	In-vehicle data summary, Los Angeles—*o*-Xylene	Los Angeles	CA	In-vehicle, urban	9/25/97–10/3/97	2 hrs	32	100%	µg/m³	Reported	6.1	1.6×10^{1}
	In-vehicle data summary, Sacramento—*m,p*-Xylene	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	92%>MDL reported for all Sacramento samples	µg/m³	Reported	1.8	3.8×10^{1}
	In-vehicle data summary, Sacramento—*o*-Xylene	Sacramento	CA	In-vehicle, urban	9/9/97–9/16/97	2 hrs	13 commutes in 2 cars (26 total)	70%>MDL reported for all Sacramento samples	µg/m³	Reported	7.0×10^{-1}	1.3×10^{1}
	Roadside sampling data summary, Los Angeles—*m,p*-Xylene	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Reported	4.3	3.7×10^{1}
	Roadside sampling data summary, Los Angeles—*o*-Xylene	Los Angeles	CA	Roadside, urban	9/25/97–10/3/97	2 hrs	12 of the 16 commutes at 2 locations (24 total)	100%	µg/m³	Reported	1.6	1.3×10^{1}
	Roadside sampling data summary, Sacramento—*m,p*-Xylene	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	92%>MDL reported for all Sacramento samples	µg/m³	Reported	1.1	1.1×10^{1}

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998) (*Continued*)	1–4 commutes		7.0×10^{-1}	2.3				Ambient samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		2.2×10^{1}	3.6×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		7.8	1.3×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		1.8	3.1×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	1–4 commutes		7.0×10^{-1}	1.1×10^{1}				Range in average concentrations represents averages reported by commute type and car.
	2–4 commutes		9.9	2.0×10^{1}				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	2–4 commutes		3.7	7.5				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
	1–4 commutes		1.2	8.9				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Rodes et al. (1998) (*Continued*)	Roadside sampling data summary, Sacramento—*o*-Xylene	Sacramento	CA	Roadside, urban	9/9/97–9/16/97	2 hrs	9 of the 13 commutes at 2 locations (18 total)	70%>MDL reported for all Sacramento samples	µg/m³	Reported	6.0×10^{-1}	3.8
Zielinska et al. (1998)	Summary of AZ HAPs program fixed site monitoring data—*m*/*p*-Xylenes	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	4.0×10^{1}
	Summary of AZ HAPs program fixed site monitoring data—*o*-Xylene	Multiple (5) locations	AZ	Urban and rural	Apr 1994–Apr 1996 (~ 1 yr at each site)	24 hrs	~ 60 per site		µg/m³ (converted from ppb)	Directly from reference	0.0	1.4×10^{1}
	Summary of AZ HAPs program temporary site monitoring data—*m*/*p*-Xylenes	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	2.4	1.3×10^{2}
	Summary of AZ HAPs program temporary site monitoring data—*o*-Xylene	Multiple (4) locations	AZ	Urban	June 1994–Mar 1996 (~ 1 week to 2 months at each site)	24 hrs	4–17 per site		µg/m³ (converted from ppb)	Directly from reference	1.0	2.4×10^{1}

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Table B.23. Ambient and Outdoor Exposure Data Summaries (*Continued*). Xylene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Rodes et al. (1998) (*Continued*)	1–4 commutes		8.0×10^{-1}	3.6				Roadside samples were collected simultaneously during commutes for in-vehicle measurements. Range in average concentrations represents averages over different commute types.
Zielinska et al. (1998)	1 year		1.3×10^{-1}	1.3×10^{1}				
	1 year		9.0×10^{-2}	4.6				
	~ 1 week to 2 months		3.6	9.2×10^{1}				
	~ 1 week to 2 months		1.4	1.1×10^{1}				

HEI

Appendix B. References

The reference list for Tables B.1 through B.30 was prepared by the Gradient Corporation for HEI. Any web addresses were accessed before February 7, 2005. HEI has not updated this list.

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Appendix C. Toxicity and Health Effects Tables

INTRODUCTION

In the toxicity and health portions of the literature survey, information on acute, chronic, and subchronic health effects (including cancer and noncancer endpoints) was collected from peer-reviewed secondary sources, such as the EPA's Health Assessment Documents, U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reports, and the International Agency for Research on Cancer (IARC) monographs. The primary sources that served as the basis for key toxicity criteria were also obtained. For the seven priority MSATs (acetaldehyde, acrolein, benzene, 1,3-butadiene, formaldehyde, naphthalene, and POM), the survey was augmented with recent information from primary sources. The survey was also augmented for the nonpriority MSATs in cases in which the secondary sources were out of date (i.e., 2001 or earlier).

Tables C.1 and C.2 summarize the toxicity criteria that were readily available in the secondary sources and online, showing whether a given MSAT is considered a carcinogen, how toxic or potent it is, and the date of the most recent evaluation. The principal focus is on inhalation, because this is the predominant route of exposure to MSATs. To facilitate the comparison of criteria, all cancer and noncancer toxicity criteria are expressed in units per μg/m^3 for the inhalation route and mg/kg-day for the oral route. These tables were updated shortly before publication to reflect changes in regulatory values.

Table C.3 provides information on chronic noncancer health effects at the time the literature survey was completed (winter 2004–2005). For each MSAT, the details of the key chronic-toxicology studies that formed the basis of the toxicity criteria are summarized, starting with the Integrated Risk Information System (IRIS) and adding other sources if they were more recent. In addition, the studies on which the toxicity criteria were based are listed in the last column of the table. Criteria based on oral-route studies are included in the table only when no toxicity criteria were identified for the inhalation route.

Table C.4 provides information on chronic cancer health effects at the time the literature survey was completed. In addition, the studies on which the toxicity criteria were based are listed in the last column of the table. Criteria based on oral-route studies are included in the table only when the inhalation unit risk was not provided and the compound was classified as a carcinogen when inhaled; in these cases, the oral unit risk and associated critical study are provided.

For classes of compounds (e.g., POM and dioxins), information on the individual compounds is provided in the summary table (Table C.1), but detailed information is provided only for those that are the most toxic or the most studied. For POM, for example, detailed information was provided for benzo[*a*]pyrene; for dioxins, detailed information was provided for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin.

Appendix C. Toxicity and Health Effects Tables

Table C.5 summarizes the acute-toxicity criteria available for each MSAT at the time the literature survey was completed. This report does not include level 3 (in the acute exposure guideline levels and the *Emergency Response Planning Guidelines*), which pertains to life-threatening effects, because it was deemed too extreme to be useful in the report.

Table C.6 summarizes the studies that served as the basis for the acute-toxicity criteria for each MSAT at the time the literature survey was completed. The literature searches in this table were updated, like the literature searches in Tables C.3 and C.4, although to a lesser extent, because most of the exposure guidelines were of recent origin.

Although the hyperlinks from the tables to Web sites were active shortly before publication, HEI cannot be responsible for any subsequent changes in the Web sites referred to.

For more information about this appendix, see Introduction to Appendices B, C, D, and E.

Table C.1. Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				Cal EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC ($\mu g/m^3$)	Year	REL ($\mu g/m^3$)	Year	Route of Exposure	MRL	Year
Acetaldehyde[c]	2004	—	—	9	1991	9	1993	—	—	—
Acrolein[c]	2004	0.0005	2003 Toxicological Review	0.02	2003	0.06	2001	Intermediate inhalation	0.09 $\mu g/m^3$	Draft 2005
Arsenic Compounds (inorganic)[c]	2004	0.0003	2003	—	—	0.03	2001	Provisional chronic oral	0.0003 mg/kg-day	Draft 2005
Benzene[c]	2004	0.004	2003 Toxicological Review	30	2003	60	2000	Intermediate inhalation	9.8 $\mu g/m^3$	Draft 2005
1,3-Butadiene	2004	—	2002 Support Document	2	2002	20	2001	—	Not done – results not suitable	1992
Cr III[c]	2003	1.5	1998 Toxicological Review	—	—	—	—	—	—	2000

Table continues on next page

[a] Abbreviations and acronyms are listed in Appendix E. — = This information is not available.

[b] Primary MSATs are bolded.

[c] This literature is updated in Table C.3. Noncancer.

[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

[e] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				Cal EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC ($\mu g/m^3$)	Year	REL ($\mu g/m^3$)	Year	Route of Exposure	MRL	Year
Cr VI (chromium trioxide)[c]	2003	 0.003	1998 Toxicological Review 1998	Aerosols = 8×10^{-3} Particulates = 0.1	1998	Soluble Cr VI (except Chromic trioxide) = 0.2 Chromic trioxide = 0.002	2000	Intermediate inhalation	Aerosol mist = 0.005 $\mu g/m^3$ Particulate = 1 $\mu g/m^3$	2000
Diesel Particulates	—	—	2003 2002 Support Document (Health Assessment Document 2002[d])	5	2003	Diesel exhaust = 5	1998	—	—	—
Dioxins			—							
2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD)	2004	—	—	Not calculated because RfD/RfC < avg dose of US population; MOE ranges from < 1 to 4	2003 (EPA dioxin reassessment[e])	4×10^{-5}	2000	Intermediate oral Chronic oral	2×10^{-8} mg/kg-day 1×10^{-9} mg/kg-day	1998
1,2,3,7,8-*Penta*-CDD	—	—	—	—	—	8×10^{-5}	2000	—	—	—
1,2,3,4,7,8-*Hexa*-CDD	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,6,7,8-*Hexa*-CDD	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,7,8,9-*Hexa*-CDD	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,4,6,7,8-*Hepta*-CDD	—	—	—	—	—	4×10^{-3}	2000	—	—	—
1,2,3,4,6,7,8,9-*Octa*-CDD	—	—	—	—	—	4×10^{-2}	2000	—	—	—

Table continues on next page

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[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

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Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				Cal EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC (µg/m^3)	Year	REL (µg/m^3)	Year	Route of Exposure	MRL	Year
Furans			—							
2,3,7,8-*Tetra*-CDF	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,7,8-*Penta*-CDF	—	—	—	—	—	8×10^{-4}	2000	—	—	—
2,3,4,7,8-*Penta*-CDF	—	—	—	—	—	8×10^{-5}	2000	Intermediate oral	3×10^{-8} mg/kg-day	1994
1,2,3,4,7,8-*Hexa*-CDF	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,6,7,8-*Hexa*-CDF	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,7,8,9-*Hexa*-CDF	—	—	—	—	—	4×10^{-4}	2000	—	—	—
			—							
2,3,4,6,7,8-*Hexa*-CDF	—	—	—	—	—	4×10^{-4}	2000	—	—	—
1,2,3,4,6,7,8-*Hepta*-CDF	—	—	—	—	—	4×10^{-3}	2000	—	—	—
1,2,3,4,7,8,9-*Hepta*-CDF	—	—	—	—	—	4×10^{-3}	2000	—	—	—
1,2,3,4,6,7,8,9-*Octa*-CDF	—	—	—	—	—	4×10^{-2}	2000	—	—	—
Ethylbenzene[c]	2004	0.1	1991	1000	1991	2000	2000	Intermediate inhalation	4.3×10^3 µg/m^3	1999
Formaldehyde[c]	2004	0.2	2001	—	—	3	2000	Chronic inhalation	9.8 µg/m^3	1999
								Intermediate inhalation	37 µg/m^3	
n-Hexane[c]	2004	—	—	700	2005	7000	2000	Chronic inhalation	2.1×10^3 µg/m^3	1999

Table continues on next page

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[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

[e] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				California EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC (μg/m^3)	Year	REL (μg/m^3)	Year	Route of Exposure	MRL	Year
Lead Compounds (Separate modeling analysis for noncancer presented in report)[c]	2004	Not appropriate	2004	—	—	—	—	No acute, intermediate, or chronic MRLs have been derived for any route of exposure because of the lack of a clear threshold for the most sensitive effects in humans.	—	2005
Manganese compounds[c]	2004	0.14	1996	0.05	1993	0.2	2000	Chronic inhalation	0.04 μg/m^3	2000
Mercury compounds Methyl mercury[c]	2004	0.0001	2006 Support Document	—	—	—	—	Chronic oral	0.0003 mg/kg-day	1999
Metallic and inorganic mercury[c]	2004	—	—	0.3	1995	0.09 (inorganic mercury)	2000	Chronic inhalation	0.2 μg/m^3	1999
MTBE[c]	2004	3	1993	3000	1993	8000	2000	Chronic inhalation	2.5×10^3 μg/m^3	1996
								Intermediate inhalation	2.5×10^3 μg/m^3	

Table continues on next page

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[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

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Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				California EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC ($\mu g/m^3$)	Year	REL ($\mu g/m^3$)	Year	Route of Exposure	MRL	Year
Naphthalene	2004	0.02	1998 Toxicological Review	3	1998	9	2000	Chronic inhalation	3.7 $\mu g/m^3$	2005
Nickel compounds[c]	2004	0.02 (Ni soluable salts)	1996	—	—	Ni (except NiO) = 0.05	2000	Chronic inhalation	0.09 μg Ni/m^3	2005
						NiO = 0.10		Intermediate inhalation	0.2 μg Ni/m^3	
POM	2004	—	—	—	—	—	—	—	—	—
Acenaphthene	—	0.06	1994	—	—	—	—	Intermediate oral	0.6 mg/kg-day	1995
Acenaphthylene	—	—	—	—	—	—	—	—	—	—
Anthracene	—	0.3	1993	—	1994	—	—	Intermediate oral	10 mg/kg-day	1995
Benz[*a*]anthracene	—	—	—	—	—	—	—	—	—	—
Benzo[*b*]fluoranthene	—	—	—	—	—	—	—	—	—	—
Benzo[*j*]fluoranthene	—	—	—	—	—	—	—	—	—	—
Benzo[*k*]fluoranthene	—	—	—	—	—	—	—	—	—	—
Benzo[*g,h,i*]perylene	—	—	—	—	—	—	—	—	—	—
Benzo[*a*]pyrene (B[*a*]P)[c]	—	—	—	—	—	—	—	—	—	—
β-Chloronaphthalene	—	0.08	1990	—	—	—	—	—	—	—
Chrysene	—	—	—	—	—	—	—	—	—	—

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Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				California EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC (µg/m³)	Year	REL (µg/m³)	Year	Route of Exposure	MRL	Year
POM (*Continued*)										
Dibenz[*a,h*]acridine	—	—	—	—	—	—	—	—	—	—
Dibenz[*a,h*]anthracene	—	—	—	—	—	—	—	—	—	—
Dibenz[*a,j*]acridine	—	—	—	—	—	—	—	—	—	—
Dibenzofuran	2004	—	—	—	—	—	—	—	—	—
Dibenzo[*a,e*]pyrene	—	—	—	—	—	—	—	—	—	—
Dibenzo[*a,h*]pyrene	—	—	—	—	—	—	—	—	—	—
Dibenzo[*a,i*]pyrene	—	—	—	—	—	—	—	—	—	—
Dibenzo[*a,l*]pyrene	—	—	—	—	—	—	—	—	—	—
7H-Dibenzo[*c,g*]carbazole	—	—	—	—	—	—	—	—	—	—
7,12-dimethylbenz[*a*]-anthracene	—	—	—	—	—	—	—	—	—	—
1,6-Dinitropyrene	—	—	—	—	—	—	—	—	—	—
1,8-Dinitropyrene	—	—	—	—	—	—	—	—	—	—
Fluoranthene	—	0.04	1993	—	1994	—	—	Intermediate oral	0.4 mg/kg-day	1995
Fluorene	—	0.04	1990	—	—	—	—	Intermediate oral	0.4 mg/kg-day	1995
Indeno[1,2,3-*cd*]pyrene	—	—	—	—	—	—	—	—	—	—
3-Methylcholanthrene	—	—	—	—	—	—	—	—	—	—
5-Methylchrysene	—	—	—	—	—	—	—	—	—	—
1-Methylnaphthalene	—	—	—	—	—	—	—	Chronic oral	0.07 mg/kg-day	2005
2-Methylnaphthalene	—	4×10^{-3}	2003 Toxicological Review	—	—	—	—	Chronic oral	0.05 mg/kg-day	2005

Table continues on next page

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[c] This literature is updated in Table C.3. Noncancer.

[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

[e] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

Table C.1. (*Continued*). Chronic Noncancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS				California EPA		ATSDR		
		Oral		Inhalation						
MSAT[b]	EPA Fact Sheet Year	RfD (mg/kg-day)	Year	RfC ($\mu g/m^3$)	Year	REL ($\mu g/m^3$)	Year	Route of Exposure	MRL	Year
POM (*Continued*)										
5-Nitroacenaphthene	—	—	—	—	—	—	—	—	—	—
6-Nitrochrysene	—	—	—	—	—	—	—	—	—	—
2-Nitrofluorene	—	—	—	—	—	—	—	—	—	—
1-Nitropyrene	—	—	—	—	—	—	—	—	—	—
4-Nitropyrene	—	—	—	—	—	—	—	—	—	—
Phenanthrene	—	—	—	—	1994	—	—	—	—	—
Pyrene	—	0.03	1993	—	1994	—	—	—	—	—
Styrene[c]	2004	0.2	1990	1000	1993	900	2005	Chronic inhalation	300 $\mu g/m^3$	1992
Toluene[c]	2004	0.08	2005	5	2005	300	2000	Chronic inhalation	300 $\mu g/m^3$	2000
Xylene	2004	0.2	2003 2003 Toxicological Review	100	2003	700	2000	Chronic inhalation	217 $\mu g/m^3$	2005 Draft
								Intermediate inhalation	2640 $\mu g/m^3$	

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[b] Primary MSATs are bolded.

[c] This literature is updated in Table C.3. Noncancer.

[d] Diesel Particulates: EPA, National Center for Environmental Assessment (Washington DC) May 2002. Health assessment document for diesel engine exhaust. EPA-600/8-90-057F.

[e] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

Table C.2. Chronic Cancer Toxicity Criteria and Source Materials for Each MSAT[a]

MSAT[b]	EPA Fact Sheet Year	IRIS Cancer Class	IRIS Unit Risk per µg/m^3	IRIS Year	California EPA Cancer Potency Factor per µg/m^3	California EPA Year	NTP Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	IARC Cancer Class	IARC Year
Acetaldehyde[c]	2004	B2 – probable human carcinogen (1986)	2.2×10^{-6}	1991	2.7×10^{-6}	1999	B	Group 2B – possibly carcinogenic to humans	1999
Acrolein	2004	C – possible human carcinogen (1986) Existing data are inadequate for inhalation or oral determination (1999)	Not applicable	2003 Toxicological Review available for cancer and non-cancer effects, oral and inhalation	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1995
Arsenic Compounds (inorganic)[c]	2004	A – known human carcinogen (1986)	4.3×10^{-3}	1998	3.3×10^{-3}	1990	A	Group 1 – carcinogenic to humans	1987
Benzene[c]	2004	A – known human carcinogen (1986) Known human carcinogen for all routes (1996 – proposed cancer guidelines)	2.2×10^{-6} to 7.8×10^{-6}	2000 2003 Support Document and Response to the Peer Review available for oral and inhalation carcinogenicity	2.9×10^{-5}	1985	A	Group 1 – carcinogenic to humans	1987

Table continues on next page

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[b] Primary MSATs are bolded.

[c] This literature is updated in Tables C.4. Cancer.

[d] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

[e] IARC changed its cancer classification for 1,3-butadiene at its 2007 meeting. The new classification is Group 1–carcinogenic to humans.

[f] Revised in IARC Monograph 32, Suppl. 7 (in prep.).

Table C.2. (*Continued*). Chronic Cancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
1,3-Butadiene	2004	Carcinogenic to humans by inhalation (1999) Replaced previous classification of B2 – probable human carcinogen (1987)	3×10^{-5}	2002 Support Document available for cancer and non-cancer effects	1.7×10^{-4}	1992	A	Group 2A – probably carcinogenic to humans[e]	1999[e]
Cr III[c]	2003	D – not classifiable as to human carcinogenicity (1986) Inadequate data to determine potential carcinogenicity (1996)	—	1998	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1990
Cr VI (chromium trioxide)[c]	2003	A – known human carcinogen (1986) Known human carcinogen by inhalation (1996 – proposed cancer guidelines)	1.2×10^{-2}	1998	1.5×10^{-1}	1986	A	Group 1 – carcinogenic to humans	1990

Table continues on next page

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[d] Dioxins/Furans: EPA Dioxin Reassessment, National Center for Environmental Assessment (Washington DC) Dec 2003. Exposure and human health risk assessment of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds. Part III: Integrated summary and risk characterization for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) and related compounds (NAS Review Draft).

[e] IARC changed its cancer classification for 1,3-butadiene at its 2007 meeting. The new classification is Group 1–carcinogenic to humans.

[f] Revised in IARC Monograph 32, Suppl. 7 (in prep.).

Table C.2. (*Continued*). Chronic Cancer Toxicity Criteria and Source Materials for Each MSAT[a]

MSAT[b]	EPA Fact Sheet Year	IRIS: Cancer Class	IRIS: Unit Risk per µg/m^3	IRIS: Year	California EPA: Cancer Potency Factor per µg/m^3	California EPA: Year	NTP: Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	IARC: Cancer Class	IARC: Year
Diesel particulates	—	Diesel engine exhaust: likely to be carcinogenic to humans by inhalation (1999)	—	2003	3.0×10^{-4} (Range = 1.3×10^{-4} to 2.4×10^{-3})	1998	B diesel exhaust particulates	Group 2A – probably carcinogenic to humans Diesel engine exhaust	1989
Dioxins									
2,3,7,8-tetrachloro-dibenzo-*p*-dioxin (TCDD)	2004	Likely to be carcinogenic to humans (1999)	1×10^{-3} per pg/kg-day (oral dose based on body burden)	2003[d]	38	2003	A	Group 1 – carcinogenic to humans	1997
			TEF = 1 (WHO)	2003[d]					
1,2,3,7,8-*Penta*-CDD	—	—	—		38	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 1 (WHO)	2003[d]	(TEF = 1)				
1,2,3,4,7,8-*Hexa*-CDD	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				

Table continues on next page

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[f] Revised in IARC Monograph 32, Suppl. 7 (in prep.).

Table C.2. (*Continued*). Chronic Cancer Toxicity Criteria and Source Materials for Each MSAT[a]

MSAT[b]	EPA Fact Sheet Year	IRIS Cancer Class	IRIS Unit Risk per µg/m^3	IRIS Year	California EPA Cancer Potency Factor per µg/m^3	California EPA Year	NTP Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	IARC Cancer Class	IARC Year
Dioxins (*Continued*)									
1,2,3,6,7,8-*Hexa*-CDD	—	B2 – probable human carcinogen (1986)	1.3 (based on *hexa*-chloro-dibenzo-*p*-diozin mixture adminis-tered by gavage)	1991	3.8 (TEF = 0.1)	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]					
1,2,3,7,8,9-*Hexa*-CDD	—	B2 – probable human carcinogen (1986)	1.3 (based on *hexa*-chloro-dibenzo-*p*-diozin mixture adminis-tered by gavage)	1991	3.8 (TEF = 0.1)	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]					
1,2,3,4,6,7,8-*Hepta*-CDD	—	—	—		0.38	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.01 (WHO)	2003[d]	(TEF = 0.01)				

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Table C.2. (*Continued*). Chronic Cancer Toxicity Criteria and Source Materials for Each MSAT[a]

		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m³	Year	Cancer Potency Factor per µg/m³	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
Dioxins (*Continued*)									
1,2,3,4,6,7,8,9-*Octa*-CDD	—	—	—		0.0038	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.0001 (WHO)	2003[d]	(TEF = 0.0001)				
Furans									
2,3,7,8-*Tetra*-CDF	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				
1,2,3,7,8-*Penta*-CDF	—	—	—		1.9	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.05 (WHO)	2003[d]	(TEF = 0.05)				
2,3,4,7,8-*Penta*-CDF	—	—	—		19	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.5 (WHO)	2003[d]	(TEF=0.5)				
1,2,3,4,7,8-*Hexa*-CDF	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
Furans (*Continued*)									
1,2,3,6,7,8-*Hexa*-CDF	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				
1,2,3,7,8,9-*Hexa*-CDF	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				
2,3,4,6,7,8-*Hexa*-CDF	—	—	—		3.8	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.1 (WHO)	2003[d]	(TEF = 0.1)				
1,2,3,4,6,7,8-*Hepta*-CDF	—	—	—		0.38	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.01 (WHO)	2003[d]	(TEF = 0.01)				
1,2,3,4,7,8,9-*Hepta*-CDF	—	—	—		0.38	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.01 (WHO)	2003[d]	(TEF = 0.01)				
1,2,3,4,6,7,8,9-*Octa*-CDF	—	—	—		0.0038	2003	—	Group 3 – not classifiable as to its carcinogenicity to humans	1997
			TEF = 0.0001 (WHO)	2003[d]	(TEF = 0.0001)				

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
Ethylbenzene[c]	2004	D – not classifiable as to human carcinogenicity (1986)	—	1991	—	—	—	Group 2B – possibly carcinogenic to humans	2000
Formaldehyde[c]	2004	B1 – probable human carcinogen (1986)	1.3×10^{-5}	1991	6×10^{-6}	1992	Gas: B	Group 1 – carcinogenic to humans; sufficient evidence in both humans and animals	2006
n-Hexane[c]	2004	Data are inadequate	—	2005	—	—	—	—	—
Lead compounds[c] (Separate modeling analysis for noncancer presented in report)	2004	B2 – probable human carcinogen (1986)	—	1993	1.2×10^{-5}	1997	B	Lead: Group 2B – possibly carcinogenic to humans Group 2A – inorganic lead compounds Organolead compounds: Group 3 – not classifiable as to their carcinogenicity to humans	1987 2006
Manganese compounds[c]	2004	D – not classifiable as to human carcinogenicity (1986)	—	1996	—	—	—	—	—

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
Mercury compounds Methyl mercury[c]	2004	C – possible human carcinogen (1986)	—	1995	Inadequate human data, limited animal data	—	—	Group 2B – possibly carcinogenic to humans	1993
Metallic and inorganic mercury[c]	2004	C – possible human carcinogen (1986)	—	1995 (mercuric chloride)	Inadequate human and animal data	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1993
		D – not classifiable as to human carcinogenicity (1986)		1995 (elemental mercury)					
MTBE[c]	2004	Not available at this time	—	—	2.6×10^{-7}	1999	—	Group 3 – not classifiable as to its carcinogenicity to humans	1999
Naphthalene	2004	C – possible human carcinogen (1986)	—	1998	3.4×10^{-5}	2004	B	Group 2B – possibly carcinogenic to humans	2002
		Cannot be determined (1996)							

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
Nickel compounds[c]	2004	Ni refinery dust: A – known human carcinogen (1986)	Ni refinery dust = 2.4×10^{-4}	1991 (refinery dust)	2.6×10^{-4}	1991	Nickel compounds: A	Nickel compounds: Group 1 – carcinogenic to humans	1990
		Ni subsulfide: A – known human carcinogen (1986)	Ni subsulfide = 4.8×10^{-4}	1991 (subsulfide)			Metallic Nickel: B	Metallic nickel: Group 2B – possibly carcinogenic to humans	
		Ni carbonyl: B2 – Probable human carcinogen (1986)							
POM	2004	—	—	—	—	—	Coal tars: A Soots: A PAHs: B	—	—
Acenaphthene	—	—	—	1993	—	—	—	—	—
Acenaphthylene	—	D – not classifiable as to human carcinogenicity (1986)	—	1991	—	—	—	—	—
Anthracene	—	D – not classifiable as to human carcinogenicity (1986)	—	1991	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987
Benz[*a*]anthracene	—	B2 – probable human carcinogen (1986)	—	1994	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
			TEF = 0.1			1993			

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m³	Year	Cancer Potency Factor per µg/m³	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
POM (*Continued*)									
Benzo[*b*]fluoranthene	—	B2 – probable human carcinogen (1986)	—	1994	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987
			TEF = 0.1			1993			
Benzo[*j*]fluoranthene	—	—	—	—	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987
Benzo[*k*]fluoranthene	—	B2 – probable human carcinogen (1986)	—	1994	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987
			TEF = 0.01			1993			
Benzo[*g,h,i*]perylene	—	D – not classifiable as to human carcinogenicity (1986)	—	1990	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987
Benzo[*a*]pyrene (B[*a*]P)[c]	—	B2 – probable human carcinogen (1986)	7.3 per mg/kg-day (oral potency factor)	1994	1.1×10^{-3}	1999	B	Group 2A – probably carcinogenic to humans	1987
			TEF = 1			1993			
β-Chloronaphthalene	—	—	—	—	—	—	—	—	—

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per μg/m^3	Year	Cancer Potency Factor per μg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
POM (*Continued*)									
Chrysene	—	B2 – probable human carcinogen (1986)	— TEF = 0.001	1994	1.1×10^{-5}	1999 1993	—	Group 2B – possibly carcinogenic to humans	1987[f]
Dibenz[*a,h*]acridine	—	—	—	—	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
Dibenz[*a,h*]anthracene	—	B2 – probable human carcinogen (1986)	— TEF = 1	1994	1.2×10^{-3}	1999 1993	B	Group 2A – probably carcinogenic to humans	1987[f]
Dibenz[*a,j*]acridine	—	—	—	—	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
Dibenzofuran	2004	D – not classifiable as to human carcinogenicity (1986)	—	1990	—	—	—	—	—
Dibenzo[*a,e*]pyrene	—	—	—	—	1.1×10^{-3}	1999	B	Group 3 – not classifiable as its carcinogenicity to humans	1987[f]
Dibenzo[*a,h*]pyrene	—	—	—	—	1.1×10^{-2}	1999	B	Group 2B – possibly carcinogenic to humans	1987

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POM (*Continued*)									
Dibenzo[*a,i*]pyrene	—	—	—	—	1.1×10^{-2}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
Dibenzo[*a,l*]pyrene	—	—	—	—	1.1×10^{-2}	1999	B	Group 2A – probably carcinogenic to humans	1987[f]
7H-Dibenzo[*c,g*]carbazole	—	—	—	—	1.1×10^{-3}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
7,12-Dimethylbenz[*a*]-anthracene	—	—	—	—	7.1×10^{-2}	1999	—	—	—
1,6-Dinitropyrene	—	—	—	—	1.1×10^{-2}	1999	B	Group 2B – possibly carcinogenic to humans	1989
1,8-Dinitropyrene	—	—	—	—	1.1×10^{-3}	1999	B	Group 2B – possibly carcinogenic to humans	1989
Fluoranthene	—	D – not classifiable as to human carcinogenicity (1986)	—	1990	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987[f]
Fluorene	—	D – not classifiable as to human carcinogenicity (1986)	—	1990	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987[f]

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		IRIS			California EPA		NTP	IARC	
MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per $\mu g/m^3$	Year	Cancer Potency Factor per $\mu g/m^3$	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
POM (*Continued*)									
Indeno[1,2,3-*cd*]pyrene	—	B2 – probable human carcinogen (1986)	— TEF = 0.1	1994	1.1×10^{-4}	1999 1993	B	Group 2B – possibly carcinogenic to humans	1987[f]
3-Methylcholanthrene	—	—	—	—	6.3×10^{-3}	1999	—	—	—
5-Methylchrysene	—	—	—	—	1.1×10^{-3}	1999	B	Group 2B – possibly carcinogenic to humans	1987[f]
1-Methylnaphthalene	—	—	—	—	—	—	—	—	—
2-Methylnaphthalene	—	Inadequate to assess human carcinogenic potential (1999)	—	2003	—	—	—	—	—
5-Nitroacenaphthene	—	—	—	—	3.7×10^{-5}	1999	—	Group 2B – possibly carcinogenic to humans	1987[f]
6-Nitrochrysene	—	—	—	—	1.1×10^{-2}	1999	B	Group 2B – possibly carcinogenic to humans	1989
2-Nitrofluorene	—	—	—	—	1.1×10^{-5}	1999	—	Group 2B – possibly carcinogenic to humans	1989
1-Nitropyrene	—	—	—	—	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1989

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MSAT[b]	EPA Fact Sheet Year	Cancer Class	Unit Risk per µg/m^3	Year	Cancer Potency Factor per µg/m^3	Year	Cancer Class Human Carcinogen A: Known B: Reasonably Anticipated	Cancer Class	Year
POM (*Continued*)									
4-Nitropyrene	—	—	—	—	1.1×10^{-4}	1999	B	Group 2B – possibly carcinogenic to humans	1989
Phenanthrene	—	D – not classifiable as to human carcinogenicity (1986)	—	1990	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987
Pyrene	—	D – not classifiable as to human carcinogenicity (1986)	—	1991	—	—	—	Group 3 – not classifiable as to its carcinogenicity to humans	1987
Styrene[c]	2004	—	—	—	— styrene oxide = 4.6×10^{-5}	—	Styrene-7,8-oxide, major metabolite: B	Group 2B – possibly carcinogenic to humans	2002
Toluene[c]	2004	Data are inadequate for an assessment of the carcinogenic potential (2005)	—	2005	—	—	—	Group 3 – not classifiable as to their carcinogenicity to humans	1999
Xylene	2004	Data are inadequate for an assessment of the carcinogenic potential (1999)	—	2003	—	—	—	Group 3 – not classifiable as to their carcinogenicity to humans	1999

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Table C.3. Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Acetaldehyde								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1991	Degeneration of olfactory epithelium	Wistar rat, male	Inhalation: 4 wks (short-term) (complex exposure regimen)	NOAEL (HEC) = 8.7×10^3 µg/m^3; LOAEL (HEC) = 1.69×10^4 µg/m^3	1000	9 µg/m^3 based on NOAEL	Appelman et al. 1986; (NOAEL); 1982 (LOAEL)
Chronic REL, Cal EPA	1993	Degeneration of olfactory epithelium	Rat	Details not provided.	Details not provided.	Details not provided.	9 µg/m^3	Reference not provided by Cal EPA
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
EPA IRIS draft Toxicological Review Document (1999)	1999	This comprehensive draft review, prepared in support of the EPA IRIS file, covers the toxicokinetics, noncancer toxicity, and carcinogenicity of acetaldehyde. It also provides a revised draft RfC value. Note that although this draft report is currently available on the EPA web site, there is also a notice from EPA saying that "the draft has been pulled back for additional analysis and revision." Some of the key studies summarized by EPA (and not already summarized elsewhere in this table) are also included below.						EPA 1999
		Histopathological alterations of the tracheal epithelium	Syrian golden hamster	Inhalation: 6 hrs/day, 5 days/wk, 90 days	NOAEL (HEC) = 5.45×10^3 µg/m^3; LOAEL (HEC) = 1.88×10^4 µg/m^3	1000	5 µg/m^3	Kruysse et al. 1975 (as cited in EPA 1999)
		Histological lesions in the nasal cavity, no increased incidence of tumors	Syrian golden hamster	Inhalation: 7 hrs/day, 5 days/wk, 52 wks	LOAEL (HEC) = 2.1×10^4 µg/m^3	—	—	Feron 1979 (as cited in EPA 1999)
—	1997	In this review, the author discusses the biochemistry, genotoxicity, dosimetry, inhalation toxicology, and carcinogenicity of inhaled acetaldehyde, focusing on effects in the rat. Noncancer effects include degeneration and hyperplasia in the respiratory tract, with the nasal olfactory mucosa being the most sensitive target. The author suggests that tissue injury occurs only at concentrations sufficiently high enough to overwhelm detoxification capacity. The chemistry and toxicity of acetaldehyde is similar to that of formaldehyde. The primary rat toxicity studies reviewed were all from the 1980s (the Appelman toxicity and Woutersen carcinogenicity studies).						Morris 1997

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Acetaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2003	Asthma symptoms	Humans—asthmatic Hispanic children (10–16 yrs old), living in a Los Angeles community (n = 22)	Inhalation of traffic pollutants, concentrations of numerous individual chemicals measured (24-hr samples)	Daily, for up to 3 months, subjects filled out asthma symptom diaries and recorded peak expiratory flow (PEF) results. A positive association with at least one of several measures of increased asthma symptom severity was reported for numerous criteria air pollutants and VOCs. For example, the odds ratio for asthma symptoms from interquartile range increases in pollutants = 1.48 (95% CI = 1.16–1.87) for an interquartile range increase of 2.36 µg/m^3 acetaldehyde. No association with PEF was found. Limitations: small number of subjects, possible exposure misclassification, impossible to determine which air pollutant responsible.			Delfino et al. 2003
—	2005	Facial flushing (following alcohol intake)	Human—(47 healthy Korean volunteers)	Alcohol consumption (oral)	Information about facial flushing and alcohol consumption collected by questionnaire. There was a significant association between the *ALDH2* genotype and alcohol-induced facial flushing.			Kim et al. 2005
		Induction of micronuclei (MN)	Peripheral lymphocytes collected from 47 healthy human volunteers	In vitro MN assay, with 500 or 1500 µM acetaldehyde	Acetaldehyde induced MN in a dose-dependent manner, with the greatest frequency of MN in subjects that were homozygous for the *ALDH2*2* allele (which is associated with a lack of enzyme activity).			
		Aldehyde dehydrogenase-2 (*ALDH2*) genotypes were studied in this article because *ALDH2* exhibits genetic polymorphisms which affect the rate of metabolism of acetaldehyde to acetate (i.e., acetaldehyde detoxification). Note: This article does not directly address acetaldehyde inhalation, or health endpoints that are typically considered in developing toxicity criteria. Nonetheless, the article is useful in the context of understanding the mechanisms of acetaldehyde-induced effects, and the potential effect of genetic polymorphisms for metabolizing enzymes on an individual's health risks from alcohol/acetaldehyde exposure.						

