CPSC Staff Statement on the
Toxicology Excellence for Risk Assessment Report,
"Flame Retardant Assessment Database"
December 17, 2015, rev. January 6, 2016

The report, *Flame Retardant Assessment Database*, presents the findings of research conducted by Toxicology Excellence for Risk Assessment (TERA), in conjunction with the LifeLine Group, under a contract[1] with the U.S. Consumer Product Safety Commission (CPSC). TERA performed this work to organize human exposure information for nine selected flame-retardant chemicals into a database.

The selected flame retardants are:

- Tris(1,3-dichloro-2-propyl) phosphate (TDCPP)
- Tris(chloropropyl) phosphate, mixture of isomers (TCPP)
- Tris(2-chloroethyl) phosphate (TCEP)
- Triethyl phosphate (TEP)
- Triphenyl phosphate (TPP)
- 2-Ethylhexyl 2,3,4,5-tetrabromobenzoate (TBB)
- Di(2-ethylhexyl) tetrabromophthalate (TBPH)
- Tetrabromobisphenol A (TBBPA)
- Antimony trioxide (ATO)

TERA designed a spreadsheet to capture the key relevant concentration and exposure information identified in previous reports (TERA contract task orders 0008 and 0010). The information focused on indoor exposures (primarily indoor air, particulates, household dust, and direct or inferred migration out of products).

This research was completed in support of CPSC staff's work on flame-retardant chemicals to assess potential for exposure from household products, and to prioritize work on specific products and chemicals.

The final report, including a PDF copy of the spreadsheet, will be posted on CPSC's website to keep stakeholders informed of the progress of technical research related to the agency's regulatory activities. A portion of the work presented in the contractor report includes

[1] Task order 0015 under contract No. CPSC-D-12-0001, awarded 7/21/2015.

information relevant to staff's ongoing work to understand consumer exposures to certain organohalogen flame retardant chemicals from consumer products, including furniture, mattresses, and electronic products.

TERA

INDEPENDENT
NON-PROFIT
SCIENCE
FOR PUBLIC HEALTH
PROTECTION

Flame Retardant Exposure Assessment Database

Task Order 15
Contract Number
CPSC-D-12-0001

Final Report

December 17, 2015, rev. January 6, 2016

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Background

TERA, in conjunction with The LifeLine Group (LLG) organized previously collected exposure data on the flame retardant (FR) chemicals (listed in Table 1 below) into an Excel database. Exposure data collected and reported in previous work for CPSC was captured into a single Excel workbook. Emphasis was placed on data from the indoor environment. The purpose of creating the spreadsheet was to organize key information on data from each study that has potential relevance for assessing indoor exposure to the specified flame retardants. The spreadsheet is to provide a complete and accurate picture of the available data and evaluation of each study's quality and relevance for use in an exposure assessment.

Table 1: Selected FR chemicals for the database

FR Chemical	CASN
Trialkyl phosphates	
Tris(1,3-dichloro-2-propyl) phosphate (TDCPP)	13674-87-8
Tris(chloropropyl) phosphate, mixture of isomers (TCPP)	13674-84-5, 76649-15-5, 76025-08-6, 6145-73-9, 26248-87-3
Tris(2-chloroethyl) phosphate (TCEP)	115-96-8, 29716-44-7
Triethyl phosphate (TEP)	78-40-0
Aromatic phosphates	
Triphenyl phosphate (TPP)	1145-86-6
Brominated flame retardants	
2-Ethylhexyl 2,3,4,5-tetrabromobenzoate (TBB)	183658-27-7
Di(2-ethylhexyl) tetrabromophthalate (TBPH)	26040-51-7
Tetrabromobisphenol A (TBBPA)	79-94-7; 121839-52-9
Inorganic flame retardants	
Antimony trioxide (ATO)	1309-64-4

Approach

We designed a spreadsheet in consultation with the Contracting Officer's Representative (COR) that captures the key relevant data from the previous project reports on exposure information for nine flame retardants (see TERA reports for Tasks 0008 and 0010). As directed by the COR, we focused on indoor exposures (primarily indoor air, particulates, household dust, and direct or inferred migration out of

products) although outdoor air and some other media were captured to provide data for comparisons, as appropriate.

For the studies, relevant information from each study was captured using the column headings in Table 2. The database was initially populated with the information from relevant tables from the final reports of previous task orders. Studies were then reviewed to fill in any missing factual data. Following the data population step, each study was critically reviewed to complete the database entries, in particular evaluating the study quality with regard to relevance, representativeness, precision, and methodology. Qualitatively assessing the studies is important to provide context for the interpretation and use of the data. Table 3 describes the types of information captured for the individual quality descriptors.

Concentration data in other media, such as food and water, from the previous reports are copied into separate tabs for food and water. These studies did not undergo additional analysis or quality evaluation for the database. Similarly, the information from previous reports on biomonitoring studies were captured in separate tabs, with no additional analysis or quality evaluation. No additional literature searches were conducted for this project.

Table 2. List of database elements (column headings) and brief description of each.

Study Number	First digit is study number and main study entry. Each study is further numbered to represent each unique combination of study, FR, location, and media corresponding to a concentration measurement
Reference	Study short citation
Date Study Conducted	Date the study was conducted or the measurements were taken
Location (e.g., office, residence, room)	Where the measurement was taken
Chemical	Flame retardant name or abbreviation
Indoor air, outdoor air, dust	Media type
Suspected Source	Any products or conditions that are reported by the authors in the geographic area or space where the measurement was taken
Study Objective	Purpose or objectives of the study or hypothesis tested
Methods	For main study entry, a brief description of methods, for subrows, additional details for the particular media and/or location
Country (city/region)	Country and city or region(if reported) where the measurements were taken
n =	Number of items or locations sampled and number of replicates
n comments	Explanation for how “n” was determined
Average	Concentration labeled “average” by study authors
Mean	Concentration labeled “mean” by study authors

Median	Concentration labeled “median” by study authors
Lowest	Concentration labeled “lowest” by study authors
Highest	Concentration labeled “highest” by study authors
95th%	Concentration labeled “95th percentile” by study authors
Geometric Mean	Concentration labeled “geometric mean” by study authors
Units	Concentration units in nanograms (original study units in parentheses when not in nanograms)
Standard Deviation	Standard deviation, if given
Detection Frequency	As reported by the study authors
Limit of Detection	As indicated by author
Limit of Detection units	Units in nanograms (original study units in parentheses when not in nanograms)
Method Detection Limit	As indicated by author
Method Detection Limit units	Units in nanograms (original study units in parentheses when not in nanograms)
Quality – Relevance	See below
Quality – Representativeness	See below
Quality - Precision	See below
Quality – Methodology	See below
Comments	Highlight issues and unique features or related references for the publication.

Table 3. Quality descriptors used in the database.

A. Relevance: With CPSC’s assessment purpose—assessing human exposure in a residential setting—as the guiding principle, the information will be linked to its contribution in assessing the exposures to • populations or special conditions experienced by the populations (socioeconomic, geographical, age, gender, etc.) with emphasis on life stages • locale, as in home, day-care, office, etc. • the physics of the product or media governing potential for release, transfer, binding, accumulation or uptake of the chemicals • product type • prospective relationship to biomonitoring data • other
B. Representativeness: How can the information be applied in terms of • chemicals to which it may be applied (all, presumably all, specific ones) • relationship to pyrolytic forms of chemicals • relationship to degradates or metabolites of parent chemical • geographical, year data were collected, or other situation which favors the application of the information to US population assessment purposes • utility in prospective assessments • utility in relation to biomonitoring or other retrospective exposure profiles • other

C.	Precision: This relates to any situation in the publication that limits the data precision. For example, if data were summarized and original data not available or inadequately described for exposure assessment purposes, that precision issue will be pointed out. Issues related to number of measurements or duplicates or other methodology will be pointed out when suggestive of limitations or significant excellence.
D.	Methodology: This relates to any element of the methodology that constrains or limits the application of the information to the exposure assessment.

Results

The resulting database provides a standardized description of exposure data on nine flame retardants. As an Excel spreadsheet the entries can be sorted to be able to group data by media, location, chemical, or other relevant elements. The tab labeled "ALL CHEMS" presents the data from 108 studies in the database with 745 subrows. Food and water data (reported without additional analysis from previous tasks) can be located under their respective tabs in the same Excel file. Similarly, information on biomonitoring studies is captured in separate tabs for each FR (e.g., TCEP – bio). A list of all the studies cited in the Excel spreadsheet are found in the next section.

In capturing and reporting on these studies, we made the following observations:

- The use of individual flame retardants has changed with time and therefore human exposure and FR concentrations are changing
- Abundant information exists for many of the FRs to construct patterns of residue in multiple environments for the general US population and some subgroups for retrospective and prospective exposure assessments.
- Residue patterns expressed in the literature are derived from evolving methodologies for collection, separation and analysis of the matrices involved in the study. Different geographical and site conditions (rural, urban, proximity to transport lines or mines) and analytical processes make it necessary to consider these variables when constructing residue patterns from multiple studies.
- Abundance and quality of information differs for different FRs.
- Residue measurements for media in which ATO might exist are sometimes reported in the context of Sb residue. Depending on the methodology and subsequent statistical treatment of the data, these values may or may not represent ATO. Some may represent Sb as a consequence of ATO in the media or as a consequence of Sb uses not related to FR use. As data are extracted for use in exposure assessment, the assessor will need to examine each data source for this issue and apply the data accordingly.

Reference List for Database

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Appendix: Database Sheets

Description of fields. NR	Bold main entry line and reference in	Date the study was	Where was measurement taken? E.g., Office,		For example, dust, indoor or outdoor air,	Identify any products or conditions that	What was purpose of the study or hypothesis being tested?	In main study entry provide BRIEF general description of methods. For sub-rows, list specific methods for that media/location.	Country (and city/region if available)	Provide all information on the		Include all info provided - range (or min	Mean concentration	Median concentration	Lowest concentration	Highest concentration		Geometric average concentration	Concentration units. List in nanograms and	Standard Deviation	List whatever info is available on	Include whatever info authors give or note that they did	Concentration units. List in nanograms and put	Or whatever limit authors report, label it	Concentration units. List in nanograms and put	See Quality Sheet for explanation	See Quality Sheet for explanation	See Quality Sheet for explanation	See Quality Sheet for explanation	Anything else that we captured in the NOTES column of Tasks 8 and 10 that has not been captured to the left. PLUS -
Study Number	**Reference**	**Date Study Conduc**	**Location (e.g., office, residence.**	**Chemical**	**Media (e.g., dust, indoor air)**	**Suspected Source**	**Study Objective**	**Methods**		**n = comments**		**Average**	**Mean**	**Median**	**Lowest**	**Highest**	**95th%**	**Geometric Mean**	**Units**	**Standard Deviation**	**Detection Frequency**	**Limit of Detection**	**Limit of Detection units**	**Method Detection Limit**	**Method Detection Limit units**	**Quality - relevance**	**Quality - representativenes s**	**Quality- Precision**	**Quality - Methodology**	**Comments**
1	**Saito et al., 2007**	**2001-2003**	**House (including newly built apartment), office and laboratory**	**11 orgophosphate and 14 polybrominated FRs**	**Indoor air, outdoor air, dust**	**building materials and electrical appliances See 1.1-1.39**	**Three objectives: analytical method development; migration rate from interior surfaces and electrical appliances; indoor concentrations in Tokyo houses and offices**	**See 1.1-1.39**		**Japan, Tokyo**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**See 1.1-1.39**	**good review of market and regulatory history for different FRs used in Japan from 1993-2006 THIS IS A MIGRATION STUDY--HOUSE ITEMS TO HOUSE DUST --ALSO OFFICE VS HOUSE ALSO OP FRs versus Polybrominated FRs**
1.1	Saito et al., 2007	2002	Office	TDCPP	Plastic surface	Computer monitors	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid-extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants. Migration rates (ug/m2/h) were calculated by the amount of chemicals extracted form the surface filter (ug), the filter area (0.0017 m2) and sampling time (24 hr).	Japan, Tokyo	7	computer monitors (manufactured between 1996-2002)in 1 office building	NR	NR	ND	ND	280	NR	NR	ng/m2/hr	NR	1 of 7 samples	20.8	pg	250	ng/m2/hr	valuable migration rate study	Migration rate for FRs in computer monitors, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	
1.2	Saito et al., 2007	2003	House	TDCPP	Plastic surface	TV sets	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid-extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants. Migration rates (ug/m2/h) were calculated by the amount of chemicals extracted form the surface filter (ug), the filter area (0.0017 m2) and sampling time (24 hr).	Japan, Tokyo	8	TV sets (manufactured between 1989-2001) from 6 houses	NR	NR	ND	NR	NR	NR	NR	ng/m2/hr	NR	0 of 8 samples	20.8	pg	250	ng/m2/hr	valuable migration rate study	Migration rate for FRs in TVs, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	
1.3	Saito et al., 2007	2002, Jan-Mar	House	TDCPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	ND	ND	0.6	NR	NR	ng/m3	NR	NR	20.8	pg	0.72	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	open ventillation systems in houses BUT study conducted Jan-March during winter so may infer representation of closed windows. Air exchange not known.
1.4	Saito et al., 2007	2002, Jan-Mar	Office	TDCPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	ND	ND	8.7	NR	NR	ng/m3	NR	NR	20.8	pg	0.72	ng/m3	market sensitive for types of FRs and products in offices climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Open ventillation systems in offices BUT since conducted Jan-March may infer representation of closed windows. Air exchange not known.
1.5	Saito et al., 2007	2002, Jan-Mar	Outdoor site	TDCPP	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	20.8	pg	0.72	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.6	Saito et al., 2007	2002	Apartment living room newly built, with wood floor and polyolefine wall and ceiling coverings.	TDCPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	new apartment	NR	NR	1.3	NR	NR	NR	NR	ng/m3	NR	NR	20.8	pg	0.72	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	Air exchange not known.
1.7	Saito et al., 2007	2003	House	TCPP	Plastic surface	TV sets	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid-extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants. Migration rates (ug/m2/h) were calculated by the amount of chemicals extracted form the surface filter (ug), the filter area (0.0017 m2) and sampling time (24 hr).	Japan, Tokyo	8	TV sets (manufactured between 1989-2001)	NR	NR	420	ND	1,700	NR	NR	ng/m2/hr	NR	5 of 8 samples	27.2	pg	330	ng/m2/hr	valuable migration rate study	Migration rate for FRs in TVs, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	
	Saito et al., 2007	2002, Jan-Mar	house	TCPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	1.9	ND	1260	NR	NR	ng/m3	NR	NR	27.2	pg	0.94	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	Sampling done from Jan -March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.
1.9	Saito et al., 2007	2002, Jan-Mar	office	TCPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	6	ND	57.6	NR	NR	ng/m3	NR	NR	27.2	pg	0.94	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Sampling done from Jan -March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.