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Acetaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2005	Irritation ($ELIA_{local}$)	Humans	Not specified	NOAEL = 8700 µg/m^3	5	$ELIA_{local}$ = 1700 µg/m^3	Schupp et al. 2005
		Increased relative organ weights ($ELIA_{systemic}$)	Hamsters	Inhalation: 6 hrs/day, 5 days/wk, 90 days	NOAEL = 127,000 µg/m^3	200	$ELIA_{systemic}$ = 635 µg/m^3	
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles for non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or $ELIA_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene and compared these risk-based "acceptable" exposure levels to concentrations in cars. For the acetaldehyde $ELIA_{local}$, the authors started with a NOAEL of 8700 µg/m^3 for irritation (based on EPA 1991), and applied an uncertainty factor of 1/5, to derive an $ELIA_{local}$ of 1700 µg/m^3. For the acetaldehyde $ELIA_{systemic}$, the authors started with a NOAEL of 127,000 µg/m^3 for irritation (based on Kruyne et al. 1975), and applied a total uncertainty factor of 200 to derive an $ELIA_{systemic}$ of 635 µg/m^3. The individual uncertainty factors were 2 (extrapolation to chronic), a scaling factor of 4, an exposure-time adjustment of 5, and an intraspecies extrapolation factor of 5. The average concentration of acetaldehyde measured in chamber tests designed to simulate cars at 23°C (42 µg/m^3, as reported in FAT 1998) did not exceed the ELIAs.						
Acrolein								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	2003	Nasal lesions	Wistar rat	Inhalation: 6 hrs/day, 5 days/wk, 13 wks	LOAEL (HEC) = 20 µg/m^3	1000	0.02 µg/m^3	Feron et al. 1978

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Acrolein (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2004	Mechanisms of action (dose- and time-dependent neuronal plasma membrane disruption, induction of oxidative stress, mitochondrial impairment)	Spinal cord tissue isolated from female Hartley guinea pigs	in vitro, exposure to 1, 10, 25, 50, 100, or 200 µM acrolein for 15 min, 1, 2, or 4 hrs	in vitro LOAEL = 1 µM for 4 hrs for membrane disruption	—	—	Luo and Shi 2004
		This in vitro study investigates the potential mechanisms of action of acrolein. The authors suggest that acrolein, generated as a byproduct of oxidative stress and lipid peroxidation, may play a role in neurodegenerative disorders, such as Alzheimer's disease and secondary injury following spinal cord and brain trauma. The authors also note acrolein is a ubiquitous environmental pollutant, and that the acrolein-induced membrane disruption observed in this study may be an important mechanism in a variety of medical conditions.						
—	2004	Mechanisms of action, hepatic injury (as indicated by plasma levels of liver enzymes and protein adducts)	Male Swiss mice	Single intraperitoneal injection of 60–100 mg/kg allyl alcohol (which is readily metabolized to acrolein), administered either alone or in conjunction with hydralazine	This in vivo study investigated the mechanisms of acrolein-induced hepatotoxicity by studying the ability of hydralazine, an antihypertensive drug, to suppress acrolein-mediated toxicity by inactivating protein adducts formed by acrolein and preventing acrolein-mediated GSH depletion in the liver. The findings support the hypothesis that protein adduction plays a key role in the pathogenesis of acrolein hepatotoxicity.			Kaminskas et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Acrolein (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2002	Non-neoplastic lesions in the nasal respiratory epithelium	Rats	Inhalation: 3 days	140 µg/m^3 BMC$_{05}$	Total UF = 100, exposure time adjust-ment = 6/24	"Tolerable concentration in air" = 0.4 µg/m^3	Gomes and Meek 2002 (International Programme on Chemical Safety, World Health Organization)
		This "Concise International Chemical Assessment Document" was prepared jointly by Health Canada and Environment Canada, and reviews physical and chemical parameters, sources and levels of environmental exposure, and human and environmental effects of acute and chronic acrolein exposures. Irritant effects at the site of first contact (eg, irritation of the respiratory tract after inhalation) are considered the primary types of adverse health effects associated with acrolein exposure. Because there is no indication that the severity of acrolein effects increases with duration of exposure, an additional uncertainty factor to address the use of a short-term study was not considered appropriate. The authors also conclude that the data are inadequate to assess the potential carcinogenicity of inhaled acrolein.						
—	2002	This article reviews the evidence linking hazardous air pollutants and asthma, discussing factors that increase individual susceptibility to asthma, cellular mechanisms of asthma, and asthma epidemiology studies. Hazardous air pollutants and criteria pollutants may act synergistically to induce or exacerbate asthma. Specifically, the author addresses 28 air pollutants that could have the highest impact on asthma (including acetaldehyde, acrolein, benzene, and formaldehyde) and reviews air release information for these compounds. He suggests that the possible asthma risks from certain aldehydes (including acrolein and formaldehyde) and metals warrant additional attention.						Leikauf 2002
Arsenic Compounds (Inorganic)								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
REL, Cal EPA	2001	Reduction in fetal weight; increased incidences of intrauterine growth retardation and skeletal malformations	CFLP mouse	Inhalation	LOAEL (HEC) = 33 µg/m^3	1000	0.03 µg/m^3	Nagymajtenyi et al. 1985

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Arsenic Compounds (Inorganic, *Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	2000	Circulatory disease	US copper smelter workers (Tacoma, Washington) (n = 2802)	Inhalation: occupational exposure (estimated using air monitoring data and urinary arsenic data)	The baseline analysis in this study did not reveal any association between arsenic exposure and circulatory disease. However, after adjustment for the healthy hire effect and the healthy worker survivor effect (HWSE), the authors reported increased circulatory mortality rate ratios (particularly for cardiovascular disease) relative to their baseline model. The authors acknowledge that these results are not conclusive, but suggest that HWSE may be obscuring an association between arsenic and circulatory disease (particularly cardiovascular disease) in occupational studies.			Hertz-Picciotto et al. 2000a
—	2000	Circulatory disease	US copper smelter workers (Montana) (n = 8014)	Occupational inhalation exposure (estimated based on years working in areas of heavy, medium, or light arsenic levels)	Prompted by the 2000 Hertz-Picciotto et al. article (above), these authors re-examined their cohort of smelter workers. Unlike Hertz-Picciotto et al. they found no evidence of an association between duration of arsenic exposure and cardiovascular disease, cerebrovascular disease, or all circulatory diseases, using their baseline model or after adjustment for healthy worker survivor effect (HWSE). Consistent with most other occupational studies of arsenic-exposed workers, they found excess mortality only for respiratory cancer. In a reply, Hertz-Picciotto et al. note that the data to date are not conclusive, that the methods used to account for HWSE provide only a partial adjustment.			Lubin and Fraumeni 2000 (letter written in response to Hertz-Picciotto et al. 2000a); Hertz-Picciotto et al. 2000b (reply)
—	2001	Developmental effects	This author reviews and evaluates the evidence for arsenic teratogenicity. Although earlier studies (pre-1995) showed that intravenous or intraperitoneal injections of maternally-toxic arsenic doses could cause neural tube defects, these exposure routes and exposure levels were deemed not relevant for assessing potential human health risks. In more recent experimental animal studies, "exposure via inhalation or oral ingestion, even at concentrations that were nearly fatal to pregnant females, caused no arsenic-related abnormalities" (pg 170). The author concluded that "inorganic arsenic poses virtually no danger to developing offspring when maternal exposure occurs by relevant routes (oral and inhalation) at concentrations that are likely to be experienced in the environment or in the workplace" (p 170).					DeSesso 2001

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Arsenic Compounds (Inorganic, *Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*(*Continued*)								
—	2002	Various health endpoints	Residential population, Guizhou, China	Sources of arsenic exposure: contaminated food (50–80%), and elevated indoor air levels (20–400 µg As/m^3) (10–20%)	This review article describes some of the health effects observed in residential populations in Guizhou, China exposed to high concentrations of arsenic in indoor air and food from domestic burning of coal containing high levels of arsenic. At least 3000 patients in this area have been diagnosed with chronic arsenic poisoning. Various health effects have been reported, including skin lesions (about 17% of the residents), lung dysfunction, neuropathy, nephrotoxicity, and hepatomegaly. The authors attributed several health effects to inhalation of arsenic in indoor air: respiratory symptoms (persistent cough, chronic bron-chitis, reduced residual volume and vital capa-city, X-ray abnormalities), neurotoxicity, corneal inflammation, tearing eyes, and blurred vision.			Liu et al. 2002
Benzene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	2003	Decreased lymphocyte count	Human—occupational	Inhalation	BMCL (ADJ) = 8.2×10^3 µg/m^3	300	30 µg/m^3	Rothman et al. 1996

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Benzene (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2003	Asthma symptoms	Humans—asthmatic Hispanic children (10–16 yrs old), living in a Los Angeles community (n = 22)	Inhalation of traffic pollutants, concentrations of numerous individual chemicals measured (24-hr samples)	Daily, for up to 3 months, subjects filled out asthma symptom diaries and recorded peak expiratory flow (PEF) results. A positive association with at least one of several measures of increased asthma symptom severity was reported for numerous criteria air pollutants and VOCs. For example, the odds ratio for asthma symptoms from interquartile range increases in pollutants = 1.23 (95% CI = 1.02–1.48) for an interquartile range increase of 3.19 µg/m^3 benzene. No association with PEF was found. Limitations: small number of subjects, possible exposure misclassification, impossible to determine which air pollutant responsible.			Delfino et al. 2003
—	2004	Hematotoxicity (white blood cell and platelet counts, progenitor cell colony formation)	Humans—benzene-exposed workers from a shoe factory in China (n = 250), unexposed controls (n = 140)	Workplace inhalation of benzene Extensive exposure data (repeated individual benzene and toluene monitoring samples) was collected for up to 16 months. Average employment duration = 6.1 yrs	LOAEL < 3190 µg/m^3 for significant decreases in white blood cell and platelet counts, and decreases in progenitor cell colony formation	There was a significant dose-response trend for changes in platelets and most white blood cell measures. Genetic variants in metabolizing enzymes (myeloperoxidase and NAD(P)H:quinone oxidoreductase) affected susceptibility to benzene-induced decreases in white blood cell counts.		Lan et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Benzene (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2004	Hematotoxicity (white blood cell, red blood cell, lymphocyte, and platelet counts; hemoglobin concentration, mean corpuscular volume)	Humans—workers participating in Shell's Benzene Medical Surveillance Program (*n* = 1200)	Workplace inhalation of benzene Mean benzene exposure (TWA-8) = 1914 µg/m^3 from 1977–1988, and 447 µg/m^3 since 1988. Estimated mean duration = 12.2 yrs. (male) and 13.8 yrs (female). Some workers also had exposure to butadiene.	NOAEL for hematological effects estimated to be 1914 µg/m^3 (the mean TWA from 1977–1988). Exposures for most workers were probably lower, as benzene levels decreased over time.	The percent of abnormal values for each of the 6 hematology parameters measured was not significantly different between the exposed and control groups. The authors question whether blood count measurements have adequate sensitivity to be a useful surveillance tool for workers with low-level benzene exposures, and whether abnormal hematology is truly an early marker for leukemia.		Tsai et al. 2004
—	2002	Hematotoxicity (blood cell counts)	Humans—benzene-exposed workers in either a glue factory, shoe-making factory, or sporting goods company in China (*n* = 130 exposed, 51 controls)	Workplace inhalation of benzene Based on personal exposure monitoring, benzene levels on the day of biological sample collection ranged from 191–389,180 µg/m^3 (median = 10,208 µg/m^3); 4-wk average benzene exposures ranged from 255–173,855 µg/m^3, and cumulative benzene exposures were estimated to range from 1.9 $\times$ 10^4–2.0 $\times$ 10^6 (µg/m^3)-yrs. The workers were also exposed to toluene and xylene.	LOAEL = ≤1595 µg/m^3 (4-wk average), for decreases in red blood cells, white blood cells, and neutrophils.	The decreases in red blood cells, white blood cells, and neutrophils were dose-dependent and also were correlated with levels of urinary metabolites and albumin adducts. There was no significant effect of benzene exposure on lymphocytes.		Qu et al. 2002

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Benzene (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)								
—	2005	Major congenital and neural crest malformations	Humans—women working in university biomedical research laboratories, (n = 1629 women total, 959 exposed to benzene and/or other solvents).	Workplace (laboratory) exposure to benzene and other chemicals, exposure information based on questionnaire	There was no significant association between congenital or neural crest malformations and laboratory work in general. Long term laboratory exposure to solvents was associated with an increase in all major malformations (adjusted OR = 2.5 [95% CI = 1.0–6.0]). Long term laboratory exposure to benzene in particular was associated with an increase in neural crest malformations (adjusted OR = 3.5 [95% CI = 1.0–12.0]).			Wennborg et al. 2005
1,3-Butadiene								
References Used to Support the Toxicity Criteria Development								
RfC, IRIS	2002	Ovarian atrophy	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	$BMCL_{10}$ (HEC) = 1.94×10^3 µg/m^3 (BMC_{10} = 2.21×10^3 µg/m^3)	1000	2 µg/m^3	NTP 1993
Chronic REL, Cal EPA	2001	Ovarian atrophy	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 103 wks	LOAEL = 1.38×10^4 µg/m^3; BMC_{05} (HEC) = 553 µg/m^3	30	20 µg/m^3	NTP 1993

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
1,3-Butadiene (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES ; *defined at the end of this table*(*Continued*)								
—	2003	Asthma symptoms	Humans,— asthmatic Hispanic children (10–16 yrs old), living in a Los Angeles community (n = 22)	Inhalation of traffic pollutants, concentrations of numerous individual chemicals measured (24-hr samples)	Daily, for up to 3 months, subjects filled out asthma symptom diaries and recorded peak expiratory flow (PEF) results. A positive association with at least one of several measures of increased asthma symptom severity was reported for numerous criteria air pollutants and VOCs. For example, the odds ratio for asthma symptoms from interquartile range increases in pollutants = 1.16 (95% CI = 0.90–1.49) for an interquartile range increase of 2.9 µg/m^3 1,3-butadiene. No association with PEF was found. Limitations: small number of subjects, possible exposure misclassification, impossible to determine which air pollutant responsible.			Delfino et al. 2003
—	2002	Testicular injury (as indicated by suppressed serum levels of inhibin-B and increased levels of follicle stimulating hormone (FSH))	Humans —(n = 576, aged 20–47), stored blood samples from workers at a polymer production plant in the mid-1970's	Workplace exposures in compounding polyvinyl chloride resins (lead and phthalate esters) and manufacturing nitrile rubber (acrylonitrile, butadiene, styrene). Exposure levels ranked based on job histories.	Abnormal levels of inhibin-B and FSH were not independently associated with exposure groups, but there was an increased prevalence of workers with abnormal results (low inhibin-B and high FSH) in all 3 of the exposed groups (PVC, nitrile, and mixed exposures) in comparison with the control group. Abnormal inhibin-B and FSH levels seemed to be most strongly correlated with exposures in the production of synthetic rubber (acrylonitrile, butadiene, and styrene). The subjects with abnormal hormone levels had a higher (but not statistically significant) prevalence of reporting reproductive problems.			Lewis et al. 2002

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
1,3-Butadiene (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2001	Mortality, morbidity, and hematology (Note that the cancer results from this study are presented in Table 3-2.)	Human—male workers employed at a petrochemical facility in Texas for at least 5 years (n = 614 for the total cohort). (Note this is a follow-up study of this cohort.)	Potential workplace inhalation exposure to 1,3-butadiene monomer Monitoring data from 1979–1992, shipping area: arithmetic mean 8-hr TWA 1,3-butadiene = 22,984 µg/m^3, max = 315,588 µg/m^3 Monitoring data from 1993–1998: max in all areas < 2210 µg/m^3	Overall mortality (SMR = 0.55 [95% CI = 0.42–0.70]) was significantly lower for the cohort. There was no increase in any of the causes of morbidity (wide range of endpoints). There were no significant differences in hematological variables in the cohort. Overall, the authors concluded that "the butadiene exposure at this facility in the last 20 years does not pose a health hazard to employees."			Tsai et al. 2001
Cr III								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1998	Morphological changes in lung macrophages	Rabbit (species not specified)	Inhalation: 6 hrs/day, 5 days/wk, 4 to 6 wks	LOAEL = 600 µg/m^3	—	Endpoints observed (morphological changes) not suitable for RfC development	Johansson et al. 1986
		No detailed reports of non-carcinogenic effects in various cancer bioassays	Animals, including rats and mice	Inhalation: intrapleural injection, or intrabronchial implantation/ duration unspecified	—	—	—	Baetjer et al. 1959; Hueper and Payne 1962; Levy and Venitt 1975; Levy and Martin 1983
RfD, IRIS	1998	No effects observed	Rat (species not specified)	5% Cr_2O_3 in diet, 5 days/wk, 120 wks	NOAEL (ADJ) = 1468 mg/kg-day	1000	1.5 mg/kg-day	Ivankovic and Preussman 1975
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
An updated literature review was performed only for Cr VI (the primary chromium compound of concern).								

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Cr VI (Chromium Trioxide)								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1998	Nasal septum atrophy	Human—occupational	Inhalation: median 4.5 yrs (0.1–36 yrs)	LOAEL (ADJ) = 0.714 µg/m^3	90	8×10^{-3} µg/m^3 (aerosols)	Lindberg and Hedenstierna 1983
		Lactate dehydrogenase in bronchioalveolar lavage fluid	Wistar rats, male	Inhalation: 22 hrs/day, 30–90 days	BMD (ADJ) = 34 µg/m^3	300	0.1 µg/m^3 (particulates)	Glaser et al. 1990; Maslch et al. 1994
REL, Cal EPA	2001	Bronchoalveolar hyperplasia	Wistar rat, male	Inhalation: 22 hrs/day, 7 days/wk, 90 days	LOAEL (HEC) = 24.5 µg/m^3	100	0.2 µg/m^3 (Excluding chromium trioxide)	Glaser et al. 1990
		Nasal atrophy, nasal mucosal ulcerations, nasal septal perforations, transient pulmonary function changes	Human—occupational	Inhalation: mean 2.5 yrs (0.2–23.6 yrs)	LOAEL(HEC) = 0.68 µg/m^3	300	0.002 µg/m^3 (Chromium trioxide)	Lindberg and Hedenstierna 1983
ATSDR, MRL Intermediate	2000	Nasal irritation, mucosal atrophy, ulcerations, and transient pulmonary function changes	Human—occupational	Inhalation: median 2.5 yrs (range 0.1–36 yrs)	LOAEL (ADJ) = 0.5 µg/m^3	100	0.005 µg/m^3 (Chromic acid mist)	Lindberg and Hedenstierna 1983
		Alterations in l actate dehydrogenase in bronchio-alveolar lavage fluid	Wistar rat, male	Inhalation: 22 hrs/day, 28–90 days	BMC (ADJ) = 34 µg/m^3	30	1 µg/m^3 (Cr VI particulate compounds)	Glaser et al. 1990
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	2004	Decreased hemoglobin, total protein, albumin, and alanine aminotransferase levels	Sprague Dawley rat, male	Inhalation: 6 hrs/day, 5 days/wk, 13 wks	NOAEL = 200 µg/m^3; LOAEL = 500 µg/m^3	—	—	Kim et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Diesel Engine Exhaust								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	2003	Pulmonary inflammation and histopathology	F344 rat	Inhalation: 16 hrs/day, 6 days/wk, 130 wks	NOAEL (HEC) = 144 µg DPM/m^3	30	5 µg/m^3	Rat chronic inhalation study: Ishinishi et al. 1988; Mathematical model of DPM deposition and clearance: Yu et al. 1991
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
An updated literature review was not required because IRIS was updated in 2003.								
Dioxin								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
EPA (Dioxin Reassessment)	2003	Cardiovascular disease	Human—occupational	Up to 40 yrs	—	—	ED_{01} (excess body burden over back-ground for 1% excess risk) = 1.12×10^{-2} µg/kg (3.1×10^{-3} µg/kg 95% lower bound)	Flesch-Janys et al. 1995

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Dioxin (*Continued*)								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT (*Continued*)								
EPA (Dioxin Reassessment)	2003	Cardiovascular disease, diabetes	Human—occupational	Up to 51 yrs	—	—	Negative results	Steenland et al. 1999
EPA (Dioxin Reassessment)	2003	Cardiovascular disease	Human—occupational	Up to 39 yrs	—	—	Negative results	Zober et al. 1990 1994
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
An updated literature review was not required because EPA's dioxin reassessment was performed in 2003.								
Ethylbenzene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1991	Developmental toxicity	Wistar rat, New Zealand white rabbit	Inhalation: 6–7 hrs/day, 7 days/wk, during days 1–19 (rats) and 1–24 (rabbits) of gestation	NOAEL (HEC) = 4.34×10^5 µg/m^3; LOAEL (HEC) = 4.34×10^6 µg/m^3	300	1×10^3 µg/m^3	Andrew et al. 1981; Hardin et al. 1981
REL, Cal EPA	2000	Nephrotoxicity, body weight reduction (rats), hyperplasia of the pituitary gland; liver cellular alterations and necrosis (mice)	F344 rat, B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 103 wks	NOAEL (HEC) = 6.5×10^4 µg/m^3; LOAEL = 1.250×10^6 µg/m^3	30	2×10^3 µg/m^3	NTP 1999; Chan et al. 1998
MRL, ATSDR	1999	Developmental indices, skeletal abnormalities	Wistar rat	Inhalation: 7 hrs/day, 5 days/wk, 3 wks pregestational and days 1–19 of gestation	NOAEL (HEC) = 4.21×10^5 µg/m^3; LOAEL (HEC) = 4.27×10^6 µg/m^3	100	Intermediate MRL = 4.34×10^3 µg/m^3	Andrew et al. 1981

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Ethylbenzene (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table*								
—	2003	Maternal toxicity (decreased weight gain), fetal toxicity (reduced fetal body weight)	Sprague-Dawley rat	Inhalation: 6 hrs/day, during days 6–20 of gestation	NOAEL = 2.17×10^6 µg/m^3; LOAEL = 4.34×10^6 µg/m^3	—	—	Saillenfait et al. 2003
IARC	2000	Detailed review of ethylbenzene exposure, toxicity, and carcinogenicity, including a summary of the 1999 NTP 2-year ethylbenzene study.						
Formaldehyde								
References Used to Support the Toxicity Criteria Development								
RfC, IRIS	The inhalation RfC section does not have a revision date, the status is "no data," and an RfC is "not available at this time."							
REL, Cal EPA	2000	Nasal and eye irritation, nasal obstruction, lower airway discomfort. Histopathological nasal lesions: rhinitis, squamous metaplasia, dysplasia	Human—chemical plant workers	Inhalation: 8 hrs/day, 5 days/wk, average 10 yrs (range 1–36 yrs)	NOAEL (HEC) = 32 µg/m^3; LOAEL (mean) = 260 µg/m^3	10	3 µg/m^3	Wilhelmsson and Holmstrom 1992; Edling et al. 1988
MRL, ATSDR	1999	Nasopharyngeal irritation and lesions in nasal epithelium	Cynomolgus monkey	Inhalation: 22 hrs/day, 7 days/wk, 26 wks	NOAEL = 1.21×10^3 µg/m^3; LOAEL = 3.63×10^3 µg/m^3	30	Intermediate MRL = 36.9 µg/m^3	Rusch et al. 1983
		Mild histological effects: eye and upper respiratory tract irritation, mild damage to the nasal epithelium	Human—chemical plant and furniture factory workers	Inhalation: workplace exposures, 10.4 yrs (avg)	LOAEL = 2.95×10^{-4} µg/m^3	30	Chronic MRL = 9.84 µg/m^3	Holmstrom et al. 1989

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Formaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1998	Neurotoxic effects	Human	This article cites numerous research studies that have suggested a causal relationship between chronic, low-level formaldehyde exposure and neurotoxic effects, such as disturbances of memory, concentration, mood, equilibrium, and sleep. The authors then discuss some of the study limitations, including selection bias in recruiting study participants and unreliability of participant recall in determining background variables and estimating exposure levels. The authors conclude that overall, these methodological weaknesses prohibit definitive conclusions about the relationship between formaldehyde exposure and neurobehavioral consequences.				Williams and Lees-Haley 1998
—	2001	Embryotoxicity and teratogenesis	Rat	This review article addresses embryo toxicity and teratogenicity associated with formaldehyde exposure. The authors reviewed a number of rat studies with varying exposure regimens (exposure prior to mating, during mating, or during the entire gestation period). Some of the observed effects included: increased embryo mortality, increased fetal anomalies, decreased concentrations of ascorbic acid, abnormalities in enzymes of mitochondria, lysosomes, and the endoplasmic reticulum, and metabolic acidosis.				Thrasher and Kilburn 2001
—	2001	Reproductive and developmental effects	Human Animal	In this comprehensive review article, the authors evaluated the potential for reproductive and developmental effects from formaldehyde exposure. Based on a review of 22 animal studies, the authors conclude "there is no credible evidence of reproductive or developmental toxicity" under exposure levels and routes relevant to humans (pg 31). The authors also reviewed 11 epidemiologic studies. A meta-analysis showed some evidence of increased risk of spontaneous abortion (meta-relative risk = 1.4 [95% CI = 0.9–2.1]). However, after accounting for reporting and publication biases, the authors found no evidence of increased risk of spontaneous abortion (meta-relative risk = 0.7 [95% CI = 0.5–1.0]) (pg 17). The authors noted that it was difficult to draw conclusions about other reproductive outcomes (such as birth weight and infertility), due to inconsistencies and study limitations in the few studies available for these endpoints. Overall, the authors concluded that reproductive and developmental effects were unlikely at formaldehyde exposure levels encountered in workplaces.				Collins et al. 2001

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Formaldehyde (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)								
—	2002	This comprehensive formaldehyde review summarizes controlled chamber studies, workplace studies, community studies, and histological studies of nasal mucosa. Based on this review, the author concluded that "it is not possible to identify a specific NOAEL or LOAEL for formaldehyde" (pg 23). While these studies are useful for setting exposure ranges associated with acute sensory irritation, human studies alone "are not adequate to serve as a reference concentration for estimating risk, or lack thereof, for a lifetime of exposure to formaldehyde" (pg 23). "The weight of evidence does not indicate that formaldehyde produces pathological changes to mucous membranes or the eyes, especially at the exposure (492 to 3690 µg/m^3) used to evaluate sensory irritation and pulmonary function changes." (pg 29) The author also discusses some of the key study limitations, such as confounding by multiple exposures, selection bias in community surveys, and the use of subjective health endpoints.						Bender 2002
Health Canada	2003	This comprehensive article, prepared by Health Canada under the Canadian Environmental Protection Act (CEPA), reviews a variety of health effects observed in human and animal studies involving formaldehyde exposure. The authors conclude that irritant effects on the eyes, nose, and throat are the most sensitive noncancer health endpoints, and that "only a very small proportion of the population experiences symptoms of irritation following exposure to 0.1 ppm (120 µg/m^3) formaldehyde" (pg 103). They also note that "formaldehyde is not likely to affect reproduction or development," "there is little convincing evidence that formaldehyde is neurotoxic," and "formaldehyde is unlikely to be associated with suppression of the immune response" (pg 88–89).						Litelpo and Meek 2003
—	2003	Asthma symptoms	Humans—asthmatic Hispanic children (10–16 yrs old), living in a Los Angeles community (n = 22)	Inhalation of traffic pollutants, concentrations of numerous individual chemicals measured (24-hr samples)	Daily, for up to 3 months, subjects filled out asthma symptom diaries and recorded peak expiratory flow (PEF) results. A positive association with at least one of several measures of increased asthma symptom severity was reported for numerous criteria air pollutants and VOCs. For example, the odds ratio for asthma symptoms from interquartile range increases in pollutants = 1.37 (95% CI = 1.04–1.80) for an interquartile range increase of 3.89 µg/m^3 formaldehyde. No association with PEF was found. Limitations: small number of subjects, possible exposure misclassification, impossible to determine which air pollutant responsible.			Delfino et al. 2003

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Formaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2005	Local irritation of the upper respiratory tract	Human—volunteers	Short term inhalation: 370 µg/m^3 (exposure details not specified)	NOAEL = 370 µg/m^3	~3	$ELIA_{systemic}$ = 125 µg/m^3 $ELIA_{local}$ = 125 µg/m^3	Schupp et al. 2005
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles for non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or $ELIA_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene, and compared these risk-based "acceptable" exposure levels to concentrations in cars. For formaldehyde, the authors considered the German MAK value of 370 µg/m^3 (essentially a NOAEL for local irritation of the upper respiratory tract, based on Deutsch Forschungsgemeinschaft 2000 and Schlink et al. 1999), and the maximum indoor air exposure level of 125 µg/m^3 (about the German MAK value) recommended by the former Bundesgesundheitsamt in Germany (BGA 1992). The study authors concluded that this factor of about 3 was an appropriate uncertainty factor for extrapolation to the general population. Therefore, because local irritation of the upper respiratory tract was considered to be the critical mechanism for acute and chronic toxicity, as well as "the most likely threshold mechanism that precedes tumor formation," this value of 125 µg/m^3 was used for the STELIA, $ELIA_{systemic}$, $ELIA_{local}$, and $ELIA_{cm}$. The average concentration of formaldehyde measured in chamber tests designed to simulate cars at 23°C (48 µg/m^3, as reported in FAT 1998) did not exceed the ELIAs.						
—	2004	Allergic inflammatory responses (immunogenic and neurogenic)	Mice—female, C3H/He (allergic mouse model) (*n* = 5 per group)	Inhalation of 101, 483, or 2305 µg/m^3 formaldehyde, 16 hrs/day, 5 days/wk, 12 wks.	LOAEL = 101 µg/m^3 (significantly decreased levels of nerve growth factor in bronchioalveolar lavage fluid in immunized mice)	Additional effects were observed at higher dose levels. The authors note that this is the first experimental evidence of formaldehyde-induced differential immunogenic and neurogenic responses in allergic mice.		Fujimaki et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Formaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2002	Asthma	Humans— children aged 6 mo–3 yr. Case control study: asthma cases (n = 88) and controls (n = 104) from Perth, Australia	Inhalation of formaldehyde indoors. Formaldehyde measured in children's bedroom and living room in winter and summer (mean = 27.5–30.2 µg/m^3, max = 189.7–224 µg/m^3).	LOAEL = 60 µg/m^3 for a significantly increased risk of asthma	Asthma subjects, and also children who reported wheeze, were exposed to significantly higher average indoor levels of formaldehyde. Children exposed to ≥ 60 µg/m^3 formaldehyde were found to be 39% more likely to have asthma than those who were not exposed to such levels.		Rumchev et al. 2002
***n*-Hexane**								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1993	Neurotoxicity (electrophysiological alterations)	Human— workers in a tungsten carbide alloy factory	Inhalation: 8 hrs TWA exposure (duration adjusted) = 7.3 × 10^4 µg/m^3, exposure duration (avg) = 6.2 yrs	LOAEL (HEC) = 7.3 × 10^4 µg/m^3	300	200 µg/m^3 *	Sanagi et al. 1980
		Epithelial lesions in the nasal cavity	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 90 days	NOAEL (HEC) = 3.8 × 10^4 µg/m^3; LOAEL (HEC) = 7.7 × 10^4 µg/m^3	—	—	Dunnick et al. 1989

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* This value has been updated. See Table C.1.

Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
***n*-Hexane (*Continued*)**								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT (*Continued*)								
REL, Cal EPA	2000	Peripheral neuropathy (electromyographic alterations; dose-related abnormal posture and muscle atrophy)	SM-A strain mouse, male	Inhalation: 24 hrs/day, 6 days/wk, 1 yr	LOAEL = 8.83×10^5 µg/m^3; NOAEL (HEC) = 2.04×10^5 µg/m^3	30	7×10^3 µg/m^3	Miyagaki 1967
MRL, ATSDR	1999	Neurotoxicity (alterations in muscle strength, vibration sensation, and motor nerve conduction velocity)	Human—workers in a tungsten carbide alloy factory	Inhalation: 8 hrs TWA exposure = $2.05 \times 10^5 \pm 1.45 \times 10^5$ µg/m^3, exposure duration (avg) = 6.2 yrs	LOAEL = 0.20 µg/m^3	100	2.12×10^3 µg/m^3	Sanagi et al. 1980
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1991	Various health endpoints evaluated, including histologic evaluations and neurobehavioral assessments	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 13 wks (for all doses tested: 0, 1.8×10^6, 3.5×10^6, 1.4×10^7, and 3.2×10^7 µg/m^3) An additional group was exposed to 3.5×10^6 µg/m^3 for 22 hrs/day, 5 days/wk,13 wks (denoted "continuous")	The incidence and severity of nasal lesions increased with increasing dose. Inflammatory, erosive, and regenerative lesions of the olfactory and respiratory epithelium were observed in most mice at 3.2×10^7 µg/m^3, while minimal olfactory epithelial changes were present in only a few mice at 3.5×10^6 µg/m^3 and 1.8×10^6 µg/m^3. Minimal nerve damage (paranodal swellings) occurred at 3.5×10^6 µg/m^3 (continuous) and 3.2×10^7 µg/m^3. The only behavior change was a decrease in locomotor activity in female mice at 3.5×10^6 µg/m^3 (continuous) and 3.2×10^7 µg/m^3. (The author also summarizes numerous previously published human and animal studies.) The author concluded that "exposure of mice to concentrations up to (3.2×10^7 µg/m^3) resulted in only minimal toxicity," and "exposure-related lesions of the nasal cavity occurred after *n*-hexane exposure, but minimal or no effects were seen at 3.5×10^6 µg/m^3 or below" (pg 3).			Dunnick 1991 (NTP Toxicity study)

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
***n*-Hexane (*Continued*)**								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	1993	Polyneuropathy	In this review, the author summarizes: early case reports (1960s) of *n*-hexane-induced polyneuropathy, a subsequent early animal study showing *n*-hexane induced peripheral nerve impairment in mice, studies of workers exposed to *n*-hexane, and the history of revisions to the Japanese TLV (from 1.77×10^6 µg/m^3 to 3.53×10^5 µg/m^3 in 1967 to 1.41×10^5 µg/m^3 in 1986). The author concludes that exposure to > 3.53×10^5 µg/m^3 *n*-hexane could cause overt polyneuropathy, and that the Japanese TLV of 1.41×10^5 µg/m^3 is low enough to prevent subclinical impairment of peripheral nerves.					Takeuchi 1993
—	1996	Persistent sensory nerve effects	Human—workers diagnosed with *n*-hexane induced polyneuropathy (*n* = 90)	Inhalation: prior occupational exposure, shoe manufacturing workers	—	—	—	Valentino 1996
		In this follow-up study, the authors re-evaluated electroneurographic patterns for 90 subjects previously diagnosed with n-hexane induced polyneuropathy. For all of the subjects, at least one year had passed since diagnosis and cessation of occupational *n*-hexane exposure; for some of the subjects, over ten years had passed. The authors found a complete recovery of motor nerve velocities. In contrast, sensory nerve effects remained statistically different from controls, even after more than ten years without exposure.						
—	1997	Significant reduction in total serum immunoglobulin levels compared to unexposed controls	Human—workers in Turkish shoe factories (*n* = 35)	Inhalation: occupational exposure	TWA exposure = 8.12×10^4 to 7.59×10^5 µg/m^3 (mean = 4.24×10^5 µg/m^3)	—	—	Karakaya et al. 1997
		The authors also summarized four previously published rodent studies showing suppression of a variety of immune functions following exposure to hexane metabolites. Overall, although the available animal data are "not sufficient to make a proper judgment of risk," the authors conclude that their findings "provide further evidence that *n*-hexane toxicity is not limited to the nervous system, but that it can also effect the immune system in humans" (p 124).						

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
***n*-Hexane (*Continued*)**								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table*** (***Continued***)								
—	1999	Neurotoxicity	In this review, the author summarizes the history of *n*-hexane neurotoxicity studies, beginning with the first case reports in Japanese literature in the 1960s and the first US case report in 1971. The author describes numerous subsequent studies showing neuropathy at "relatively low levels exposures to *n*-hexane." The author compares the history of *n*-hexane neurotoxicity studies with the history of *n*-hexane occupational standards in the US and other countries to illustrate what they conclude are the shortcomings of US occupational standards. The author concludes that "because a growing number of clinical reports have identified clinical and subclinical neurotoxicity from *n*-hexane near, at, and below the current time-weighted average TLV of 1.77×10^5 µg/m^3, even this level is too high to protect all workers" (p 457).					Lanska 1999
—	2002	Color vision impairment: significant differences in color discrimination compared to controls	Human—leather industry workers diagnosed with polyneuropathy following *n*-hexane exposure ($n = 26$)	Inhalation: occupational exposure	—	—	—	Issever et al. 2002
		The authors conclude that these results may indicate a relationship between *n*-hexane exposure and development of defects in color vision.						

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Lead Compounds								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
IRIS, EPA	2004	Lead exposure can be associated with various health effects, such as neurotoxicity and developmental delays. Young children are more sensitive to health effects from lead, and have a higher risk of lead exposure, due to frequent hand-to-mouth behavior. Health effects associated with lead exposures are generally evaluated based on blood lead levels, as opposed to using standard toxicity criteria (i.e., reference concentrations or cancer unit risks). In its IRIS file for lead, EPA concluded that it is inappropriate to develop reference values for lead.						EPA 2004
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
NAAQS, EPA	2004	EPA has set a National Ambient Air Quality Standard (NAAQS) for lead of 1.5 µg/m^3 (quarterly average).					1.5 µg/m^3	EPA 2004
Blood lead level, CDC	2004	The Centers for Disease Control and Prevention (CDC) has identified 10 µg/dL as the blood lead level (BLL) of concern in children. A CDC work group recently reviewed the literature to evaluate the evidence for health effects at blood lead levels < 10 µg/dL, and concluded that "while available evidence does not permit a definitive causal inter-pretation of the observed associations between higher BLLs in the range < 10 µg/dL and adverse health indicators, the weight of available evidence favors, and does not refute, the interpretation that these associations are, at least in part, causal." Although health effects have been postulated to occur below 10 µg/dL, the CDC has not revised its blood lead level of concern, because (1) at levels less than 10 µg/dL, clinical interventions are not effective at lowering blood lead levels or reducing risks, (2) inaccuracies inherent in laboratory testing preclude accurate blood lead level classification below 10 µg/dL, and (3) setting a new level of concern would be arbitrary because there is no clear evidence of a threshold below which adverse effects are not experienced.					Blood lead level of concern in children: 10 µg/dL	CDC 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Lead Compounds (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
Gradient Corp.	2004	EPA's Adult Lead Model (EPA 2003) can be used to predict adult blood lead levels associated with given exposure conditions. Gradient Corp. has used this model to evaluate incremental increases in blood lead levels at various air lead concentrations of potential interest. The model determines the incremental increase in blood lead due to the lead source of interest (in this case, exposure to lead in air), as follows: $$\Delta PbB_{air} = \frac{EF}{AT} \times \frac{ET}{24} PbA \times InhR \times AF_a \times BKSF$$ Lead uptake is calculated by multiplying the concentration of lead in air (PbA) by the inhalation rate (InhR, 20 m^3/day), and the absorption fraction (AF) for lead in air (0.32). The exposure frequency was assumed to be 24 hrs/day, 365 days/year. The averaging time (AT) for chronic exposure to lead in soil is assumed to be one year (i.e., 365 days). The biokinetic slope factor (BKSF) relates the incremental lead uptake into the body to an incremental increase in blood lead level in adults. EPA's default value of 0.4 (µg/dL per µg/day) was used for the BKSF. The incremental blood leads are presented in the next column. Blood lead increments ranged from 0.002 to 0.1 µg/dL.					Incremental increases in adult blood lead levels: • 0.002 µg/dL at the minimum (mean) air conc. 9.67 × 10^{-4} µg/m^3 • 0.07 µg/dL at the maximum (mean) air conc. 0.027 µg/m^3 • 0.006 µg/dL at the mean in-vehicle conc. 0.0024 µg/m^3 • 0.1 µg/dL at the maximum in-vehicle conc. 0.04 µg/m^3	—

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Lead Compounds (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
Gradient Corp.	2004	The Integrated Exposure Uptake Biokinetic (IEUBK) Model (EPA 1994) can be used to predict children's blood lead levels associated with given exposure conditions. The IEUBK Model is a computer-based deterministic simulation that estimates the blood lead concentration in children resulting from their exposure to lead in soil, dust, drinking water, diet, and air. Gradient Corp. has used this model to evaluate incremental increases in blood lead levels at various air lead concentrations of potential interest. Specifically, the model estimates the intake and uptake of lead into the body and then uses biokinetic modeling to predict blood lead levels. Because of variations in behavior and physiology among individual children, different children will have different blood lead levels, even if they are exposed to the same environment. The IEUBK Model addresses this by treating its central estimate of blood lead concentration (averaged over childhood from age 0 to 7 yrs) as a geometric mean (GM) of a lognormal distribution among similarly exposed children. A default GSD of 1.6 is used to calculate the proportion of children in the variable population whose blood lead concentration is above 10 µg/dL. To calculate incremental blood lead levels, Gradient Corp. performed a baseline calculation where the model was run using an air concentration of zero. Subsequent model runs used potential air concentrations of interest ranging from 9.67×10^{-4} µg/m^3 to 0.04 µg/m^3 (which included the minimum and maximum mean air lead concentrations for ambient air and in-vehicle). The modeling results showed that the blood lead outputs were the same in all cases, indicating that the model is not sensitive enough to detect a difference in blood lead due to these very low air lead concentrations.						—
Manganese								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1993	Impairment of neurobehavioral function	Human—occupational	Inhalation: 5.3 yrs (0.2–17.7 yrs)	LOAEL (HEC) = 50 µg/m^3	1000	0.05 µg/m^3	Roels et al. 1992 Roels et al. 1987
Chronic REL, Cal EPA	2000	Impairment of neurobehavioral function	Human—occupational	Inhalation: 8 hrs/day, 5 days/wk, average 5.3 yrs (0.2–17.7 yrs)	LOAEL (HEC) = 54 µg/m^3	300	0.2 µg/m^3	Roels et al. 1992
Chronic MRL, ATSDR	2000	Abnormal performance in neurobehavioral tests	Human—occupational	Inhalation: 5.3 yrs (0.2–17 yrs)	$BMDL_{10}$ (ADJ) = 17.6 µg/m^3	500	0.04 µg/m^3	Roels et al. 1992

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Manganese (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1999	Impaired performance on simple reaction time, motor function, memory tests	Human—occupational (Review of Mn studies using psychological tests)	Inhalation: 9.9 yrs (1–35 yrs)	LOAEL = 150 $\mu g/m^3$ (average worker exposures)	—	—	Iregren 1999
—	2001	Neurotoxicity	Human—occupational	Inhalation	This study provides evidence that parkinsonism may develop at a younger age in welders, as compared to the general population, thus suggesting that welding fumes (which contain manganeses) may be a risk factor for parkinsonism.			Racette et al. 2001
—	2003	No significance neurobehavioral effects (motor function, cognitive ability, simple reaction time)	Human—occupational, South African mine workers	Inhalation: 10.8 yrs (1–41 yrs)	NOAEL = 210 $\mu g/m^3$ (average exposure across all jobs)	—	—	Myers et al. 2003a
—	2003	Memory, cognitive ability, motor function, simple reaction time, postural tremor, sway	Human—occupational, South African smelter	Inhalation: 18.2 yrs (SD 7.6 yrs)	According to the study authors, results provided little convincing evidence of neurobehavioral effects (avg exposure ranged up to 5.08 × 10^3 $\mu g/m^3$). However, there were exposure-related differences for digit span and digit symbol tests (both of which test cognitive ability).			Myers et al. 2003b

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Mercury Compounds								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS (elemental mercury)	1995	Hand tremor, increases in memory disturbance; slight subjective and objective evidence of autonomic dysfunction	Human—occupational	Inhalation	LOAEL (ADJ) = 9 μg/m^3	30	0.3 μg/m^3 (elemental mercury)	Fawer et al. 1983; Piikivi and Tolonen 1989; Piikivi and Hanninen 1989; Piikivi 1989; Ngim et al. 1992; Liang et al. 1993
REL, Cal EPA	2000	Nervous system: hand tremor, memory and sleep disturbances, neurobehavioral and autonomic dysfunction	Human—occupational	Inhalation: average duration = 13.7–15.6 yrs	LOAEL (HEC) = 8.9 μg/m^3	100	0.09 μg/m^3 (Mercury salts, elemental mercury)	Fawer et al. 1983; Piikivi and Tolonen 1989; Piikivi and Hanninen 1989; Piikivi 1989; Ngim et al. 1992; Liang et al. 1993
MRL, ATSDR (chronic inhalation MRL for metallic mercury vapor)	2001	Increased frequency of hand tremors	Human—occupational, manufacture of fluorescent tubes, chloralkali, or acetaldehyde	Inhalation: average duration = 15.3 yrs	LOAEL (ADJ) = 6.2 μg/m^3	30	0.2 μg/m^3	Fawer et al. 1983
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1996	This review summarizes research presented at a 1996 conference on the neurotoxicity of mercury. Most of the studies presented focus on methylmercury exposure and health effects, and not metallic or inorganic mercury. The authors conclude that "there is limited understanding of the effects at lower levels of exposure" (p 13).						Cranmer et al. 1996

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Mercury Compounds (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	1999	Immunotoxicity	This article reviews studies investigating exposure to metallic mercury vapor and the effect on various immune parameters (eg, immunoglobulin levels, acute phase proteins, autoantibodies, and polymorphonuclear leucocyte functions). The available studies vary considerably, with some positive, some negative, and some borderline results. Some data suggest suppressing effects on the human immune system, while other data suggest stimulating effects. The authors conclude that "a full understanding of the relevance of the immunotoxicity tests to man is still incomplete" (p 10). The authors also note that "no positive report that mercury vapor could be carcinogenic in man has appeared up to now" (p 10).					Moszczynski 1999
—	1999	Reproductive toxicity	This review summarizes animal studies, case studies, and epidemiologic studies evaluating potential reproductive toxicity from mercury vapor exposure. Reproductive problems (spontaneous abortion, stillbirths, congenital malformations, infertility, menstrual cycle disturbances, inhibition of ovulation, and behavioral effects in offspring) have been reported, but the studies "establishing a relationship between occupational mercury exposure and reproductive problems most likely concern women exposed to mercury concentrations approaching or exceeding the TLV." The authors conclude that "the safety of moderate and even low occupational exposure is, however, not proven and safe levels are not determined" (p 254).					Schuurs 1999
—	2000	This review addresses elemental mercury and methylmercury. Exposure to about 5×10^3 to 10^4 μg/m^3 mercury vapor can result in bronchitis, bronchiolitis, pneumonitis, excitability, and tremors. Moderate and repeated exposure (less than a few mg/m^3, > 0.05 mg/m^3 mercury vapor) causes tremor, erethism, and gingivitis. Lower repeated exposure causes "micromurcurialism," characterized by weakness, fatigue, anorexia, loss of weight, and gastrointestinal disturbances. Exposure to mercury vapor levels around 50 μg/m^3 has been associated with minor renal tubular defects, tiredness, memory disturbance, subclinical finger tremor, slower and attenuation of power spectrum EEG, and other neurobehavioral and neuropsychological effects. Some effects persist after cessation of exposure.						Satoh 2000
—	2003	This comprehensive article reviews elemental mercury, inorganic mercury, and organic mercury. Health effects associated with high concentrations of mercury vapor include pneumonitis, bronchitis, and acrodyna (diffuse pruritic rash). Health effects associated with lower concentrations of mercury vapor include CNS defects, insomnia, forgetfulness, loss of appetite, tremor, erethism, and other peripheral and autonomic signs with long term exposure to lower levels. Health effects associated with inorganic mercury salts include renal injury, CNS damage, anemia, tremors, central neuropathy, acrodynia, and behavior alterations. The authors also discuss at length the possible immunotoxic effects of mercury, and suggest that low levels of mercury exposure (< 40 μg/kg bw) in adults may exacerbate systemic autoimmunity in susceptible individuals.						Tchounwou et al. 2003

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Mercury Compounds (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)								
—	2003	This review article addresses mercury vapor from dental amalgams, exposure to mercury vapor from spills or cultural or religious uses, methylmercury in fish, and ethylmercury (thimerosal) in vaccines. The target organs for mercury vapor are noted to be the central nervous system, the peripheral nervous system, and the kidney. The authors summarize that bronchial irritation, pneumonitis, metallic taste, stomatitis, gingivitis, and increased salivation occur at > 1000 µg/m^3 mercury vapor, and that proteinureia, peripheral neuropathy, erethism (bizarre behavior), and tremor occur at > 500 µg/m^3. "Today's occupational exposures, such as in the dental office, are lower and may lead to mild, reversible effects on the kidney or mild cognitive changes and memory loss" (p 1733). Although possible associations between long-term exposure to low concentrations of mercury vapor from amalgams and degenerative diseases such as Alzheimer's disease, multiple sclerosis, and Parkinson's disease have been suggested, the authors conclude that the available epidemiologic studies show no connection.						Clarkson et al. 2003
—	2004	This comprehensive review article addresses sources and effects of methylmercury, ethylmercury, elemental mercury, and inorganic mercury, with a focus on children. The authors note that according to ATSDR, "inhalation of elemental mercury vapors in concentrations greater than (50 µg/m^3) for significant periods is considered unsafe" (pg 219). The authors cite numerous case studies involving acute and chronic elemental mercury vapor exposure and discuss a number of health effects, including cough, dyspnea, fever, tremors, malaise, axonal sensorimotor polyneuropathy, gingivitis, delusions, hallucinations, mercurial eretheism, pulmonary dysfunction, and acrodynia in children. The authors also summarize case studies involving inorganic mercury exposure and note various health effects including fatigue, insomnia, weight loss, paresthesias of the feet and hands, erythema, pruritus, excessive perspiration and hypersalivation, progressive weakness in the extremities, renal tubular dysfunction, and neuropsychiatric disorders.						Counter and Buchanan 2004
—	2004	This article reviews neurotoxic and developmental effects for methylmercury, ethylmercury, and inorganic mercury. The authors discuss neurotoxic effects from exposure to mercury vapor, including erethism (bizarre behavior including excitability, insomnia, memory loss, excessive shyness, and aggression), tremor, gingivitis, neuropsychological effects in adults, and acrodynia or pink disease in children. In contrast to organic mercury, "remarkably little is known about the developmental neurotoxicity of elemental mercury or inorganic mercury compounds" (p 1027). WHO is referenced as noting that, "even for adults, information is insufficient to propose a no observable adverse effect level" for inorganic mercury (p 1027). The authors also discuss the fact that various US regulatory bodies have interpreted the scientific literature differently, leading to confusion for the public.						Davidson et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
MTBE								
References Used to Support the Toxicity Criteria Development								
RfC, IRIS	1993	Increased absolute and relative liver and kidney weights and increased severity of spontaneous renal lesions (females), increased prostration (females), and swollen periocular tissue (males and females)	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	NOAEL (HEC) = 2.59×10^5 µg/m^3; LOAEL (HEC) = 1.946×10^6 µg/m^3	100	3×10^3 µg/m^3	Chun et al. 1992
REL, Cal EPA	2000	Nephrotoxicity, prostration, periocular swelling	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	NOAEL (HEC) = 2.60×10^5 µg/m^3 ; LOAEL = 1.1×10^7 µg/m^3	30	8×10^3 µg/m^3	Chun et al. 1992, Bird et al. 1997
ATSDR, MRL Chronic	1996	Chronic progressive nephropathy leading to increased mortality and decreased mean survival time	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	NOAEL (ADJ) = 2.56×10^5 µg/m^3; LOAEL = 1.08×10^7 µg/m^3	100	2.53×10^3 µg/m^3	Chun et al. 1992
Selected References from Updated Literature Searches, ***defined at the end of this table***								
—	2001	MTBE functions as a nontraditional genotoxicant, and several mechanisms have been proposed to explain its mode of action (eg, functioning as a cytotoxic not a mitogenic agent, involvement in hormonal mechanisms, or operating as a promoter instead of a complete carcinogen). Some studies have suggested that its two main metabolites, formaldehyde and tributanol, may be the source of MTBE's carcinogenicity in animals (the human carcinogenic potential remains unclear). A role for DNA repair in MTBE carcinogenesis was recently revealed, which explains some of the effects. The totality of the evidence shows that, for the majority of the nonoccupationally exposed human population, MTBE is unlikely to produce lasting adverse health effects. A small segment of the population (eg, asthmatic children, the elderly), may be at increased risk for toxicity, but no studies have evaluated this possibility.						Ahmed 2001

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Naphthalene								
References Used to Support the Toxicity Criteria Development								
RfC, IRIS	1998	Nasal effects: hyperplasia and metaplasia in respiratory and olfactory epithelium, respectively	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 103 wks	LOAEL (HEC) = 9.3×10^3 μg/m^3	3000	3 μg/m^3	NTP 1992
REL, Cal EPA	2000	Nasal inflammation, olfactory epithelial metaplasia, respiratory epithelial hyperplasia	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 104 wks	LOAEL (ADJ) = 9.4×10^3 μg/m^3	1000	9 μg/m^3	NTP 1992
MRL, ATSDR	2003	Nonneoplastic lesions in nasal olfactory epithelium and respiratory epithelium	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 105 wks	LOAEL (HEC) = 1.05×10^{-3} μg/m^3	300	Chronic MRL = 3.67 μg/m^3	Abdo et al. 2001; NTP 1992; NTP 2000
Selected References from Updated Literature Searches, *defined at the end of this table*								
An updated literature review was not required because the ATSDR MRL was updated in 2003.								
Nickel Compounds								
References Used to Support the Toxicity Criteria Development								
RfC, IRIS	—	IRIS RfC (for soluble nickel salts, nickel carbonyl, nickel refinery dust, and nickel subsulfide): "Not available at this time."						
REL, Cal EPA (Nickel and nickel compounds)	2000	Respiratory and hematopoietic system: pathological changes in the lung, nasal epithelium and lymph nodes	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 104 wks	LOAEL = 60 μg/m^3 (as nickel sulfate hexahydrate) NOAEL (HEC) = 1.6 μg Ni/m^3	30	0.05 μg Ni/m^3	NTP 1994a (the final 1996 version of this report was obtained, instead of the earlier 1994 version)

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Nickel Compounds (*Continued*)								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT (*Continued*)								
REL, Cal EPA (Nickel oxide)	2000	Respiratory and hematopoietic system: pathological changes in the lung and lymph nodes	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 104 wks	LOAEL (HEC) = 30 µg Ni/m^3	300	0.1 µg Ni/m^3	NTP 1994b (the final 1996 version of this report was obtained, instead of the earlier 1994 version)
MRL, ATSDR	2003	Chronic active inflammation in the lung	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 13 wks	LOAEL = 110 µg Ni/m^3 NOAEL (HEC) = 5.2 µg Ni/m^3	30	Intermediate MRL = 0.2 µg Ni/m^3	NTP 1996
		Chronic active inflammation and lung fibrosis	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	LOAEL = 60 µg Ni/m^3 NOAEL (HEC) = 2.7 µg Ni/m^3	30	Chronic MRL = 0.09 µg Ni/m^3	NTP 1996
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1999	This general review of nickel addresses human exposure sources, toxicokinetics, mechanisms, toxicity, carcinogenicity, biomonitoring, and treatment. In summarizing noncancer health effects associated with chronic exposure to inhaled nickel, the author notes several cardiorespiratory effects, including asthma, chronic hypertrophic rhinitis and sinusitis, nasal polyposis, and perforations of the nasal septum. Barceloux notes that "nephrotoxicity is not a prominent feature of chronic nickel toxicity" (p 247). Although reproductive and developmental effects have been observed in animals exposed to high concentrations, "there has been no documentation of either reproductive or developmental effects following exposure to nickel in the environment. Similarly, no significant reproductive or developmental abnormalities have been detected in the work setting" (p 249).						Barceloux 1999

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Nickel Compounds (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table*** (***Continued***)								
Haber et al. 2000 (the authors were a panel formed by Toxicology Excellence for Risk Assessment (TERA), under contract to EPA, Health Canada, and others)	2000	Lung fibrosis	F344 rat, male	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs (nickel sulfate)	$BMCL_{10}$ (HEC) = 1.7 µg Ni/m^3; NOAEL (HEC) = 2.1 µg Ni/m^3	10	0.02 µg Ni/m^3	Haber et al. 2000 (RfC based on data from NTP 1996)
		Irregular opacities in chest radiographs	Human—nickel sinter plant workers	Inhalation: workplace exposure (soluble and insoluble nickel)	Minimal LOAEL (HEC) = 18 to 200 µg Ni/m^3	100	0.2 to 2 µg Ni/m^3 (value not recommend for use; calculated only for comparison purposes)	Haber et al. 2000 (RfC based on data from Muir et al. 1993)
		This comprehensive analysis considered numerous animal studies and chose the 1996 NTP bioassay as the most appropriate for derivation of an RfC. They determined NOAELs and developed benchmark concentrations ($BMCL_{10}$) for various endpoints, then determined lung fibrosis in male rats to be the most sensitive endpoint. Although the authors concluded that uncertainties severely limit the use of the one available human study on noncancer effects, they nonetheless calculated an RfC, and noted that the RfC based on human data was comparable to, or an order of magnitude higher than, the RfC based on animal data. The authors conclude that overall confidence in the RfC is medium to high. The authors note that "after EPA review, the conclusions of the assessment will also be summarized for EPA's Integrated Risk Information System (IRIS)" (p 210).						

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
POM								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
ATSDR	1995	In this toxicological profile for PAHs (POMs), both non-cancer and cancer effects are reviewed. Mice fed high levels of benzo[*a*]pyrene during pregnancy had difficulty reproducing as did their offspring. Furthermore, the offspring of pregnant mice fed benzo[*a*]pyrene suffered from birth defects and decreased body weight. Studies in animals have also shown that PAHs can cause harmful effects on skin, body fluids, and the immune system after both short- and long-term exposure. None of these effects have been reported in humans. "Adverse noncancer respiratory effects, including bloody vomit, breathing problems, chest pains, chest and throat irritation, and abnormalities in chest X-rays have been reported in humans exposed to PAHs and respirable particles in a rubber factory" (p 116). Adverse effects on respiratory tissues in animals have also been reported. "No studies were located regarding cardiovascular, gastrointestinal, hematological, musculoskeletal, hepatic, dermal, or ocular effects in humans or animals following inhalation exposure to any of the 17 PAHs discussed in this profile (p 16)."						ATSDR 1995
—	2004	Neurotoxic effects (effects on long-term potentiation [LTP] a cellular correlate of learning and memory) in the F1 generation. Pregnancy outcomes (number of pups/litter, number of resorptions) also reported.	Rats—F344 Pregnant dams exposed (n = 20), male pups (n = 10, treated; n = 12, controls) tested on postnatal days 60–70	Maternal, nose-only inhalation exposure to 100 µg/m^3 B[*a*]P carbon black aerosol for 4 hrs/day, gestational days 11–21 Gestational exposure for the rat pups.	LOAEL = 100 µg/m^3 for effects on LTP. There was also a statistically sig-nif-icant increase in resorptions at this dose.	—	—	Wormley et al. 2004

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Styrene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1993	CNS effects	Human—occupational	Inhalation: 8.6 ± 4.5 yrs	NOAEL (HEC) = 3.4×10^4 µg/m^3	30	1×10^3 µg/m^3	Mutti et al. 1984
REL, Cal EPA	2000	Neuropsychological deficits, as measured by memory and sensory motor function tests	Human—occupational	Inhalation: 8.6 ± 4.5 yrs	BMC_{05} (HEC) = 2.6×10^3 µg/m^3	3	900 µg/m^3	Mutti et al. 1984
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	2002	CNS effects – color vision	Human—occupational	Inhalation: chronic, duration varied	Threshold for decreased color vision = 2.13×10^5 µg/m^3	—	—	Cohen et al. 2002 (with support from Gobba et al. 1991; Gobba and Cavalleri 1993; Eguchi et al. 1995; Campagna et al 1995)
—	2002	Ototoxicity (inner ear and 8th cranial nerve)	F344 rat	Inhalation: 14 hrs/day, 7 days/wk, 3 wks (Pryor) or 14 hrs/day, 5 days/wk, 3 wks (Yano)	NOAEL = 8.52×10^5 µg/m^3; LOAEL = 3.41×10^6 µg/m^3	—	—	Cohen et al. 2002 (with support from Pryor et al. 1987; Yano et al. 1992)

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria/ Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Toluene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	1992	Neurological effects	Human—occupational	Inhalation: average exposure duration = 5.7 yrs	NOAEL = none; LOAEL (HEC) = 1.20 × 10^5 µg/m^3	300	400 µg/m^3 *	Foo et al. 1990
		Erosion of olfactory epithelium in male rats and degeneration of respiratory epithelium in both sexes	F344 rat	Inhalation: 6.5 hrs/day, 5 days/wk, 2 yrs	LOAEL (HEC) = 7.9 × 10^4 µg/m^3	—	—	NTP 1990
Chronic inhalation MRL, ATSDR	2000	Color vision impairment	Human—occupational	Inhalation: average duration, 16 to 18 yrs	LOAEL (ADJ) = 3.1 × 10^4 µg/m^3	100	300 µg/m^3	Zavalic et al. 1998
REL, Cal EPA	2000	Decreased brain weight (subcortial limbic area), altered dopamine receptor binding (caudate-putamen)	Sprague Dawley rat, male	Inhalation: 6 hrs/day, 5 days/wk, 4 wks, 29–40 days recovery	NOAEL (HEC) = 3 × 10^4 µg/m^3;	100	300 µg/m^3	Hillefors-Berglund et al. 1995 (with support from Orbaek and Nise 1989 and Foo et al. 1990)

* This value has been updated. See Table C.1.

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Table C.3. (*Continued*). Summary of Chronic Noncancer Toxicity Data for Each MSAT

Toxicity Criteria / Source	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Criteria	Reference
Toluene (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2001	Spontaneous abortion	Human—occupational	Inhalation: duration varied	Results from several occupational studies suggest an association between spontaneous abortion and toluene exposure. However, uncertainties and limitations in the studies suggest "cautious interpretation" of the findings.			Bukowski 2001 (with support from Ng et al. 1992)
—	2004	Leukoencephalopathy (a neurological syndrome associated with toluene abuse, characterized by dementia and damage to brain white matter)	Human—occupational exposure and inhalant abuse	Inhalation: duration varied	Chronic toluene abuse (high exposure) is clearly associated with neurotoxicity. However, the LOAEL for damage to brain white matter is an area of uncertainty. Leukoencephalopathy has not been proven to occur at permissible occupational levels, although a single study reported subtle white matter changes in exposed workers.			Filley et al. 2004 (with support from Filley and Kleinschmidt-DeMasters 2001 and Thuomas et al. 1996)
Xylene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
RfC, IRIS	2003	Impaired motor coordination (decreased rotarod performance and decreased latency in the paw-lick response in the hot-plate test)	Wistar rat	Inhalation: 6 hrs/day, 5 days/wk; 6 months	NOAEL (HEC) = 3.9×10^4 µg/m^3; LOAEL (HEC) = 7.8×10^4 µg/m^3	300	100 µg/m^3	Korsak et al. 1994
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
An updated literature review was not required because IRIS was updated in 2003.								

Selected References from Updated Literature Searches:

The toxicity and health portions of the literature survey took advantage of peer-reviewed secondary sources of information, such as the EPA's Health Assessment Documents, U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reports, and International Agency for Research on Cancer (IARC) monographs. Information on chronic, noncancer endpoints was collected from these sources. In addition, the primary sources that key toxicity criteria were based upon were identified and obtained. The survey was augmented with information from primary sources for the seven priority MSATs. The survey was also augmented for the remaining 14 nonpriority MSATs. In cases where the secondary sources were out of date (i.e., 2001 or earlier).

Table C.4. Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Acetaldehyde						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer potency, Cal EPA	1999	Rat nasal tumor incidence data	Wistar rat (male more sensitive than female)	Inhalation: 6 hrs/day, 5 days/wk, up to 28 months	2.7×10^{-6} per µg/m^3	Woutersen et al. 1986
Cancer unit risk, EPA (IRIS)	1991	Nasal adeno-carcinoma and squamous cell carcinoma	SPF Wistar rat, male	Inhalation: 6 hrs/day, 5 days/wk, 28 months	2.2×10^{-6} per µg/m^3	Woutersen and Appelman 1984 (document unavailable, not included in documents provided to HEI)
Cancer classification, IARC	1999	Adenocarcinomas and squamous cell carcinomas of the nasal mucosa at all three dose levels	Wistar rat	Inhalation: 6 hrs/day, 5 days/wk, for a max of 28 months	Unit risk not calculated Overall evaluation: possibly carcinogenic to humans (Group 2B)	Woutersen et al. 1986
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	2002	Increase in total malignant tumors	Sprague-Dawley rat	Ingestion of acetaldehyde in drinking water: 104 wks Dose levels ($\times 10^3$ µg/L) 2500, 1500, 500, 250, 50, and 0	Increase in total malignant tumors in all treated groups except males at 250×10^3 µg/L (statistically significant only in the high-dose groups). Increase in mammary tumors in all treated females except the 250×10^3 µg/L group (increase not dose-related). Increased incidence of carcinomas of the Zymbal gland, external ear ducts, nasal sinuses, and oral cavity in the high dose groups.	Soffritti et al. 2002

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Acetaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
EPA IRIS *draft* Toxicological Review Document	1999	This comprehensive *draft* review, prepared in support of the EPA IRIS file, covers the toxicokinetics, noncancer toxicity, and carcinogenicity of acetaldehyde and provides a revised *draft* Unit Risk value. Note that although this *draft* report is currently available on the EPA web site, there is also a notice from EPA saying that "the draft has been pulled back for additional analysis and revision." Some of the key studies summarized by EPA (and not already summarized elsewhere in this table) are also included below.				EPA 1999
		Nasal adenocarcinomas and squamous cell carcinomas	Wistar rat	Inhalation: 6 hrs/day, 5 days/wk, 28 months	1.3×10^{-5} per µg/m^3	Woutersen et al. 1985, 1986 (as cited in EPA 1999)
		Nine cases of cancer identified in cohort: squamous cell bronchial tumors (*n* = 5), squamous cell oral cavity tumors (*n* = 2), one adenocarcinoma of the stomach (*n* = 1), and adenocarcinoma of the cecum (*n* = 1).	Human—occupational German chemical workers (*n* = 220)	Inhalation Acetaldehyde concentrations reported to range from 1 to 7×10^3 µg/m^3 (0.55–3.9 ppm)	Unit risk not calculated. Incidence rate of 6000 per 100,000 population compared to 1200 per 100,000 in the general German population.	Bittersohl 1974 (as cited in EPA 1999)
		All 9 patients were smokers and there were other major limitations (eg, incidence rates not age-adjusted, concurrent exposures to other chemicals). EPA considered the data "inadequate to evaluate the carcinogenicity of acetaldehyde."				
		Increased incidence of laryngeal tumors (statistically significant in males only) Acetaldehyde also enhanced carcinogenicity of intratracheally instilled B[*a*]P	Syrian golden hamster	Inhalation: 7 hrs/day, 5 days/wk, 52 wks	—	Feron et al. 1982 (as cited in EPA 1999)

Table continues on next page

Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Acetaldehyde (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	1997	In this review, the author discusses the biochemistry, genotoxicity, dosimetry, inhalation toxicology, and carcinogenicity of inhaled acetaldehyde, focusing on effects in the rat. Tumors observed in the rat include squamous cell carcinomas and adenocarcinomas originating from respiratory epithelial cells and olfactory mucosa. The olfactory mucosa is the most sensitive target, with nasal tumors observed at exposure concentrations of 1.35×10^6 µg/m^3 (750 ppm) or higher. The author suggests that nasal respiratory epithelial cytotoxicity is critical for the tumorigenic response, and that exposure to non-cytotoxic concentrations may pose limited cancer risk. The author goes on to suggest that carcinogenicity may only occur at concentrations sufficiently high enough to overwhelm detoxification capacity. The primary rat toxicity/carcinogenicity studies reviewed were all from the 1980s (the Appelman and Woutersen studies).				Morris 1997
—	2005	Genetic polymorphism for metabolizing enzyme (alcohol dehydrogenase [ADH] genotypes)	Humans— Heavy alcohol consumers with upper aerodigestive tract cancer (n = 107) compared to matched alcoholic controls with no cancer (n = 103).	Chronic ethanol consumption (oral), exposure to acetaldehyde as a metabolite of ethanol	—	Visapaa et al. 2005
		Acetaldehyde, a metabolite of ethanol, is suspected to be responsible for alcohol-related cancers. ADH genotypes were studied in this article because both ADH and aldehyde dehydrogenase (ALDH) exhibit genetic polymorphisms which affect the rate of metabolism of ethanol to acetaldehyde and acetaldehyde to acetate. In this study, the *ADH1C*1* allele was found to be significantly increased in heavy alcohol consumers with upper aerodigestive tract cancer compared to matched alcoholic controls with no cancer. The authors concluded, "heavy drinkers homozygous for the *ADH1C*1* allele have a predisposition to develop upper aerodigestive tract cancer, possibly due to elevated salivary acetaldehyde levels following alcohol consumption." Note: Even though this article does not directly address acetaldehyde inhalation, it is useful in the context of understanding the mechanisms of acetaldehyde-induced cancer and the potential effect of genetic polymorphisms for metabolizing enzymes on an individual's alcohol/acetaldehyde cancer risk.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Acetaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2005	Increased relative organ weights	Hamsters	Inhalation: 6 hrs/day, 5 days/wk, 90 days	$ELIA_{cm}$ = 635 µg/m^3	Schupp et al. 2005
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles for non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or $ELIA_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene and compared these risk-based "acceptable" exposure levels to concentrations in cars. For the acetaldehyde $ELIA_{cm}$, the authors discussed that it was plausible that acetaldehyde produces tumors in the olfactory epithelium due to regenerative proliferation. Assuming a threshold mechanism for carcinogenesis, they decided to use 635 µg/m^3, the $ELIA_{systemic}$ (see the non-cancer table), as the $ELIA_{cm}$ for acetaldehyde. The average concentration of acetaldehyde measured in chamber tests designed to simulate cars at 23°C (42 µg/m^3, as reported in FAT 1998) did not exceed the ELIAs.				
Acrolein						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	2003	The IRIS acrolein carcinogenicity section was updated in 2003; the potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure. A quantitative estimate of carcinogenic risk is not applicable. (Under the former guidelines, acrolein was classified as a possible human carcinogen, Category C.)				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Acrolein (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table*						
—	2002	Liver tumor incidence	Neonatal mice—B6C3F1 (*n* = 23–24 per group)	Intraperitoneal injection of 75 or 150 nmol (1/3 of the total dose on day 8, and 2/3 of the total dose on day 15). Test animals were killed at 12–15 months of age.	The authors used the same protocol to test tumorigenicity induced by lipid peroxidation using a number of other chemicals. Only the positive controls had a statistically significant increase in tumors (liver tumors in male mice). The authors concluded that the B6C3F1 neonatal mouse is not sensitive to carcinogens that indirectly induce an increase in endogenous DNA adduct formation through lipid peroxidation or oxidative stress (such as acrolein).	Von Tungeln et al. 2002
Arsenic Compounds (Inorganic)						
References Used to Support the Toxicity Criteria Development						
Cancer unit risk, EPA (IRIS)	1998	Increased lung cancer mortality	Human—smelter workers	Inhalation	4.3×10^{-3} per µg/m^3	Brown and Chu 1983a,b,c; Lee-Feldstein 1983; Higgins 1982 (document unavailable, not included in documents provided to HEI); Enterline and Marsh 1982

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Arsenic Compounds (Inorganic, *Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table*						
—	1994	Lung cancer	Human— smelter workers (Tacoma WA, Montana, and Sweden)	Inhalation	1×10^{-3} per µg/m^3	Viren and Silvers 1994
		The authors used updated results from the Tacoma smelter worker cohort, results from Swedish smelter workers, and results from the Montana cohort to evaluate the lung cancer dose response for arsenic. They used a linear absolute risk model to derive the unit risk estimates, consistent with the modeling approach used to develop the EPA unit risk of 4.3×10^{-3}. The authors calculated a unit risk of 1.28×10^{-3} based on the Tacoma smelter cohort, 0.89×10^{-3} for the Swedish study, and a composite unit risk of 1.43×10^{-3} considering all three cohorts. Overall, the authors concluded that "a summary unit risk of 1×10^{-3} seems wholly consistent with the recently available epidemiologic data" (p 137).				
—	1998	Mortality statistics	Human— Belgian residents	Inhalation (0.3 µg As/m^3) Ingestion (20–50 µg As/L drinking water)	—	Buchet and Lison 1998
		This population had 3- to 4-fold higher urinary arsenic excretion compared to controls, but mortality by diseases of the nervous system, liver and heart, and cancers was not increased. Lung cancer mortality was increased in men (but not women) living around zinc smelters, which the authors noted might be related to past occupational exposure and/or smoking habits. Overall, the authors concluded that "a low to moderate level of environmental exposure to inorganic arsenic (0.3 µg As/m^3 of air; 20–50 µg As/L of drinking water) does not seem to affect the causes of mortality, suggesting in particular nonlinearity of the dose-response relationship for arsenic and cancer" (p 125).				
—	1999	Lung cancer	Human— US copper smelter workers (Tacoma WA) (n = 2802)	Inhalation	1–2 $\times 10^{-3}$ per µg/m^3	Viren and Silvers 1999
		This article used follow-up data for the cohort of Tacoma smelter workers (published in 1994) to further evaluate the lung cancer dose response for airborne arsenic. The authors conclude that the nonlinearity observed in earlier Canadian analyses was likely due to confounding by year of hire and other sources of bias. Overall, the authors conclude that "the linear excess absolute risk model (EMR) proposed by EPA best described the 1995 data," and recommend that "a unit risk estimate in the range of 1–2 $\times 10^{-3}$ seems realistic for Tacoma and Ronnskar (Swedish) smelter workers" (p 128).				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Arsenic Compounds (Inorganic, *Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2000	Respiratory cancer	Human— US copper smelter workers (Montana) (n = 8014)	Inhalation	Excess relative risk 2.1×10^{-4} per µg/m^3-yr (95% CI = 1×10^{-4}– 4.6×10^{-4})	Lubin et al. 2000
		This article provides results from new follow-up studies on the Montana copper smelter workers (the "Lee-Fraumeni" cohort). The authors reported significantly increased standardized mortality ratios (SMR [95% CI]) for all causes (1.14 [1.11–1.17]), all cancers (1.13 [1.07–1.21]), respiratory cancer (1.55 [1.41–1.70]), diseases of the nervous system and sense organs (1.31 [1.01–1.7]), nonmalignant respiratory diseases (1.56 [1.42–2.12]), emphysema (1.73 [1.41–2.12]), ill-defined conditions (2.26 [1.85–2.77]), and external causes (1.35 [1.23–1.49]). Relative risks for respiratory cancer increased with increasing exposure duration; the authors reported a linear relation between risk of respiratory cancer and cumulative exposure to airborne arsenic. Based on a compilation of results from numerous occupational studies of workers exposed to airborne arsenic, SMRs were not consistently elevated for any other cancer other than respiratory cancer. The authors concluded that "there was no evidence that inhaled arsenic increased mortality from other causes, with the possible exception of chronic obstructive pulmonary disease" (p 564).				
Benzene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	2000	Leukemia, chiefly acute myelogenous leukemia (AML)	Human— occupational	Inhalation	Range 2.2×10^{-6}– 7.8×10^{-6} per µg/m^3	Rinsky et al. 1981, 1987; Paustenbach et al. 1993; Crump and Allen 1984; Crump 1992, 1994; EPA 1998

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***						
—	2002	Significant increase in leukemia; no significant increase in multiple myeloma	Human— update of rubber hydrochloride worker cohort (cohort followed since 1976)	Inhalation: duration of employment for leukemia cases = 1 month to 20 yrs.	—	Rinsky et al. 2002
		Leukemia – White males: SMR = 2.56 (95% CI = 1.43–4.22) males and females, all races: SMR = 2.47 (95% CI = 1.38–4.07). Best estimate of relative risk from exposure to OSHA PEL of 3.19 $\times$ 10^3 µg/m^3-year over a 45-year working lifetime is 2.05; the risk is 1.53 at the ACGIH TLV of 1.60 $\times$ 10^3 µg/m^3 and at the NIOSH REL, risk drops to 1.1.				
—	2000	Non-Hodgkins Lymphoma – Results of individual studies as well as from the pooled analysis indicated that petroleum workers were not at an increased risk of NHL as a result of their exposure to benzene or benzene-containing petroleum products in their work environment	Human— occupational, 26 international cohorts of petroleum workers exposed to benzene or benzene-containing petroleum products (308,000 workers combined)	Inhalation Observation period of 60 years, 1937–1996	—	Wong and Raabe 2000
		To the extent it could be analyzed (length of employment not consistently provided), there was no significant upward trend between length of employment and NHL risk (SMR = 0.90 [95% CI = 0.82–0.98]). Various stratum-specific analyses (eg, refinery workers) have similar results. When cohorts stratified by length of observation, no pattern was detected. No difference in NHL mortality between workers hired before 1950 and those hired in or after 1950, even though exposure levels before 1950 were much higher than later on.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2002	Update of benzene exposure and health effects in China	Human—occupational. Update of Chinese study in collaboration with NCI. Study expanded to include 74,828 workers exposed to benzene and other substances between 1972 and 1987 at 712 factories in 12 Chinese cities.	Inhalation	—	Wong 2002
		Detailed criticism of the exposure analysis presented in Hayes et al. (2001, a review and reanalysis of benzene epidemiology literature). Concludes that exposure levels among Chinese workers are similar to, if not higher than, the benzene levels reported in the pliofilm study.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2003	Risk of leukemia increased at cumulative exposures above 6.38 × 10^3 µg/m^3-yrs	Human—occupational Conducted a case-control study of lymphohematopoietic cancer nested within the existing cohort of Australian petroleum workers previously found to have an excess of lymphohematopoietic cancer	Inhalation Mean duration of employment prior to diagnosis was 20.4 years (standard deviation of 9.0 years), and ranged from 4.3 to 43 years	The first significant. increase was at 6.4 to 12.8 × 10^3 µg/m^3-yrs (OR = 6.1 [95% CI = 1.4–26.0]) The dose-response consistently increased starting at 2.55 × 10^4 – 5.10 × 10^4 µg/m^3-yrs (OR = 5.9 [95% CI = 1.3–27.0]).	Glass et al. 2003
		Cases on average had a higher lifetime cumulative exposure than control subjects, and a greater proportion of cases were in higher exposure categories. No increase in risk for non-Hodgkin lymphoma/multiple myeloma was found with increasing exposure to benzene. For leukemia the ORs were found to be elevated for 3 of the 5 exposure groups (groups 2, 4, and 5).				
—	2003	An update of the exposure analyses that form the basis of EPA's current unit risk factor.	Human—occupational	Inhalation and dermal	These data could be combined with current or future mortality information to calculate a new cancer potency factor or occupational health standard for benzene.	Williams and Paustenbach 2003
		They found that the previous analyses conducted of the pliofilm cohort, Paustenbach et al. (1992) generally overestimated exposures for those job categories that had the highest exposure by about a factor of 2 to 4. Rinsky et al. (1981, 1987) underpredicted benzene exposures for most jobs. Crump and Allen (1984) both under- and over-predicted benzene exposures, depending on the specific job category and time period. The new estimates presented in this analysis incorporate what is considered to be the most likely range of plausible exposure values, and provide better characterization of the potential workplace exposures for this cohort.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2005	Mortality and cancer incidence	Humans—workers occupationally exposed to benzene on or before 1966–1967, from a total of 233 plants in England and Wales (*n* = 5514)	Workplace inhalation exposure to benzene. Generally, exposures were not well characterized. Some of the facilities had benzene exposure information available. Many of the workers would have also been exposed to other carcinogens.	<u>Significant increases</u> (SMR [95%CI]): Lip cancer (974 [118–3519]) Lung and bronchus cancer (121 [107–135]) Acute non-lymphocytic leukemia (ANLL) (183 [100–307]) Secondary and unspecified (140 [109–178]) All neoplasms (109 [101–117]) <u>Significant decreases</u> (SMR [95%CI]): Mental disorders (50 [21–98]) Digestive system diseases (76 [56–100]) Accidents (55 [35–82]) <u>Cancer incidence</u> (SRR [95%CI]): All malignant neoplasms (107 [100–114]) Esophagus (61 [35–99]) Lung and bronchus (119 [106–134]) Pleura (237 [133–391]) The only carcinogenic effect of benzene on the lymphohemato-poietic system was ANLL. The increases in lung cancer and mesothelioma were suspected to be due to exposures to other carcinogens and not benzene.	Sorahan et al. 2005

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table*** **(*Continued*)**						
—	2004	Acute childhood leukemia	Children—case-control study of 280 leukemia cases and 285 controls	Potential environmental exposure to benzene and other hydrocarbons. Exposure information collected by interviews of mothers.	Residing next to an auto repair garage or gas station (benzene-emitting sources) during childhood was associated with childhood leukemia (OR = 4.0 [95% CI = 1.5–10.3]), and in particular, acute non-lymphocytic childhood leukemia (OR = 7.7 [95% CI = 1.7–34.3]). A statistically significant trend was found between duration of childhood exposure to a neighboring repair garage or gas station and acute leukemia. No clear association was found for childhood leukemia and maternal exposure to hydrocarbons, residential traffic density, or other types of neighboring businesses.	Steffen et al. 2004
—	2004	Mortality, including lymphohematopoietic cancers	Humans—workers employed for at least 1 month in benzene-exposed jobs (in 1 of 3 relevant production areas of a Michigan Dow Chemical facility), on or after 1938 (*n* = 2266) (Note this was a follow-up study of this cohort.)	Workplace inhalation exposure to benzene (average duration of exposure = 4.8 years, average intensity of exposure was 30,624 µg/m^3). To estimate exposure, jobs were assigned to an exposure category.	The authors note that risk for leukemia was "slightly above background" (SMR = 1.14 [95% CI = 0.59–1.99]) They also note that the SMR for non-malignant diseases of the blood was the highest SMR found in the study (SMR = 2.17 [95% CI = 0.87–4.48]), and that the risk seemed to increase with increasing duration of benzene exposure. Overall, risks had decreased since the previous investigation of this cohort. However, despite the authors discussions that some of the SMRs were elevated, it is important to recognize that *none* were elevated with statistical significance. The only statistically significant changes were decreases in all causes of death (SMR = 0.9 [95% CI = 0.85–0.96]) and all heart disease (SMR = 0.9 [95% CI = 0.81–0.99]).	Bloemen et al. 2004

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2003	Mortality, including lymphohematopoietic cancers	Humans—all hourly workers beginning employment at the Solutia (Monsanto) plant in Saugét IL 1940–1977 (n = 4417)	Workplace inhalation exposure to benzene. Exposure estimates stratified based on time, department, and job.	The authors suggested there was a trend (not significant) for increasing multiple myeloma risk with increasing cumulative benzene exposure. SMRs (95% CIs) were:	Collins et al. 2003
					• 1.1 (0.3–2.5) non-exposed group • 1.4 (0.2–5.1) < 3190 (µg/m^3)-yrs group • 1.5 (0.2–5.4) 3190–19,140 (µg/m^3)-yrs group • 2.6 (0.7–6.7) > 19,140 (µg/m^3)-yrs group There was little evidence of such a trend for all leukemias, acute non-lymphocytic leukemias (ANL), or other lymphohematopoietic cancers. The authors also noted that workers exposed to peak exposures > 3.2 × 10^5 µg/m^3 for ≥ 40 days had greater (not significant) risk SMRs (95%CI) were: • 2.7 (0.8–6.4) all leukemias • 4.1 (0.5–14.9) ANL • 4.0 (0.8–11.7) multiple myeloma The authors suggest that the number of peak exposures > 3.2 × 10^5 µg/m^3 benzene is a better predictor of risk However, despite the authors discussions of elevated SMRs and suggested trends, it is important to recognize that none of the potentially benzene-related endpoints were elevated with statistical significance.	

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Benzene (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2002	Leukemia	Humans—nested case-control study, with leukemia cases (*n* = 72) and controls (*n* = 285) selected from a larger cohort of men employed at a French gas and electricity utility for ≥ 1 year between 1978 and 1989	Potential workplace inhalation of benzene (from "use of solvents" and "exposure to gasoline"). Workers also had potential workplace exposures to other chemicals. Benzene exposure estimated based on a job-exposure matrix. The estimated median TWA benzene exposure was 510 µg/m^3. Mean employment duration > 20 years.	The risk of leukemia was increased in workers with cumulative benzene exposures ≥ 53,592 (µg/m^3)-yrs (OR = 3.6 [95% CI = 1.1–11.7]). There was a trend for increasing risk with increasing exposure (OR = 1.2 [95% CI = 1.0–1.5]) per 31,900 (µg/m^3)-yrs increase in exposure). There was no clear association with a particular leukemia cell type. Leukemia was more strongly associated with exposures to benzene following a 10–20 year latency period. In previous epidemiologic studies, increased leukemia risks were usually not apparent at these relatively low ranges of occupational benzene exposure.	Guenel et al. 2002
—	2003	This article reviews the available non-tumor data (in other words, data besides tumor incidence) for benzene, 1,3-butadiene, and vinyl chloride and addresses the usefulness of this data in cancer risk assessment. With respect to benzene, the authors review non-tumor data to characterize the mode of action and the usefulness of internal measures to define dose to target tissue. There seem to be multiple mechanisms that contribute to benzene-induced leukemia, and it is uncertain which metabolites are the most carcinogenic. Benzene can induce numerous types of genetic damage. An understanding of the genetic factors that can affect benzene risk (eg, genetic polymorphisms for metabolizing enzymes) can be helpful in modeling inter-individual differences and in estimating risk for a population. Since the induction of specific chromosomal alterations is believed to be one of the critical elements in benzene-induced leukemogenesis, chromosomal aberration data can be analyzed to provide insight into the shape of the dose-response curve for benzene in the low dose region.				Albertini et al. 2003

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
1,3-Butadiene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	2002	Leukemia	Human—occupational (male)	Inhalation: duration not specified	3×10^{-5} per µg/m^3	Delzell et al. 1995, 1996; Macaluso et al. 1996
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	2001	Leukemia mortality rates	Human—workers employed for at least one year during 1943 and 1991 in one of six synthetic rubber plants (n = 13,130). (Note these authors had previously published a study of this cohort, but the original exposure estimation approach was controversial. This study was based on revised exposure estimates.)	Workplace inhalation exposures to 1,3-butadiene, styrene, and dimethyl-dithiocarbamate. Cumulative exposure estimates based on a revised analysis of work histories. The revised TWA exposure estimates for 1,3-butadiene were about 4–6 times higher than the original estimates.	There was a statistically significant association between leukemia and the highest exposure category of 1,3-butadiene ($\geq 8.0 \times 10^5$ (µg/m^3)-yrs, RR = 3.8 [95% CI = 1.6–9.1]), the highest exposure category of styrene ($\geq 2.6 \times 10^5$ (µg/m^3)-yrs, RR = 3.2 [95% CI = 1.2–8.8]), and all of the exposure categories for dimethyl-dithiocarbamate. For 1,3-butadiene, the association was stronger for (µg/m^3)-yrs due to exposure intensities $> 2.2 \times 10^5$ µg/m^3. The independent effect of each chemical was difficult to evaluate.	Delzell et al. 2001

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
1,3-Butadiene (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2001	Mortality for lymphohematopoietic cancers, leukemia, non-Hodgkin lymphoma, and all causes of death	Humans—male workers employed for at least 6 months between 1943 and 1996 at a 1,3-butadiene monomer production facility (*n* = 2800). (Note this was a follow-up study of this cohort. The pattern of results seen were similar to those seen in earlier reports on this cohort.)	Workplace inhalation exposure to 1,3-butadiene. Exposure ranked based on potential for exposure in each job category.	Statistically significant increase in all lymphohematopoietic cancers (LHCs), (SMR = 141 [95% CI = 105–186]), but none of the SMRs for individual LHCs were statistically significantly elevated. Based on time first employed, the SMR for all LHC was statistically significant only for those first employed before 1950. The SMRs for all LHC were highest for those employed less than 5 years. The observed decrease in SMRs with increasing length of employment is inconsistent with the expected dose-response relationship. Furthermore, there was no association between the estimate of 1,3-butadiene exposure and any LHC category, confirming the lack of a dose-response effect. Overall, the authors conclude "there was no increase in risk with increasing butadiene exposure." Statistically significant decrease in all causes of death, (SMR = 89 [95% CI = 84–94]).	Divine and Hartman 2001

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
1,3-Butadiene (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2001	Mortality, morbidity, and hematology (Note that the non-cancer results from this study are presented in Table C.3.)	Human— male workers employed at a petrochemical facility in Texas for at least 5 years (*n* = 614 for the total cohort) (Note this is a follow-up study of this cohort.)	Potential workplace inhalation exposure to 1,3-butadiene monomer Monitoring data from 1979–1992, shipping area: arithmetic mean 8-hr TWA 1,3-butadiene = 22,984 µg/m^3, max = 3.2×10^5 µg/m^3 Monitoring data from 1993–1998: max in all areas < 2210 µg/m^3	All cancer mortality (SMR = 0.57 [95% CI = 0.32–0.92]) was significantly lower for the cohort. Lymphohematopoietic cancer in the cohort was about the same as the comparison population (SMR = 1.06 [95% CI = 0.22–3.11]). Overall, the authors concluded "the butadiene exposure at this facility in the last 20 years does not pose a health hazard to employees."	Tsai et al. 2001

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
1,3-Butadiene (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2001	Consistent with EPA's cancer risk assessment guidelines, the authors derived new quantitative estimates of leukemia risk for 1,3-butadiene based on updated dose estimates and lymphohematopoietic cancer data from Delzell et al. (2001, see table entry above) and modifications proposed by the Chemical Manufacturers Association (CMA). The new Delzell exposure estimates were "substantially" greater than original estimates. For example, the average dose (($\mu g/m^3$)-yrs) for workers that died from leukemia was more than 6-fold greater than the original exposure estimate. The CMA proposed modifications are: (1) characterize the dose for the highest dose group (> 4.4×10^5 ($\mu g/m^3$)-yrs) using the mean dose value rather than the arbitrary value of 5.5×10^5 ($\mu g/m^3$)-yrs originally used; (2) use the traditional default assumption of a 70-year lifetime instead of the 85-year lifetime originally assumed by EPA; and (3) use average adult inhalation rates instead of EPA's original assumption of 20 m^3/day. These modifications affect the linear Poisson regression modeling used to calculate cancer potency. For comparison, at the time of publication of this Sielken and Valdez-Flores article, EPA estimated an EC_{01} = 2564 $\mu g/m^3$, and a Unit Risk = 3.9×10^{-6} per ($\mu g/m^3$) (based on a 1998 draft EPA risk assessment). (Note that in 2002, EPA issued a revised Unit Risk of 3×10^{-5} per ($\mu g/m^3$), based on an LEC_{01} = 561 $\mu g/m^3$ [EPA IRIS 2005].)			Incorporating the Delzell updated exposure estimates resulted in a 2.5-fold decrease in risk, based on an increase in the EC_{01} (the effective concentration corresponding to an extra risk of leukemia of 1%) from 2652 $\mu g/m^3$ to 6188 $\mu g/m^3$. The resulting cancer potency (Unit Risk) = 1.6×10^{-6} per ($\mu g/m^3$). Incorporating the CMA recommended modifications resulted in an additional 5.4-fold decrease in risk, based on an increase in the EC_{01} from 6188–33,371 $\mu g/m^3$. Incorporating both the Delzell updated exposure estimates and the CMA modifications resulted in a 13-fold decrease in risk, based on an increase in the EC_{01} from 2652–33,371 $\mu g/m^3$. The resulting revised Unit Risk = 3.0×10^{-7} per ($\mu g/m^3$), and the resulting upper bound Unit Risk = 5.0×10^{-7} per ($\mu g/m^3$).	Sielken and Valdez-Flores 2001
—	2001	This article reviews the metabolism and mechanisms of action of 1,3-butadiene, addressing species differences between mice, rats, and humans and the basis for interspecies extrapolations. Mice seem to be the most susceptible to 1,3-butadiene carcinogenicity because they generate higher levels of DNA-reactive metabolites, while humans seem to be at the lowest risk from 1,3-butadiene exposure. Overall, the authors conclude butadiene "is unlikely to be a human carcinogen at the low exposure concentrations currently encountered in the environment or workplace."				Bond and Medinsky 2001

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
1,3-Butadiene (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2005	Brain tumors (summary of results from an NTP study). Profile of genetic alterations in brain tumors	Male and female B6C3F1 mice	Inhalation of 4.4×10^5, 6.9×10^5, 1.4×10^6, or 2.8×10^6 µg/m^3 1,3-butadiene, for 6 hrs/day, 5 days/wk, for 13, 26, 40, or 60 weeks	A total of 6 malignant gliomas and 2 neuroblastomas were observed at 1.4×10^6 µg/m^3. Many of the tumors had genetic alterations similar to those reported in human brain tumors (eg, p53 alterations). Based on the location of the brain tumors and the predominant pattern of mutations, the authors concluded that the observed brain tumors may be chemically induced.	Kim et al. 2005
—	2003	This article reviews the available non-tumor data for benzene, 1,3-butadiene, and vinyl chloride and addresses the usefulness of this data in cancer risk assessment. With respect to 1,3-butadiene, the authors review metabolism data, hemoglobin and DNA adduct data, and genotoxicity data to understand species differences in susceptibility to 1,3-butadiene (mice are more susceptible than rats, and human susceptibility is believed to be more like rats than mice). This information can be used in risk assessment to improve inter-species extrapolations. Genotoxicity is hypothesized to be the mechanism responsible for 1,3-butadiene-induced carcinogenicity.				Albertini et al. 2003
Cr III						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1998	Lung tumor incidence	Animals, including rats and mice	Inhalation: intrapleural injection, or intrabronchial implantation/ duration unspecified	No increase in lung tumor incidence	Baetjer et al. 1959; Hueper and Payne 1962; Levy and Venitt 1975; Levy and Martin 1983
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
Updated cancer literature performed only for Cr VI, the primary chromium compound of interest.						

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT						
Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Cr VI (Chromium Trioxide)						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1998	Lung cancer mortality	Human—occupational	Inhalation: up to 20 yrs	1.2×10^{-2} per µg/m^3	Mancuso 1975
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	2003	Lung cancer mortality	Human—occupational	Inhalation: occupational tenure = 1 to 32 yrs	Risk of lung cancer mortality (assuming 45 yrs occupational exposure): 2.05×10^{-3} per µg/m^3 (relative risk model), 2.16×10^{-3} per µg/m^3 (additive risk model). Risk of lung cancer mortality (assuming continuous exposures): 9.78×10^{-3} per µg/m^3 (relative risk model), 1.25×10^{-2} per µg/m^3 (additive risk model).	Crump et al. 2003
—	2003	Mortality from all causes, all cancers, and lung cancer	Human—former workers of a US chromate production plant	Inhalation: duration of employment at least 1 yr	—	Luippold et al. 2003
		"SMRs were significantly increased for all causes combined (SMR = 129), all cancers combined (SMR = 155), and lung cancer (SMR = 241). A trend test showed a strong relation between lung cancer mortality and cumulative hexavalent exposure. Lung cancer mortality was increased for the highest cumulative exposure categories (≥ 1.05 to < 2.70 mg/m^3-years, SMR = 365; ≥ 2.70 to 23 mg/m^3-years, SMR = 463), but not for the first three exposure groups. Significantly increased SMRs were also found for year of hire before 1960, 20 or more years of exposed employment, and latency of 20 or more years."				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Diesel Engine Exhaust						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	2003	Lung cancer	Human—numerous epidemiology studies of occupationally exposed populations	Inhalation: varied	"The absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk."	EPA 2003
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
An updated literature search was not required because IRIS was updated in 2003.						
Dioxin						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Unit Risk, EPA (Dioxin Reassessment)	2003	Carcinogenicity—all cancer sites combined	Human—occupational	Inhalation: up to 51 yrs	Upper bound slope factor: 1×10^{-3} per pg TCDD/kg-d Range: 0.57×10^{-3} to 5.1×10^{-3} per pg TCDD/kg-d	Steenland et al. 2001; Becher et al. 1998
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
An updated literature search was not required because the EPA Dioxin Reassessment was released in 2003.						
Ethylbenzene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1991	Classification: D, "not classifiable as to human carcinogenicity." Basis: "nonclassifiable due to lack of animal bioassays and human studies". Quantitative estimate of carcinogenic risk is "not available."				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Ethylbenzene (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table*						
IARC	2000	Rats: increased renal tumors (adenomas and carcinomas). Mice: increased lung adenomas and carcinomas in males, liver adenomas and carcinomas in females.	F344 rat, B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	—	NTP 1999
		Classification: Group 2B, possibly carcinogenic to humans (inadequate evidence in humans, sufficient evidence in experimental animals). (The IARC Working Group noted that the increased incidences of lung and liver adenomas in mice were within the historical control range.)				
—	2002	Increased renal tubule hyperplasia and neoplasms	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	—	Hard 2002
		The kidneys from the 1999 NTP ethylbenzene carcinogenicity study were histopathologically reevaluated to define the mode of action. The author concluded that the primary mode of action underlying the increase in renal tumors was an exacerbation of CPN (chronic progressive nephropathy, an age-related spontaneous renal disease) by ethylbenzene. Because CPN has no human disease counterpart, this pathway was considered to have no relevance to humans for risk assessment purposes.				
—	2003	Male rat kidney: α2u-globulin accumulation, accelerated CPN, regenerative cell proliferation. Mouse liver and lungs: formation of a toxic metabolite and regenerative cell proliferation.	F344 rat, B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 1 or 4 wks	—	Stott et al. 2003
		The study results suggest a mode of action for ethylbenzene carcinogenicity involving increased cell proliferation and altered cell population dynamics in male rat kidney and mouse liver and lungs. "Several of these changes have been associated with nongenotoxic modes of tumorigenesis that, significantly, are reversible upon cessation of dosing and display clear thresholds." (p 62)				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1991	Nasal squamous cell carcinoma	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	1.3×10^{-5} per µg/m^3	Kerns et al. 1983
Cal EPA	1992	Squamous nasal carcinoma incidence	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	6.0×10^{-6} per µg/m^3	Kerns et al. 1983; EPA 1987; OEHHA 1992
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	1997	This comprehensive review article summarizes formaldehyde carcinogenicity studies, discusses formaldehyde metabolism and mechanisms, and compares rodent vs. human nasal passages. The author discusses uncertainties involved in rat-to-human extrapolation for formaldehyde, but ultimately supports the use of the rat model. The author concludes that there is "a demonstrated, and reproducible, experimental cancer response threshold," and that there are "major differences in the biology of the nose for high ($\geq 7.38 \times 10^3$ µg/m^3) vs. low ($\leq 2.46 \times 10^3$ µg/m^3) airborne exposure concentrations" (p 293). Overall, the author recommends that for formaldehyde, "low concentration ($\leq 2.46 \times 10^3$ µg/m^3 airborne exposure) extrapolation, where no tissue damage is observed, be uncoupled from the responses at high concentrations ($\geq 7.38 \times 10^3$ µg/m^3), where epithelial degeneration, regenerative replication, and inflammation appear to be essential driving forces in formaldehyde carcinogenesis" (p 291).				Morgan 1997
—	1997	In this meta-analysis, the authors reviewed 47 epidemiologic studies involving formaldehyde exposure. They reported no evidence of a relationship between formaldehyde and either lung cancer or sinonasal cancer. For nasopharyngeal cancer, they reported a "meta relative risk" of 1.0 for cohort studies and 1.3 for case-control studies. Overall, the authors conclude that "the available studies do not support a causal relationship between formaldehyde exposure and nasopharyngeal cancer" (p 639). (The authors note that their conclusion conflicts with conclusions from two previous meta-analyses, because they included data from additional studies, corrected for underreporting, and other methodological differences.)				Collins et al. 1997

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
CIIT	1999	This comprehensive review includes a hazard characterization and dose response assessment for inhaled formaldehyde. Formaldehyde induces DNA-protein cross-links (DPX) and cytotoxicity that result in regenerative cell proliferation. The mode of action for tumor induction at higher concentrations is different from that at lower concentrations because of the involvement of regenerative cell proliferation. The authors developed a biologically-based, two-stage clonal growth model for carcinogenicity. For comparison, a benchmark dose model was also used to extrapolate formaldehyde-induced cancer in rats to potential cancer risk in humans. "Overall, the predicted risk levels for formaldehyde are considerably lower than in previous cancer risk assessments and in the benchmark dose assessment" (p 7–42).				CIIT 1999
Health Canada	2003	Nasal cavity tumors	Rat	Inhalation	Risk = 8.8×10^{-6} for workers with a 40 yr occupational exposure to 1.23×10^3 µg/m^3 (1 ppm) formaldehyde (p 104).	Litelpo and Meek 2003
		This comprehensive article reviews the results from 5 formaldehyde bioassays in rats, as well as epidemiology studies and mechanistic information. Exposure response in the rat bioassays "was similar and highly nonlinear, with sharp increases in tumor incidence in the nasal cavity occurring only at concentrations greater than 7.2×10^3 µg/m^3 (6 ppm) formaldehyde" (p 88). Based on a biologically-based, formaldehyde-specific model, the "predicted additional risk of upper respiratory tract cancer for nonsmoking workers with an 80-yr lifetime continuous exposure to 4.8 µg/m^3 (0.004 ppm) formaldehyde and having 40 yr of occupational exposure (8h/d, 5d/wk) to 1.2×10^3 µg/m^3 (1 ppm) formaldehyde was 8.8×10^{-6}. For the general population, the predicted additional risks of upper respiratory tract cancer for nonsmokers, associated with an 80-yr continuous exposure to levels of formaldehyde between 1.2 and 120 µg/m^3 (0.001 and 0.1 ppm), range from 2.3×10^{-10} to 2.7×10^{-8}, respectively" (p 104).				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
IARC	2004	Overall IARC evaluation: formaldehyde is carcinogenic to humans (Group 1). There is "sufficient evidence" in humans and experimental animals for the carcinogenicity of formaldehyde. (Note that this is a higher classification than previous IARC evaluations.)				IARC 2004; www-cie.iarc.fr/htdocs/monographs/vol88/formal.html
		IARC reviewed human and animal carcinogenicity data, including data from several human studies published since their 1995 evaluation (follow-up results from 3 cohort studies and 3 new case-control studies (the specific references were not listed by IARC)). Regarding the epidemiologic data, IARC concluded that "the results of the study of industrial workers in the USA, supported by the largely positive findings from other human studies, provided sufficient epidemiological evidence that formaldehyde causes nasopharyngeal cancer in humans." "There is strong, but not sufficient evidence for a causal association between leukaemia and occupational exposure to formaldehyde." "There is only limited epidemiological evidence that formaldehyde causes sinonasal cancer in humans."				Note that this IARC Monograph, Vol 88 was "in preparation" and not officially published at the time of this literature search. This table entry is based on the summary chapter provided on the IARC web page, last updated by IARC on 9/7/04[a].