1.10	Saito et al., 2007	2002, Jan-Mar	outdoor site	TCPP	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	ND	3.1	NR	NR	ng/m3	NR	NR	27.2	pg	0.94	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.11	Saito et al., 2007	2002	laboratory	TCPP	Indoor air	NR	Part of QA procedure	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	lab, duplicate samples	NR	NR	NR	0.95	0.99	NR	NR	ng/m3	NR	2 out of 2 samples, same lab	27.2	pg	0.94	ng/m3	Part of QA procedure	N/A	N/A	N/A	
1.12	Saito et al., 2007	2001	Apartment living room newly built, with wood floor and polyolefine wall and ceiling coverings.	TCPP	Indoor air	Interior surfaces	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	new apartment	NR	NR	5.5	NR	NR	NR	NR	ng/m3	NR	detected in one house	27.2	pg	0.94	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	building materials manufactured during that time period in Japan	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	Air exchange rates unknown
1.13	Saito et al., 2007	2003	House	TCEP	Plastic surface	TV sets	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants. Migration rates (ug/m2/h) were calculated by the amount of chemicals extracted form the surface filter (ug), the filter area (0.0017 m2) and sampling time (24 hr).	Japan, Tokyo	8	TV sets (manufacture d between 1989-2001)	NR	NR	1,400	ND	13,000	NR	NR	ng/m2/hr	NR	5 of 8 samples	19.2	pg	230	ng/m2/hr	valuable migration rate study	Migration rate for FRs in TVs, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	
1.14	Saito et al., 2007	2002, Jan-Mar	house	TCEP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	1.3	ND	136	NR	NR	ng/m3	NR	NR	19.2	pg	0.67	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	open ventillation systems in houses BUT study conducted Jan-March during winter so may infer representation of closed windows. Air exchange not known.
1.15	Saito et al., 2007	2002, Jan-Mar	office	TCEP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	3.3	ND	42.1	NR	NR	ng/m3	NR	NR	19.2	pg	0.67	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Sampling done from Jan - March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.
1.16	Saito et al., 2007	2002, Jan-Mar	outdoor site	TCEP	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	19.2	pg	0.67	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.17	Saito et al., 2007	2002	laboratory	TCEP	Indoor air	NR	Part of QA procedure	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	lab, duplicate samples	NR	NR	NR	0.65	0.72	NR	NR	ng/m3	NR	2 out of 2 samples, same lab	19.2	pg	0.67	ng/m3	Part of QA procedure	N/A	N/A	N/A	
1.18	Saito et al., 2007	2001	Apartment living room newly built, with wood floor and polyolefine wall and ceiling coverings.	TCEP	Indoor air	Interior surfaces	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	new apartment	NR	NR	1.2	NR	NR	NR	NR	ng/m3	NR	detected in one house	19.2	pg	0.67	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	building materials manufactured during that time period in Japan	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	Air exchange rates unknown
1.19	Saito et al., 2007	2002, Jan-Mar	house	TEP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	2.4	ND	58.2	NR	NR	ng/m3	NR	NR	7.6	pg	0.26	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	open ventillation systems in houses BUT study conducted Jan-March during winter so may infer representation of closed windows. Air exchange not known.
1.20	Saito et al., 2007	2002, Jan-Mar	office	TEP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	3.2	0.44	8.8	NR	NR	ng/m3	NR	NR	7.6	pg	0.26	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Sampling done from Jan - March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.

1.21	Saito et al., 2007	2002, Jan-Mar	outdoor site	TEP	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	ND	1.4	NR	NR	ng/m3	NR	NR	7.6	pg	0.26	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas. Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.22	Saito et al., 2007	2002	laboratory	TEP	Indoor air	NR	Part of QA procedure	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	lab, duplicate samples	NR	NR	NR	0.6	0.67	NR	NR	ng/m3	NR	2 out of 2 samples, same lab	7.6	pg	0.26	ng/m3	Part of QA procedure	N/A	N/A	N/A	
1.23	Saito et al., 2007	2001	Apartment living room newly built, with wood floor and polyolefine wall and ceiling coverings.	TEP	Indoor air	Interior surfaces	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	1	new apartment	NR	NR	214	NR	NR	NR	NR	ng/m3	NR	detected in one house	7.6	pg	0.26	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	building materials manufactured during that time period in Japan	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	Air exchange rates unknown
1.24	Saito et al., 2007	2002	Office	TPP	Plastic surface	Computer monitors	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for	Japan, Tokyo	7	computer monitors (manufactured between 1996-2002)	NR	NR	690	ND	20,700	NR	NR	ng/m2/hr	NR	5 of 8 samples	6.8	pg	250	ng/m2/hr	valuable migration rate study	Migration rate for FRs in computer monitors, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	
1.25	Saito et al., 2007	2003	House	TPP	Plastic surface	TV sets	Study Migration Rate for FRs in outer casings of electric appliances	Surface wiped with ethanol and allowed to dry for 10 mins. Solid extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction,	Japan, Tokyo	8	TV sets (manufactured between 1989-2001)	NR	NR	330	ND	6,700	NR	NR	ng/m2/hr	NR	2 of 8 samples	6.8	pg	250	ng/m2/hr	valuable migration rate study	Migration rate for FRs in TVs, perhaps electronic devices	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and	
1.26	Saito et al., 2007	2002, Jan-Mar	house	TPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	6.8	pg	0.24	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	open ventillation systems in houses BUT study conducted Jan-March during winter so may infer representation of closed windows. Air exchange not known.
1.27	Saito et al., 2007	2002, Jan-Mar	office	TPP	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	ND	ND	0.86	NR	NR	ng/m3	NR	NR	6.8	pg	0.24	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Sampling done from Jan - March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.
1.28	Saito et al., 2007	2002, Jan-Mar	outdoor site	TPP	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	6.8	pg	0.24	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas. Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.29	Saito et al., 2007	2002, Jan-Mar	house	TBBPA	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	18	houses	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	173	pg	1.2	ng/m3	market sensitive for types of FRs and products in homes climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	open ventillation systems in houses BUT study conducted Jan-March during winter so may infer representation of closed windows. Air exchange not known.
1.3	Saito et al., 2007	2002, Jan-Mar	office	TBBPA	Indoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	14	Offices	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	173	pg	1.2	ng/m3	Limited--market sensitive for types of FRs and products in offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because of FR market changes, Japanese building materials during these dates and open ventillation systems	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	All offices studied were obliged to use fire-resistant materials while constructing the interior according to the Fire Services Act in Japan. Sampling done from Jan - March in Tokyo homes. Air exchange rates unknown, and although window ventillation possible, unknown if windows were opened.
1.31	Saito et al., 2007	2002, Jan-Mar	outdoor site	TBBPA	outdoor air	NR	Monitoring	Sampling used a quartz fiber filter (47 mm) in first stage, and a solid phase extraction disk (EmporeTM Disk C18, 47 mm) in the second phase. Filters loaded in aluminum holder and air passed through at at flow rate of 10 l/min for 24 hr (14.4 m3). Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants.	Japan, Tokyo	8	outdoor sites	NR	NR	ND	NR	NR	NR	NR	ng/m3	NR	Not detected in any samples	173	pg	1.2	ng/m3	Limited--market sensitive for types of FRs and products in homes/offices venting to outside of structure climate sensitive because of open ventillation systems in buildings	limited representativeness because sampling sites near windows and building--not representative of ambient ourdoor air in region, may represent air contiguous to building	ranges reported along with LOD< Method Detection Limits and recovery rates. Cannot discern sampling location or house/office area	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	samples taken near ventillation sites expressing indoor residues onto outside building areas. Thus outdoor residues represent timing of open window -- climate sensitive as well as degree of indoor air content Cannot tell if these sites are outside offices or houses
1.32	Saito et al., 2007	2001	Apartment living room newly built, with wood floor and polyolefine wall and ceiling coverings.	TDCPP	Surface of varnished plywood and polyolefine covering	floor, wall, ceiling	Study Migration Rate for FRs from building materials to interior surfaces	Surface wiped with ethanol and allowed to dry for 10 mins. Solid extraction disks (EmporeTM Disk check C18, 47 mm) were placed such that they made contact with floor, wall, or ceiling for 24 hrs using a stainless steel cover. Collected analytes were extracted with acetone and ultrasonic extraction, then concentrated with nitrogen. Concentrated extracts were analyzed by GC-FPD for organophoshpate FRs and GC-AED for polybrominated flame retardants. Migration rates (ug/m2/h) were calculated by the amount of chemicals extracted form the surface filter (ug), the filter area (0.0017 m2) and sampling time (24 hr).	Japan, Tokyo	1	new apartment	NR	NR	ND	NR	NR	NR	NR	ng/m2/hr (migration)	NR	Not detected in any samples	20.8	pg	250	ng/m2/hr (migration)	valuable migration rate study	Migration rate for FRs in similar building materials	Good, individual data reported or ranges reported along with LOD< Method Detection Limits and recovery rates.	excellent detail of methods, QA, calculation, sources, all technical details of collection, analysis, calculation of results and sensitivity as well as situational details	

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2A.5	Bradman et al., 2014	NR	Child care centers	TCEP	Indoor air	Building material, upholestered furniture, electronics, and foam napping equipment	see 2A		Samples were collected over 6–10 h when children were present at the ECEs. The indoor air sampling system used a single rotary vane pump installed in a stainless steel box, lined with foil-faced fiberglass sound insulation to reduce noise, to pull air through a manifold equipped with taper-tube flow meters. Air was pulled at 4 l/min onto two identical pre-cleaned polyurethane foam (PUF) plug cartridges in parallel. Sampling methods did not include filters to collect particles upstream of the PUF plug, therefore, reported levels of less volatile PBDEs may be underestimated because fine particles with adsorbed PBDEs could pass through the PUF.	United States, California	39	facilities	NR	2.69	0.91	NR	15.34	12.94	NR	ng/m3	3.89	65%	NR	NR	NR	NR	Very relevant to exposure assesments for children in US	relationships to environmental media available in children's environments.	Extensive detail provided for all data.	Excellent, extensive detail on all methodology aspects, sampling, comparisons to other studies, sampling, analytical and computatinal.	The average attendance per facility was 44 children (range = 4–200). Seventy-six percent of the children were 3+ years old, 19% were 2–3 years, and 5% were less than 2 years of age; 95% of the children spent at least 1–2 h outside each day, with some spending up to 6 h outside, depending on the weather. Thirty-seven percent of children spent >8 h per day in child care, 41% spent 5–8 h, and 22% spent less than 5 h.
2A.6	Bradman et al., 2014	NR	Child care centers	TDCPP	Indoor air	Building material, upholestered furniture, electronics, and foam napping equipment	see 2A		See 2A.5	United States, California	39	facilities	NR	0.59	0.53	NR	1.99	1.25	NR	ng/m3	0.36	90%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.7	Bradman et al., 2014	NR	Child care centers	TBB	Indoor air	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	40	facilities	NR	0.58	<MDL	NR	16.23	2.29	NR	ng/m3	2.6	15%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.8	Bradman et al., 2014	NR	Child care centers	TBPH	Indoor air	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	40	facilities	NR	0.23	<MDL	NR	5.39	0.99	NR	ng/m3	0.87	17.5%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.9	Bradman et al., 2014	NR	Child care centers	TCEP	Dust	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	39	facilities	NR	935.9	319.1	NR	6834.9	6750.7	NR	ng/g	1580.2	100%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.10	Bradman et al., 2014	NR	Child care centers	TDCPP	Dust	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	39	facilities	NR	6189.4	2265	NR	70931	36927	NR	ng/g	12710.5	100%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.11	Bradman et al., 2014	NR	Child care centers	TBB	Dust	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	39	facilities	NR	1062.3	362.4	NR	14,812	6557.9	NR	ng/g	2510.1	100%	100%	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2A.12	Bradman et al., 2014	NR	Child care centers	TBPH	Dust	Upholstered furniture and foam napping equipment	see 2A		See 2A.5	United States, California	39	facilities	NR	431.1	132.9	NR	7,489.70	1299.3	NR	ng/g	1191.9	100%	NR	NR	NR	NR	See 2A.5	See 2A.5	See 2A.5	See 2A.5	See 2A.5
2B	**Bradman et al., 2014**	**NR**	**Child care centers**	**TCEP, TDCPP, TBB, TBPH**	**Indoor air and dust**	**Building material, upholestered furniture, electronics, and foam napping equipment**	**This is published verison of 2A, Bradman et. Al, 2012. Extensive detail presented in original document**		**See 2B.1-2B.8**	**United States, California**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**See 2B.1-2B.8**	**Very relevant to exposure assesments for children in US**	**relationships to environmental media available in children's environments.**	**Extensive detail provided for all data.**	**Excellent, extensive detail on all methodology aspects, sampling, comparisons to other studies, sampling, analytical and computatinal.**	**This is the published version of 2A. The average attendance per facility was 44 children (range = 4–200). Seventy-six percent of the children were 3+ years old, 19% were 2–3 years, and 5% were less than 2 years of age; 95% of the children spent at least 1–2 h outside each day, with some spending up to 6 h outside, depending on the weather. Thirty-seven percent of children spent >8 h per day in child care, 41% spent 5–8 h, and 22% spent less than 5 h.**
2B.1	Bradman et al., 2014	NR	Child care centers	TCEP	Indoor air	Building material, upholestered furniture, electronics, and foam napping equipment	See 2B		Samples were collected over 6–10 h when children were present at the ECEs. The indoor air sampling system used a single rotary vane pump installed in a stainless steel box, lined with foil-faced fiberglass sound insulation to reduce noise, to pull air through a manifold equipped with taper-tube flow meters. Air was pulled at 4 l/min onto two identical pre-cleaned polyurethane foam (PUF) plug cartridges in parallel. Sampling methods did not include filters to collect particles upstream of the PUF plug, therefore, reported levels of less volatile PBDEs may be underestimated because fine particles with adsorbed PBDEs could pass through the PUF.	United States, California	39	facilities	NR	2.69	0.91	NR	15.34	12.94	NR	ng/m3	3.89	65%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.2	Bradman et al., 2014	NR	Child care centers	TDCPP	Indoor air	Building material, upholestered furniture, electronics, and foam napping equipment	See 2B		See 2B.1	United States, California	39	facilities	NR	0.59	0.53	NR	1.99	1.25	NR	ng/m3	0.36	90%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.3	Bradman et al., 2014	NR	Child care centers	TBB	Indoor air	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	40	facilities	NR	0.58	<MDL	NR	16.23	2.29	NR	ng/m3	2.6	15%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.4	Bradman et al., 2014	NR	Child care centers	TBPH	Indoor air	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	40	facilities	NR	0.23	<MDL	NR	5.39	0.99	NR	ng/m3	0.87	17.5%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.5	Bradman et al., 2014	NR	Child care centers	TCEP	Dust	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	39	facilities	NR	935.9	319.1	NR	6834.9	6750.7	NR	ng/g	1580.2	100%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.6	Bradman et al., 2014	NR	Child care centers	TDCPP	Dust	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	39	facilities	NR	6189.4	2265	NR	70931	36927	NR	ng/g	12710.5	100%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.7	Bradman et al., 2014	NR	Child care centers	TBB	Dust	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	39	facilities	NR	1062.3	362.4	NR	14,812	6557.9	NR	ng/g	2510.1	100%	100%	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
2B.8	Bradman et al., 2014	NR	Child care centers	TBPH	Dust	Upholstered furniture and foam napping equipment	See 2B		See 2B.1	United States, California	39	facilities	NR	431.1	132.9	NR	7,489.70	1299.3	NR	ng/g	1191.9	100%	NR	NR	NR	NR	See 2B	See 2B	See 2B	See 2B	
3	**Marklund et al., 2005a**	**NR**	**Houses, Work (daycare, hospital, radio and textile shop, office, plastics factories, laboratory), Public places (hotel, prison, university lobby, library, dance hall, furniture shop, bowling alley)**	**TCEP**	**Indoor air**	**Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverings).**	**Purpose of the study was to investigate levels, exposure and possible sources of 12 OPs in indoor air and to compare the results with OP levels previously reported for dust samples collected at the same locations in Marklund et al., 2003.**	**See 3.1-3.13**		Sweden	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**	**See 3.1-3.13**		**Good relevance to general public Swedish study with relevance to exposure to OP s in public and domestic environments via air/dust for most countries with similar building materials and consumer products.**	**Relevant to these chemicals, this era and most countries with similar products and building materials. Suggestive of higher exposure opportunities (per unit time/person) in public areas vs domestic areas. Study illustrates probable variability in exposure opportunity of different population groups given activities in spaces, age of buildings and contents, influences from nearby construction or use of space.**	**Small numbers of samples represented the different spaces and high variability limits the correlations especially for chemical/location consideration. Taken as a chemical group and considered over domestic/public, quantitative value improves.**	**Correlations drawn between dust measurements and air concentrations drawn a year later may be irrelevant given the dynamics of the spaces, use of materials in those spaces over the year, variable ventillation rates, small number of samples for correlations, etc. Recovery levels were low for some compounds without explanation. Ventillation rates and other variables assumed, not measured or verified. Variability explained with plausible assumptions, but not verified.**	**excellent overview of bulk uses of OP's in consumer products and building materials and levels reported in various materials and environments [see intro of publication]**
3.1	Marklund et al., 2005a	NR	House	TCEP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinss).	See 3.0		Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorresponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	2	Duplicate samples from 2 houses	NR	NR	NR	0.4	3	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0	

3.3	Marklund et al., 2005a	NR	Work (daycare, hospital, radio and textile shop, office, plastics factories, laboratory)	TCEP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	8	buildings, duplicate smaples	NR	NR	NR	0.7	730	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.4	Marklund et al., 2005a	NR	Public places (hotel, prison, university lobby, library, dance hall, furniture shop, bowling alley)	TCEP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	7	buildings, duplicate smaples	NR	NR	NR	2	590	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.5	Marklund et al., 2005a	NR	House	TCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	2	Duplicate samples from 2 houses	NR	NR	NR	38	210	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.6	Marklund et al., 2005a	NR	Work (daycare, hospital, radio and textile shop, office, plastics factories, laboratory)	TCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	8	buildings, duplicate smaples	NR	NR	NR	27	160	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.7	Marklund et al., 2005a	NR	Public places (hotel, prison, university lobby, library, dance hall, furniture shop, bowling alley)	TCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	7	buildings, duplicate smaples	NR	NR	NR	69	570	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.8	Marklund et al., 2005a	NR	House	TDCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	2	Duplicate samples from 2 houses	NR	NR	NR	<0.5	<0.5	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.9	Marklund et al., 2005a	NR	Work (daycare, hospital, radio and textile shop, office, plastics factories, laboratory)	TDCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	8	buildings, duplicate smaples	NR	NR	NR	<0.2	150	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.10	Marklund et al., 2005a	NR	Public places (hotel, prison, university lobby, library, dance hall, furniture shop, bowling alley)	TDCPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	7	buildings, duplicate smaples	NR	NR	NR	<0.2	6	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.11	Marklund et al., 2005a	NR	House	TPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	2	Duplicate samples from 2 houses	NR	NR	NR	<0.3	8.8	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.12	Marklund et al., 2005a	NR	Work (daycare, hospital, radio and textile shop, office, plastics factories, laboratory)	TPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	8	buildings, duplicate smaples	NR	NR	NR	0.7	23	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
3.13	Marklund et al., 2005a	NR	Public places (hotel, prison, university lobby, library, dance hall, furniture shop, bowling alley)	TPP	Indoor air	Building material, furniture, consumer products (such as acoustic ceilings, upholstered furniture, wall coverings, floor polish and polyvinylchloride floor coverinas).	See 3.0	Samples collected on solid-phase extraction (SPE) coumns connected to a stationary pump and placed at a height coorexponding to the breathing zone of people. Approximately 1.7 m3 (1.0-2.7 m3) of air was pumped through the sampler at a flow of ~2.5 l/min for ~10 hr using a laboratory vaccuum pump.	Sweden	7	buildings, duplicate smaples	NR	NR	NR	<0.1	18	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 3.0	See 3.0	See 3.0	See 3.0
4A	**Bergh et al., 2011a**	**NR**	**Houses, day care centers, work places**	**TCEP, TDCPP, TPP**	**Indoor air, dust**	**NR**	**The main aim of this study was to determine typical concentrations and concentration ranges of targeted phosphate and phthalate esters in both air and settled dust in indoor environments frequently occupied by humans.**	**See 4A.1-4A18**		**Sweden, Sockholm**	**See 4A.1-4A18**	**See 4A.1-4A18**		**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**See 4A.1-4A18**	**Relevant for quantitative exposure assessment for general population and selected subpopulations**	**Sampling sites from northern climates in buildings and environments characteristic for Nordic countries.**	**Mean, Median, Min/Max given for n samples at each site.**	**Contemporary methods for sampling and analysis.**
4A.1	Bergh et al., 2011a	NR	Day care centers	TCEP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC-powered pump (NO26.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Day care centers	NR	47	25	7.8	230	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A

4A.2	Bergh et al., 2011a	NR	Work places	TCEP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Work places	NR	21	10	ND	140	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.3	Bergh et al., 2011a	NR	Houses	TCEP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Houses	NR	8.3	4.8	ND	28	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.4	Bergh et al., 2011a	NR	Day care centers	TDCPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Day care centers	NR	6.7	ND	ND	30	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.5	Bergh et al., 2011a	NR	Work places	TDCPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Work places	NR	24	28	ND	73	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.6	Bergh et al., 2011a	NR	Houses	TDCPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Houses	NR	3.1	ND	ND	17	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.7	Bergh et al., 2011a	NR	Day care centers	TPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Day care centers	NR	0.1	ND	ND	0.9	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.8	Bergh et al., 2011a	NR	Work places	TPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Work places	NR	0.6	ND	ND	2.7	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.9	Bergh et al., 2011a	NR	Houses	TPP	Indoor air	NR	see 4A	Air sampling was conducted by using an AC powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent). The air samples were collected during daytime for approximately eight hours. In the private houses, the sampling equipment was placed in a central location with all adjacent doors in the house open. No inhabitants were present in the house during sampling. In the offices and day care centers, working activities continued as usual and sampling equipment was placed so as not to disturb the activities.	Sweden, Sockholm	10	Houses	NR	0.2	ND	ND	0.8	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.10	Bergh et al., 2011a	NR	Day care centers	TCEP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bal´lsta, Sweden) attached to the intake nozzle of an	Sweden, Sockholm	10	Day care centers	NR	51000	30000	2500	150000	NR	NR	ng/g (Mean: 51; Median: 30; range: 2.5-150 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.11	Bergh et al., 2011a	NR	Work places	TCEP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bal´lsta, Sweden) attached to the intake nozzle of an Alto AERD 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Work places	NR	36000	6700	1300	260000	NR	NR	ng/g (Mean: 36; Median: 6.7; range: 1.3-260 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.12	Bergh et al., 2011a	NR	Houses	TCEP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bal´lsta, Sweden) attached to the intake nozzle of an Alto AERD 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Houses	NR	7600	2100	ND	33000	NR	NR	ng/g (Mean: 7.6 Median: 2.1; range: ND-33 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A