[a] Now published: IARC. 2006. Formaldehyde, 2-Butoxyethanol and 1-*tert*-Butoxypropan-2-ol. Vol 88.

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2004	Cancer mortality	Human—workers employed at one of 10 US formaldehyde-producing or -using facilities prior to 1966 through 1994 (*n* = 25,619, 1921 deaths and 865,708 person-years of follow-up). Median follow-up duration = 35 years. (Note that this is a follow-up study of this cohort)	Workplace inhalation exposures Median 8-hr TWA = 553 µg/m^3 formaldehyde (range 12.3–5228 µg/m^3)	A significant excess of nasopharyngeal cancer was observed for exposed workers (SMR = 2.10 [95% CI = 1.05–4.21]). Analyses based on a variety of formaldehyde exposure measures suggested an exposure-response relationship for nasopharyngeal tumors and possibly an association between other upper respiratory tract sites. There was no clear association with pancreas, brain, lung, or prostate cancers. Mortality from all solid tumors was significantly lower than expected. The authors note that they also found a significant association between peak and average exposure to formaldehyde and mortality from leukemia, particularly myeloid leukemia, for this cohort (detailed in a separate publication).	Hauptmann et al. 2004

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2004	Mortality	Human—workers exposed to formaldehyde for ≥ 3 months at one of three garment plants in GA and PA (*n* = 11,039) (Note that this is a follow-up study of this cohort.)	Workplace inhalation exposures Geometric mean TWA in the early 1980s = 184.5 µg/m^3 (range 110.7–246 µg/m^3) formaldehyde Median duration of employment = 3.3 years	The authors focus on a non-significant increase in mortality from myeloid leukemia (SMR = 1.44 [95% CI = 0.80–2.37]) with mortality greatest for workers first exposed in the earliest years (presumably higher exposure levels), workers with ≥10 years of exposure, and workers with ≥ 20 years since first exposure. There was no increase in mortality from nasal, pharyngeal, laryngeal, trachea, bronchus, or lung cancers. Mortality from all causes and all cancers was significantly less than expected. The only statistically significant increase over the total study period (1955–1998) was for mortality from "other" heart diseases (i.e., not ischemic heart disease, cardiomyopathy, or conductive disorders).	Pinkerton et al. 2004
—	2002	Pharyngeal cancer (PC) and nasopharyngeal cancer (NPC) mortality	Human—workers employed at a plastics-producing plant between 1941 and 1984 (*n* = 7328) Nested case control included 7 NPC cases, and 15 PC cases, matched with controls	Workplace inhalation exposures to formaldehyde, particulates, and pigment Median average formaldehyde concentration for exposed workers = 169.7 µg/m^3	Statistically significant increases for PC (2.23-fold) and NPC (5-fold) were observed. However, despite the statistically significant increase, analyses based on a variety of formaldehyde exposure measures did not exhibit a consistent dose-response relationship. For example, both short- and long-term workers had similarly elevated risks. Overall, the authors concluded that the observed increases in PC and NPC in this cohort were unlikely to be associated with formaldehyde.	Marsh et al. 2002

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2003	This article presents a benchmark dose risk assessment for inhaled formaldehyde. The authors combined benchmark dose and pharmacokinetic modeling to estimate formaldehyde cancer risks to humans, considering both tumor and cell proliferation endpoints in rats. Both the tumor and cell proliferation data showed a non-linear dose-response relationship. Benchmark concentrations were extrapolated to humans using two mechanistic models: (1) computational fluid dynamics to estimate rate of delivery to the nasal lining; and (2) a pharmacokinetic model combined with a computational fluid dynamic method based on DNA-protein cross links. In general, the use of mechanistically-based extrapolation models helps reduce uncertainties in risk estimates. The predicted cancer risk in humans at low exposure levels was found to be similar to EPA's risk assessment. The authors concluded that linear extrapolation over-predicts risks and that a non-linear margin-of-exposure (MOE) approach is the most appropriate for assessing human health risks from formaldehyde.				Schlosser et al. 2003
—	2004	This article presents dose-response modeling for inhaled formaldehyde, using a three-dimensional, computational fluid dynamic model of the human respiratory tract to predict human dosimetry, dose-response data for cytolethality/regenerative cellular proliferation (CRCP) and DNA-protein cross-linking (DPX), and clonal growth modeling to link DPX and CRCP with tumor formation. General (i.e., not formaldehyde specific) human tumor incidence data was used to identify baseline parameter values for the model. Animal data was only used if human data was not available. The authors conclude that cancer risks associated with inhaled formaldehyde are *de minimis* ($\leq 10^{-6}$) at relevant human exposure levels and that protection from non-cancer effects of formaldehyde should be sufficiently protective against potential carcinogenic effects.				Connolly et al. 2004

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Formaldehyde (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table* (*Continued*)						
—	2005	Local irritation of the upper respiratory tract (as the most likely threshold mechanisms preceding tumor formation) NOAEL = 370 µg/m^3, UF ≈ 3	Human volunteers	Short term inhalation: 370 µg/m^3 (exposure details not specified)	$ELIA_{cm}$ = 125 µg/m^3	Schupp et al. 2005
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles for non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or $ELIA_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene and compared these risk-based "acceptable" exposure levels to concentrations in cars. For formaldehyde, the authors considered the German MAK value of 370 µg/m^3 (essentially a NOAEL for local irritation of the upper respiratory tract, based on Deutsch Forschungsgemeinschaft 2000 and Schlink et al. 1999) and the maximum indoor air exposure level of 125 µg/m^3 (about 1/3 the German MAK value) recommended by the former Bundesgesundheitsamt in Germany (BGA 1992). The study authors concluded that this factor of about 3 was an appropriate uncertainty factor for extrapolation to the general population. Therefore, because local irritation of the upper respiratory tract was considered to be the critical mechanism for acute and chronic toxicity, as well as "the most likely threshold mechanism that precedes tumor formation," this value of 125 µg/m^3 was used for the STELIA, $ELIA_{systemic}$, $ELIA_{local}$, and $ELIA_{cm}$. The average concentration of formaldehyde measured in chamber tests designed to simulate cars at 23°C (48 µg/m^3, as reported in FAT 1998) did not exceed the $ELIA_{cm}$.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
***n*-Hexane**						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1991	As of 1991, the IRIS *n*-hexane carcinogenicity assessment has been listed as "under review". The carcinogenicity assessment is "not available at this time."				
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	1999	Increase in the combined incidence of hepatocellular adenomas and carcinomas in female mice at the high dose only (3.18×10^7 µg/m^3, 9000 ppm).	B6C3F1 mouse	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	—	Daughtrey et al. 1999
		No evidence of carcinogenicity in rats. The only histopathological finding of note was upper respiratory tract tissue irritation (LOAEL = 3.18×10^6 µg/m^3, 900 ppm).	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	—	
		Note that the test material in this study **was not** pure *n*-hexane, but was commercial hexane solvent, a mixture containing 52% *n*-hexane and smaller amounts of other six-carbon isomers. The authors noted that "the relevance for humans of these hexane-induced mouse liver tumors is questionable" (p 28). The authors also noted that "no neurotoxic effects characteristic of *n*-hexane were observed" (p 28).				
Literature search conducted and reviewed, but no other studies were found specifically relating to possible carcinogenicity of *n*-hexane.						

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Lead Compounds						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1993				Not applicable	EPA 2004
		EPA classifies lead as a probable human carcinogen (B2), based on increased tumors (primarily kidney tumors) in rodent bioassays, but recommends that a numerical estimate of carcinogenic risk not be used.				
Cancer potency, Cal EPA	1997	Kidney tumor incidence data	Rat (species not specified)	Oral, lead acetate administered in feed	1.2×10^{-5} per µg/m^3	Azar et al. 1973
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
Given that possible health effects from lead exposure are typically evaluated using blood lead levels, an updated literature search was determined to be unnecessary.						
Manganese						
Literature search conducted and reviewed, but no other studies were found specifically relating to possible carcinogenicity of manganese.						
Mercury Compounds						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS) elemental mercury	1995	Classification: D, "not classifiable as to human carcinogenicity." Basis: "based on inadequate human and animal data." "Epidemiologic studies failed to show a correlation between exposure to elemental mercury vapor and carcinogenicity; the findings in these studies were confounded by possible or known concurrent exposure to other chemicals, including human carcinogens, as well as life style factors (*eg*, smoking)." No quantitative estimate of carcinogenic risk is provided.				
Cancer unit risk, EPA (IRIS) mercuric chloride	1995	Classification: C, "possible human carcinogen." Basis: "based on the absence of data in humans and limited evidence of carcinogenicity in rats and mice." Several carcinogenicity studies (oral exposures) were reviewed, but many of the tumor results were equivocal, of questionable relevance, or limited due to an inadequate study design. No quantitative estimate of carcinogenic risk (from oral or inhalation exposure) is provided.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Mercury Compounds (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
—	1998	Liver, lung, and ovarian cancer	Mercury miners and millers ($n = 6784$ men and 265 women)	Inhalation of inorganic mercury	—	Boffetta et al. 1998
		Increased liver cancer mortality (SMR = 1.64 [95% CI = 1.18–2.22]) was observed. Increased lung cancer mortality (SMR = 1.19 [95% CI = 1.03–1.38]) was also observed, but the authors noted that this may be explained by co-exposure to silica and radon. Three ovarian cancer deaths were reported, which the authors noted were "likely representing an excess" (p 591). The authors concluded that "exposure to inorganic mercury in mines and mills does not seem strongly associated with cancer risk, with the possible exception of liver cancer" (p 591).				
MTBE						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1993	—	—	—	IRIS cancer assessment not available at this time.	—
Cal EPA	1999	Kidney adenomas and carcinomas	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 24 months	2.6×10^{-7} per µg/m^3	Chun et al. 1992, Bird et al. 1997
		Male rat Leydig (testicular) interstitial cell tumors and female rat leukemia and lymphomas	Sprague Dawley rat	Gavage: 4 days/wk, 104 weeks		Belpoggi et al. 1995, 1997, 1998

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
MTBE (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table*						
—	2003	Hormone levels (eg, testosterone, corticosterone, LH, prolactin). Testosterone production declined 38–49% of control within hours of gavaging. Reductions less dramatic or nonexistent if sampled longer after treatment or with lower doses; nondetectable after 28 days of treatment. Overall only mild effects on hormone-dependent organ weights.	Sprague Dawley rat, male	Subchronic gavage exposure. 5 separate in vivo protocols to answer the question: could MTBE cause rat Leydig cell tumors by altering hormone levels? 1) every other day (14 treatments in 27 days) 2) daily for 28 days 3) 5 daily treatments in castrated rats with hormone replacement 4) 28 days 5) 14 consecutive days	None derived. Authors conclude reduced Leydig cell steroidogenesis enzyme activity may be a possible mechanism of carcinogenesis.	de Peyster et al. 2003
		Testosterone production declined 29–50%	Leydig cells exposed to MTBE or *t*-butanol (major metabolite)	In vitro exposures, 3 hrs	—	

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Naphthalene						
References Used to Support the Toxicity Criteria Development						
Cancer unit risk, EPA (IRIS)	1998	Predominantly benign respiratory tumors	Mouse	Inhalation: 6 hrs/day, 5 days/wk, 2 yrs	Classification: Group C, a possible human carcinogen. An inhalation unit risk was not derived "because of the weakness of the evidence (observations of predominant benign respiratory tumors in mice at high dose only) that naphthalene may be carcinogenic in humans."	NTP 1992
Cal EPA	2004	Nasal respiratory epithelial adenoma and nasal olfactory epithelial neuroblastoma	F344 rat	Inhalation: 6.2 hrs/day, 5 days/wk, 105 wks	3.4×10^{-5} per µg/m^3	NTP 2000; OEHHA 2002
Selected References from Updated Literature Searches, *defined at the end of this table*						
An updated literature search was not required because Cal EPA was updated in 2004.						

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Nickel Compounds						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS) nickel, soluble salts	1994	"The EPA has not evaluated soluble salts of nickel, as a class of compounds, for potential human carcinogenicity."				
Cancer unit risk, EPA (IRIS) nickel carbonyl	1991	Classification: B2, "probable human carcinogen." Basis: "based upon the observation of pulmonary carcinomas and malignant tumors at various sites in rats administered nickel carbonyl by inhalation and intravenous injection, respectively." The low survival rate for both control and treated animals in the inhalation study, and the use of an intravenous route of exposure in the other study, preclude a quantitative risk estimate.				
Cancer unit risk, EPA (IRIS) nickel refinery dust)	1991	Lung cancer	Human—refinery workers	Inhalation	2.4×10^{-4} per µg/m^3	Enterline and Marsh 1982; Chovil et al. 1981; Peto et al. 1984; Magnus et al. 1982
		Classification: A, "human carcinogen." Basis: "Human data in which exposure to nickel refinery dust caused lung and nasal tumors in sulfide nickel matte refinery workers in several epidemiologic studies in different countries, and on animal data in which carcinomas were produced in rats by inhalation and injection."				
Cancer unit risk, EPA (IRIS) nickel subsulfide)	1991	Lung cancer	Human—refinery workers	Inhalation	4.8×10^{-4} per µg/m^3	Enterline and Marsh 1982; Chovil et al. 1981; Peto et al. 1984; Magnus et al. 1982
		Classification: A, "human carcinogen." Basis: "Increased risks of lung and nasal cancer in humans exposed to nickel refinery dust, most of which was believed to have been nickel subsulfide; increased tumor incidences in animals by several routes of administration in several animal species and strains, and positive results in genotoxicity assays." The incremental unit risk estimate for nickel refinery dust was used with a multiplication factor of 2 to account for the roughly 50% nickel subsulfide composition.				
Cal EPA (nickel and nickel compounds)	1991	Lung cancer	Human—Ontario nickel refinery sinter plant workers	Inhalation: 5 or more yrs workplace exposure	2.6×10^{-4} per µg/m^3	Chovil et al. 1981; Roberts et al. 1983; Muir et al. 1984; CDHS 1991

Table continues on next page

Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Nickel Compounds (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***						
—	2000	This comprehensive analysis reviews animal and human data to evaluate the carcinogenicity of soluble and insoluble nickel. Occupational exposure to mixed soluble and insoluble nickel is associated with lung and nasal cancer. Insoluble, but not soluble, nickel has been shown to be carcinogenic in animal studies. The authors conclude that while soluble nickel may enhance the carcinogenicity of other chemicals, "the data are insufficient to provide adequate dose-response information to be useful in risk assessment" (p 224). They also note that "the overall data suggest a nonlinear dose-response relationship for carcinogenicity, but the data are insufficient to determine the doses at which such nonlinearities occur" (p 210). The authors conclude that, under EPA's 1986 cancer guidelines, inhaled soluble nickel should be classified as "cannot be determined," or "D, not classifiable as to human carcinogenicity," because the data are "inadequate for an assessment of human carcinogenic potential" (p 224). The authors note that "after EPA review, the conclusions of the assessment will also be summarized for EPA's Integrated Risk Information System (IRIS)" (p 210).				Haber et al. 2000 (the authors were a panel formed by Toxicology Excellence for Risk Assessment (TERA), under contract to EPA, Health Canada, and others)
—	2000	Respiratory cancer	Human—Norwegian nickel refinery workers	Inhalation	The aim of this article was to develop refined quantitative historical exposure estimates for this cohort.	Grimsrud et al. 2000
—	2002	This review article summarizes animal studies showing nickel carcinogenesis via various routes of administration. The authors also briefly review epidemiology studies, noting an increased risk of respiratory tract and nasal cancers in nickel workers. The authors provide a detailed discussion of nickel mechanistic studies to evaluate the molecular basis for nickel carcinogenesis (including alteration of transcription factors and signaling pathways, changes in calcium homeostasis, and induction of oxidative stress).				Denkhaus and Salnikow 2002
—	2002	This article reviews human, animal, and mechanistic information to evaluate hypotheses about the carcinogenic potential of soluble (vs. insoluble) nickel compounds. Human epidemiology studies show an association between exposure to nickel refinery dust (containing soluble and insoluble nickel compounds) and respiratory cancers. However, animal inhalation studies have generally failed to show a carcinogenic potential for soluble nickel. In vitro data suggest that the bioavailability of nickel is important; tumor induction requires sufficient quantities of nickel ion to be present at nuclear sites within respiratory target cells. Because water-soluble nickel compounds immediately dissociate into nickel ions and are rapidly cleared from the lung, cellular uptake is inefficient. Overall, the authors conclude that "water-soluble nickel compounds, by themselves, will not be complete human carcinogens. However, if inhaled at concentrations high enough to induce chronic lung inflammation, these compounds may enhance carcinogenic risks associated with inhalation exposure to other substances" (p 841).				Oller 2002

Table continues on next page

Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Nickel Compounds (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2003	This comprehensive article presents an integrated analysis of human epidemiologic data, occupational exposure measurements, animal data from cancer bioassays, and mechanistic information, to evaluate respiratory cancer risks associated with low-level nickel exposures. The authors discuss the animal and mechanistic data supporting "threshold-like dose-responses" for nickel carcinogenicity. Based on epidemiologic data, "high exposure" cohorts have increased lung cancer risk (3–4 fold excesses), while most "low exposure" cohorts show no statistical evidence of increased lung cancer risk. Using lung cancer dose-response functions from animal studies (adjusted for differences in deposition, clearance, particle size distributions, and exposure patterns), predicted risks at high exposure levels are consistent with those observed in high exposure worker cohorts. This consistency provides greater confidence in using animal dose-response data to estimate human risks at lower exposure levels. Excess lung cancer risks, estimated using animal dose-response data, are less than 10^{-4} for the low levels of exposure typical in current workplaces.				Seilkop and Oller 2003
—	2003	This review article summarizes epidemiologic studies showing that both water-insoluble and water-soluble nickel compounds are carcinogenic to the human respiratory tract, and experimental animal studies showing that nickel compounds induce tumors at virtually all sites of application. The authors cite a 1990 conclusion by IARC that "respiratory cancer risks are primarily related to exposure to soluble nickel concentrations above 1×10^3 µg/m^3 and to exposure to less soluble forms at concentrations above 1×10^4 µg/m^3" (p 68). However, this article primarily focuses on possible genetic and epigenetic mechanisms of nickel carcinogenesis, such as nickel interactions with various molecular components of the cell, generation of reactive oxygen species, and interference with the metabolism of essential metals.				Kasprzak et al. 2003

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
POM (Benzo[*a*]pyrene)						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1994	Forestomach, squamous cell papillomas and carcinomas	CFW-Swiss mouse	Oral, in diet, 1 to 197 days	7.3 per mg/kg-day (B[*a*]P) oral potency factor, geometric mean)	Neal and Rigdon 1967
		Forestomach, larynx, and esophagus, papillomas and carcinomas (combined)	Sprague Dawley rat	Oral, in diet, lifetime exposure	4.5 to 11.7 per mg/kg-day (range calculated from two studies)	Brune et al. 1981

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
POM (Benzo[*a*]pyrene) (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table*						
—	1994	Lung tumor incidence	Wistar rat, female	Inhalation: 17 hrs/day, 5 days/wk, 10 or 20 months	2×10^{-2} per µg/m^3	Heinrich et al. 1994
—	1985	Lung cancer in US coke-oven workers	Human—occupational	Inhalation	1×10^{-2} per µg/m^3 (assuming 25 yrs occupational exposure)	Pott 1985
—	2000	Respiratory cancer	Human—occupational	Inhalation	8.7×10^{-2} per µg/m^3	WHO 2000
—	1989	Malignant lung tumor incidence	Mouse (strain not specified)	Inhalation: 6 hrs/day, 5 days/wk, 13 wks	4×10^{-1} per µg/m^3	RIVM 1989 pg 139 (UR based on data from Kniznikow et al. 1982)
—	1989	Lung tumor incidence	Syrian golden hamster, male	Inhalation: 3 to 4.5 hrs/day, lifetime	2.8×10^{-4} per µg/m^3	RIVM 1989 pg 140 (UR based on data from Thyssen et al. 1981)
—	1989	Squamous cell carcinomas of the lung	Rat (strain not specified)	Inhalation: 1 hr/day, 5 days/wk, total of 494 exposures	5.9×10^{-4} per µg/m^3	RIVM 1989 pg 140 (UR based on data from Laskin et al. 1970)
—	1989	Lung cancer mortality	Human—indoor exposure to coal smoke, China	Inhalation: cooking 17 hrs/wk (avg)	6.7×10^{-2} per µg/m^3	RIVM 1989, pg 140
—	1989	Lung cancer mortality	Human—review of 3 epidemiology studies	Inhalation: lifetime	1×10^{-1} per µg/m^3 ('most appropriate value' based on review of epi. studies)	RIVM 1989, pg 147 (UR based on data from Tuomisto and Jantunen)

Table continues on next page

Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
POM (Benzo[*a*]pyrene) (*Continued*)						
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table*** (*Continued*)						
—	1991	Respiratory tumors	Syrian golden hamster, male	Inhalation: 3 to 4.5 hrs/day, 7 days/wk, lifetime	0.37–1.7 × 10^{-3} per µg/m^3	California Air Resources Board 1994; Collins et al. 1991 (UR based on data from Thyssen et al. 1981)
—	1991	Respiratory tumors	Syrian golden hamster	Intratracheal instillation, once/wk, 30 wks	4.5–4.8 × 10^{-3} per µg/m^3	California Air Resources Board 1994; Collins et al. 1991 (UR based on data from Saffiotti et al. 1972)
—	1991	Respiratory tumors	Syrian golden hamster	Intratracheal instillation, once/wk, 52 wks	4.4 × 10^{-3} per µg/m^3	California Air Resources Board 1994; Collins et al. 1991 (UR based on data from Feron et al. 1973)
—	1983	Lung-cancer mortality	Human—occupational, UK gas workers	Inhalation: 8 hrs/day, 5 days/wk, average of 23 yrs	4.3 × 10^{-1} per µg/m^3	Pike 1983 (UR based on data from Doll et al. 1965; 1972)
—	1994	Lung-cancer mortality	Human—occupational, aluminum smelters	Inhalation	9.0 × 10^{-2} per µg/m^3 [c]	Bostrom et al. 2002 (UR based on data from Armstrong et al. 1994)
—	2004	Lung cancer incidence	Human—occupational, aluminum smelters and other PAH pollution sources	Inhalation	Lung cancer risk: 5.3 per µg/m^3 (based on dispersion-adjusted B[*a*]P measurements), 2.1 per µg/m^3 (based on dispersion-adjusted B[*a*]P-equivalent PAH exposures)	Vyskocil et al. 2004

[c] Unable to verify derivation of unit risk.

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
POM (Benzo[*a*]pyrene) (*Continued*)						
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)						
—	2005	In this review article, the authors discuss concerns that B[*a*]P may not be the best surrogate for evaluating PAH mixtures (in particular, in the context of evaluating lung cancer risk from air pollution in urban areas). Dibenzo[*a,h*]anthracene (DBA) and dibenzo[*a,l*]pyrene (DB[*a,l*]P) are estimated to have much greater carcinogenic potency than B[*a*]P. After consideration of various biomarkers of exposure and effect as well as the usefulness and accessibility of various biological samples, the authors propose testing a novel biomonitoring approach for predicting lung cancer risk, studying DBA- and DB[*a,l*]P-specific DNA adducts in nasal cells from occupational cohorts known to be exposed to high ambient levels of PAHs.				Okona-Mensah et al. 2005
—	2004	Forestomach tumors (based on a study by Culp et al. 1998)	Mice—female, B6C3F1 (based on a study by Culp et al. 1998)	Oral, 2-year feeding study (based on a study by Culp et al. 1998)	"Guideline Dose" for oral B[*a*]P carcinogenesis = 0.00008 mg/kg-d	Fitzgerald et al. 2004
		The authors used a modified benchmark dose (BMD) approach to develop a "Guideline Dose" for oral B[*a*]P carcinogenesis of 0.00008 mg/kg-d, based on a modeled 5% extra tumor incidence ($BMD_{0.05}$) of 0.362 mg/kg/d, and a total uncertainty factor of 4500 (5 for interspecies extrapolation, 10 for intraspecies variability, 2 for database inadequacy, 9 for malignancy, and 5 for genotoxicity). This modified BMD approach was developed by the National Health and Medical Research Council of Australia, in an effort to avoid the over-conservatisms often inherent in other BMD models. In comparison, the EPA default BMD approach is to use the 95% lower confidence limit on the dose associated with a 10% extra tumor risk level. The authors proposed a corresponding B[*a*]P soil guideline value of 5 mg/kg (soil). The authors also questioned the common practice of using toxicity equivalence factors (TEFs) based on B[*a*]P, and suggest that a PAH other than B[*a*]P should be considered as the risk driver. The tumor responses to dietary coal tar in the Culp study were qualitatively and quantitatively different than the responses to B[*a*]P alone; B[*a*]P could not explain the coal tar-induced lung tumors. 7*H*-benzo[*c*]fluorene was suggested as possibly playing a key role in PAH-induced lung carcinogenicity. This discussion about the most appropriate approach for evaluating PAH mixtures is relevant for both oral and inhalation exposures.				

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Styrene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
IARC	2002	Lymphatic and hematopoietic neo-plasms	Human—occupational	Inhalation: duration varied	Overall, small statistically unstable risks	Frentzel-Beyme et al. 1978; Ott et al. 1980; Hodgson & Jones 1985; Okun et al. 1985; Coggon et al. 1987; Bond et al. 1992; Kolstad et al. 1993, 1994, 1995; Kogevinas et al. 1994a,b; Wong et al. 1994; Anttila et al. 1998; Sathiakumar et al. 1998; Loughlin et al. 1999; Delzell et al. 2001
IARC	2002	Carcinogenicity	CD-1 mouse	Inhalation: 6 hrs/day, 5 days/wk Females – 98 wks Males – 104 wks	Increase in bronchioloalveolar carcinomas in females inhaling 6×10^5 µg/m^3; Increase in pulmonary adenomas at doses of 0.75, 1.5, 6×10^5 µg/m^3 in females and 1.5, 3, 6×10^5 µg/m^3 in males	Cruzan et al. 2001
IARC	2002	Carcinogenicity	Charles River CD rat	Inhalation: 6 hrs/day, 5 days/wk, 104 wks	No evidence of carcinogenicity	Cruzan et al. 1998
—	2002	Lung tumors	Human	PBPK inhalation model based on mice and rats, 2 yr studies	Using PBPK modeling for interspecies extrapolations, humans expected to be 100-fold less sensitive than mice to styrene exposure	Sarangapani et al. 2002 (with support from Cruzan et al. 1998 and Cruzan et al. 2001)

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Table C.4 (*Continued*). Summary of Chronic Cancer Toxicity Data for Each MSAT

Toxicity Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	Unit Risk, Potency, or Result	Reference
Toluene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	1994	Carcinogenicity	F344 rat	Inhalation: 6 hrs/day, 5 days/wk, 106 wks	Inadequate data – no carcinogenic responses, highest dose < MTD	CIIT 1980
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*						
A literature search was performed, but no articles related to toluene carcinogenicity were identified.						
Xylene						
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT						
Cancer unit risk, EPA (IRIS)	2003	Tumor incidence	F344 rat, B6C3F1 mouse	Oral gavage: 5 days/wk, 103 wks	Inadequate data, no evidence of carcinogenicity	NTP 1986
Cancer unit risk, EPA (IRIS)	2003	Tumor incidence	Sprague Dawley rat	Oral gavage: 4 to 5 days/wk, 104 wks	Inadequate data, predominantly negative results	Maltoni et al. 1983, 1985

Selected References from Updated Literature Searches:

The toxicity and health portions of the literature survey took advantage of peer-reviewed secondary sources of information, such as the EPA's Health Assessment Documents, U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reports, and International Agency for Research on Cancer (IARC) monographs. Information on chronic and subchronic health effects (cancer endpoints) was collected from these sources. In addition, the primary sources that key toxicity criteria were based upon were identified and obtained. The survey was augmented with information from primary sources for the seven priority MSATs. The survey was also augmented for the remaining 14 nonpriority MSATs. In cases where the secondary sources were out of date (i.e., 2001 or earlier).

Table C.5. Acute Toxicity Criteria for Each MSAT[a]

MSAT	NRC/NAC AEGL-1[b] Concentration (µg/m^3)[d] 10 min	30 min	60 min	4 hr	8 hr	Last Updated	NRC/NAC AEGL-2[c] Concentration (µg/m^3)[d] 10 min	30 min	60 min	4 hr	8 hr	Last Updated
Acetaldehyde	8.1×10^4	8.1×10^4	8.1×10^4	8.1×10^4	8.1×10^4	2004	6.12×10^5	6.12×10^5	4.86×10^5	3.06×10^5	1.98×10^5	2004
Acrolein	70[p]	70[p]	70[p]	70[p]	70[p]	2004	920[p]	410[p]	230[p]	230[p]	230[p]	2004
Arsenic compounds[e]	—	—	—	—	—	—	—	—	—	—	—	—
Benzene	4.15×10^5[p]	2.33×10^5[p]	1.66×10^5[p]	5.74×10^4[p]	2.87×10^5[p]	2002	6.38×10^6[p]*	3.51×10^6[p]	2.55×10^6[p]	1.28×10^6[p]	6.38×10^5[p]	2003
1,3-Butadiene	1.48×10^6*	1.48×10^6*	1.48×10^6*	1.48×10^6*	1.48×10^6*	2004	1.48×10^7*	1.48×10^7*	1.17×10^7*	7.51×10^6*	5.97×10^6*	2004
Dioxins and furans[f]	—	—	—	—	—	—	—	—	—	—	—	—
Formaldehyde	1.11×10^3[p]	1.11×10^3[p]	1.11×10^3[p]	1.11×10^3[p]	1.11×10^3[p]	2003	1.72×10^4[p]	1.72×10^4[p]	1.72×10^4[p]	1.72×10^4[p]	1.72×10^4[p]	2003
n-Hexane	NR[p]	NR[p]	NR[p]	NR[p]	NR[p]	2004	1.69×10^7[p]*	1.16×10^7[p]*	1.16×10^7[p]*	1.16×10^7[p]*	1.16×10^7[p]*	2004
Mercury compounds[e]	—	—	—	—	—	—	—	—	—	—	—	—
MTBE	—	—	—	—	—	—	—	—	—	—	—	—
Naphthalene	—	—	—	—	—	—	—	—	—	—	—	—
Nickel compounds[e]	—	—	—	—	—	—	—	—	—	—	—	—
Styrene	8.52×10^4[p]	8.52×10^4[p]	8.52×10^4[p]	8.52×10^4[p]	8.52×10^4[p]	2003	9.8×10^5[p]	6.82×10^5[p]	5.54×10^5[p]	5.54×10^5[p]	5.54×10^5[p]	2003
Toluene	7.54×10^5‡	7.54×10^5‡	7.54×10^5‡	7.54×10^5‡	7.54×10^5‡	2004	3.73×10^6‡	2.15×10^6‡	1.92×10^6‡	1.92×10^6‡	1.92×10^6‡	2004
Xylenes (mixed)[g]	5.67×10^5[p]	5.67×10^5[p]	5.67×10^5[p]	5.67×10^5[p]	5.67×10^5[p]	2003	4.80×10^6[p]*	2.62×10^6[p]	1.75×10^6[p]	1.75×10^6[p]	1.75×10^6[p]	2003

Please see footnotes at end of table.