4A.13	Bergh et al., 2011a	NR	Day care centers	TDCPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Day care centers	NR	28000	9100	3900	150000	NR	NR	ng/g (Mean: 28; Median: 9.1; range: 3.9-150 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.14	Bergh et al., 2011a	NR	Work places	TDCPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Work places	NR	30000	17000	3300	91000	NR	NR	ng/g (Mean: 30; Median: 17; range: 3.3-91 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.15	Bergh et al., 2011a	NR	Houses	TDCPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Houses	NR	12000	10000	2200	27000	NR	NR	ng/g (Mean: 12; Median: 10; range: 2.2-27 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.16	Bergh et al., 2011a	NR	Day care centers	TPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Day care centers	NR	3500	1900	300	17000	NR	NR	ng/g (Mean: 3.5; Median: 1.9; range: 0.3-17 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.17	Bergh et al., 2011a	NR	Work places	TPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Work places	NR	8800	5300	900	32000	NR	NR	ng/g (Mean: 8.8; Median: 5.3; range: 0.9-32 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4A.18	Bergh et al., 2011a	NR	Houses	TPP	Dust	NR	see 4A	Dust samples were collected at each sampling site after air sampling. Dust was collected, on preweighed cellulose filters, from the tops of bookshelves, cupboards, desks, and/or casings of windows and doors at least 0.8 m above the floor. Sampling was performed with the filters mounted in styrene–acrylonitrile holders inserted in a polypropylene nozzle (Kriminalteknisk Materiel AB, Bå˚lsta, Sweden) attached to the intake nozzle of an Alto AERO 840 industrial strength vacuum cleaner.	Sweden, Sockholm	10	Houses	NR	106000	1200	100	4200	NR	NR	ng/g (Mean: 106; Median: 1.2; range: 0.1-4.2 µg/g)	NR	NR	NR	NR	NR	NR	See 4A	See 4A	See 4A	See 4A
4B	**Bergh et al., 2011b**	**2006-2007, winter**	**Apartments**	**TEP, TCEP, TPP**	**Indoor air**	**building materials**	**The major aims of this study were: (i) to investigate the possible correlation between levels of OPEs and phthalates within multi-storey buildings with high and low prevalence of sick building symptoms, (ii) to investigate intra and inter building variations, (iii) association of levels of OPEs and phthalates with building characteristics, and (iv) to identify potential sources and the air levels of organophosphate and phthalate esters in indoor environments.**	**See 4B.1**		**Sweden, Sockholm**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**See 4B.1**	**General exposure assessment in multi-story buildings as per building characteristics in Stockholm.**	**Representative of multi-building environments in cold environments.**	**MDL, mean, median, min-max reported for each analyte in n samples, reported for different groupings by building "reputation" as high or low risk for health syndromes.**	**Contemporary methodology for collections, analyses.**	**analysis of correlations to health syndromes not considered as part of this review.**
4B.1	Bergh et al., 2011b	2006-2007, winter	Apartments	TCEP	Indoor air	building materials	see 4B	Air sampling was conducted by using an AC-powered pump (N026.1.2AN.18, KNF Neuberger, Freiburg, Germany) to draw the air through a commercially available solid phase extraction (SPE) cartridge (25 mg aminopropyl silica adsorbent).	Sweden, Sockholm	22	Low risk for sick building syndrome (2-4 apartments per bldg)	NR	10	4	ND	170	NR	NR	ng/m3	NR	NR	NR	NR	1.0	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TCEP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	23	High risk for sick building syndrome (2-4 apartments per bldg)	NR	10	4	ND	230	NR	NR	ng/m3	NR	NR	NR	NR	1.0	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TCEP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	45	Multi-storied apartment buildings (45 buildings, 169 apartments)	NR	10	4	ND	230	NR	NR	ng/m3	NR	NR	NR	NR	1.0	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TEP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	22	Low risk for sick building syndrome (2-4 apartments per bldg)	NR	10	4	0.84	210	NR	NR	ng/m3	NR	NR	NR	NR	0.12	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TEP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	23	High risk for sick building syndrome (2-4 apartments per bldg)	NR	18	5	<0.18	300	NR	NR	ng/m3	NR	NR	NR	NR	0.12	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TEP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	45	Multi-storied apartment buildings (45 buildings, 169 apartments)	NR	14	4	<0.18	300	NR	NR	ng/m3	NR	NR	NR	NR	0.12	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TPP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	22	Low risk for sick building syndrome (2-4 apartments per bldg)	NR	<3.1	<3.1	ND	12	NR	NR	ng/m3	NR	NR	NR	NR	<3.1	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TPP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	23	High risk for sick building syndrome (2-4 apartments per bldg)	NR	<3.1	<3.1	ND	25	NR	NR	ng/m3	NR	NR	NR	NR	<3.1	ng/m3	See 4B	See 4B	See 4B	See 4B
	Bergh et al., 2011b	2006-2007, winter	Apartments	TPP	Indoor air	building materials	see 4B	See 4B.1	Sweden, Sockholm	45	Multi-storied apartment buildings (45 buildings, 169 apartments)	NR	3.6	<3.1	ND	25	NR	NR	ng/m3	NR	NR	NR	NR	<3.1	ng/m3	See 4B	See 4B	See 4B	See 4B
4C	**Bergh et al., 2012**		**Purchased dust standard sample**	**TEP, TCEP, TDCPP, TPP**	**dust**	**SRM 2585 Standard**	**The aim of this work was to determine the concentration of 7 phthalates and 15 OPEs present in SRM 2585 house dust using exhaustive extraction, cleanup with SPE analysis using GC-MS/MS.**	**See 4C.1-4C.4**		**Sweden, Sockholm**		**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**See 4C.1-4C.4**	**The official dust standard used in many studies as part of their QA and comparisons to any other standards used in their studies.**	**Excellent detail to show LOQs , MDLs and values (mean, SD,) in this reference material**	**Excellent methodology as performed at NIST.**	**NIST Standard SRM 2585 original paper.**
4C.1	Bergh et al., 2012		Purchased dust standard sample	TCEP	dust	SRM 2585 Standard	4C	SRM 2585 organic contaminants in house dust was obtained from the National Institute of Standard and Technology.	Sweden, Sockholm	7		NR	840	NR	NR	NR	NR	NR	ng/g (0.84 µg/g)	60	NR	NR	NR	80	ng/g (0.08 µg/g)	See 4C	See 4C	See 4C	See 4C

4C.2	Bergh et al., 2012		Purchased dust standard sample	TEP	dust	SRM 2585 Standard	4C	SRM 2585 organic contaminants in house dust was obtained from the National Institute of Standard and Technolosv.	Sweden, Sockholm	7		NR	<MDL	NR	NR	NR	NR	NR	NR	ng/g (0.07 µg/g)	NR	NR	NR	NR	70	ng/g (0.07 µg/g)	See 4C	See 4C	See 4C	See 4C		
4C.3	Bergh et al., 2012		Purchased dust standard sample	TDCPP	dust	SRM 2585 Standard	4C	SRM 2585 organic contaminants in house dust was obtained from the National Institute of Standard and Technolosv.	Sweden, Sockholm	9		NR	2300	NR	NR	NR	NR	NR	ng/g (2.3 µg/g)	280	NR	NR	NR	690	ng/g (0.69 µg/g)	See 4C	See 4C	See 4C	See 4C		
4C.4	Bergh et al., 2012		Purchased dust standard sample	TPP	dust	SRM 2585 Standard	4C	SRM 2585 organic contaminants in house dust was obtained from the National Institute of Standard and Technolosv.	Sweden, Sockholm	7		NR	1100	NR	NR	NR	NR	NR	ng/g (1.1 µg/g)	100	NR	NR	NR	60	ng/g (0.06 µg/g)	See 4C	See 4C	See 4C	See 4C		
5	**Carlsson et al., 1997**	**NR**	**Schools, day cares, office building**	**TCEP, TCPP,TPP**	**Indoor air, outdoor air**	**NR**	**Identify the occurrence of organophosphates in indoor air from common work environments (office building,day care center, 3 schools)**	**See 5.1-5.10**	**Sweden**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**See 5.1-5.10**	**Limited value for prospective exposure assessment. Good for retrospective or comparisons with biomonitoring where body loading occurred durine this era.**	**No unique features.**	**Limited utility for creating distribution: Mean and CV for "up to 4 samples" for each site given.**	**Methodology circa 1993 without MS/MS techniques. Internal standards used, NIST standards not yet available.**	**As cited by Destaillats, H., Maddalena, R.L., Singer, B.C., Hodgson, A.T., McKone, T.E., Indoor pollutants emitted by office equipment: Areview of reported data and information needs. Vol. 2013, 2007 from the original TERA/Lifline TCEP report.**
5.1	Carlsson et al., 1997	NR	Schools	TCEP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	3	4 duplicate measures at each location	NR	NR	NR	18	250	NR	NR	ng/m3 (range of mean values)	NR	NR	NR	NR	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.2	Carlsson et al., 1997	NR	Day care	TCEP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF plugs.	Sweden	1	4 duplicate measures	NR	144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.3	Carlsson et al., 1997	NR	Office buildings	TCEP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	1	4 duplicate measures	NR	NR	NR	11	9.9	NR	NR	ng/m3 (range of mean values)	NR	NR	NR	NR	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.4	Carlsson et al., 1997	NR		TCEP	Outdoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF plugs.	Sweden		2 samples; outside one office building and one school	NR	<1	NR	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 5.0	See 5.0	See 5.0	These samples are for method confirmation purpose: ONE OUTDOOR SAMPLE OUTSIDE OFFICE BLDG, ONE OUTSIDE SCHOOL. ONE SAMPLE EACH for "all OP esters" : BOTH <1ng/m3 were confirmatory for assuming inside source of FRs, not outside ambient air contamination.	
5.5	Carlsson et al., 1997	NR	School	TCPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	3	4 duplicate measures at each location	NR	NR	NR	<LOD	41	NR	NR	ng/m3 (range of mean values)	NR	NR	0.5	ng/m3	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.6	Carlsson et al., 1997	NR	Day care	TCPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	1	4 duplicate measures	NR	NR	NR	2.9	34	NR	NR	ng/m3 (range of mean values)	NR	NR	0.5	ng/m3	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.7	Carlsson et al., 1997	NR	Offices	TCPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	1	4 duplicate measures	NR	NR	NR	1.4	34	NR	NR	ng/m3 (range of mean values)	NR	NR	0.5	ng/m3	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.8	Carlsson et al., 1997	NR	School	TPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	3	4 duplicate measures at each location	NR	NR	NR	<LOD	0.8	NR	NR	ng/m3 (range of mean values)	NR	NR	1.5	ng/m4	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.9	Carlsson et al., 1997	NR	Day care	TPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	1	4 duplicate measures	NR	<LOD	NR	NR	NR	NR	NR	ng/m3 (range of mean values)	NR	NR	2.5	ng/m5	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
5.10	Carlsson et al., 1997	NR	Offices	TPP	Indoor air	NR	see 5.0	Stationary air sampling performed with a personal sampler with a 25-mm binder-free A/E borosilicate glass fiber filter and two PUF pluas.	Sweden	1	4 duplicate measures	NR	NR	NR	0.4	0.7	NR	NR	ng/m3 (range of mean values)	NR	NR	3.5	ng/m6	NR	NR	See 5.0	See 5.0	See 5.0	See 5.0		
6A	**Staaf and Ostman, 2005a, b**	**NR**	**Private homes, car, garage, office, workshop, stores, health care facilities**	**TCEP,TEP, TDCPP, TPP**	**Indoor air**	**Building materials, furniture, electronics, upholstery, carpet**	**The objective was to monitor the concentrations of organophosphorus triesters to gain knowledge about the occurrence of these compounds with respect to absolute concentrations and concentration profiles in various categories of indoor environments.**	**See 6A.1-6A.20**	**Sweden, Stockholm**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**See 6A.1-6A.20**	**Relevant to consideration of source materials and site conditions by inference. Relevant to normal commercial living environments including public spaces, domestic spaces, transportation**	**Swedish study relevant to most general living environments for OP FRs of that era. Retrospective exposure assessments and comparisons to estimates of body load. Relevant to consideration of source materials by inference.**	**Few samples per site and condition limit confidence in concentration values. Good site/condition descriptions for each value important to infer contributions to variation. Much inference, bias, suggestion inherent throughout work. Exposure estimate very rough and simplistic.**	**Good focus on detailing factors that influence variation: humidity, ventilation, type of site, contents of site, pir particles, inside vs outside air. But, few samples per site/condition limits quantification.**	**Notes outdoor air tested and results were <1 ng/m3 suggesting sources of Ops not from outside**
6A.1	Staaf and Ostman, 2005a	NR	Private homes	TEP	Indoor air	Building materials, furniture, electronics, upholstery	See 6.0	samplers were placed at a height of about 0.5 metres above the floor. In private homes they were placed in the centre of the flat/floor leaving all doors to other rooms open to let the air circulate freely. Air samples were collected during daytime with no persons present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	10	houses and apartments (construction between 1876-2004), 5 parallel samples from each location	NR	NR	NR	1	21	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.2	Staaf and Ostman, 2005a	NR	Car	TEP	Indoor air	NR	See 6.0	Samples were collected in the breathing zone of the driver, having the sampling pump outside the vehicle and the tubes through the slightly lowered window into the samplers. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml). Sampling was done with the ventilation fan set to operate in "normal" mode.	Sweden, Stockholm	1	1 car (manufacture d 2003), 5 parallel samples from each location	NR	NR	220	NR	NR	NR	NR	ng/m4	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.3	Staaf and Ostman, 2005a	NR	Garage, subway car, buses	TEP	Indoor air	NR	See 6.0	Sampling was done in the two buses and the subway car while turned off with no ventilation. Sampling was also collected from the garage where the buses and subway car were parked overnight. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	6	I subway car (manufacture d 2003), 2 buses (manufacture d 1997 and 2003), 5 parallel samples from each location	NR	NR	NR	1	56	NR	NR	ng/m5	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.4	Staaf and Ostman, 2005a	NR	Office	TEP	Indoor air	Furniture, upholstery, carpet, computers, printers, copy machines	See 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location, computers turned off during samoline	NR	NR	NR	1	2	NR	NR	ng/m6	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.5	Staaf and Ostman, 2005a	NR	Workshop (bakery, printing press, e-waste dismantling)	TEP	Indoor air	NR	See 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location	NR	NR	NR	1	23	NR	NR	ng/m7	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.6	Staaf and Ostman, 2005a	NR	Stores (electronics, bicycles, clothes, carpets)	TEP	Indoor air	NR	See 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	4	5 parallel samples from each location	NR	NR	NR	1	19	NR	NR	ng/m8	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.7	Staaf and Ostman, 2005a	NR	Health care facility	TEP	Indoor air	Furniture, upholstery, computer	See 6.0	Sampling during daytime with normal ventilation and working activity. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location; 2 examination rooms without computers and 1 doctor office with 4 desks and computers (turned off) were samoled.	NR	NR	NR	7	13	NR	NR	ng/m9	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.8	Staaf and Ostman, 2005a	NR	Private homes	TCEP	Indoor air	Building materials, furniture, electronics, upholstery	see 6.0	samplers were placed at a height of about 0.5 metres above the floor. In private homes they were placed in the centre of the flat/floor leaving all doors to other rooms open to let the air circulate freely. Air samples were collected during daytime with no persons present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	10	houses and apartments (construction between 1876-2004), 5 parallel samples from each location	NR	NR	NR	1	115	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		
6A.9	Staaf and Ostman, 2005a	NR	Car	TCEP	Indoor air	NR	see 6.0	Samples were collected in the breathing zone of the driver, having the sampling pump outside the vehicle and the tubes through the slightly lowered window into the samplers. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml). Sampling was done with the ventilation fan set to operate in "normal" mode.	Sweden, Stockholm	1	1 car (manufacture d 2003), 5 parallel samples from each location	NR	NR	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A		