Table C.5. (*Continued*) Acute Toxicity Criteria for Each MSAT[a]

	AIHA ERPG-1[h]		AIHA ERPG-2[i]		ATSDR MRL[j]			Cal EPA REL[k]		
MSAT	Concentration (µg/m^3)	Last Updated	Concentration (µg/m^3)	Last Updated	Route of Exposure	Concentration (µg/m^3 unless noted)	Last Updated	Concentration (µg/m^3 unless noted)	Average Time (hr)	Last Updated
Acetaldehyde	1.8×10^4	2004	3.6×10^5	2004	—	—	—	—	—	—
Acrolein	229	1989	1.15×10^3	1989	Inhalation	0.115	1990	0.19	1	1999
Arsenic compounds[e]	—	—	—	—	Provisional oral	5×10^{-3} mg/kg-day	2000	0.19	4	1999
Benzene	1.6×10^5	1996	4.79×10^5	1996	Inhalation	159.5	1997	1.28×10^3	6	1999
1,3-Butadiene	2.21×10^4	1997	4.42×10^5	1997	—	—	—	—	—	—
Dioxins and furans[f]	—	—	—	—	Oral TCDD	2×10^{-7} mg/kg-d	1998	—	—	—
					Oral 2,3,4,7,8-Penta-CDF	1×10^{-6} mg/kg-d	1994			
Formaldehyde	1.23×10^3	1988	1.23×10^4	1988	Inhalation	49.2	1999	93.5	1	1999
n-Hexane	—	—	—	—	—	—	—	—	—	—
Mercury compounds[e]	None[l]	2002	2×10^3 (vapor)	2002	Oral	7×10^{-3} mg Hg/kg-day	1999	1.8 (inorganic)	1	1999
MTBE	—	—	—	—	Inhalation	7.21×10^3	1996	—	—	—
Naphthalene	—	—	—	—	Oral	0.6 mg/kg-day	2003 Draft	—	—	—
Nickel compounds[e]	—	—	—	—	—	—	—	6	1	1999
Styrene	2.13×10^5	1995	1.07×10^6	1995	—	—	—	2.17×10^4	1	1999
Toluene	1.89×10^5	1996	1.13×10^6	1996	Inhalation	3.77×10^3	2000	3.69×10^4	1	1999
Xylene (mixed)[g]	—	—	—	—	Inhalation	4.4×10^3	1995	2.2×10^4	1	1999

Please see footnotes at end of table.

Table C.5. (*Continued*) Acute Toxicity Criteria for Each MSAT: *footnotes for table*

[a] No acute criteria or relevant literature were available for chromium compounds, diesel particulates, ethylbenzene, lead compounds, manganese compounds, or polycyclic organic matter (POM). POM (also known as PolyNuclear Aromatic Hydrocarbon [PNAs] and Polycyclic Aromatic Hydrocarbon [PAHs]) includes organic compounds with more than one benzene ring and which have a boiling point greater than or equal to 100°C. No acute toxicity criteria are available for POMs either as individual compounds or as a group.

[b] National Research Council, National Advisory Committee Acute Exposure Guideline Level-1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

[c] National Research Council, National Advisory Committee Acute Exposure Guideline Level-2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

[d] p = proposed.
— = no information.
NR = not recommended due to insufficient data.
* = ≥ 10% lower explosive limit (4.47 × 10^7 µg/m^3 for benzene, 4.42 × 10^7 µg/m^3 for butadiene, 3.88 × 10^7 µg/m^3 for *n*-hexane, 3.93 × 10^7 µg/m^3 for xylene).
‡ = interim.

[e] Although different metal species vary in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e., the sum of all species).

[f] This refers to two large groups of chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans. With the exception of two acute oral MRL values (ATSDR), no acute toxicity criteria is available for individual compounds or for these compounds as a group.

[g] The conversion factor from ppm to µg/m^3 for Xylene used was the average of the conversion factors of *m*-, *o*-, and *p*-Xylene.

[e] Although different metal species vary in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e., the sum of all species).

[f] This refers to two large groups of chlorinated dibenzo-*p*-dioxins and chlorinated dibenzofurans. With the exception of two acute oral MRL values on the next page (ATSDR), no acute toxicity criteria is available for individual compounds or for these compounds as a group.

[g] The conversion factor from ppm to µg/m^3 for Xylene used was the average of the conversion factors of *m*-, *o*-, and *p*-Xylene.

[h] American Industrial Hygiene Association Emergency Response Planning Guidelines-1: 1 hour exposure; no more than mild transient adverse health effects and no clearly defined objectionable odor.

[i] American Industrial Hygiene Association Emergency Response Planning Guidelines-2: 1 hour exposure; no irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

[j] Agency for Toxic Substances and Disease Registry Minimal Risk Level: The airborne concentration of a substance without an appreciable risk of adverse effects (other than cancer) over a duration of exposure up to 14 days.

[k] California EPA Reference Exposure Level: An exposure that is not likely to cause adverse effects in a human population, including sensitive subpopulations, exposed to that concentration for one hour on an intermittent basis.

[l] Adverse effects delayed for over 1 hour.

Table C.6. Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Acetaldehyde								
References Used to Support the Toxicity Criteria Development								
ERPG-1, AIHA	2004	Odor detection	Human	Inhalation	LOAEL = 1.26×10^3 µg/m^3	—	1.8×10^4 µg/m^3	AIHA 1989
		Eye irritation	Human	Inhalation: 15 min	LOAEL = 4.5×10^4 µg/m^3	—		Silverman et al. 1946
ERPG-2, AIHA	2004	Red eyes and transient conjunctivitis	Human	Inhalation: 15 min	LOAEL = 3.6×10^5 µg/m^3	—	3.6×10^5 µg/m^3	Silverman et al. 1946
		Mild upper respiratory tract irritation	Human	Inhalation: 30 min	LOAEL = 2.4×10^5 µg/m^3	—		Sim and Pattle 1957
AEGL-1, EPA	Sep-04	Discomfort	Human	Inhalation: 15 min	LOAEL = 4.5×10^4 µg/m^3	1	8.1×10^4 µg/m^3 at all time points[a]	Silverman et al. 1946
AEGL-2, EPA	Sep-04	Dyspnea and excitation	Wistar rat	Inhalation: effects observed during first 30 min of 6 hr exp	NOAEL = 4×10^6 µg/m^3	10	6.12×10^5 (10 and 30 min), 4.86×10^5 (1 h), 3.06×10^5 (4 h), 1.98×10^5 (8 h) µg/m^3 [a]	Appelman et al. 1982
Selected References from Updated Literature Searches, *defined at the end of this table*								
—	2005	Bronchoconstriction, airway obstruction, changes in intratracheal pressure (asthma)	Artificially-ventilated, anaesthetized guinea pigs—male (*n* = about 400 total, 6 per dose)	Intravenous injection of a single dose of acetaldehyde (diluted in saline) Dose levels = 6.25, 12.5, 25, 50, or 100 mg/kg	LOAEL = 6.25 mg/kg	Acetaldehyde is hypothesized to be a main factor in alcohol-induced asthma. Acetaldehyde caused a dose-dependent increase in intratracheal pressure, vascular permeability, levels of circulating blood histamine, and airway obstruction (The authors' main focus was to compare the activity of 3 chemicals in preventing acetaldehyde-induced pulmonary changes.)		Rossoni et al. 2005

[a] AEGL value based on personal communication with Dr. Falke, EPA/Office of Pollution Prevention & Toxics, AEGL Committee Member

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Acetaldehyde (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)								
—	2005	Eyes itch	Sensitive humans	Acute (15 min) inhalation	LOAEL = 45,800 µg/m^3	3	STELIA = 15,300 µg/m^3	Schupp et al. 2005
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles for non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or ELIA$_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene and compared these risk-based "acceptable" exposure levels to concentrations in cars. For the acetaldehyde STELIA, the authors started with a LOAEL of 45,800 µg/m^3 for itching of eyes in some sensitive individuals (based on Deutsch Forschungsgemeinschaft 1971) and applied an uncertainty factor of 3 to derive a STELIA of 15,300 µg/m^3. The estimated acetaldehyde concentration at 65°C (1680 µg/m^3—an exposure scenario potentially relevant for starting a car that has been parked in the sun) did not exceed the STELIA.						
Acrolein								
References Used to Support the Toxicity Criteria Development								
AEGL-1, EPA	Jan-04	Eye irritation, "annoyance"/ discomfort	Human	Inhalation	Threshold = 210 µg/m^3	3	70 µg/m^3 at all time points	Weber-Tscopp et al. 1977
AEGL-2, EPA	Jan-04	10–25% decrease in respiratory rate and moderate to severe eye and nose irritation	Human	Inhalation: 1 hr	Threshold = 690 µg/m^3	3	920 µg/m^3 (10 min), 410 µg/m^3 (30 min), 230 µg/m^3 (1, 4, 8 hr)	Weber-Tscopp et al. 1977

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Acrolein (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table*								
—	2004	Lung function (based on spirometric measurements, FEV_1, FVC, $FEF_{25–75}$)	Human—firefighters performing prescribed burns of forest and range (*n* = 65)	Inhalation of smoke during prescribed burn (average 5.4 hrs) Mean acrolein = 22.9 µg/m^3 (range 0–93.9 µg/m^3)	Concentrations of acrolein, formaldehyde, $PM_{3.5}$, and carbon monoxide were measured in personal breathing zone samples. There was a significant decrement in all three measures of lung function (comparing pre-shift to post-shift values). However, no significant associations were found with any of the individual toxic components of smoke measured (including acrolein and formaldehyde), nor was there any evidence of a dose-response relationship. The relatively small changes in lung function decrements were suggested to be at least partly due to the healthy worker effect.			Slaughter et al. 2004
Arsenic Compounds								
References Used to Support the Toxicity Criteria Development								
REL, Cal EPA	1999	Decreased fetal weight	Mouse—pregnant (species not specified)	Inhalation: 4 hrs/day, 4 days	LOAEL = 190 µg/m^3	1000	0.19 µg/m^3	Nagymajtenyi et al. 1985
No relevant studies were available to update acute toxicity criteria for arsenic.								

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Benzene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
AEGL-1, EPA	Dec-02	Mild CNS effects	Human	Inhalation: 2 hrs	NOAEL = 3.40×10^5 µg/m^3	3	4.15×10^5 (10 min), 2.33×10^5 (30 min), 1.66×10^5 (1 hr), 5.74×10^4 (4 hr), 2.87×10^4 (8 hr) µg/m^3	Srbova et al. 1950
AEGL-2, EPA	Jun-03	Locomotor activity	Rat	Inhalation: 4 hrs	NOAEL = 1.24×10^7 µg/m^3	10	6.38×10^6 (10 min), 3.51×10^6 (30 min), 2.55×10^6 (1 hr), 1.28×10^6 (4 hr), 6.38×10^5 (8 hr) µg/m^3	Molnar et al. 1986
No relevant studies were available to update acute toxicity criteria for benzene.								
1,3-Butadiene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
AEGL-1, EPA	Dec-04	Eye irritation, difficulty focusing	Human	Inhalation: 7 hrs	Point of departure = 4.42×10^6 µg/m^3	3	1.48×10^6 µg/m^3 at all time points	Carpenter et al. 1944
AEGL-2, EPA	Dec-04	Absence of effects	Rat	Inhalation: 6 hrs/day, 5 days/week, 3 months	NOAEL = 1.77×10^7 µg/m^3	3	1.48×10^7 (10 and 30 min), 1.17×10^7 (1 hr), 7.51×10^6 (4 hr), 5.97×10^6 (8 hr) µg/m^3 [a]	Crouch et al. 1979
No relevant studies were available to update acute toxicity criteria for 1,3-butadiene.								

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Chromium Compounds								
No relevant studies were available to update acute toxicity criteria for chromium.								
Diesel Engine Exhaust								
No relevant studies were available to update acute toxicity criteria for diesel engine exhaust.								
Dioxin								
References Used to Support the Toxicity Criteria Development								
Oral acute MRL, ATSDR	1998	Immunological effects, impaired resistance to infection	B6C3F1 mouse—female	Acute oral gavage	NOAEL = 0.005 µg/kg-day; LOAEL = 0.01 µg/kg-day	30 (an additional modifying factor of 0.7 was applied to account for bioavailability differences)	2×10^{-7} mg/kg-day TCDD	Burleson et al. 1996
Oral acute MRL, ATSDR	1994	Mild thymic lymphoid hypoplasia	Hartley guinea pigs—male	Acute oral	LOAEL = 3 µg/kg-day	1000	1×10^{-6} mg/kg-d 2,3,4,7,8-*Penta*-CDF	Moore et al. 1979

Table continues on next page

Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Dioxin (Continued)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2001	Cancer, multiple sites	Human— (Zone A, highest exposure; Zone B, lower exposure; Zone R, lowest exposure)	Inhalation: Residential exposure due to 1976 accident at small chemical plant during trichlorophenol production.	Elevated deaths from rectal cancer—no latency-related pattern. Non-significant excess of "other" digestive and lung cancers. Increased all cause mortality in 5–9 yr period only in Zone A: RR = 1.4 (1.0–2.0). From 15–20 yrs, lung cancer RR = 2.4 (1.0–5.8). Multiple myeloma had highest rates between 10 and 15 yrs latency in Zone B: 10–15 yr RR = 6.3 (1.9–21.0). Females in Zone A over a 5–9 yr period had an excess of colon cancer (RR = 8.0 (2.0–32.5), and other digestive cancers, RR = 11.3 (1.5–82.6), and melanoma, RR = 25.2 (3.3–195.2). In zones A and B combined, males had excess of all cancer deaths between 15 and 20 yrs, RR = 1.1 (1.0–1.3).			Bertazzi et al. 2001
Ethylbenzene								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2000	Ototoxicity (mid-frequency hearing loss)	Wag/Rij rat	Inhalation: 8 hrs/day, 5 days	NOAEL = 1.30×10^6 µg/m^3; LOAEL = 1.74×10^6 µg/m^3	—	—	Cappaert et al. 2000
Formaldehyde								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
AEGL-1, EPA	Jun-03	Slight eye irritation	Human	Inhalation: 6 min	NOAEL = 1.11×10^3 µg/m^3; LOAEL = 1.23×10^3 µg/m^3	1	1.1×10^3 µg/m^3 at all time points	Bender et al. 1983
AEGL-2, EPA	Mar-03	Mild lacrimation with adaptation	Human	Inhalation: 30 min	LOAEL = 1.70×10^4 µg/m^3	1	1.72×10^4 µg/m^3 at all time points	Sim and Pattle 1957

Table continues on next page

Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Formaldehyde (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, ***defined at the end of this table***								
—	2005	Local irritation of the upper respiratory tract	Human—volunteers	Short term inhalation: 370 µg/m^3 (exposure details not specified)	NOAEL = 370 µg/m^3	~3	STELIA = 125 µg/m^3	Schupp et al. 2005
		The authors developed an approach (including recommended uncertainty factors) for developing maximum "acceptable" exposure levels for VOCs released inside cars: (1) Short Term Exposure Levels Inside Automotive Vehicles, or STELIAs; (2) chronic Exposure Levels Inside Automotive vehicles of non-genotoxic substances, or ELIAs; and (3) ELIAs for carcinogenic and mutagenic substances, or ELIA$_{cm}$. They applied this concept to acetaldehyde, formaldehyde, and xylene and compared these risk-based "acceptable" exposure levels to concentrations in cars. For formaldehyde, the authors considered the German MAK value of 370 µg/m^3 (essentially a NOAEL for local irritation of the upper respi-ratory tract, based on Deutsch Forschungsgemeinschaft 2000 and Schlink et al 1999) and the maximum indoor air exposure level of 125 µg/m^3 (about 1/3 the German MAK value) recommended by the former Bundesgesundheitsamt in Germany (BGA 1992). The study authors concluded that this factor of about 3 was an appropriate uncertainty factor for extrapolation to the general population. Therefore, because local irritation of the upper respiratory tract was considered to be the critical mechanism for acute and chronic toxicity, as well as "the most likely threshold mechanism that precedes tumor formation," this value of 125 µg/m^3 was used for the STELIA, ELIA$_{systemic}$, ELIA$_{local}$, and ELIA$_{cm}$. The average concentration of formaldehyde measured in chamber tests designed to simulate cars at 23°C (48 µg/m^3) did not exceed the ELIAs. However, the estimated formaldehyde concentration at 65°C (1470 µg/m^3—an exposure scenario potentially relevant for starting a car that has been parked in the sun) did exceed the STELIA, suggesting a possible concern for short term exposures to formaldehyde in cars.						
—	2004	Lung function (based on spirometric measurements, FEV$_1$, FVC, FEF$_{25–75}$)	Human—firefighters performing prescribed burns of forest and range (*n* = 65)	Inhalation of smoke during prescribed burn (average 5.4 hrs) Mean formaldehyde = 66.4 µg/m^3 (range 0–258.3 µg/m^3)	Concentrations of acrolein, formaldehyde, PM$_{3.5}$, and carbon monoxide were measured in personal breathing zone samples. There was a significant decrement in all three measures of lung function (comparing pre-shift to post-shift values). However, no significant associations were found with any of the individual toxic components of smoke measured (including acrolein and formaldehyde), nor was there any evidence of a dose-response relationship. The relatively small changes in lung function decrements were suggested to be at least partly due to the healthy worker effect.			Slaughter et al. 2004

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Formaldehyde (*Continued*)								
—	2003	Potentiation of allergic bronchoconstriction	Guinea pigs—male, albino, Hartley strain (n = 20–33 per group)	Transnasal exposure to 0.1 or 1.0% formaldehyde, 3 times per week, 6 weeks				Kita et al. 2003
		Three groups of animals were tested. The "non-sensitized" group was exposed to formaldehyde for 6 weeks, followed by an acute challenge with increasing concentrations of methacholine at 5-minute intervals. The "passively sensitized" group was exposed to formaldehyde for 5 weeks, then given an injection of anti-ovalbumin serum, then exposed for one additional week to formaldehyde, and then challenged with ovalbumin. The "actively sensitized" group was first given an injection of cyclophosphamide, followed by an injection of ovalbumin and aluminum hydroxide two days later (sensitization), and a booster injection of ovalbumin and aluminum hydroxide three weeks later. The 6-week exposure to formaldehyde began on the day of the first ovalbumin injection, after which the animals were challenged with ovalbumin. Formaldehyde significantly potentiated antigen-induced bronchoconstriction (increase in the lateral pressure of the tracheal tube) in a dose-dependent manner. Formaldehyde also increased antibody titer (IgG). These effects were observed in actively sensitized guinea pigs, but not in non-sensitized or passively sensitized animals. Overall, the authors concluded that repeated formaldehyde exposure does not induce asthma, but worsens asthma (allergic bronchoconstriction) by enhancing antigenic sensitization.						
—	2004	Locomotor activity and exploratory behavior	AB-Mice—adult, male (n = 20 per group)	Single inhalation exposure to 1353, 2829, or 6396 µg/m^3 formaldehyde for 2 hours	LOAEL = 1353 µg/m^3			Malek et al. 2004
		In all exposure groups, motion activity was significantly reduced, and exploratory behaviors (eg, frequency of rearing, floor sniffing) were altered. Some of the parameters remained significantly altered 24 hours after exposure. No signs of overt toxicity (lacrimation, nasal secretion, or regurgitation) were observed at these exposure levels.						

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
***n*-Hexane**								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
AEGL-1, EPA	Jun-04	—	—	—	—	—	Not recommended due to insufficient data	—
AEGL-2, EPA	Jun-04	Reduced respiration associated with some narcosis	Rat	Inhalation: 6 hrs	Point of departure = 3.53×10^7 µg/m^3 Scaled to 10-min exposure using exponent of $n = 3$; 30 min, 1 hr, 4 hr, and 8 hr AEGL-2 equal because steady state reached by 30 min	3	1.69×10^7 µg/m^3 (10 min), 1.16×10^7 µg/m^3 (30 min, 1, 4, 8 hr)	Bus et al. 1982
Lead Compounds								
Exposures were very low (see exposure component), so acute toxicity is not a concern.								
Manganese Compounds								
Studies about acute toxicity of manganese were focused on metal fume fever and were therefore not relevant to developing acute criteria for MSATs.								
Mercury Compounds								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
ERPG-1, AIHA	2002	Mercury vapor is odorless and produces no irritation or other early warning signs. Derivation of an ERPG-1 value is not appropriate.					Not appropriate	ATSDR 1999

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Mercury Compounds (*Continued*)								
ERPG-2, AIHA	2002	Symptoms of elemental mercury intoxication	Human	Inhalation: periods of hours or days	NOAEL = 400 to 2000 µg/m^3	—	2000 µg/m^3 (vapor)	Bidstrup et al. 1951; Benning 1958; Battigelli 1960; Elghany et al. 1997; Stopford et al. 1978; Takahata et al. 1970; Valic and Jacobs 1965; Watanabe 1969; Yoshida and Yamamura 1982
REL, Cal EPA	1999	CNS disturbances in offspring	Rat—pregnant	Inhalation: 1 hr	LOAEL = 1.8 × 10^3 µg/m^3	1000	1.8 µg/m^3 (inorganic)	Danielson et al. 1993
MTBE								
References Used to Support the Toxicity Criteria Development								
ATSDR, MRL	1996	Neurological effects: concentration-related increases in ataxia and duck-walk gait in both sexes	F344 rat	Inhalation: 6 hrs. Observation at 1, 6, and 24 hrs post-exposure	NOAEL (ADJ) = 7.21 × 10^5 µg/m^3 LOAEL = 1.44 × 10^7 µg/m^3 for transient effects (seen at 1 hr post-exposure, but not 6 or 24 hr)	100	7.21 × 10^3 µg/m^3	Gill 1989

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
MTBE (*Continued*)								
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1998	Irritative symptoms, discomfort, CNS effects, nasal and ocular effects.	Human— 10 male volunteers	2 hours at three levels 1.8 × 10^4, 9 × 10^4, 1.8 × 10^5 µg/m^3) during light physical work. Each person expo-sed 3 times (to a different concentration each time); at least 2 weeks between successive exposures.	NOAEL = 1.8 × 10^5 µg/m^3 for eye measurements, inflammatory markers in nasal lavage fluid. Various nasal effects at 1.8 × 10^4 µg/m^3 and 9 × 10^4 µg/m^3, but not dose-related.	—	—	Nihlen et al. 1998
		Aim was to assess acute health effects up to the Swedish occupational exposure limit value with both a questionnaire and objective methods (eg, blinking frequency, nasal lavage) administered before, during, and after exposure. Nonsignificant increases in nasal airway resistance but not related to exposure level. Nonsignificant tendency of decreased nasal volume but no clear dose-effect relationship. Conclusion: "no or minimal acute effects of MTBE vapor on short-term exposure at relatively high levels."						
—	2003	Respiratory parameters	F344 rat— male	Inhalation: nose only. 4 hrs MTBE only; 7 consecutive days gasoline followed by MTBE / gasoline on day 8.	—	—	—	Benson et al. 2003
		Inhalation of MTBE alone or with gasoline had no concentration-dependent effect on respiratory minute volume. MTBE equivalents rapidly distributed to all tissues examined, with the largest percentages distributed to the liver. Between 1.44 × 10^5 µg/m^3 and 1.44 × 10^6 µg/m^3 (4-hr MTBE exposure) significant decrease in the elimination half-life of VOCs in breath and a significant increase in the percentage of IBB (initial body burdens) of MTBE equivalents eliminated as VOCs in breath. Gasoline co-exposure significantly decreased the percentage of the MTBE equivalent IBBs in tissues and increased rates of elimination of MTBE equivalents. The study indicates that the uptake and fate of inhaled MTBE are altered upon increasing exposure levels from 1.44 × 10^4 µg/m^3 and 1.44 × 10^6 µg/m^3, suggesting that toxic effects observed previously upon repeated inhalation of concentrations of 1.44 × 10^6 µg/m^3 or greater may not necessarily be linearly extrapolated to effects that might occur at lower concentrations. Further, coexposure to gasoline, whether acute or repeated, decreases body tissue burdens of MTBE equivalents and enhances the elimination rate of MTBE and its metabolites, thereby potentially reducing the toxic effects of the MTBE compared to when it is inhaled alone.						

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
MTBE (*Continued*)								
Selected References from Updated Literature Searches, *defined at the end of this table* (*Continued*)								
—	2000	Symptoms, odor ratings, neurobehavioral performance on a task of driving simulation, and psychophysiologic responses (heart and respiration rate, endtidal CO_2, finger pulse volume, electromyograph, finger temperature) were measured before, during, and immediately after exposure.	12 individuals selected based on self-report of symptoms (self-reported sensitives; SRSs) associated with MTBE compared to 19 controls without self-reported sensitivities.	Inhalation: exposed for 15 min to clean air, gasoline, gasoline with 11% MTBE, and gasoline with 15% MTBE. Double-blind, repeated measures, controlled exposure.	—	—	—	Fiedler et al. 2000
		Relative to controls, SRSs (self-reported sensitive persons) reported significantly more total symptoms when exposed to gasoline with 15% MTBE than when exposed to gasoline with 11% MTBE or to clean air. However, these differences in symptoms were not accompanied by significant differences in neurobehavioral performance or psychophysiologic responses. No significant differences in symptoms or neurobehavioral or psychophysiologic responses were observed when exposure to gasoline with 11% MTBE was compared to exposure to clean air or to gasoline. Thus, the present study, although showing increased total symptoms among SRSs when exposed to gasoline with 15% MTBE, did not support a dose-response relationship for MTBE exposure nor the symptom specificity associated with MTBE in epidemiologic studies.						
Naphthalene								
References Used to Support the Toxicity Criteria Development								
MRL, ATSDR (draft)	2003	Neurotoxicity	Sprague Dawley rat—pregnant	Gavage/gestation days 6-15	LOAEL = 50 mg/kg-day	90	0.6 mg/kg-day	NTP 1991

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Nickel Compounds								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
REL, Cal EPA	1999	Respiratory system: > 15% decrease in FEV_1	Human with occupational asthma (n = 7)	Inhalation: 30 min	LOAEL = 33 µg Ni/m^3	6	6 $µg/m^3$	Cirla et al. 1985
SELECTED REFERENCES FROM UPDATED LITERATURE SEARCHES, *defined at the end of this table*								
—	1988	Histopathologic lesions in nasal epithelium, lung and bronchial lymph nodes; lung inflammation; reduced body weight; lethargy	F344 rat and B6C3F1 mouse	Inhalation of nickel sulfate hexahydrate aerosol: 6 hrs/day, 12 days	LOAEL = 3.5×10^3 µg $NiSO_4 \cdot 6H_2O/m^3$ (corresponding to 840 µg soluble Ni/m^3)	—	—	Benson et al. 1988
—	2002	Changes in inflammatory responses and mucus secretion (biochemical characteristics of acute bronchiolitis)	Wistar rat, male	Inhalation of nickel chloride aerosol (via whole body): 5 hrs/day, 5 days	Effects observed following 5-day exposure regimen of 850 $µg/m^3$ (day 1), 240 $µg/m^3$ (days 2–5)	—	—	Ishihara et al. 2002
—	2003	Effects on heart rate and electrocardiogram measurements	Old beagle dog with preexisting cardiac abnormalities (n = 7)	Inhalation of respirable particles (via mouth, not nose): 3 hrs/day, 3 successive days	NOAEL = 60 $µg/m^3$ nickel oxide; NOAEL = 100 $µg/m^3$ nickel sulfate	No effects on heart rate or electrocardiogram measurements observed at the single dose tested.		Muggenburg et al. 2003

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
POM								
No acute toxicity criteria are available for POMs either as individual compounds or as a group.								
Selected References from Updated Literature Searches, *defined at the end of this table*								
—	2003	Male reproductive parameters (testicular steroidogenesis, epididymal function)	Rats—adult, F344 (*n* = 10 per group)	Inhalation: 25, 75, or 100 µg B[*a*]P/m^3, 4 hr/day, 10 days (Testosterone and luteinizing hormone concentrations tested only at 75 µg/m^3.)	NOAEL = 25 µg/m^3, LOAEL = 75 µg/m^3	Reduced progressive motility of sperm at 75 and 100 µg/m^3 in a concentration-dependent manner. Initial decline in plasma testosterone concentrations at 75 µg/m^3, followed by a compensatory increase in testosterone levels. Increases in luteinizing hormone concentrations at 75 µg/m^3. No effect on testis weight or density of stored sperm at any B[*a*]P concentration.		Inyang et al. 2003
—	2005	Altered immune responses	Mice—female, Balb/cA (*n* = 5 per group)	Single intranasal instillation of 0.05 mg B[*a*]P	LOAEL = Single intranasal instillation of 0.05 mg B[*a*]P	Altered immune responses indicated by significantly increased levels of serum IgE antibodies to mite allergen extract, and increased cytokine secretion (IL-4, IL-10, IL-12p70, IFN-γ) in spleen cultures.		Kadkhoda et al. 2005

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Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Styrene								
References Used to Support the Toxicity Criteria Development								
AEGL-1, EPA	Sep-03	Minor irritation and headache	Human	Inhalation, mostly: 4 hr exposures	NOAEL = 8.52×10^4 µg/m^3; LOAEL = 2.13×10^5 µg/m^3	1	8.52×10^4 µg/m^3 at all time points	Seeber et al. 2002
AEGL-2, EPA	Sep-03	Eye and throat irritation	Human	Inhalation: 1 hr	NOAEL = $2.17\ 10^5$ µg/m^3; LOAEL = 4.22×10^5 µg/m^3 (for 20 min)	100	9.80×10^5 µg/m^3 (10 min), 6.82×10^5 µg/m^3 (30 min), 5.54×10 µg/m^3 (1, 4, 8 hr)	Stewart et al. 1968
Toluene								
References Used to Support the Toxicity Criteria Development								
AEGL-1, EPA	Sep-04	No effects to minor discomfort and subtle neuro-behavioral effects	Human	Inhalation: up to 8 hrs	NOAEL = 7.54×10^5 µg/m^3	1	7.54×10^5 µg/m^3 at all time points	17 studies including: Astrand et al. 1972; Gamberale and Hulten-gren 1972; Stewart et al. 1975; Baelum et al. 1990

Table continues on next page

Table C.6 (*Continued*). Summary of Acute Toxicity Data for Each MSAT

Tox Criteria	Year	Endpoint	Animal Strain or Human Population	Route and Duration of Exposure	NOAEL and LOAEL	Uncertainty Factor	Toxicity Value	Reference
Toluene (*Continued*)								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT (*Continued*)								
AEGL-2, EPA	Sep-04	Obvious central nervous system depression	Human	Inhalation: 20 min	NOAEL = 2.64×10^6 µg/m^3; 4 and 8 hr equal to 1 hr value (steady state in blood and brain by 1 hr)	1	3.73×10^6 µg/m^3 (10 min), 2.15×10^6 µg/m^3 (30 min), 1.92×10^6 µg/m^3 (1, 4, 8 hr)	Gabmerale and Hultengren 1972
		Attention deficit	Monkey	Inhalation: 50 min	NOAEL = 7.45×10^6 µg/m^3 higher respiratory rate and cardiac output in monkeys relative to body weight (50 min monkey ≅ 20 min human)	3		Taylor and Evans 1985
Xylene								
REFERENCES USED TO SUPPORT THE TOXICITY CRITERIA DEVELOPMENT								
AEGL-1, EPA	Dec-03	Eye irritation	Human	Inhalation: 30 min	90% of subjects exposed to 400 ppm had mild effects	3	5.67×10^5 µg/m^3 at all time points	Hastings et al. 1984
AEGL-2, EPA	Dec-03	Poor coordination	Rat	Inhalation: 4 hrs	LOAEL = 5.67×10^6 10 and 30 min; values based on PBPK modeling; 1 hr, 4 hr, and 8 hr values equivalent because steady state reached at 1 hr	3	4.80×10^6 µg/m^3 10 min), 2.62×10^6µg/m^3 (30 min), 1.75×10^6 µg/m^3 (1, 4, 8 hr)	Carpenter et al. 1975

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The toxicity and health portions of the literature survey took advantage of peer-reviewed secondary sources of information, such as the EPA's Health Assessment Documents, U.S. Agency for Toxic Substances and Disease Registry (ATSDR) reports, and International Agency for Research on Cancer (IARC) monographs. Information on acute, chronic, and subchronic health effects (including cancer and noncancer endpoints) was collected from these sources. In addition, the primary sources that key toxicity criteria were based upon were identified and obtained. The survey was augmented with information from primary sources for the seven priority MSATs. The survey was also augmented for the remaining 14 nonpriority MSATs. In cases where the secondary sources were out of date (i.e., 2001 or earlier).

HEI

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The reference list for Tables C.1–C.6 was prepared by the Gradient Corporation for HEI. Any web addresses were accessed before February 7, 2005. HEI has not updated this list. All literature identified by Gradient is included. The list is organized by chemical.

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Appendix D. Indoor Exposure Tables

Introduction

The tables in Appendix D summarize information on indoor air concentrations for six of the seven priority MSATs (not including naphthalene).

Table D.1 is a summary of the sources of data on indoor air concentrations for each MSAT, including brief descriptions of each study and details of study time periods, locations, and types of location (e.g., residences, office buildings, and schools), as well as a description of each location and notes.

Table D.2 is a matrix of data sources showing the MSATs investigated in each study used for indoor air concentration information.

Tables D.3 through D.8 are data summaries for each MSAT. Certain MSATs are represented by one or more surrogate compounds.

Although the hyperlinks from the tables to Web sites were active shortly before publication, HEI cannot be responsible for any subsequent changes in the Web sites referred to.

For more information about this appendix, see Introduction to Appendices B, C, D, and E.

Table D.1. Indoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
EPA Indoor Air Studies						
Girman et al. (1999)	Conference proceedings summarizing preliminary findings from the EPA Building Assessment Survey and Evaluation (BASE) study of 56 randomly selected public and private office buildings	Summer 1995–Winter 1997-98	Nationwide	Public and commercial office buildings	56 randomly selected public and private office buildings across the US, excluding buildings with highly publicized indoor air quality problems	Samples collected in 56 randomly selected buildings, with 3 indoor sampling locations/building.
Recent, Peer-Reviewed Residential Indoor Air Monitoring Studies						
Adgate et al. (2004a)	Journal article summarizing screening-phase indoor measurements collected in 284 households and intensive-phase personal, indoor, and outdoor measurements for 10 VOCs collected in a probability sample of 72 households as part of the Minnesota Children's Pesticide Exposure Study (MNCPES)	May–Sept 1997	Multiple locations, MN	Urban, nonurban residences	Households recruited from cities of Minneapolis and St Paul (designated urban households) and Rice and Goodhue Counties (designated nonurban households). 97% of homes were single-family homes, and approximately 20% were homes with smokers present.	Weighted distributions from intensive-phase sampling stated to be representative of more than 58,000 urban and 4,000 nonurban households.
Adgate et al. (2004b)	Journal article summarizing exposure measurements for 15 VOCs conducted in multiple locations (outdoors, indoors at school, indoors at home, and personal samples) among a study population of 113 children attending two inner-city schools in Minneapolis	Winter (1/24/00–2/18/00) and Spring (4/9/00–5/12/00)	Minneapolis MN	Urban residences and schools	Two inner-city Minneapolis schools serving predominantly low-income households. Approximately 20% of households had smokers present, 64% were apartments.	Children were participants in School Health Initiative: Environment, Learning, and Disease (SHIELD) study, which consisted of a randomly-selected ethnically and racially diverse sample of inner-city children in Minneapolis.
Chuang et al. (1999)	Journal article summarizing PAH exposure data collected during study of North Carolina children in low-income families	Feb–Aug 1995 (2 homes sampled in Feb 1994)	Durham and Piedmont, NC	Inner city and rural low-income housing	24 low-income homes included in study, 14 inner-city homes and 10 rural homes; 5 homes had smokers present.	
Clayton et al. (1999)	Journal article summarizing extensive exposure data (indoor, outdoor, and personal air; dust; tap water; food; urine; blood) from the EPA National Human Exposure Assessment Survey (NHEXAS) Phase I field study conducted in EPA Region V in July 1995–May 1997	July 1995–May 1997	EPA Region V (IL, IN, OH, MI, MN, WI)	Residences	Approximately 250 study participants selected via probability sampling for inclusion in study.	Most households were sampled once, but one subset was sampled up to 3 times.
Feng and Zhu (2004)	Journal article summarizing subset of 30 indoor air samples analyzed for carbonyl compounds from 75 randomly selected homes in Ottawa, Canada	Not provided	Ottawa, Canada	Urban residences	Samples drawn from subset of 75 randomly selected homes.	

Table continues on next page

Table D.1. (*Continued*) Indoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Residential Indoor Air Monitoring Studies (*Continued*)						
Gordon et al. (1999)	Journal article summarizing preliminary residential environmental measurements (indoor, outdoor, and personal air; dust; soil; dermal wipes) from the EPA National Human Exposure Assessment Survey (NHEXAS) Arizona pilot study	Not provided in paper, but assumed to be 1995–1997	Arizona	Residences	Probability-based sampling of approx. 170 residences	
Kinney et al. (2002)	Journal article summarizing personal, indoor, and outdoor sampling conducted in 1999 as part of the Toxic Exposure Assessment, a Columbia/Harvard (TEACH) study, an urban air toxics study of inner-city New York City neighborhoods	Winter and summer 1999, 8 weeks/season	New York City	Urban residences	Inner-city neighborhoods primarily in northern Manhattan and the South Bronx, but also including the boroughs of Queens and Brooklyn. All study participants were nonsmokers.	
Mukerjee et al. (1997)	Journal article summarizing residential air, household dust, and soil pollutant data collected during 1993 Lower Rio Grande Valley Environmental Scoping Project	Spring 1993, summer 1994	Lower Rio Grande Valley	Urban and rural residences	Nine residences sampled during study, three located in city of Brownsville and six in rural agricultural areas, all but one within economically-disadvantaged areas or substandard housing communities	Authors report that smoking activities occurred in majority of study homes. Six residences were sampled during both seasons.
Naumova et al. (2002)	Journal article summarizing indoor and outdoor PAH measurements collected in 55 nonsmoking residences in three urban areas during June 1999–May 2000 as part of Relationship of Indoor, Outdoor, and Personal Air study (RIOPA)	June 1999–May 2000	Los Angeles CA, Houston TX, and Elizabeth NJ	Urban residences	Nonsmoking residences in urban areas near dominant emission sources, with LA and Elizabeth homes near high-traffic roadways	
Payne-Sturges et al. (2004)	Journal article summarizing personal, indoor, and outdoor sampling of 33 nonsmoking adult residents conducted as part of a community-based exposure assessment conducted in Baltimore	Jan 2000–June 2001	Baltimore MD	Urban residences	South Baltimore communities in close proximity to large chemical industries as well as nearby interstate highways and local truck traffic servicing industry	
Phillips et al. (2005)	Journal article summarizing personal, indoor, and outdoor VOC data collected in four OK cities as part of the Oklahoma Urban Air Toxics Study	Not provided (although assumed to be very recent)	4 Oklahoma cities	Urban residences	Sampling conducted in 37 different urban detached, single-family homes, all nonsmoking	
Reiss et al. (1995)	Journal article summarizing indoor carbonyl measurements made in four Boston-area residences in winter of 1993 and in nine residences during summer of 1993	Winter and Spring 1993	Boston MA	Urban and suburban residences	Included both unattached and attached dwelling units; homes with smokers specifically excluded, and wood-burning fireplaces not operated during the sampling periods.	Sampling conducted in a total of 9 different residences, with 4 sampled in both seasons and 5 sampled during only the summer sampling season.

Table continues on next page

Table D.1. (*Continued*) Indoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Residential Indoor Air Monitoring Studies (*Continued*)						
Sawant et al. (2004)	Journal article summarizing indoor and outdoor carbonyl measurements made inside 20 residences and 7 schoolrooms in Mira Loma, western Riverside County CA	Sept 2001 to Jan 2002	Mira Loma CA	Semi-rural residences	Sampling conducted in 20 residences, nearly all with gas heating and 5 with smoking inside, and in 7 classrooms (2 portables) within the area high school	
Sax et al. (2004)	Journal article summarizing personal, indoor, and outdoor sampling conducted in 1999 and 2000 as part of the Toxic Exposure Assessment, a Columbia/ Harvard (TEACH) study, an urban air toxics study of inner-city New York City and LA neighborhoods	Winter and summer 1999 (NYC) and winter and fall 2000 (LA)	New York NY and Los Angeles CA	Urban residences	Primarily inner city neighborhoods in both NYC and LA, all nonsmoking homes	
Sexton et al. (2004)	Journal article summarizing personal, indoor, and outdoor sampling for 15 VOCs conducted over 3 seasons in 1999 among population of 71 nonsmoking adults in three Minneapolis-St Paul urban neighborhoods	Apr–Nov 1999	Minneapolis-St Paul MN	Urban residences	3 urban neighborhoods (Phillips, East St Paul, Battle Creek) with different outdoor VOC concentration profiles, including large manufacturing plant located near East St Paul neighborhood	
Van Winkle and Scheff (2001)	Journal article summarizing VOC, PAH, and trace element data collected indoors and outdoors at 10 homes for 10 months (1994–1995) as part of a Public Health Assessment in Southeast Chicago	June 1994–Apr 1995	Southeast Chicago IL	Urban residences	Study area heavily industrialized with many known air toxic emission source types including manufacturing facilities, coke plants, municipal solid waste landfills, on-road vehicles, etc. All nonsmoking homes.	Ten homes monitored on either quarterly or monthly basis for 10-month period.
Zhang et al. (1994)	Journal article summarizing indoor and outdoor carbonyl measurements made in suburban New Jersey homes in summer 1992	Summer 1992	Central New Jersey	Suburban residences	Six homes included in study, each nonsmoking and with natural gas stoves/ovens and central air-conditioning.	All indoor samples collected in kitchens with gas-on and gas-off combustion conditions.
Recent, Peer-Reviewed Commercial Building / School Indoor Air Monitoring Studies						
Daisey et al. (1992)	Journal article summarizing VOC measurements from 12 northern California office buildings with different ventilation types	June–Sept 1990	San Francisco Bay Area CA	Urban office buildings	Included buildings with natural ventilation, mechanical ventilation with operable windows and no AC, and mechanical ventilation with sealed windows and AC; each with smoking prohibited except in specific areas and 9 out of 12 built prior to 1970.	Samples collected in 32 areas within the 12 buildings, with indoor locations chosen to represent potential exposures.

Table continues on next page

Table D.1. (*Continued*) Indoor Exposure Data Sources

Reference	Reference Description	Study Time Period	Study Locations	Locations Type	Locations Description	Notes
Recent, Peer-Reviewed Commercial Building / School Indoor Air Monitoring Studies (*Continued*)						
Levy et al. (2002)	Journal article summarizing PM and PAH measurements made in a variety of non-residential microenvironments in Boston MA	Summer 2000	Boston MA	Urban nonresidential micro-environments	Sampled indoor nonresidential microenvironments included a public library, coffee shop, mall, food court, apartment, and hospital, several in high-traffic areas and all nonsmoking.	Two traffic microenvironments included in study- subway station and bus- were excluded from data compilation.
Shendell et al. (2004)	Journal article summarizing VOC measurements made during a pilot study of portable and traditional classrooms in Los Angeles County	June 2000–June 2001	Los Angeles CA	Urban portable and traditional school class-rooms	Seven schools in two school districts included in study, from which 20 classrooms (13 portables and seven in main buildings) were randomly selected for sampling.	
Subramanian et al. (2004)	Journal article summarizing airborne carbonyl measurements made inside six large Midwestern US office buildings	Nov 1996–Oct 1998	IA, NE, MN	Urban office buildings	Included six private office buildings, all classified as non-complaint environments	In general, sampling conducted from 4 different locations (3 indoors, 1 outdoors) at each building.
Wilson et al. (2001)	Journal article summarizing persistent organic pollutant measurements (eg, PAHs, phthalates, pesticides, PCBs) in multiple media at 10 child day care centers located in central NC	Spring 1997	Durham, Chapel Hill, Raleigh NC	Rural and urban child day care centers	Three centers located in rural communities and six in urban centers	
Large-Scale California Air Resources Board (ARB) Studies						
Fortmann et al. (2001) www.arb.ca.gov/research/abstracts/97-330.htm	ARB report summarizing experimental study conducted in a CA test house to investigate the impact of residential cooking activities on exposures to particulate and gaseous air toxics	Feb 2000	Rohnert Park CA	Residence	Small single-story ranch style home used as a test house	Indoor measurements conducted in kitchen for realistic cooking tests using gas range, electric range, and microwave.
Sheldon et al. (1992a) www.arb.ca.gov/research/abstracts/a933-144.htm	ARB report summarizing indoor and outdoor PAH and phthalate measurements made in 125 Riverside CA homes as part of the PTEAM study	Fall 1990	Riverside CA	Urban residences	Data collected from probability sample of homes representing 61,520 households in Riverside with at least one nonsmoking resident over the age of 10	Based on questionnaire responses, little use of indoor heating appliances occurred during study period, and less than 30% of homes reported any smoking.
Sheldon et al. (1992b) www.arb.ca.gov/research/abstracts/a833-156.htm	ARB report summarizing large indoor air VOC study conducted during a single season for a probability sample of 128 households in Woodland CA	May and June 1990	Woodland CA	Urban residences	Woodland is a medium-size city in a predominantly agricultural region of CA	Data collected from probability sample of homes representing 15,008 households in Woodland target area at time of study.
Sheldon et al. (1993) www.arb.ca.gov/research/abstracts/ a033-132.htm	ARB report summarizing indoor and outdoor PAH measurements made in 280 Northern California homes in winter 1992	Winter 1992	Placerville and Roseville, CA	Urban residences	Homes selected to represent specific combustion source categories including tobacco smoking, fireplaces, woodstoves, and gas heat	
Whitmore et al. (2003) www.arb.ca.gov/research/abstracts/00-317.htm	ARB report summarizing California Portable Classrooms Study (PCS) Phase I survey (i.e., a questionnaire and passive formaldehyde sampling) of a randomly selected sample of all CA public schools with at least one portable classroom and a Phase II field study of a subset of these schools.	Phase I Study: Spring 2001; Phase II Field Study: Oct 2001–Feb 2002	CA (statewide)	Portable and traditional school classrooms	911 classrooms (644 portable and 267 traditional) included within Phase I survey, and 201 classrooms at 67 schools statewide included within Phase II field study	Formaldehyde data collected using passive monitors in Phase I, while indoor air data collected for suite of VOCs and carbonyls during Phase II study component.

Table D.2. Indoor Exposure Data Sources for Each MSAT

Data Source	MSAT					
	Acetaldehyde	Acrolein	Benzene	1,3-Butadiene	Formaldehyde	POM[a]
EPA Indoor Air Studies						
Building Assessment Survey and Evaluation (BASE) Study— Girman et al. (1999)			✓			
Recent, Peer-Reviewed Residential Indoor Air Monitoring Studies						
Adgate et al. (2004a)			✓			
Adgate et al. (2004b)[b]			✓			
Chuang et al. (1999)						✓
Clayton et al. (1999)			✓			
Feng and Zhu (2004)	✓	✓			✓	
Gordon et al. (1999)			✓	✓	✓	
Kinney et al. (2002)	✓		✓	✓	✓	
Mukerjee et al. (1997)			✓	✓		✓
Naumova et al. (2002)						✓
Payne-Sturges et al. (2004)			✓			
Phillips et al. (2005)			✓			
Reiss et al. (1995)	✓	✓			✓	
Sawant et al. (2004)	✓	✓			✓	
Sax et al. (2004)	✓		✓	✓	✓	
Sexton et al. (2004)			✓			
Van Winkle and Scheff (2001)			✓	✓		✓
Zhang et al. (1994)	✓				✓	
Recent, Peer-Reviewed Commercial Building / School Indoor Air Monitoring Studies						
Daisey et al. (1992)			✓			
Levy et al. (2002)						✓
Shendell et al. (2004)	✓		✓		✓	
Subramanian et al. (2000)	✓				✓	
Wilson et al. (2001)						✓
Large-Scale California Air Resources Board (ARB) Studies						
Fortmann et al. (2001)	✓				✓	✓
Sheldon et al. (1992a)						✓
Sheldon et al. (1992b)		✓	✓	✓		
Sheldon et al. (1993)						✓
Whitmore et al. (2003)	✓	c	✓	c	✓	

[a] Surrogates used for POM include total polycyclic aromatic hydrocarbons (Total PAHs) as well as seven PAHs identified by EPA as probable human carcinogens and used as surrogates for the larger group of POM compounds in EPA air toxics evaluations.

[b] Also included indoor monitoring in school classrooms of study participants.

[c] Acrolein and 1,3-butadiene were also included as target analytes, but acrolein results were excluded from the report due to sample interferences and the analytical methods were not able to quantify 1,3-butadiene.

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Table D.3. Indoor Exposure Data Summaries. Acetaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Feng and Zhu (2004)	Summary of Ottawa, Canada residential indoor data	Ottawa	ON	Residences	Not given	100 mins	30	100%	µg/m³	Directly from reference	4.4	3.8×10^1
Fortmann et al. (2001)	Summary of residential cooking experimental data	Rohnert Park	CA	Test house	Feb 2000	1 hr 30 mins to 5 hrs 8 mins	6	100%	µg/m³	Directly from reference	1.3×10^1	4.3×10^2
Reiss et al. (1995)	Summary of Boston-area residential indoor sampling data—winter sampling season	Boston	MA	Residences	Winter 1993	24 hrs	14	100%	µg/m³ (converted from ppb)	Directly from reference	7.9	1.8×10^1
	Summary of Boston-area residential indoor sampling data—spring sampling season	Boston	MA	Residences	Spring 1993	24 hrs	26	100%	µg/m³ (converted from ppb)	Directly from reference	2.5	3.0×10^1
Sawant et al. (2004)	Summary of Mira Loma residential indoor sampling data	Mira Loma	CA	Residences	Sept 2001 –Jan 2002	24 hrs	83	100%	µg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	7.8×10^{-1}	2.4×10^1
	Summary of Mira Loma schoolroom indoor sampling data	Mira Loma	CA	School rooms, including two portable units	Sept 2001 –Jan 2002	24 hrs	28	100%	µg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	4.5	2.5×10^1
Sax et al. (2004)	Summary of TEACH Project LA winter residential indoor data	Los Angeles (South Central)	CA	Residences	Winter 2000 (Feb–Mar)	2 days	40	100%	µg/m³	Directly from reference	4.1	3.6×10^1

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Table D.3. Indoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Feng and Zhu (2004)	100 mins	1.8×10^1						Samples were a subset of samples from 75 randomly selected homes in the city of Ottawa.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. Aldehyde measurements made in only a subset of cooking tests.
Reiss et al. (1995)	48 hrs	1.2×10^1						Four homes were sampled during consecutive 24-hr periods, with multiple sampling locations in the larger residences.
	48 hrs	9.2						Nine homes were sampled during consecutive 24-hr periods (including four previously sampled during the winter), with multiple sampling locations in the larger residences.
Sawant et al. (2004)	6 days	1.0×10^1	1.1	1.8×10^1	9.0	1.1	2.0×10^1	Homes sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Ranges in average and median concentrations represent ranges in home averages and medians.
	6 days	1.2×10^1	7.0	1.7×10^1	1.1×10^1	6.9	1.5×10^1	School rooms sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Sampling was not conducted in one school room due to logistical constraints. Ranges in average and median concentrations represent ranges in classroom averages and medians.
Sax et al. (2004)	2 days	1.5×10^1			1.5×10^1			One 2-day sample collected at each study participant residence.

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Table D.3. Indoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Sax et al. (2004)	Summary of TEACH Project LA fall residential indoor data	Los Angeles (South Central)	CA	Residences	Fall 2000 (Sept–Oct)	2 days	33	100%	µg/m³	Directly from reference	3.5	2.3×10^1
Sax et al. (2004); Kinney et al. (2002)	Summary of TEACH Project NYC summer residential indoor data	New York	NY	Residences	Summer 1999 (June–Aug)	2 days	41	100%	µg/m³	Directly from reference	2.9	9.2×10^1
	Summary of TEACH Project NYC winter residential indoor data	New York	NY	Residences	Winter 1999 (Feb–Apr)	2 days	37	100%	µg/m³	Directly from reference	5.4	5.4×10^1
Shendell et al. (2004)	Summary of Los Angeles County portable and traditional classroom indoor sampling data	Los Angeles	CA	Portable and traditional school classrooms	June 2000–June 2001	5 days			µg/m³	Directly from reference	1.0×10^{-1}	2.5×10^1
Subramanian et al. (2000)	Summary of Midwestern US large office building indoor sampling data	Urban areas	IA, NE, MN	Large office buildings	Nov 1996–Oct 1998	8 hrs	23 measurement periods		µg/m³ (converted from ppb)	Directly from reference		
Whitmore et al. (2003)	Summary of California portable classrooms study Project Phase II indoor sampling data	Statewide	CA	Portable and traditional school classrooms	Oct 2001–Feb 2002	~ 6–8 hrs	199	98.6%	µg/m³ (converted from ppb)	Directly from reference	< 1.4	2.0×10^1 (P95)
Zhang et al. (1994)	Summary of suburban New Jersey residential indoor sampling data	Central NJ	NJ	Residences	Summer 1992	2.5–3 hrs	36	100%	µg/m³ (converted from ppb)	Directly from reference	1.2	2.9×10^1

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Table D.3. Indoor Exposure Data Summaries (*Continued*). Acetaldehyde (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sax et al. (2004)	2 days	9.6			8.6			One 2-day sample collected at each study participant residence.
Sax et al. (2004); Kinney et al. (2002)	2 days	1.5×10^1			1.1×10^1			One 2-day sample collected at each study participant residence.
	2 days	1.6×10^1			1.4×10^1			One 2-day sample collected at each study participant residence.
Shendell et al. (2004)	School wk averaged over sampling during both cooling and heating seasons	6.8			6.0			Samples collected during both heating and cooling seasons from 20 classrooms (13 portables, 7 in main building) from seven schools within two school districts. Data reported reflect school wkly integrated averages, Monday AM to Friday PM, including both school hrs and overnight.
Subramanian et al. (2000)	2 yrs	5.0						Samples collected seasonally from six different buildings, multiple indoor sampling locations per building, over 2 yrs.
Whitmore et al. (2003)	~ 6-8 hrs	1.2×10^1			1.1×10^1			Data reported are for Phase II field study where measurements made in 201 classrooms at 67 schools statewide.
Zhang et al. (1994)	6 days	5.3						Six homes were sampled each afternoon for 6 days.

Table D.4. Indoor Exposure Data Summaries. Acrolein (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Feng and Zhu (2004)	Summary of Ottawa, Canada residential indoor data	Ottawa	ON	Residences	Not given	100 mins	30	0%	μg/m³	Directly from reference	< 2	< 2
Reiss et al. (1995)	Summary of Boston-area residential indoor sampling data—winter sampling season	Boston	MA	Residences	Winter 1993	24 hrs	14	0%	μg/m³ (converted from ppb)	Directly from reference	$< 1 \times 10^{-1}$	$< 1 \times 10^{-1}$
	Summary of Boston-area residential indoor sampling data—spring sampling season	Boston	MA	Residences	Spring 1993	24 hrs	26	0%	μg/m³ (converted from ppb)	Directly from reference	$< 1 \times 10^{-1}$	$< 1 \times 10^{-1}$
Sawant et al. (2004)	Summary of Mira Loma residential indoor sampling data	Mira Loma	CA	Residences	Sept 2001 –Jan 2002	24 hrs	83	94%	μg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	$< 7.0 \times 10^{-2}$	6.9
	Summary of Mira Loma schoolroom indoor sampling data	Mira Loma	CA	School rooms, including two portable units	Sept 2001 –Jan 2002	24 hrs	28	86%	μg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	$< 7.0 \times 10^{-2}$	2.4
Sheldon et al. (1992b)	Summary of Woodland CA main study residential indoor sampling data	Woodland	CA	Residences	May and June 1990	24 hrs	62 VVOC samples	80%	μg/m³	Directly from reference	< 2.0	2.1×10^{1} (P90)

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Table D.4. Indoor Exposure Data Summaries (*Continued*). Acrolein (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Feng and Zhu (2004)								Samples were a subset of samples from 75 randomly selected homes in city of Ottawa.
Reiss et al. (1995)								Four homes were sampled during consecutive 24-hr periods, with multiple sampling locations in the larger residences.
								Nine homes were sampled during consecutive 24-hr periods (including four previously sampled during the winter), with multiple sampling locations in the larger residences.
Sawant et al. (2004)	6 days	1.4	6.4×10^{-2}	3.6	1.7	6.4×10^{-2}	2.6	Homes sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Ranges in average and median concentrations represent ranges in home averages and medians.
	6 days	1.2	4.8×10^{-1}	2.1	1.7	8.0×10^{-2}	2.1	School rooms sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Sampling was not conducted in one school room due to logistical constraints. Ranges in average and median concentrations represent ranges in classroom averages and medians.
Sheldon et al. (1992b)	24 hrs				4.1			Monitoring conducted during one 24-hr period in a single season for a probability sample of 128 households in Woodland CA. Data provided are descriptive statistics—ARB report also provides weighted descriptive statistics representing the estimated 15,008 permanent residences in Woodland target area at time of study.

Table D.5. Indoor Exposure Data Summaries. Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Adgate et al. (2004a)	Minnesota screening-phase indoor air data summary	Statewide	MN	Residences	May–Sept 1997	6 days	282	100%	µg/m³	Directly from reference	1.4	1.3×10^{1} (P95)
	Minnesota intensive-phase indoor air data summary	Statewide	MN	Residences	May–Sept 1997	6 days	101	100%	µg/m³	Directly from reference	1.4	7.5 (P95)
Adgate et al. (2004b)	Minneapolis spring indoor school data summary	Minneapolis	MN	Schools	4/9/00–5/12/00	5 days	47	90.5%	µg/m³	Directly from reference		1.0 (P90)
	Minneapolis winter indoor school data summary	Minneapolis	MN	Schools	1/24/00–2/18/00	5 days	39	77.1%	µg/m³	Directly from reference		1.6 (P90)
	Minneapolis spring indoor home data summary	Minneapolis	MN	Residences	4/9/00–5/12/00	2 days	88	99%	µg/m³	Directly from reference		7.2 (P90)
	Minneapolis winter indoor home data summary	Minneapolis	MN	Residences	1/24/00–2/18/00	2 days	93	100%	µg/m³	Directly from reference		6.2 (P90)
Clayton et al. (1999)	NHEXAS Region V indoor air data summary	Statewide	IL, IN, OH, MI, MN, WI	Residences	July 1995–May 1997	6 days	402	99.8%	µg/m³	Directly from reference		1.3×10^{1} (P90)
Daisey et al. (1994)	Phase I California healthy building study data summary	San Francisco	CA	Office buildings	June–Sept 1990	8 hrs			µg/m³	Directly from reference	$< 1.0 \times 10^{-1}$	2.7
Girman et al. (1999)	EPA BASE study results	Nationwide	US	Public and commercial office buildings	Summer 1995–Winter 1997-98	8–10 hrs	> 200	81–100%	µg/m³	Directly from reference	6.0×10^{-1}	1.7×10^{1}

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Table D.5. Indoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Adgate et al. (2004a)	6 days	4.6			3.3			One six-day sample collected from each of 284 residences; 2 samples had invalid results for benzene. Summary statistics are weighted distributions estimated for more than 42,000 urban and 3,000 nonurban households.
	6 days	3.9			3.1			One six-day sample collected from each of 101 residences from the 284 screening-phase residences. Summary statistics are weighted distributions estimated for more than 58,000 urban and 4,000 nonurban households.
Adgate et al. (2004b)	5 wks				6.0×10^{-1}			Samples collected from 5 rooms in two schools
	4 wks				6.0×10^{-1}			Samples collected from 5 rooms in two schools
	2 days				2.1			A single 2-day sample collected at each study participant's residence
	2 days				2.2			A single 2-day sample collected at each study participant's residence
Clayton et al. (1999)	6 days	7.2			4.4			Most households sampled once, but a subset sampled up to 3 times.
Daisey et al. (1994)	8 hrs	9.8×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. Samples collected from 12 office buildings within a total of 32 areas.
Girman et al. (1999)								Samples collected in 56 randomly selected buildings, with 3 indoor sampling locations per building

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Table D.5. Indoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Gordon et al. (1999)	NHEXAS Arizona pilot study indoor air data summary	Statewide	AZ	Residences	1995–1997	6–7 days	185	49%	µg/m³	Directly from reference	< 2.4×10^{-1}	9.0×10^{1}
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study indoor air data summary—spring sampling season	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	9	100%	µg/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study indoor air data summary—summer sampling season	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	100%	µg/m³	Directly from reference		
Payne-Sturges et al. (2004)	Baltimore indoor air data summary	Baltimore	MD	Residences	Jan 2000–June 2001	3 days	33		µg/m³	Directly from reference		8.34 (P90)
Phillips et al. (2005)	Oklahoma urban air toxics study daytime indoor air data summary	Four Oklahoma Cities	OK	Residences	Not provided	12 hrs	40		µg/m³	Directly from reference		1.4×10^{1}
	Oklahoma urban air toxics study nighttime indoor air data summary	Four Oklahoma Cities	OK	Residences	Not provided	12 hrs	40		µg/m³	Directly from reference		1.1×10^{2}
Sax et al. (2004)	Summary of TEACH Project LA winter residential indoor data	Los Angeles (South Central)	CA	Residences	Winter 2000 (Feb–Mar)	2 days	40	100%	µg/m³	Directly from reference	1.6	1.7×10^{1}
	Summary of TEACH Project LA fall residential indoor data	Los Angeles (South Central)	CA	Residences	Fall 2000 (Sept–Oct)	2 days	32	100%	µg/m³	Directly from reference	1.0	6.3

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Table D.5. Indoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Gordon et al. (1999)	6–7 days				1.3			Samples from ~ 170 homes.
Mukerjee et al. (1997)	3 wks				2.4			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.4			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Payne-Sturges et al. (2004)	3 days	3.7			2.5			One 3-day sample collected from 33 different residences.
Phillips et al. (2005)	12 hrs				6.2×10^{-1}			One 12-hr daytime sample collected from 37 different residences with 3 residences sampled on two occasions.
	12 hrs				1.2			One 12-hr nighttime sample collected from 37 different residences with 3 residences sampled on two occasions.
Sax et al. (2004)	2 days	4.9			4.3			One 2-day sample collected at each study participant residence.
Sax et al. (2004)	2 days	2.5			2.3			One 2-day sample collected at each study participant residence.

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Table D.5. Indoor Exposure Data Summaries (*Continued*). Benzene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Sax et al. (2004); Kinney et al. (2002)	Summary of TEACH Project NYC summer residential indoor data	New York	NY	Residences	Summer 1999 (June–Aug)	2 days	30	38%	µg/m³	Directly from reference	1.5	6.3
	Summary of TEACH Project NYC winter residential indoor data	New York	NY	Residences	Winter 1999 (Feb–Apr)	2 days	36	100%	µg/m³	Directly from reference	1.7	3.9×10^{1}
Sexton et al. (2004)	Minneapolis-St Paul indoor air data summary	Minneapolis-St Paul	MN	Residences	Apr–Nov 1999	2 days	292	99.7%	µg/m³	Directly from reference		1.5×10^{1} (P90)
Sheldon et al. (1992b)	Summary of Woodland CA main study residential indoor sampling data	Woodland	CA	Residences	May and June 1990	24 hrs	104 VOC samples	98%	µg/m³	Directly from reference	$< 3.8 \times 10^{-1}$	8.3 (P90)
Shendell et al. (2004)	Summary of Los Angeles County portable and traditional classroom indoor sampling data	Los Angeles	CA	Portable and traditional school classrooms	June 2000–June 2001	5 days			µg/m³	Directly from reference	7.0×10^{-1}	3.4
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	48	100%	µg/m³	Directly from reference	1.3	3.4×10^{1}
Whitmore et al. (2003)	Summary of California portable classrooms study Project Phase II indoor sampling data	Statewide	CA	Portable and traditional school classrooms	Oct 2001 – Feb 2002	~ 6–8 hrs	73	63.7%	µg/m³ (converted from ppb)	Directly from reference	< 2	4.1 (P95)

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Table D.5. Indoor Exposure Data Summaries (*Continued*). Benzene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sax et al. (2004); Kinney et al. (2002)	2 days	1.7			1.5			One 2-day sample collected at each study participant residence.
	2 days	5.3			3.6			One 2-day sample collected at each study participant residence.
Sexton et al. (2004)	2 days	5.8				1.9		Samples collected over 3 seasons from residences of 71 study participants. Authors note that a manufacturing plant is located near one of neighborhoods (East St Paul).
Sheldon et al. (1992b)	24 hrs				2.2			Monitoring conducted during one 24-hr period in a single season for a probability sample of 128 households in Woodland CA. Data provided are descriptive statistics—ARB report also provides weighted descriptive statistics representing the estimated 15,008 permanent residences in Woodland target area at time of study.
Shendell et al. (2004)								Samples collected during both heating and cooling seasons from 20 classrooms (13 portables, 7 in main building) from seven schools within two school districts. Data reported reflect school wkly integrated averages, Monday AM to Friday PM, including both school hrs and overnight.
Van Winkle and Scheff (2001)	10 months	4.1			2.9			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).
Whitmore et al. (2003)	~ 6–8 hrs	1.8			1.1			Data reported are for VOC samples collected in subset of the 201 classrooms at 67 schools included in Phase II field study.

Table D.6. Indoor Exposure Data Summaries. 1,3-Butadiene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Gordon et al. (1999)	NHEXAS Arizona pilot study indoor air data summary	Statewide	AZ	Residences	1995–1997	6–7 days	24	4%	µg/m³	Directly from reference	$< 3.8 \times 10^{-1}$	6.0×10^{-1}
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study indoor air data summary—spring sampling season	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	9	67%	µg/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study indoor air data summary—summer sampling season	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	µg/m³	Directly from reference		
Sax et al. (2004)	Summary of TEACH Project LA winter residential indoor data	Los Angeles (South Central)	CA	Residences	Winter 2000 (Feb–Mar)	2 days	40	60%	µg/m³	Directly from reference	$< 6.0 \times 10^{-2}$	1.8
	Summary of TEACH Project LA fall residential indoor data	Los Angeles (South Central)	CA	Residences	Fall 2000 (Sept–Oct)	2 days	32	38%	µg/m³	Directly from reference	$< 6.0 \times 10^{-2}$	1.5
Sax et al. (2004); Kinney et al. (2002)	Summary of TEACH Project NYC summer residential indoor data	New York	NY	Residences	Summer 1999 (June–Aug)	2 days	30	44%	µg/m³	Directly from reference	$< 6.0 \times 10^{-2}$	1.2×10^{1}
	Summary of TEACH Project NYC winter residential indoor data	New York	NY	Residences	Winter 1999 (Feb–Apr)	2 days	36	64%	µg/m³	Directly from reference	$< 6.0 \times 10^{-2}$	5.8
Sheldon et al. (1992b)	Summary of Woodland CA main study residential indoor sampling data	Woodland	CA	Residences	May and June 1990	24 hrs	62 VVOC samples	9.8%	µg/m³	Directly from reference	< 1.2	1.0×10^{1}
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	48	81%	µg/m³	Directly from reference	< LOD	2.5

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Table D.6. Indoor Exposure Data Summaries (*Continued*). 1,3-Butadiene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Gordon et al. (1999)	6–7 days				$< 3.8 \times 10^{-1}$			Samples from subset of ~ 170 homes included in pilot study VOC sampling.
Mukerjee et al. (1997)	3 wks				8.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				1.4			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Sax et al. (2004)	2 days	5.0×10^{-1}			5.0×10^{-1}			One 2-day sample collected at each study participant residence.
	2 days	2.0×10^{-1}			$< 6.0 \times 10^{-2}$			One 2-day sample collected at each study participant residence.
Sax et al. (2004); Kinney et al. (2002)	2 days	1.2			$< 6.0 \times 10^{-2}$			One 2-day sample collected at each study participant residence.
	2 days	1.0			7.0×10^{-1}			One 2-day sample collected at each study participant residence.
Sheldon et al. (1992b)	24 hrs	4.7						Monitoring conducted during one 24-hr period in a single season for a probability sample of 128 households in Woodland CA. Data provided are descriptive statistics—ARB report also provides weighted descriptive statistics representing the estimated 15,008 permanent residences in the Woodland target area at time of study.
Van Winkle and Scheff (2001)	10 months	4.2×10^{-1}			2.6×10^{-1}			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).