6A.10	Staaf and Ostman, 2005a	NR	Garage, subway car, buses	TCEP	Indoor air	NR	see 6.0	Sampling was done in the two buses and the subway car while turned off with no ventilation. Sampling was also collected from the garage where the buses and subway car were parked overnight. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	6	I subway car (manufactured 2003), 2 buses (manufactured 1997 and 2003), 5 parallel samples from each location	NR	320	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.11	Staaf and Ostman, 2005a	NR	Office	TCEP	Indoor air	Furniture, upholstery, carpet, computers, printers, copy machines	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location, computers turned off during sampling	NR	NR	NR	6	870	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.12	Staaf and Ostman, 2005a	NR	Workshop (bakery, printing press, e-waste dismantling)	TCEP	Indoor air	NR	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location	NR	NR	NR	3	29	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.13	Staaf and Ostman, 2005a	NR	Stores (electronics, bicycles, clothes, carpets)	TCEP	Indoor air	NR	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	4	5 parallel samples from each location	NR	NR	NR	11	56	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.14	Staaf and Ostman, 2005a	NR	Health care facility	TCEP	Indoor air	Furniture, upholstery, computer	see 6.0	Sampling during daytime with normal ventilation and working activity. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location; 2 examination rooms without computers and 1 doctor office with 4 desks and computers (turned off) were sampled.	NR	NR	NR	9	350	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.15	Staaf and Ostman, 2005a	NR	Car	TDCPP	Indoor air	NR	see 6.0	Samples were collected in the breathing zone of the driver, having the sampling pump outside the vehicle and the tubes through the slightly lowered window into the samplers. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml). Sampling was done with the ventilation fan set to operate in "normal" mode.	Sweden, Stockholm	1	1 car (manufactured 2003), 5 parallel samples from each location	NR	NR	NR	ND	5	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.16	Staaf and Ostman, 2005a	NR	Electronic dismantling facility	TDCPP	Indoor air	NR	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location	NR	NR	NR	ND	7	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.17	Staaf and Ostman, 2005a	NR	Private homes	TPP	Indoor air	NR	see 6.0	samplers were placed at a height of about 0.5 metres above the floor. In private homes they were placed in the centre of the flat/floor leaving all doors to other rooms open to let the air circulate freely. Air samples were collected during daytime with no persons present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	10	houses and apartments (construction between 1876-2004), 5 parallel samples from each location	NR	NR	NR	ND	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.18	Staaf and Ostman, 2005a	NR	Transport (car and garage)	TPP	Indoor air	NR	see 6.0	Samples were collected in the breathing zone of the driver, having the sampling pump outside the vehicle and the tubes through the slightly lowered window into the samplers. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml). Sampling was done with the ventilation fan set to operate in "normal" mode.	Sweden, Stockholm	2	1 car (manufactured 2003) and the garagae, 5 parallel samples from each location	NR	NR	NR	1	3	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.19	Staaf and Ostman, 2005a	NR	Offices	TPP	Indoor air	NR	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location, computers turned off during sampling	NR	NR	NR	ND	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6A.20	Staaf and Ostman, 2005a	NR	Workshop (bakery, printing press, e-waste dismantling)	TPP	Indoor air	NR	see 6.0	Office and store facilities were investigated during the night with reduced ventilation and no personnel present. Stationary sampler with SPE cartridge containing an aminopropyl silica phase (25 mg, 1 ml).	Sweden, Stockholm	3	5 parallel samples from each location	NR	NR	NR	ND	17	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 6A	See 6A	See 6A	See 6A				
6B	**Staaf and Ostman, 2005b**	**NR**	**electronics dismantling facility and Lecture halls**	**TCEP**	**Indoor air**	**NR**	**The objective of this study was to develop and validate a fast and simple method for sampling and analysis of organic pollutants in indoor air with focus on organophosphate esters.**	**See 6B.1-6B.2**	**Sweden, Stockholm**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**See 6B.1-6B.2**	**Limited use for quantitative exposure assessment but excellent presentation for consideration of methodologies as employed by other researchers.**	**Quantifies efficiency of use of SPE Cartridges in sampling methodologies used here and will be useful to consider other studies.**	**Limited data presentation for analyte measurements. Precision and detail aimed at parameters demonstrating methodology features.**	**Illustration of use of SPE cartridges for sampling by adsorptive enrichment, as well as for extraction and clean-up methodology.**	**Methodology Paper: use of SPE Cartridges**
6B.1	Staaf and Ostman, 2005b	NR	electronics dismantling facility and Lecture halls	TCEP	Indoor air	NR		An SPE cartridge containing an aminopropyl silica phase was used for the air sampling of organophosphate triesters. Air was drawn through the sampler using a pump for stationary sampling.	Sweden, Stockholm	2	I lecture hall with computers and 1 without computers	NR	NR	NR	ND	3	NR	NR	ng/m4	NR	NR	NR	NR	NR	NR	See 6B	See 6B	See 6B	See 6B				
6B.2	Staaf and Ostman, 2005b	NR	electronics dismantling facility and Lecture halls	TPP	Indoor air	NR		An SPE cartridge containing an aminopropyl silica phase was used for the air sampling of organophosphate triesters. Air was drawn through the sampler using a pump for stationary sampling.	Sweden, Stockholm	2	I lecture hall with computers and 1 without computers	NR	NR	NR	ND	1	NR	NR	ng/m5	NR	NR	NR	NR	NR	NR	See 6B	See 6B	See 6B	See 6B				
7	**Hartmann et al., 2004**	**NR**	**Offices, Public buildings, Cars**	**TCEP**	**Indoor air**	**polyurethane foams in upholstery and plastics in electronic equipment**	**The goals of this study were to develop analytical methods for a broad range of these compounds, to perform a screening of various indoor air environments to which the average person is typically exposed and then apply the results to a risk assessment.**	**Indoor air samples, one sample per site, were collected at 12 locations in and around Zurich..**	**Switzerland, Zurich**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	**See 7.1-7.5**	General interest for consideration of domestic sites, workplaces, old and new vehicles, public places for broad range of general public.	General interest for consideration of possible exposure variables encountered in types of public venues--e.g. new/old vehicles (probably European models), but methodology limits use for quantitative consideration.	Limited -- Single sample for each of many different situtions and variation parameters	Limited -- Methodology of pre-2004 era involves possible bakground contam at lab and limited LOD and limited recovery rates for some. Small dust particles not measures--presents significant issue for analytical results.	
7.1	Hartmann et al., 2004	NR	Cars	TCEP	Interior air - vehicle	polyurethane foams in upholstery	See 7.0	The air samples were collected on polyurethane foam plugs (PUFs) at a sampling rate of 4l/min taken for 8h each, with the exception of the theater and electronics store 3 night samples with 6 and 14h of sampling time, respectively. The air intakes were placed so that they would be in the approximate breathing zone of people who would occupy those spaces.	Switzerland, Zurich	2	sampled one new car, one 1-yr old car, one 9-yr old car empty and occupied	NR	NR	NR	ND	9.4	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 7.0	New/old cars (pre 2004, but models and car value may greatly influence material used in construction of vehicle interior and air circulation systems, etc. May not represent present or future US vehicles. Questionable	See 7.0		See 7.0	
7.2	Hartmann et al., 2004	NR	Offices	TCEP	Indoor air	polyurethane foams in upholstery and plastics in electronic equipment	See 7.0	The air samples were collected on polyurethane foam plugs (PUFs) at a sampling rate of 4l/min taken for 8h each, with the exception of the theater and electronics store 3 night samples with 6 and 14h of sampling time, respectively. The air intakes were placed so that they would be in the approximate breathing zone of people who would occupy those spaces.	Switzerland, Zurich	2	2 offices sampled once, 1 office sampled twice	NR	NR	NR	6.1	56	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 7.0	See 7.0	See 7.0		See 7.0	
7.3	Hartmann et al., 2004	NR	Theater	TCEP	Indoor air	polyurethane foams in upholstery and plastics in electronic equipment	See 7.0	The air samples were collected on polyurethane foam plugs (PUFs) at a sampling rate of 4l/min taken for 8h each, with the exception of the theater and electronics store 3 night samples with 6 and 14h of sampling time, respectively. The air intakes were placed so that they would be in the approximate breathing zone of people who would occupy those spaces.	Switzerland, Zurich	1	single sample from 1 theater	NR	36	NR	NR	NR	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 7.0	See 7.0	See 7.0		See 7.0	
7.4	Hartmann et al., 2004	NR	Furniture stores	TCEP	Indoor air	polyurethane foams in upholstery and plastics in electronic equipment	See 7.0	The air samples were collected on polyurethane foam plugs (PUFs) at a sampling rate of 4l/min taken for 8h each, with the exception of the theater and electronics store 3 night samples with 6 and 14h of sampling time, respectively. The air intakes were placed so that they would be in the approximate breathing zone of people who would occupy those spaces.	Switzerland, Zurich	2	Sampled 2 furniture stores	NR	NR	NR	6.3	11.9	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 7.0	See 7.0	See 7.0		See 7.0	

7.5	Hartmann et al., 2004	NR	Electronic stores	TCEP	Indoor air	polyurethane foams in upholstery and plastics in electronic equipment	See 7.0	The air samples were collected on polyurethane foam plugs (PUFs) at a sampling rate of 4l/min taken for 8h each, with the exception of the theater and electronics store 3 night samples with 6 and 14h of sampling time, respectively. The air intakes were placed so that they would be in the approximate breathing zone of people who would occupy those spaces.	Switzerland, Zurich	3	1 store sampled once, 2 stores sampled twice	NR	NR	NR	2.2	22	NR	NR	ng/m3	NR	NR	0.15	ng/m3	NR	NR	See 7.0	See 7.0	See 7.0	See 7.0		
8	**Fromme et al., 2014a**	**2011-2012 (November to May)**	**Daycare centers**	**TCEP**	**Indoor air, dust**	**NR**	**The aim was to investigate exposure to certain OPs to characterize exposure of vulnerable subsets of the population.**	**See 8.1-8.5**	**Germany, Bavaria, Berlin and North Rhine-Westphalia**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**See 8.1-8.5**	**Relevant to US children < 5years in day care settings (significant percentage) Same analytes likely in US children as in these German children**	**Relevance of dust and air measurements and absorption as indicated by urine metabolites. Perspective on comparison to analytes in air and dust, and perspective on percent contributio to overall exposure from all possible sources. Also notes body load of OPs even at this age.**	**N/A**	**Excellent: As per Fromme 2013 -- both gaseous and particulate measurements. Excellent: use of Standard SRM 2585 for validation of methodology. <LOD = 1/2 LOD Good statistics with consideration of age and location variables**	**Children provided a urine sample to correlate with indoor air and dust samples. Urine metabolites used as comparison with the analytes measured in dust and air and for perspective on relative contribution of exposure at day care to overall exposure**
8.1	Fromme et al., 2014a	2011-2012 (November to May)	Daycare centers	TCEP	Indoor air	NR	see 8.0	Gaseous and particulates sampled with glass fiber filter followed by a PUF plug. A GGP sampler was used with a constant air flow of 3.5 L/min over approximately 6 hours.	Germany, Bavaria, Berlin and North Rhine-Westphalia	63	constructed between 1885-2011	NR	2.2	<0.20	<0.20	33	7.5	NR	ng/m3	NR	11	NR	NR	NR	NR	See 8.0	See 8.0	See 8.0	See 8.0		
8.2	Fromme et al., 2014a	2011-2012 (November to May)	Daycare centers	TCEP	Dust	NR	see 8.0	ALK dust filter mounted on a sampler connected to a vacuum cleaner, vacuumed for 5-10 minutes	Germany, Bavaria, Berlin and North Rhine-Westphalia	63	constructed between 1885-2012	NR	1,350	400	100	8,300	4,900	NR	ng/g Mean: (1.15 mg/kg) Median: (0.40 mg/kg) Range: (0.1-8.3 mg/kg) 95th: (4.9 me/kg)	NR	63	NR	NR	NR	NR	See 8.0	See 8.0	See 8.0	See 8.0		
9	**Fromme et al., 2014b**	**NR**	**House**	**TBB, TBPH, TBBPA**	**Dust**	**Electronic devices, upholstery, carpet, insultation board**	**1) Methodology comparison using GC-MS vs LC-MS/MS analysis. 2) Determination of some BFRs in house dust to get an indicator of the use of these chemicals in Germany and to assess the daily nondietary exposure to these substances via the ingestion of dust.**	**See 9.1-9.3**	**Germany**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**See 9.1-9.3**	**Good for Metodology standards and values reported relevant to general population in US as well as Germany. Using intake default for contact and or ingestion, will be relevant to toddlers.**	**Good for method comparison and consideration of methods used in other papers.**	**Good comparion of results from both methods presented. But for dust intake calculations, median and 95th percentiles reported for dust consumption from GC/MS method or LC/MS, whichever higher using median or 95th percentil EPA default values. Details of all analyte dust concentration values inconsistently reported, sometimes only for median levels and not for all compounds. Details of intake parameters not presented.**	**Sampling from household vacuum as per German sampling guidelines, but not validated against Dust Standard. Good assessment of GC vs LC analytical systems. <LOD = 1/2 LOD Dust intake uses US EPA default factors.**	**tedious reporting in text with little use of tables or good presentation of results. But, data could be important for setting up BFRs dust concentration value distributions.**
9.1	Fromme et al., 2014b	NR	House	TBB	Dust	NR	See 9.0	Collected bags of vacuum cleaners regularly used in the house.	Germany, (Southern) and Munich	20	none	NR	4.2	<3.0	3	13.6	12.5	NR	ng/g	NR	8	3	ng/g	NR	NR	See 9.0	See 9.0	See 9.0	See 9.0		
9.2	Fromme et al., 2014b	NR	House	TBPH	Dust	NR	See 9.0	Collected bags of vacuum cleaners regularly used in the house.	Germany	20	none	NR	436	343	25	2,274	811	NR	ng/g	NR	20	1.5	ng/g	NR	NR	See 9.0	See 9.0	See 9.0	See 9.0		
9.3	Fromme et al., 2014b	NR	House	TBBPA	Dust	NR	See 9.0	Collected bags of vacuum cleaners regularly used in the house.	Munich	20	none	NR	44.1	28	2.9	233	105	NR	ng/g	NR	20	NR	NR	NR	NR	See 9.0	See 9.0	See 9.0	See 9.0		
10	**Hutter et al., 2013**	**NR**	**Elementary schools;**	**TCEP**	**Indoor air PM10, PM2.5**	**NR**	**Qunatify indoor pollutin in elementary schools to explore the influence of indoor air pollution on health and cognitive performance.**	**See 10.1-10.5**	**Austria**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**See 10.1-10.5**	**Young school children in general populations of similar societies (including US).**	**Useful for creating concentration distribution in dust and particulates in air.**	**Results for 36 samples reported as mean, max, min >LOQ for Dust and P10and P2.5 Provides detail for use in creating distribution . Focus on few variables with multiple samples improves use quantitatively.**	**Good: Collection methods over durable periods at multiple sites and over multiple seasons and 2 rooms per building. Better than most strategies for sampling**	**cognitive measurements made but not considered here.**
10.1	Hutter et al., 2013	Spring and fall	Elementary schools;	TCEP	Indoor air PM10	NR	see 10	Glass filter attached to Digital High Volume sampler for PM2.5 and 10	Austria	36	36 samples, 2 classrooms for 9 schools, Spring and fall: PM10	NR	NR	141,000	<LOD	4,700,000	NR	NR	ng/g Median: (141 mg/kg) Range: (<LOD-4.700 ma/ka)	NR	35	NR	NR	NR	NR	See 10.0	See 10.0	See 10.0	See 10.0		
10.2	Hutter et al., 2013	Spring and fall	Elementary schools;	TCEP	Indoor air PM2.5	NR	see 10	Glass filter attached to Digital High Volume sampler for PM2.5 and 10	Austria	36	36 samples, 2 classrooms for 9 schools, Spring and fall: PM2.5	NR	NR	522,00	<LOD	11,000,000	NR	NR	ng/g Median: (522.0 mg/kg) Range: (<LOD-11.000 ma/ka)	NR	35	NR	NR	NR	NR	See 10.0	See 10.0	See 10.0	See 10.0		
10.3	Hutter et al., 2013	Spring and fall	Elementary schools;	TDCPP	Indoor air PM10	NR	see 10	Glass filter attached to Digital High Volume sampler for PM2.5 and 10	Austria	36	36 samples, 2 classrooms for 9 schools, Spring and fall: PM10	NR	NR	90,000	<LOD	4,200,000	NR	NR	ng/g (Mean: 90 µg/m3; Range: <LOD-4200 µg/m3)	NR	35	NR	NR	NR	NR	See 10.0	See 10.0	See 10.0	See 10.0		
10.4	Hutter et al., 2013	Spring and fall	Elementary schools;	TDCPP	Indoor air PM2.5	NR	see 10	Glass filter attached to Digital High Volume sampler for PM2.5 and 10	Austria	36	36 samples, 2 classrooms for 9 schools, Spring and fall; PM2.5	NR	NR	164,000	29000	16,000,000	NR	NR	ng/g (Mean: 164 µg/m3; Range: 29-16,000 µg/m3)	NR	35	NR	NR	NR	NR	See 10.0	See 10.0	See 10.0	See 10.0		
10.5	Hutter et al., 2013	Spring and fall	Elementary schools	TCEP	Dust	NR	see 10	Sampled classrooms in spring and fall; School personnel used industrial vacuum cleaner to provide dust samples.	Austria	36	36 samples, 2 classrooms for 9 schools, Spring and fall; PM2.5	NR	NR	2,500	<600	35,000	NR	NR	ng/g Median: (2.5 µg/m3) Range: (<0.6-35 µg/m3)	NR	36	NR	NR	NR	NR	See 10.0	See 10.0	See 10.0	See 10.0		
11	**Yang et al., 2014**	**2013, Feb-Apr**	**Offices**	**TCEP, TCPP, TDCPP, TPP**	**Indoor air**	**common office furniture and electronic products**	**Collected suspended particles with different diameters in offices and analyzed the levels and characteristics of 10 OPFRs on the particles and preliminary exposure assessments were conducted.**	Sampling device was placed near the center of the room, and sampling took place at 1 m above the ground. All adjacent doors were closed, but the windows were open, to simulate common conditions during working hours. An Anderson eight-stage nonviable cascade impactor with a back-up filter was employed to collect size segregated PM at a flow rate of 28.3 L/min using glass fiber filters.	**China, Hangzhou**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**See 11.1-11.4**	**Relevant to exposure to OPFRs for general population in public spaces and some workplace and home/office environments**	**Insightful for considering findings on other studies where concentrations of analytes may be on particles and the imprtance of vapor pressure on results.**	**Good graphics of findings but means and distributions described in text for concentrations. Tedious for use in quantitative assessments.**	**UPLC-MS/MS analysis <LOD=1/2 LOD Good particulate matter concentration method and distribution and correspondence to analyte concentration.**	Segregation of analytes on MMAD (mass median aerodynamic diameter) <1um TDCPP, TcrP, TEHP, <2.5 um Trpp, TBEP, EHDPP Ops with low Vp adsofb on small particles, therefore may deposit in nasopharyngal area during inhalation. INHALATION EXPOSURES calculated for diff particulate depositions
11.1	Yang et al., 2014	2013, Feb-Apr	Offices	TCEP	Indoor air	common office furniture and electronic products	See 11.0	See 11.0	China, Hangzhou	10	NR	NR	4.91	3.11	1.03	13.38	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 11.0	See 11.0	See 11.0	See 11.0		
11.2	Yang et al., 2014	2013, Feb-Apr	Offices	TCPP	Indoor air	common office furniture and electronic products	See 11.0	See 11.0	China, Hangzhou	10	NR	NR	24.2	7.76	0.83	81.04	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 11.0	See 11.0	See 11.0	See 11.0		
11.3	Yang et al., 2014	2013, Feb-Apr	Offices	TPP	Indoor air	common office furniture and electronic products	See 11.0	See 11.0	China, Hangzhou	10	NR	NR	2.09	1.41	0.25	10.21	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 11.0	See 11.0	See 11.0	See 11.0		
11.4	Yang et al., 2014	2013, Feb-Apr	Offices	TDCPP	Indoor air	common office furniture and electronic products	See 11.0	See 11.0	China, Hangzhou	10	NR	NR	2.25	0.63	0.04	14.3	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 11.0	See 11.0	See 11.0	See 11.0		
12	**Kanazawa et al., 2010**	**2006-2007, Oct-Jan**	**Houses**	**TCEP, TCP, TDCPP, TPP**	**Indoor air**	**building materials (walls, ceilings), curtains**	**The aim of this study was to evaluate the levels of semi-volatile compounds (SVOCs) in residential detached houses in Sapporo, Japan, and whether exposure to these SVOCs was associated with the development of building related symptoms named sick house syndrome (SHS).**	**See 12.1-12.12**	**Japan, Sapporo**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**See 12.1-12.12**	**Relevant to construction of range of FRs in buildings under different variables for general populations of all ages. Includes phosphate triesters.**	**Factors contributing to exposure differences considered for general buildings and conditions. These correlated to health of inhabitants and SVOC concentration**	**Limited: Detection rates and concentrations given as combined concentrations of gaseous and particulate phases. Median and ranges (? Max, Min) reported for n samples. Detail on dust for multi-surface and floor given as median and grange of n samples**	**Descriptions of analytical methodology limited.**	**relationship to SBS/SHS not considered here. Also no comment on health effects methodology or quality.**
12.1	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TCEP	Indoor air	building materials (walls, ceilings), curtains	See 12.0	Air sampling was performed at a height of 1.0–1.5 m from a floor and about 1 m from a wall. 47-mm Empore Disks C18 extractio disks were used in a vacuum pump with air passing through at 200 ml/min for 48 hours	Japan, Sapporo	41	none	NR	NR	15.5	<MDL	297	NR	NR	ng/m3	NR	60%	NR	NR	12.6	ng/m3	See 12.0	See 12.0	See 12.0	See 12.0		
12.2	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TEP	Indoor air	building materials (walls, ceilings), curtains	See 12.0	Air sampling was performed at a height of 1.0–1.5 m from a floor and about 1 m from a wall. 47-mm Empore Disks C18 extractio disks were used in a vacuum pump with air passing through at 200 ml/min for 48 hours	Japan, Sapporo	41	none	NR	NR	62.3	18.1	511	NR	NR	ng/m3	NR	100%	NR	NR	5.1	ng/m3	See 12.0	See 12.0	See 12.0	See 12.0		

12.3	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TDCPP	Indoor air	building materials (walls, ceilings), curtains	See 12.0	Air sampling was performed at a height of 1.0–1.5 m from a floor and about 1 m from a wall. 47-mm Empore Disks C18 extractio disks were used in a vacuum pump with air pasing through at 200 ml/min for 48 hours	Japan, Sapporo	41	none	NR	NR	<MDL	<MDL	61.4	NR	NR	ng/m3	NR	37.50%	NR	NR	11.5	ng/m3	See 12.0	See 12.0	See 12.0	See 12.0
12.4	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TPP	Indoor air	building materials (walls, ceilings), curtains	See 12.0	Air sampling was performed at a height of 1.0–1.5 m from a floor and about 1 m from a wall. 47-mm Empore Disks C18 extractio disks were used in a vacuum pump with air pasing through at 200	Japan, Sapporo	41	none	NR	NR	<MDL	<MDL	17.5	NR	NR	ng/m3	NR	37.50%	NR	NR	4.8	ng/m3	See 12.0	See 12.0	See 12.0	See 12.0
12.5	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TCEP	Dust, floor	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	41	Samples from all over floor	NR	NR	7500	<MDL	308000	NR	NR	ng/g (7.5 mg/kg; 308 mg/kg)	NR	97.60%	NR	NR	1300	ng/g (1.3 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.6	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TEP	Dust, floor	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	40	Samples from all over floor	NR	NR	<MDL	<MDL	2100	NR	NR	ng/g (2.1 mg/kg)	NR	20.00%	NR	NR	520	ng/g (0.52 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.7	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TDCPP	Dust, floor	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	41	Samples from all over floor	NR	NR	4000	<MDL	105000	NR	NR	ng/g (4 mg/kg; 105 mg/kg)	NR	73.20%	NR	NR	1200	ng/g (1.2 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.8	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TPP	Dust, floor	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	40	Samples from all over floor	NR	NR	0	0	0	NR	NR	ng/g	NR	0.00%	NR	NR	490	ng/g (0.49 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.9	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TCEP	dust, multi-surface	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	41	Samples from tops of doors, shelves, cupboards,	NR	NR	9800	<MDL	70700	NR	NR	ng/g (9.8 mg/kg; 70.7 mg/kg)	NR	92.70%	NR	NR	1300	ng/g (1.3 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.10	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TEP	dust, multi-surface	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	40	Samples from tops of doors, shelves, cupboards,	NR	NR	<MDL	<MDL	2100	NR	NR	ng/g (2.1 mg/kg)	NR	30.00%	NR	NR	520	ng/g (0.52 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.11	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TDCPP	dust, multi-surface	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	41	Samples from tops of doors, shelves, cupboards,	NR	NR	22300	5800	127000	NR	NR	ng/g (22.3 mg/kg; 5.8 mg/kg; 127 mg/kg)	NR	100.00%	NR	NR	1200	ng/g (1.2 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
12.12	Kanazawa et al., 2010	2006-2007, Oct-Jan	Houses	TPP	dust, multi-surface	NR	See 12.0	Dust samples were collected using a vacuum cleaner (National HC-V15, Matsushita Electric Works, Ltd.,Osaka, Japan) equipped with a paper dust bag.	Japan, Sapporo	40	Samples from tops of doors, shelves, cupboards,	NR	NR	0	0	0	NR	NR	ng/g	NR	0.00%	NR	NR	490	ng/g (0.49 mg/kg)	See 12.0	See 12.0	See 12.0	See 12.0
13	**Dodson et al., 2012**	**2006 & 2011**	**Houses**	**TCEP, TBPH, TBB, TBBPA, TPP, TDCPP**	**Dust**	**furniture, electronics, carpet**	**Dust collected in 16 California homes in 2006 and 2011 were analyzed for BFRs and OPFRs and 13 legacy chemicals for inference on mixtures and potential sources to characterize FR chemicals in homes over time.**	**See 13.1-13.16**	**United States, California, San Francisco Bay Area**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**See 13.1-13.16**	**General population exposures retrospectively (before regulations) and current for BRFs and OPFRs**	**Shows changes in analytes over time in house dust suggesting chaning sources and/or use in products and/or emission rates**	**Very Good detail of results incl. %>LOQ and individual analytes Good presentation of data for quantitative use in building concentration distributions.**	**Very Good: Sampling methodology standardized and good QA. Multiple sample preps used as appropriate and good analysis methods and QA with comparison to NIST certified reference SRM 2585 Organics in Indoor Dust**	**Measurement at two time periods allows for the investigation of changes in residential levels, which likely reflect patterns of use. This work contributes to the ongoing characterization of evolving exposures to FR chemicals in homes. Good review of uses, health effects of analytes in Table 2.**
13.1	Dodson et al., 2012	2006	Houses	TCEP	Dust	furniture, electronics, carpet	See 13.0	Samples were collected by trained field staff using a Eureka Mighty-Mite vacuum cleaner fitted with a specially designed PTFE Teflon crevice tool attachment modified to collect dust into a cellulose extraction thimble (19 × 90 mm). Samples were collected by slowly dragging the crevice tool for approximately 30 min over surfaces in the living areas of the home.	United States, California, San Francisco Bay Area	16	houses	NR	NR	5100	610	160000	NR	NR	ng/g	NR	**100%**	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.2	Dodson et al., 2012	2011	Houses	TCEP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2700	330	110000	NR	NR	ng/g	NR	**100%**	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.3	Dodson et al., 2012	2006	Houses	TBB	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	48	4	740	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.4	Dodson et al., 2012	2011	Houses	TBB	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	100	45	5900	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.5	Dodson et al., 2012	2006	Houses	TBPH	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	140	36	1900	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.6	Dodson et al., 2012	2011	Houses	TBPH	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	260	<2	3800	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.7	Dodson et al., 2012	2006	Houses	TPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	3000	580	14000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.8	Dodson et al., 2012	2011	Houses	TPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2800	790	36000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.9	Dodson et al., 2012	2006	Houses	TEP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	28	<20	410	NR	NR	ng/g	NR	56%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.10	Dodson et al., 2012	2011	Houses	TEP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	<20	<20	250	NR	NR	ng/g	NR	31%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.11	Dodson et al., 2012	2006	Houses	TCPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2100	340	120000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.12	Dodson et al., 2012	2011	Houses	TCPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2200	490	140000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.13	Dodson et al., 2012	2006	Houses	TDCPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2800	730	24000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.14	Dodson et al., 2012	2011	Houses	TDCPP	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	2100	920	4400	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.15	Dodson et al., 2012	2006	Houses	TBBPA	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	260	<10	3400	NR	NR	ng/g	NR	94%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0
13.16	Dodson et al., 2012	2011	Houses	TBBPA	Dust	furniture, electronics, carpet	See 13.0	See 13.1	United States, California, San Francisco Bay Area	16	houses	NR	NR	200	22	2000	NR	NR	ng/g	NR	100%	NR	NR	NR	NR	See 13.0	See 13.0	See 13.0	See 13.0