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Table D.7. Indoor Exposure Data Summaries. Formaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Feng and Zhu (2004)	Summary of Ottawa, Canada residential indoor data	Ottawa	ON	Residences	Not given	100 mins	30	100%	µg/m³	Directly from reference	5.8	8.5×10^1
Fortmann et al. (2001)	Summary of residential cooking experimental data	Rohnert Park	CA	Test House	Feb 2000	1 hr 30 mins–5 hrs 8 mins	6	100%	µg/m³	Directly from reference	3.7×10^1	4.2×10^2
Gordon et al. (1999)	NHEXAS Arizona pilot study indoor air data summary	Statewide	AZ	Residences	1995–1997	6–7 days	189	69%	µg/m³	Directly from reference	$< 1.2 \times 10^1$	4.1×10^2
Reiss et al. (1995)	Summary of Boston-area residential indoor sampling data—winter sampling season	Boston	MA	Residences	Winter 1993	24 hrs	14	100%	µg/m³ (converted from ppb)	Directly from reference	7.4	2.0×10^1
	Summary of Boston-area residential indoor sampling data—spring sampling season	Boston	MA	Residences	Spring 1993	24 hrs	26	100%	µg/m³ (converted from ppb)	Directly from reference	7.3	6.6×10^1
Sawant et al. (2004)	Summary of Mira Loma residential indoor sampling data	Mira Loma	CA	Residences	Sept 2001–Jan 2002	24 hrs	83	100%	µg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	1.5	4.6×10^1
	Summary of Mira Loma schoolroom indoor sampling data	Mira Loma	CA	School rooms, including two portable units	Sept 2001–Jan 2002	24 hrs	28	100%	µg/m³	Raw data provided by study authors and stats calculated by Gradient Corp.	7.7	2.2×10^1
Sax et al. (2004)	Summary of TEACH Project LA winter residential indoor data	Los Angeles (South Central)	CA	Residences	Winter 2000 (Feb–Mar)	2 days	40	100%	µg/m³	Directly from reference	7.9	5.9×10^1

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Table D.7. Indoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Feng and Zhu (2004)	100 mins	2.8×10^1						Samples were a subset of samples from 75 randomly selected homes in the city of Ottawa.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. Aldehyde measurements made in only a subset of cooking tests.
Gordon et al. (1999)	6-7 days				2.1×10^1			Samples from ~ 170 homes.
Reiss et al. (1995)	48 hrs	1.4×10^1						Four homes were sampled during consecutive 24-hr periods, with multiple sampling locations in the larger residences.
	48 hrs	2.0×10^1						Nine homes were sampled during consecutive 24-hr periods (including four previously sampled during the winter), with multiple sampling locations in the larger residences.
Sawant et al. (2004)	6 days	1.6×10^1	1.5	3.5×10^1	1.5×10^1	1.5	3.7×10^1	Homes sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Ranges in average and median concentrations represent ranges in home averages and medians.
	6 days	1.5×10^1	1.1×10^1	2.0×10^1	1.4×10^1	1.1×10^1	2.0×10^1	School rooms sampled over 12 days, with sampling conducted in six alternating 24-hr segments. Sampling was not conducted in one of the school rooms because of logistical constraints. Ranges in average and median concentrations represent ranges in classroom averages and medians.
Sax et al. (2004)	2 days	2.1×10^1			1.8×10^1			One 2-day sample collected at each study participant residence.

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Table D.7. Indoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Sax et al. (2004)	Summary of TEACH Project LA fall residential indoor data	Los Angeles (South Central)	CA	Residences	Fall 2000 (Sept–Oct)	2 days	33	100%	µg/m³	Directly from reference	8.2	3.2×10^1
Sax et al. (2004); Kinney et al. (2002)	Summary of TEACH Project NYC summer residential indoor data	New York	NY	Residences	Summer 1999 (June–Aug)	2 days	41	100%	µg/m³	Directly from reference	5.8	5.1×10^1
	Summary of TEACH Project NYC winter residential indoor data	New York	NY	Residences	Winter 1999 (Feb–Apr)	2 days	37	100%	µg/m³	Directly from reference	5.2	2.2×10^1
Shendell et al. (2004)	Summary of Los Angeles County portable and traditional classroom indoor sampling data	Los Angeles	CA	Portable and traditional school classrooms	June 2000–June 2001	5 days			µg/m³	Directly from reference	1.3×10^1	5.5×10^1
Subramanian et al. (2000)	Summary of Midwestern US large office building indoor sampling data	Urban areas	IA, NE, MN	Large office buildings	Nov 1996–Oct 1998	8 hrs	23 measurement periods		µg/m³ (converted from ppb)	Directly from reference		
Whitmore et al. (2003)	Summary of California Portable Classrooms Study Project Phase II indoor sampling data	Statewide	CA	Portable and traditional school classrooms	Oct 2001 to Feb 2002	~ 6–8 hrs	199	100%	µg/m³ (converted from ppb)	Directly from reference		2.9×10^1 (P95)
	Summary of California Portable Classrooms Study Project Phase I indoor sampling data	Statewide	CA	Portable and traditional school classrooms	Spring 2001	Primarily 7–10 days	911	97%	µg/m³ (converted from ppb)	Directly from reference	< 7.4	7.6×10^1 (P95)
Zhang et al. (1994)	Summary of Suburban New Jersey residential indoor sampling data	Central NJ	NJ	Residences	Summer 1992	2.5–3 hrs	36	100%	µg/m³ (converted from ppb)	Directly from reference	3.3×10^1	1.3×10^2

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Table D.7. Indoor Exposure Data Summaries (*Continued*). Formaldehyde (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sax et al. (2004)	2 days	1.6×10^1			1.5×10^1			One 2-day sample collected at each study participant residence.
Sax et al. (2004); Kinney et al. (2002)	2 days	2.1×10^1			1.9×10^1			One 2-day sample collected at each study participant residence.
	2 days	1.2×10^1			1.2×10^1			One 2-day sample collected at each study participant residence.
Shendell et al. (2004)	School wk averaged over sampling during both cooling and heating seasons	2.2×10^1			2.0×10^1			Samples collected during both heating and cooling seasons from 20 classrooms (13 portables, 7 in main building) from seven schools within two school districts. Data reported reflect school wkly integrated averages, Monday AM to Friday PM, including both school hrs and overnight.
Subramanian et al. (2000)	2 yrs	8.6						Samples collected seasonally from six different buildings, multiple indoor sampling locations per building, over 2 yrs.
Whitmore et al. (2003)	~ 6–8 hrs	1.6×10^1			1.5×10^1			Data reported are for Phase II field study where measurements were made in 201 classrooms at 67 schools statewide.
	Primarily 7–10 days	3.3×10^1			2.7×10^1			Data reported are for Phase I study component where passive formaldehyde samplers were mailed to schools and valid data were obtained from 911 classrooms (644 portable and 267 traditional). Authors note that passive sampler is a screening method and that it is not intended to be highly accurate and sensitive (i.e., typically within 20–30% of active monitor concentration).
Zhang et al. (1994)	6 days	6.7×10^1						Six homes were sampled each afternoon for 6 days.

Table D.8a. Indoor Exposure Data Summaries. POM (Total PAH as Surrogate) (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase total PAH	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	3.7×10^2	9.9×10^3
Levy et al. (2002)	Urban Boston nonresidential indoor data summary—continuous particle-bound total PAH	Boston	MA	Urban nonresidential indoor spaces	June–Aug 2000	Continuous	Total of 669 10-min time periods with valid data		ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	2.2×10^1	3.5×10^2
	Houston residential indoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.1×10^1	3.1×10^2
	Los Angeles residential indoor air data summary—particle- ($PM_{2.5}$) and gas-phase total PAH	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	1.6×10^1	2.2×10^2

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Table D.8a. Indoor Exposure Data Summaries (*Continued*). POM (Total PAH as Surrogate) (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chuang et al. (1999)	24 hrs	2.5×10^3						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home was sampled during one 24-hr period.
Levy et al. (2002)	~ 12 hrs		5.0	1.2×10^1				Average concentration range represents minimum and maximum median concentrations across 6 of the indoor nonresidential microenvironments studied by Levy et al. (including a public library, coffee shop, mall, food court, apartment, and hospital; it excludes two transportation microenvironments—subway and bus). Each microenvironment sampled a minimum of 3 times, approximately 4 hrs each time.
Naumova et al. (2002)								One 48-hr sample was collected in each home. All homes were nonsmoking.
								One 48-hr sample was collected in each home. All homes were nonsmoking.
								One 48-hr sample collected in each home. All homes were non-smoking homes.

Table D.8b. Indoor Exposure Data Summaries. POM: Benz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	1.1×10^{-1}	3.1
Fortmann et al. (2001)	Summary of residential cooking experimental data—particle- (PM_{10}) and gas-phase	Rohnert Park	CA	Test house	Feb 2000	1 hr 30 mins–5 hrs 8 mins	9	11%	ng/m³	Directly from reference	< LOD	1.8×10^{1}
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	100%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	8.3×10^{-3}	9.3×10^{-2}
	Elizabeth residential indoor air data summary–particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	1.4×10^{-2}	9.7×10^{-2}
	Houston residential indoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.9×10^{-3}	1.1

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Table D.8b. Indoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chuang et al. (1999)	24 hrs	5.9×10^{-1}						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home was sampled during one 24-hr period.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. PAH measurements made in subset of cooking experiments.
Mukerjee et al. (1997)	3 wks				4.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Naumova et al. (2002)	48 hrs	2.7×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	4.4×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	2.2×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.

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Table D.8b. Indoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Maximum
Naumova et al. (2002)	Houston residential indoor air data summary–particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.7×10^{-3}	1.7×10^{-1}
	Los Angeles residential indoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	4.7×10^{-3}	7.1×10^{-2}
	Los Angeles residential indoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	2.0×10^{-3}	8.9×10^{-2}
Sheldon et al. (1992a)	Riverside, CA PTEAM residential indoor PAH study data summary—particle- and gas-phase	Riverside	CA	Residences	Fall 1990	12 hrs	115 daytime samples; 113 nighttime samples	49.1% for daytime samples; 56.3% for nighttime samples	ng/m³	Directly from reference	$< 1.1 \times 10^{-1}$	3.0×10^{-1} (P90)
Sheldon et al. (1993)	Data summary for homes with smoking: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	52		ng/m³	Directly from reference		1.1×10^{1}
	Data summary for homes with smoking/fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	11		ng/m³	Directly from reference		5.1
	Data summary for homes with fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	45		ng/m³	Directly from reference		2.3

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Table D.8b. Indoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Naumova et al. (2002)	48 hrs	1.0×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	1.5×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	2.0×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
Sheldon et al. (1992a)	24 hrs				1.1×10^{-1}			Two 12-hr indoor air samples collected during daytime and overnight periods in subset of 125 homes monitored as part of the PTEAM main study. Data reported are weighted air concentrations for the combined 24-hr daytime and night-time sampling period in each home.
Sheldon et al. (1993)	24 hrs	1.3			5.8×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, wood-stoves, gas heating, and smoking.
	24 hrs	1.1			6.8×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, wood-stoves, gas heating, and smoking.
	24 hrs	4.3×10^{-1}			1.7×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, wood-stoves, gas heating, and smoking.

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Table D.8b. Indoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Sheldon et al. (1993)	Data summary for homes with woodstove: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	54		ng/m³	Directly from reference		7.8
	Data summary for homes with woodstove/ gas heat: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	22		ng/m³	Directly from reference		8.8×10^{-1}
	Data summary for homes with no source: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	36		ng/m³	Directly from reference		8.9×10^{-1}
	Data summary for homes with gas heat: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	51		ng/m³	Directly from reference		2.0
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	45	7%	ng/m³	Directly from reference	< LOD	1.4×10^{1}
Wilson et al. (2001)	North Carolina child day care center indoor air data summary—particle- and gas-phase	Durham, Chapel Hill, Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m³	Directly from reference	7.3×10^{-2}	1.5×10^{-1}

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Table D.8b. Indoor Exposure Data Summaries (*Continued*). POM: Benz[*a*]anthracene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sheldon et al. (1993)	24 hrs	5.5×10^{-1}			2.0×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	3.2×10^{-1}			2.6×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.7×10^{-1}			1.1×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	3.2×10^{-1}			1.0×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
Van Winkle and Scheff (2001)	10 months	5.6×10^{-1}			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).
Wilson et al. (2001)	48 hrs	1.1×10^{-1}						Ten day care centers included in study, with one 48-hr sampling session per center.

Table D.8c. Indoor Exposure Data Summaries. Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase BbF+BkF	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	1.7×10^{-1}	5.8
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase BbF	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	100%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase BbF	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase BkF	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	100%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase BkF	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary—gas-phase BbF+BkF	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	5.0×10^{-3}	3.1×10^{-2}
	Elizabeth residential indoor air data summary—particle-phase ($PM_{2.5}$) BbF+BkF	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	1.3×10^{-1}	5.7×10^{-1}

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chuang et al. (1999)	24 hrs	1.3						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home was sampled during one 24-hr period.
Mukerjee et al. (1997)	3 wks				3.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	3 wks				3.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Naumova et al. (2002)	48 hrs	8.9×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	2.9×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Naumova et al. (2002)	Houston residential indoor air data summary—gas-phase BbF+BkF	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	6.1×10^{-3}	1.0×10^{-1}
	Houston residential indoor air data summary—particle-phase ($PM_{2.5}$) BbF+BkF	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.1×10^{-2}	2.9
	Los Angeles residential indoor air data summary—gas-phase BbF+BkF	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	6.0×10^{-3}	3.4×10^{-2}
	Los Angeles Residential Indoor Air Data summary—Particle-Phase ($PM_{2.5}$) BbF+BkF	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	2.0×10^{-2}	7.4×10^{-1}
Sheldon et al. (1992a)	Riverside, CA PTEAM residential indoor PAH study data summary—particle- and gas-phase BkF	Riverside	CA	Residences	Fall 1990	12 hrs	115 daytime samples; 113 nighttime samples	39.4% for daytime samples; 33.9% for nighttime samples	ng/m³	Directly from reference	$< 8.0 \times 10^{-2}$	3.5
Sheldon et al. (1993)	Data summary for homes with smoking: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	52		ng/m³	Directly from reference		3.6×10^{1}
	Data summary for homes with smoking/fireplace: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	11		ng/m³	Directly from reference		1.5×10^{1}

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Naumova et al. (2002)	48 hrs	2.5×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	9.6×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	1.3×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	1.5×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking homes.
Sheldon et al. (1992a)	24 hrs	1.7			6.2×10^{-1}			Two 12-hr indoor air samples collected during daytime and overnight periods in subset of 125 homes monitored as part of the PTEAM main study. Data reported are unweighted air concentrations for the combined 24-hr daytime and nighttime sampling period in each home.
Sheldon et al. (1993)	24 hrs	3.7			2.0			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	3.7			2.8			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Sheldon et al. (1993)	Data summary for homes with fireplace: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	45		ng/m³	Directly from reference		6.4
	Data summary for homes with woodstove: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	54		ng/m³	Directly from reference		2.1×10^1
	Data summary for homes with woodstove/ gas heat: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	22		ng/m³	Directly from reference		4.4
	Data summary for homes with no source: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	36		ng/m³	Directly from reference		5.9
	Data summary for homes with gas heat: Northern California residential indoor PAH study—particle- and gas-phase BbF and BkF	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	51		ng/m³	Directly from reference		8.3
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase BbF	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	45	2%	ng/m³	Directly from reference	< LOD	3.0

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sheldon et al. (1993)	24 hrs	1.6			8.4×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	2.0			7.9×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.5			1.3			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	8.1×10^{-1}			5.6×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.5			6.4×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
Van Winkle and Scheff (2001)	10 months	6.7×10^{-2}			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase BkF	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	45	2%	ng/m^3	Directly from reference	< LOD	3.0
Wilson et al. (2001)	North Carolina child day care center indoor air data summary—particle- and gas-phase BbF	Durham, Chapel Hill, Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m^3	Directly from reference	$< 4 \times 10^{-2}$	1.7×10^{-1}
	North Carolina child day care center indoor air data summary—particle- and gas-phase BkF	Durham, Chapel Hill, Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m^3	Directly from reference	$< 4 \times 10^{-2}$	1.1×10^{-1}

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Table D.8c. Indoor Exposure Data Summaries (*Continued*). Benzo[*b*,*k*]fluoranthene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Van Winkle and Scheff (2001)	10 months	6.7×10^{-2}			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).
Wilson et al. (2001)	48 hrs	1.3×10^{-1}						Ten day care centers included in study, with one 48-hr sampling session per center.
	48 hrs	8.1×10^{-2}						Ten day care centers included in study, with one 48-hr sampling session per center.

Table D.8d. Indoor Exposure Data Summaries. Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	5.0×10^{-2}	4.5
Fortmann et al. (2001)	Summary of residential cooking experimental data—particle- (PM_{10}) and gas-phase	Rohnert Park	CA	Test house	Feb 2000	1 hr 30 mins to 5 hrs 8 mins	9	56%	ng/m³	Directly from reference	< LOD	2.1×10^{1}
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	88%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	33%	ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15	0%	ng/m³	Directly from reference	$< \sim 3 \times 10^{-3}$	$< \sim 3 \times 10^{-3}$
	Elizabeth residential indoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	5.5×10^{-3}	2.5×10^{-1}
	Houston residential indoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	4.0×10^{-3}	1.0×10^{-2}

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chuang et al. (1999)	24 hrs	7.0×10^{-1}						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home was sampled during one 24-hr period.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for cooking with gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. PAH measurements made in subset of cooking experiments.
Mukerjee et al. (1997)	3 wks				4.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Naumova et al. (2002)	48 hrs	$< \sim 3 \times 10^{-3}$						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	1.1×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	7.3×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Naumova et al. (2002)	Houston residential indoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	2.7×10^{-3}	1.0
	Los Angeles residential indoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	3.7×10^{-3}	7.7×10^{-3}
	Los Angeles residential indoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	1.0×10^{-2}	5.6×10^{-1}
Sheldon et al. (1992a)	Riverside, CA PTEAM residential indoor PAH study data summary—particle- and gas-phase	Riverside	CA	Residences	Fall 1990	12 hrs	115 daytime samples; 113 nighttime samples	68.1% for daytime samples; 75.0% for nighttime samples	ng/m³	Directly from reference	$< 8.0 \times 10^{-2}$	6.5×10^{-1} (P90)
Sheldon et al. (1993)	Data summary for homes with smoking: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	52		ng/m³	Directly from reference		2.8×10^{1}
	Data summary for homes with smoking/fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	11		ng/m³	Directly from reference		8.6

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Naumova et al. (2002)	48 hrs	1.8×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	6.0×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
	48 hrs	6.1×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking.
Sheldon et al. (1992a)	24 hrs				1.9×10^{-1}			Two 12-hr indoor air samples collected during daytime and overnight periods in subset of 125 homes monitored as part of the PTEAM main study. Data reported are weighted air concentrations for the combined 24-hr daytime and nighttime sampling period in each home.
Sheldon et al. (1993)	24 hrs	2.2			1.1			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	2.1			1.3			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s): City or County	Study Location(s): State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range: Minimum	Individual Sample Measurement Range: Maximum
Sheldon et al. (1993)	Data summary for homes with fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	45		ng/m³	Directly from reference		3.4
	Data summary for homes with woodstove: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	54		ng/m³	Directly from reference		1.6×10^1
	Data summary for homes with woodstove/ gas heat: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	22		ng/m³	Directly from reference		2.4
	Data summary for homes with no source: Northern california residential indoor PAH sudy—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	36		ng/m³	Directly from reference		3.2
	Data summary for homes with gas heat: Northern California residential indoor PAH sudy—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	51		ng/m³	Directly from reference		4.8
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	45	4%	ng/m³	Directly from reference	< LOD	3.0

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sheldon et al. (1993)	24 hrs	1.0			4.7×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.2			4.1×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	7.9×10^{-1}			8.3×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	4.1×10^{-1}			2.9×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	8.3×10^{-1}			2.5×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
Van Winkle and Scheff (2001)	10 months	9.0×10^{-2}			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Wilson et al. (2001)	North Carolina child day care center indoor air data summary—particle- and gas-phase	Durham, Chapel Hill and Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m³	Directly from reference	5.4×10^{-2}	1.6×10^{-1}

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Table D.8d. Indoor Exposure Data Summaries (*Continued*). Benzo[*a*]pyrene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Wilson et al. (2001)	48 hrs	1.0×10^{-1}						Ten day care centers included in study, with one 48-hr sampling session per center.

Table D.8e. Indoor Exposure Data Summaries. Chrysene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	3.0×10^{-2}	3.4
Fortmann et al. (2001)	Summary of residential cooking experimental data—particle- (PM_{10}) and gas-phase	Rohnert Park	CA	Test house	Feb 2000	1 hr 30 mins–5 hrs 8 mins	9	44%	ng/m³	Directly from reference	< LOD	1.2×10^{1}
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	38%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary—gas-phase	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	2.5×10^{-2}	4.0×10^{-1}
	Elizabeth residential indoor air data summary—particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999–May 2000	48 hrs	15		ng/m³	Directly from reference	4.0×10^{-2}	2.4×10^{-1}
	Houston residential indoor air data summary—gas-phase	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	5.0×10^{-2}	1.5
	Houston residential indoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999–May 2000	48 hrs	21		ng/m³	Directly from reference	1.6×10^{-2}	9.6×10^{-1}

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Table D.8e. Indoor Exposure Data Summaries (*Continued*). Chrysene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Chuang et al. (1999)	24 hrs	8.4×10^{-1}						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home was sampled during one 24-hr period.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. PAH measurements made in subset of cooking experiments.
Mukerjee et al. (1997)	3 wks				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 wks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Naumova et al. (2002)	48 hrs	1.0×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	1.1×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	2.7×10^{-1}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	7.1×10^{-2}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.

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Table D.8e. Indoor Exposure Data Summaries (*Continued*). Chrysene (Columns continue on next page)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Naumova et al. (2002)	Los Angeles residential indoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	4.0×10^{-2}	2.1×10^{-1}
	Los Angeles residential indoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999–May 2000	48 hrs	19		ng/m³	Directly from reference	1.6×10^{-2}	1.2×10^{-1}
Sheldon et al. (1992a)	Riverside, CA PTEAM residential indoor PAH study data summary—particle- and gas-phase	Riverside	CA	Residences	Fall 1990	12 hrs	115 daytime samples; 113 nighttime samples	80.3% for daytime samples; 84.7% for nighttime samples	ng/m³	Directly from reference	$< 9.0 \times 10^{-2}$	5.8×10^{-1} (P90)
Sheldon et al. (1993)	Data summary for homes with smoking: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	52		ng/m³	Directly from reference		1.1×10^{1}
	Data summary for homes with smoking/fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	11		ng/m³	Directly from reference		4.3
	Data summary for homes with fireplace: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	45		ng/m³	Directly from reference		2.9
	Data Summary for Homes with Woodstove: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	54		ng/m³	Directly from reference		7.6

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Table D.8e. Indoor Exposure Data Summaries (*Continued*). Chrysene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Naumova et al. (2002)	48 hrs	8.3×10^{-2}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
	48 hrs	5.6×10^{-2}						Reported as chrysene + triphenylene; mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were nonsmoking.
Sheldon et al. (1992a)	24 hrs				1.8×10^{-1}			Two 12-hr indoor air samples collected during daytime and overnight periods in subset of 125 homes monitored as part of the PTEAM main study. Data reported are weighted air concentrations for the combined 24-hr daytime and nighttime sampling period in each home.
Sheldon et al. (1993)	24 hrs	2.0			9.6×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.5			1.3			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	5.6×10^{-1}			2.7×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	6.1×10^{-1}			2.8×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.

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Table D.8e. Indoor Exposure Data Summaries (*Continued*). Chrysene (Columns continue on next page)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Sheldon et al. (1993)	Data summary for homes with woodstove/ gas heat: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	22		ng/m³	Directly from reference		1.1
	Data summary for homes with no source: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	36		ng/m³	Directly from reference		1.0
	Data summary for homes with gas heat: Northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	51		ng/m³	Directly from reference		2.5
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase	Chicago	IL	Residences	June 1994–Apr 1995	24 hrs	45	11%	ng/m³	Directly from reference	< LOD	3.0
Wilson et al. (2001)	North Carolina child day care center indoor air data summary—particle- and gas-phase	Durham, Chapel Hill, Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m³	Directly from reference	6.0×10^{-2}	1.5×10^{-1}

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Table D.8e. Indoor Exposure Data Summaries (*Continued*). Chrysene (*Columns continued from previous page*)

Source (*Continued*)	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means: Overall	Minimum	Maximum	Overall Median and/or Range of Medians: Overall	Minimum	Maximum	Notes
Sheldon et al. (1993)	24 hrs	4.1×10^{-1}			3.5×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	2.4×10^{-1}			1.8×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	4.0×10^{-1}			1.8×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
Van Winkle and Scheff (2001)	10 months	2.0×10^{-1}			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).
Wilson et al. (2001)	48 hrs	1.1×10^{-1}						Ten day care centers included in study, with one 48-hr sampling session per center.

Table D.8f. Indoor Exposure Data Summaries. 7,12-Dimethylbenz[*a*]anthracene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
No data identified.												

Table D.8f. Indoor Exposure Data Summaries (*Continued*). 7,12-Dimethylbenz[*a*]anthracene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
No data identified.								

Table D.8g. Indoor Exposure Data Summaries Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Chuang et al. (1999)	North Carolina low-income housing indoor air data summary—particle- and gas-phase	Durham and Piedmont	NC	Residences	Primarily Feb–Aug 1995 (2 homes in Feb 1994)	24 hrs	24		ng/m³	Directly from reference	3.0×10^{-2}	8.8
Fortmann et al. (2001)	Summary of residential cooking experimental data—particle- (PM_{10}) and gas-phase	Rohnert Park	CA	Test house	Feb 2000	1 hr 30 mins to 5 hrs 8 mins	9	0%	ng/m³	Directly from reference	< LOD	< LOD
Mukerjee et al. (1997)	Lower Rio Grande Valley environmental scoping study spring season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Spring 1993	24 hrs	8	38%	ng/m³	Directly from reference		
	Lower Rio Grande Valley environmental scoping study summer season indoor air data summary—particle- ($PM_{2.5}$) and gas-phase	Lower Rio Grande Valley	TX	Residences	Summer 1994	24 hrs	6	17%	ng/m³	Directly from reference		
Naumova et al. (2002)	Elizabeth residential indoor air data summary–gas-phase	Elizabeth	NJ	Urban	June 1999-May 2000	48 hrs	15		ng/m³	Directly from reference	2.7×10^{-3}	5.3×10^{-3}
	Elizabeth residential indoor air data summary–particle-phase ($PM_{2.5}$)	Elizabeth	NJ	Urban	June 1999-May 2000	48 hrs	15		ng/m³	Directly from reference	9.7×10^{-2}	8.4×10^{-1}
	Houston residential indoor air data summary—gas-phase	Houston	TX	Urban	June 1999-May 2000	48 hrs	21		ng/m³	Directly from reference	2.8×10^{-3}	2.0×10^{-2}

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Table D.8g. Indoor Exposure Data Summaries (*Continued*). Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Chuang et al. (1999)	24 hrs	8.8×10^{-1}						14 homes were in the inner city, the other 10 were in rural areas. 5 homes had smokers present. Each home sampled during one 24-hr period.
Fortmann et al. (2001)								Indoor measurements conducted in kitchen of residential house where 32 cooking tests were conducted for gas range, electric range, and microwave, including frying foods, broiling foods, cooking meat in the oven, and oven-cleaning. PAH measurements made in subset of cooking experiments.
Mukerjee et al. (1997)	3 wks				2.0×10^{-1}			Nine homes were monitored for 3 weeks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
	10 days				2.0×10^{-1}			Nine homes were monitored for 3 weeks in spring 1993, and six of the nine were resampled for 10 days the following summer. Authors report that smoking activities occurred in majority of study homes.
Naumova et al. (2002)	48 hrs	4.0×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .
	48 hrs	3.3×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .
	48 hrs	4.8×10^{-3}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .

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Table D.8g. Indoor Exposure Data Summaries (*Continued*). Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s)		Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range	
		City or County	State								Minimum	Maximum
Naumova et al. (2002)	Houston residential indoor air data summary—particle-phase ($PM_{2.5}$)	Houston	TX	Urban	June 1999-May 2000	48 hrs	21		ng/m³	Directly from reference	7.4×10^{-3}	6.9
	Los Angeles residential indoor air data summary—gas-phase	Los Angeles	CA	Urban	June 1999-May 2000	48 hrs	19	0%	ng/m³	Directly from reference	$< \sim 2 \times 10^{-3}$	$< \sim 2 \times 10^{-3}$
	Los Angeles residential indoor air data summary—particle-phase ($PM_{2.5}$)	Los Angeles	CA	Urban	June 1999-May 2000	48 hrs	19		ng/m³	Directly from reference	1.6×10^{-2}	1.2
Sheldon et al. (1992a)	Riverside, CA PTEAM residential indoor PAH study data summary—particle- and gas-phase	Riverside	CA	Residences	Fall 1990	12 hrs	115 daytime samples; 113 nighttime samples	68.5% for daytime samples; 68.6% for nighttime samples	ng/m³	Directly from reference	$< 2.2 \times 10^{-1}$	1.4 (P90)
Sheldon et al. (1993)	Data summary for homes with smoking: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	52		ng/m³	Directly from reference		3.2×10^{1}
	Data summary for homes with smoking/fireplace: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	11		ng/m³	Directly from reference		8.8
	Data summary for homes with fireplace: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	45		ng/m³	Directly from reference		5.7

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Table D.8g. Indoor Exposure Data Summaries (*Continued*). Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Naumova et al. (2002)	48 hrs	7.1×10^{-2}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .
	48 hrs	$< \sim 2 \times 10^{-3}$						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .
	48 hrs	2.0×10^{-1}						Mean concentration provided is geometric mean rather than arithmetic mean. One 48-hr sample collected in each home. All homes were non-smoking .
Sheldon et al. (1992a)	24 hrs				3.9×10^{-1}			Two 12-hr indoor air samples collected during daytime and overnight periods in subset of 125 homes monitored as part of the PTEAM main study. Data reported are weighted air concentrations for the combined 24-hr daytime and nighttime sampling period in each home.
Sheldon et al. (1993)	24 hrs	2.8			1.7			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	2.6			1.5			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.7			1.0			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.

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Table D.8g. Indoor Exposure Data Summaries (*Continued*). Indeno[1,2,3-*cd*]pyrene (*Columns continue on next page*)

Source	Data Description	Study Location(s) City or County	Study Location(s) State	Location Type	Study Time Period	Sample Duration	Number of Samples	Detection Frequency	Units	Source of Summary Stats	Individual Sample Measurement Range Minimum	Individual Sample Measurement Range Maximum
Sheldon et al. (1993)	Data summary for homes with woodstove: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	54		ng/m³	Directly from reference		1.7×10^{1}
	Data summary for homes with woodstove/gas heat: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	22		ng/m³	Directly from reference		3.8
	Data summary for homes with no source: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	36		ng/m³	Directly from reference		4.9
	Data summary for homes with gas heat: northern California residential indoor PAH study—particle- and gas-phase	Placerville and Roseville	CA	Residences	Winter 1992	24 hrs	51		ng/m³	Directly from reference		6.6
Van Winkle and Scheff (2001)	Southeast Chicago indoor air data summary—particle- and gas-phase	Chicago	IL	Residences	June 1994-Apr 1995	24 hrs	45	0%	ng/m³	Directly from reference	< LOD	< LOD
Wilson et al. (2001)	North Carolina child day care center indoor air data summary—particle- and gas-phase	Durham, Chapel Hill and Raleigh	NC	Day care centers	Spring 1997	48 hrs			ng/m³	Directly from reference	$< 4 \times 10^{-2}$	9.0×10^{-2}

Table D.8g. Indoor Exposure Data Summaries (*Continued*). Indeno[1,2,3-*cd*]pyrene (*Columns continued from previous page*)

Source	Data Averaging Period	Overall Arithmetic Mean and/or Range of Means			Overall Median and/or Range of Medians			Notes
		Overall	Minimum	Maximum	Overall	Minimum	Maximum	
Sheldon et al. (1993)	24 hrs	1.9			8.3×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.4			1.4			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	9.2×10^{-1}			7.7×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
	24 hrs	1.4			8.0×10^{-1}			One 24-hr sample collected from each of 280 homes, including homes with a variety of combustion sources including fireplaces, woodstoves, gas heating, and smoking.
Van Winkle and Scheff (2001)	10 months	< LOD			< LOD			Ten homes monitored on either quarterly or monthly basis for 10-month period. Southeast Chicago study area within heavily industrialized area with many known air toxic emission source types (including coke plants, manufacturing facilities, municipal solid waste landfills, on-road vehicles, etc.).
Wilson et al. (2001)	48 hrs	6.4×10^{-2}						Ten day care centers included in study, with one 48-hr sampling session per center.

Appendix D. References

The reference list for Tables D.1–D.14 was prepared by the Gradient Corporation for HEI. Any web addresses were accessed before August 30, 2005. HEI has not updated this list.

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Appendix E. Abbreviations and Other Terms

Abbreviation List for Appendices B–D

ACGIH	American Conference of Industrial Hygienists
ADJ	adjusted for continuous exposure; e.g., BMCL (ADJ)
AML	acute myeloid leukemia (also referred to as acute myelogenous leukemia)
ARB	Air Resources Board (California)
ATSDR	Agency for Toxic Substances and Disease Registry (U.S.)
BMC	benchmark concentration. A concentration that produces a predetermined change (listed as BMC_x) in response rate of an adverse effect compared to background.
BMCL	benchmark concentration lower confidence limit
BMD	benchmark dose
CI	confidence interval
DPM	diesel particulate matter
DEOG	diesel exhaust organic gases
EPA	Environmental Protection Agency (U.S.)
GSD	geometric standard deviation
HEC	human equivalent concentration
HWSE	healthy worker survivor effect
IARC	International Agency for Research on Cancer
IRIS	Integrated Risk Information System (EPA)
LOD	limit of detection
LOAEL	lowest observed adverse effect level
MRL	minimal risk level
NHEXAS	EPA National Human Exposure Assessment Survey
NHL	non-hodgkin lymphoma
NOAEL	no observed adverse effect level
NTP	National Toxicology Program (U.S.)
OR	odds ratio
PAH	polycyclic aromatic hydrocarbon
PBPK	physiologically based pharmacokinetic
PNA	polynuclear aromatic hydrocarbon
POM	polycyclic organic matter
PTEAM	particle total exposure assessment methodology study
REL	reference exposure level (California EPA)
RfC	reference concentration–inhalation (EPA)
RfD	reference dose–oral (EPA)
RIOPA	Relationship of Indoor, Outdoor, and Personal Air study
SMR	standardized mortality ratio

SRR	standardized risk ratio
TEACH	Toxic Exposure Assessment, a Columbia/Harvard study
TEF	toxicity equivalency factor
TLV	threshold limit value
TWA	time weighted average
UF	uncertainty factor
VOCs	volatile organic compound
VVOC	very volatile organic compound