14	**Fang et al., 2013**	**2009**	**Houses and cars**	**TCEP**	**Dust**	**polyurethane foam (PUF) in baby products, cars and furniture**	**The goals of this study were: (1) to prepare and purify a V6 commercial standard, (2) develop a method to analyze V6 in dust samples, (3) measure V6 levels in foam from baby products previously identified as having V6, (4) measure V6 in house and car dust samples to provide more information on its detection and abundance in indoor environments, and (5) examine the relationship between TCEP and V6 in foam products and indoor dust to determine the importance of V6 as a source for TCEP.**	**See 14.0-14.3**		**United States, Boston, MA**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**	**See 14.0-14.3**		**General population exposure to TCEP and the V6 FRs.**	**Quantitative relationship between V6 FR and the TCEP contaminant highly characteristic for FRs now in use.**	**Av, for n products +- SD in each site (house, car, baby products**	**Contemporary methodology and standards used.**	**TCEP noted as an impurity in V6 and found in homes, foam and cars. Thus significant source for TCEP Suggested high use of V6 in car interiors.**
14.1	Fang et al., 2013	2009	Houses	TCEP	Dust	furniture	See 14.0	dust samples were collected using a Eureka Mighty-Mite vacuum cleaner (model 3670) and crevice tool attachment. House dust samples were obtained in the bedroom from 20 Boston (MA). area houses during 2009.	United States, Boston, MA	20	houses	NR	NR	50.2	<20	1350	NR	NR	ng/g	NR	48%	NR	NR	NR	NR	See 14	See 14	See 14	See 14	
14.2	Fang et al., 2013	NR	Baby products	TCEP	Foam	PUF	See 14.0	Foam analyzed from 12 products that previously were identified to contain V6.	United States, Boston, MA	12		3600000	NR	NR	1,100,000	5,900,000	NR	NR	ng/g	1600000	NR	NR	NR	NR	NR	See 14	See 14	See 14	See 14	Most detections were in nursing pillows but it was also detected in one sleep positioner, one portable mattress, and one baby carrier.
14.3	Fang et al., 2013	2009	cars	TCEP	dust	PUF	See 14.0	car dust, 20 samples were collected from the surfaces of the front and back seats of participants' cars. The information on the car manufacturer, production year, and sampling date were recorded.	United States, Boston, MA	20	inside surfaces of 20 cars	NR	NR	1080	<20	50120	NR	NR	ng/g	NR	95%	NR	NR	NR	NR	See 14	See 14	See 14	See 14	
15	**Stapleton et al., 2014**	**NR**	**Houses**	**TCEP, TBB, TBPH,TBBPA , TDCPP**	**Dust and Handwipes**	**PUF in furniture and baby products**	**Objectives of the study were to: (1) examine the correlations between flame retardant residues on children's hands and levels measured in house dust; (2) examine longitudinal associations in PBDE levels measured in house dust and handwipes collected from the same set of children approximately two years apart, and (3) determine if age and hand washing frequency were predictors of FR levels in handwipes.**	**See 15.1-15.10**		**United States, Boston, North Carolina**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**See 15.1-15.10**	**Important for parameters defining exposure assesment to young children, especially changes in age-related behaviour and hand-to-mouth events. Shows longitudinal associations**	**Important re: methodology for estimating oral exposure from hand contact with surface house dust using handwipe methodology. Shows time dependent changes in house dust analyte levels**	**Results presented as geometric mean and range for n samples with % detect for each analyte. Good for quantitative use.**	**Good methodology for sample strategy, analytical method and data evaluation. Shows longitudinal associations . Results compared to NIST Standard SRM 2585**	**Study suggests changes in childrens' behavior is significant factor in changes of residue in handwipes. Important issue for consideration of exposure assumptions re age group differences. HAND-TO-MOUTH default values important to consider with age change.**
15.1	Stapleton et al., 2014	2012, sring	Houses	TCEP	Handwipe	PUF in furniture and baby products		Hands wiped with sterile gauze wipe soaked in isopropyl alcohol, samples taken from both hands.	United States, North Carolina	43	children	NR	NR	NR	24	197	NR	NR	ng/g	NR	47%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.2	Stapleton et al., 2014	2012, sring	houses	TCEP	Dust	PUF in furniture and baby products	See 15.0	Floor dust samples were taken in the room identified by the parent as where the child spends most of his/her time. The dust was collected on both hardwood and carpeted floor using a vacuum cleaner with a cellulous thimble inserted in the hose attachment until a sufficient amount (at least 100 mg) had accumulated.	United States, North Carolina	30	houses	NR	NR	NR	20	6920	NR	348	ng/g	NR	100%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	A short questionnaire was also administered during the home visit, which collected information on the time the child last washed their hands, how often they washed their hands on average, and where the child spends most of his/her time. Once completed, the child's height and weight were also recorded.
15.3	Stapleton et al., 2014	2012, sring	Houses	TBB	Handwipe	PUF in furniture and baby products	See 15.0	Hands wiped with sterile gauze wipe soaked in isopropyl alcohol, samples taken from both hands.	United States, North Carolina	43	children	NR	NR	NR	<0.60	154	NR	4.1	ng/g	NR	93%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.4	Stapleton et al., 2014	2012, sring	houses	TBB	Dust	PUF in furniture and baby products	See 15.0	Floor dust samples were taken in the room identified by the parent as where the child spends most of his/her time. The dust was collected on both hardwood and carpeted floor using a vacuum cleaner with a cellulous thimble inserted in the hose attachment until a sufficient amount (at least 100 mg) had accumulated.	United States, North Carolina	30	houses	NR	NR	NR	6	2430	NR	97	ng/g	NR	100%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.5	Stapleton et al., 2014	2012, sring	Houses	TBPH	Handwipe	PUF in furniture and baby products	See 15.0	Hands wiped with sterile gauze wipe soaked in isopropyl alcohol, samples taken from both hands.	United States, North Carolina	43	children	NR	NR	NR	<0.70	116	NR	2.5	ng/g	NR	53%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.6	Stapleton et al., 2014	2012, sring	houses	TBPH	Dust	PUF in furniture and baby products	See 15.0	Floor dust samples were taken in the room identified by the parent as where the child spends most of his/her time. The dust was collected on both hardwood and carpeted floor using a vacuum cleaner with a cellulous thimble inserted in the hose attachment until a sufficient amount (at least 100 mg) had accumulated.	United States, North Carolina	30	houses	NR	NR	NR	82.9	20960	NR	604	ng/g	NR	100%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.7	Stapleton et al., 2014	2012, sring	Houses	TBBPA	Handwipe	PUF in furniture and baby products	See 15.0	Hands wiped with sterile gauze wipe soaked in isopropyl alcohol, samples taken from both hands.	United States, North Carolina	43	children	NR	NR	NR	<0.02	35	NR	0.4	ng/g	NR	70%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.8	Stapleton et al., 2014	2012, sring	houses	TBBPA	Dust	PUF in furniture and baby products	See 15.0	Floor dust samples were taken in the room identified by the parent as where the child spends most of his/her time. The dust was collected on both hardwood and carpeted floor using a vacuum cleaner with a cellulous thimble inserted in the hose attachment until a sufficient amount (at least 100 mg) had accumulated.	United States, North Carolina	30	houses	NR	NR	NR	<0.2	245	NR	7.9	ng/g	NR	76%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.9	Stapleton et al., 2014	2012, sring	Houses	TDCPP	Handwipe	PUF in furniture and baby products	See 15.0	Hands wiped with sterile gauze wipe soaked in isopropyl alcohol, samples taken from both hands.	United States, North Carolina	43	children	NR	NR	NR	<7	530	NR	74.2	ng/g	NR	96%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
15.10	Stapleton et al., 2014	2012, sring	houses	TDCPP	Dust	PUF in furniture and baby products	See 15.0	Floor dust samples were taken in the room identified by the parent as where the child spends most of his/her time. The dust was collected on both hardwood and carpeted floor using a vacuum cleaner with a cellulous thimble inserted in the hose attachment until a sufficient amount (at least 100 mg) had accumulated.	United States, North Carolina	30	houses	NR	NR	NR	621	13110	NR	2730	ng/g	NR	100%	NR	NR	NR	NR	See 15.0	See 15.0	See 15.0	See 15.0	
16	**Fan et al., 2014**	**NR**	**Urban homes**	**TCEP, TPP, TCPP, TDCPP**	**Dust**	**NR**	**The objectives of this sudy were to develop an analytical method to simultaneously measure the concentrations of 13 OPEs in indoor house dust, and then to compare fresh dust and household dust sampling methods for the determination of OPEs in settled indoor dust.**	**See 16.1-16.8**		**Canada**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**See 16.1-16.8**	**Two Important Points of Relevance: 1) Methodology for collection and analysis; 2) levels of OP esters in urban houses in North America for general population exposure asmts.**	**Important conclusions re: sampling methodology and analytical methodology. Contribution to NIST standard SRM 2585 for Household dust. Comparisons of two different vacuum sampling methodologies and intra/linter day variations notable for consideration of other studies' methodology and impact on results**	**Excellent detail on results for quantitative use and relation to standards.**	**Excellent methodology presentation; Comparisons of two vacuum sampling techniques presented. Analysis: solvent extraction with sonication, solid phase extraction cleanup, GC/PCI-MS/MS analysis with inter and intra-day varuations.**	**Conclusions: Household vacuum dust bag collection approximates other standardized methods for collection; GC/PCI-MS/MS probably best analytical for OP esters. Standards for NIST SRM 2585**
16.1	Fan et al., 2014	NR	Urban homes	TCEP	Dust	NR	See 16.0	Fresh Dust (FD) samples were collected by trained technicians from living areas (bedrooms, living rooms, hallways, offices) using a Pullman Holt vacuum sampler, avoiding wet areas in the (kitchens, bathrooms, laundry rooms). FD consisted of active dust and excluded old house dust found in joints and cracks in flooring or in areas where the householder does not vacuum on a regular basis. Participant asked not to vacuum the sampling areas for 1 week prior to FD sampling.	Canada	134	FD method	NR	NR	800	<MDL	33000	4400	NR	ng/g -Median: 0.8 µg/g; Max: 33 µg/g 95th: 4.4 µg/g	NR	96%	NR	NR	70	ng/g (0.07 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0	
16.2	Fan et al., 2014	NR	House	TCEP	Dust	NR	See 16.0	Household dust (HD) were obtained from the vacuum systems used by the study participants as part of their regular house cleaning routine.	Canada	134	HD method	NR	NR	600	<MDL	7000	3700	NR	ng/g - Median: 0.6 µg/g; Max: 7 µg/g; 95th: 3.7 µg/g	NR	95%	NR	NR	70	ng/g (0.07 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0	

16.3	Fan et al., 2014	NR	Houses	TPP	Dust	NR	See 16.0	Fresh Dust (FD) samples were collected by trained technicians from living areas (bedrooms, living rooms, hallways, offices) using a Pullman Holt vacuum sampler, avoiding wet areas in the (kitchens, bathrooms, laundry rooms). FD consisted of active dust and excluded old house dust found in joints and cracks in flooring or in areas where the householder does not vacuum on a regular basis. Participant asked not to vacuum the sampling areas for 1 week prior to FD sampling.	Canada	134	FD method	NR	NR	1700	260	63000	8900	NR	ng/g - Median: 1.7 µg/g; Min: 0.26 µg/g; Max: 63 µg/g; 95th: 8.9 µg/g	NR		NR	NR	200	ng/g (0.2 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
16.4	Fan et al., 2014	NR	Houses	TPP	Dust	NR	See 16.0	Household dust (HD) were obtained from the vacuum systems used by the study participants as part of their regular house cleaning routine.	Canada	134	HD method	NR	NR	1600	<MDL	9500	12000	NR	ng/g - Median: 1.6 µg/g; Max: 95 µg/g; 95th: 12 µg/g	NR		NR	NR	200	ng/g (0.2 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
16.5	Fan et al., 2014	NR	Houses	TCPP	Dust	NR	See 16.0	Fresh Dust (FD) samples were collected by trained technicians from living areas (bedrooms, living rooms, hallways, offices) using a Pullman Holt vacuum sampler, avoiding wet areas in the (kitchens, bathrooms, laundry rooms). FD consisted of active dust and excluded old house dust found in joints and cracks in flooring or in areas where the householder does not vacuum on a regular basis. Participant asked not to vacuum the sampling areas for 1 week prior to FD sampling.	Canada	134	FD method	NR	NR	1400	<MDL	56000	13000	NR	ng/g - Median: 1.4 µg/g; Max: 56 µg/g; 95th: 13 µg/g	NR	97%	NR	NR	10	ng/g (0.11 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
16.6	Fan et al., 2014	NR	Houses	TCPP	Dust	NR	See 16.0	Household dust (HD) were obtained from the vacuum systems used by the study participants as part of their regular house cleaning routine.	Canada	134	HD method	NR	NR	1100	<MDL	49000	9600	NR	ng/g - Median: 1.1 µg/g; Max: 49 µg/g; 95th: 9.6 µg/g	NR	96%	NR	NR	10	ng/g (0.11 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
16.7	Fan et al., 2014	NR	Houses	TDCPP	Dust	NR	See 16.0	Fresh Dust (FD) samples were collected by trained technicians from living areas (bedrooms, living rooms, hallways, offices) using a Pullman Holt vacuum sampler, avoiding wet areas in the (kitchens, bathrooms, laundry rooms). FD consisted of active dust and excluded old house dust found in joints and cracks in flooring or in areas where the householder does not vacuum on a regular basis. Participant asked not to vacuum the sampling areas for 1 week prior to FD sampling.	Canada	134	FD method	NR	NR	2700	120	7700	9000	NR	ng/g - Median: (2.7 µg/g) Range: (0.12-77 µg/g) 95th: (9 µg/g)	NR	100%	NR	NR	80	ng/g (0.08 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
16.8	Fan et al., 2014	NR	Houses	TDCPP	Dust	NR	See 16.0	Household dust (HD) were obtained from the vacuum systems used by the study participants as part of their regular house cleaning routine.	Canada	134	HD method	NR	NR	2000	110	101000	12000	NR	ng/g - Median: (2.0 µg/g) Range: (0.11-101 µg/g) 95th: (12 µg/g)	NR	100%	NR	NR	80	ng/g (0.08 µg/g)	See 16.0	See 16.0	See 16.0	See 16.0
17	**Kim et al., 2013**	**2008, August**	**Houses**	**TCEP, TPP**	**Dust**	**Consumer products, waste dumping**	**The objectives of this study were to (1) provide background information on indoor contamination by PFRs in the Philippines and (2) estimate the non-dietary exposure to PFRs via dust ingestion for children and adults, and (3) compare the relative significance of nondietary exposures to that of literature estimates of PFR exposure from dietary (e.g., fish) sources.**	**See 17.1-17.4**	**Philippines, Malate (residential area) and Payatas (dumping area)**	**See 17.1-17.4**	**See 17.1-17.4**	**See 17.1-17.4

18.7	Araki et al., 2014	2006, Sept-Dec	Houses	TPP	floor dust	NR	See 18.0	Dust samples collected using a hand held vacuum cleaner with a paper dust bag from all surfaces of the floor.	Japan, Sapporo, Fukushima, Nagoya, Osaka, Okayama, and Fukuoka	148	single family homes <7 yrs old	NR	NR	4,510	<MDL	245,080	NR	NR	ng/g Median: (4.51 µg/g) Max: (245.08 µg/g)	NR	NR	NR	NR	NR	NR	See 18.0	See 18.0	See 18.0	See 18.0	See 18.0
18.8	Araki et al., 2014	2006, Sept-Dec	Houses	TPP	Multi-surface dust	NR	See 18.0	Dust samples collected using a hand held vacuum cleaner with a paper dust bag from surfaces such as shelves, cupboards, frames, door frames, windowsills, TV sets, audio sets, personal computers, and interior materials such as wall and ceiling papers.	Japan, Sapporo, Fukushima, Nagoya, Osaka, Okayama, and Fukuoka	120	single family homes <7 yrs old	NR	NR	11,540	<MDL	889,180	NR	NR	Median: (11.54 µg/g) Max: (889.18 µg/g)	NR	NR	NR	NR	NR	NR	See 18.0	See 18.0	See 18.0	See 18.0	See 18.0
19.0	**Haumann and Thumulla, 2002**	**1996-2006**	**Homes, schools commercial buildings**	**TCEP, TCPP**	**Dust**	**Foams, paints, mattresses, sealants**	**OP FR levels in house dust: results from German ongoing exposure study**	**See 19.1-19.10**	**Germany**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**See 19.1-19.10**	**Pre 2004 uses in Germany. Use for retrospective exposure assesment for Germany--may not represent US**	**Dated study with samples from pre 2004 comparing to 1999 and 1982 date. Useful for longitudinal study of residues.**	**Large sampling base; Results show 50th, 90th, 95th and max percentiles across n samples**	**Dated analytical methodology.Uses German 2001 guidelines for vacuuming--after general cleaning 1 week prior. Only fine dust fractins analyzed ?? LOD for GC/MS analysis with .3-.5 mg/kg .**	**Organotin methods and results not discussed her.**
19.1	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildings	TCEP	Dust	NR	see 19.0	Dust samples (1-5 g) were collected by vacuum cleaner collection following VDI guideline 4300-8f. 8. The dust collections were performed after a general cleaning of the surfaces had been carried out one week before sample collection. During this period, no surface cleaning was allowed. The samples were collected by industrial hygienists, environmental consultants, environmental physicians, and homeowners, because of health complaints. Only the fine dust fractions were analyzed.	Germany	1569	samples	NR	NR	600	NR	330000	8400	NR	ng/g Median: (0.6 mg/kg) 95th: (8.4 mg/kg) Max: (330 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.2	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildings	TCPP	Dust	NR	see 19.0	Dust samples (1-5 g) were collected by vacuum cleaner collection following VDI guideline 4300-8f. 8. The dust collections were performed after a general cleaning of the surfaces had been carried out one week before sample collection. During this period, no surface cleaning was allowed. The samples were collected by industrial hygienists, environmental consultants, environmental physicians, and homeowners, because of health complaints. Only the fine dust fractions were analyzed.	Germany	1337	samples	NR	NR	1000	NR	470000	14000	NR	Median: (1 mg/kg) 95th: (14 mg/kg) Max: (470 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.3	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildings	TCEP	Material samples	soft foams	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	6400000	NR	NR	ng/g (6400 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.4	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCEP	Material samples	paints/finishes	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	840000	NR	NR	ng/g (840 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.5	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildings	TCEP	Material samples	mattresses	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	890000	NR	NR	ng/g (890 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.6	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCEP	Material samples	foam sealants	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	89000000	NR	NR	ng/g (89000 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.7	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCPP	Material samples	soft foams	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	16000	NR	NR	ng/g (16 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.8	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCPP	Material samples	paints/finishes	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	20000	NR	NR	ng/g (20 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.9	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCPP	Material samples	mattresses	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	16000	NR	NR	ng/g (16 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
19.10	Haumann and Thumulla, 2002	1996-2006	Homes, schools commercial buildines	TCPP	Material samples	foam sealants	see 19.0	Materials were analyzed to identify primary sources of previous findings in the dust and related emissions.	Germany	563		NR	NR	NR	NR	190000000	NR	NR	ng/g (190000 mg/kg)	NR	NR	NR	NR	NR	NR	See 19.0	See 19.0	See 19.0	See 19.0	
20	**Ingerowski et al., 2001**	**NR**	**Pooled homogenized sample from 20 buildings, mostly residences**	**TCEP, TCPP**	**Dust**	**wood preservative coatings, polyurethane mattresses, wall paper (glass fiber), polyurethane carpet backing, polyurethane soft foam, polyurethane foam fillers, floor sealing material, acoustic ceiling coatine.**	**The study was initiated to 1) investigate the distributionof TCEP and TCPP using house dust samples as a matrix; 2) inter-laboratory comparisons of methodology and results from pooled sample.**	**See 20.1-20.6**	**Germany**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**See 20.1-20.6**	**general population exposure potential considering 2001 era interior materials. Generally extrapolated globally, but consider German home design.**	**Insightful for considering source for TCEP and TCCP and loading potential in dust after 1 week from 2001 era interior materials.**	**USEFUL presentation of data across distribution of n values for each analyte in each lab.**	**Good methodology in 3 labs. Good sampling methodology. Use of internal standards compliance with 2001 guidance and standards opportunities.**	**Conclusions: Good correlations among 3 labs. Source of TCEP > foam, paint, wallpaper; source of TCPP=insulation, sealant foams. TCEP TCCP LEVELS MEASURED IN 8 INTERIOR MATERIALS**
20.1	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	356	lab 1	NR	2230	NR	NR	64000	8800	670	ng/g Arith Mean: (2.23 mg/kg) Geo Mean: (0.67 mg/kg) Max: (64 mg/kg) 95th: (8.8 me/kw)	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	
20.2	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	541	lab 2	NR	2240	NR	NR	121000	7500	640	ng/g Arith Mean: (2.24 mg/kg) Geo Mean: (0.64 mg/kg) Max: (121 mg/kg) 95th: 7.5 me/kw	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	
20.3	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	86	lab3	NR	3750	NR	NR	94000	12000	890	ng/g Arith Mean: (3.75 mg/kg) Geo Mean: (0.89 mg/kg) Max: (94 mg/kg) 95th: 12 mg/kg	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	
20.4	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	216	lab 1	NR	1160	NR	NR	33000	3400	500	ng/g Arith Mean: (1.16 mg/kg) Geo Mean: (0.50 mg/kg) Max: (33 mg/kg) 95th: (3.4 mg/kg)	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	
20.5	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	147	lab 2	NR	2030	NR	NR	36000	8800	380	ng/g Arith Mean: (2.03 mg/kg) Geo Mean: (0.38 mg/kg) Max: (36 mg/kg) 95th: (8.8 mg/kg)	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	
20.6	Ingerowski et al., 2001	NR	Pooled homogenized sample from 20 buildings, mostly residences	TCEP	Dust	See 20	See 20	Conventional vacuum with filter from clients with health problems; results from 3 laboratories	Germany	73	lab3	NR	2350	NR	NR	375000	5600	680	ng/g Arith Mean: (2.35 mg/kg) Geo Mean: (0.68 mg/kg) Max: (375 mg/kg) 95th: 5.6 me/kw	NR	NR	NR	NR	NR	NR	See 20.0	See 20.0	See 20.0	See 20.0	

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26.1	Van den Eede et al., 2012	NR	House	TCEP	Dust	NR	See 26	Vacuum dust samples	Belgium	NR	NR	NR	NR	NR	75	1310	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 26.0	See 26.0	See 26.0	See 26.0	
26.2	Van den Eede et al., 2012	NR	House	TCEP	Dust	NR	See 26	Vacuum dust samples	Romania	NR	NR	NR	NR	NR	40	1450	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 26.0	See 26.0	See 26.0	See 26.0	
26.3	Van den Eede et al., 2012	NR	House	TCEP	Dust	NR	See 26	Vacuum dust samples	Spain	NR	NR	NR	82	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 26.0	See 26.0	See 26.0	See 26.0	
27	**Cristale and Lacorte, 2013**	**NR**	**House**	**TCEP**	**Dust**	**NR**	**1)Present and validate extraction,clean-up and analysis of existing and new FRs 2) application of techniques on dust,sludge, sediment samples**	**See 27.1**	**Spain**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**See 27.1**	**Excellent methodology study and useful measurements of OPFRs in European house dust. Useful for general population exposure assessment**	**Illustrates extraction and clean-up methods for reliable quantification of existing and new FRs. Importance of NIST standard illustrated.**	**Mean/SD presented for n values in different matrices from samples. Also, comparisons with standards presented.**	**Excellent methodology described and documented.**	**Applications and measurements in matrices other than dust not considered here.**
27.1	Cristale and Lacorte, 2013	NR	House	TCEP	Dust	NR	See 27	Vacuum cleaner bag collection	Spain	NR	NR	NR	757	NR	NR	NR	NR	NR	ng/g (0.757 µg/g)	NR	NR	NR	NR	NR	NR	See 27.0	See 27.0	See 27.0	See 27.0	See 27.0
28	**Abdallah and Covaci, 2014**	**NR**	**Car, house, office, microenvironments (coffee shops, restaurants, supermarkets)**	**TCEP**	**Dust**	**NR**	**Measure the concentrations of flame retardants in microenvironments in Egypt.**	**See 28.1-28.4**	**Egypt, Asiut**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**See 28.1-28.4**	**Relevant to countries with similar socioeconomic, climate and living conditions to Egypt /northern Africa. Not relevant to US scenarios**	**Useful statistical results for exposure input for similar North African microenvironments**	**Report results as average, SD, Median, Min, max for n samples of each analyte at each site. Adequate for quantitative utility.**	**Adequate: GC-MS analytical with adequate recovery rates for dust No discussion of ventilation, type/age of cars or office /home contents,**	
28.1	Abdallah and Covaci, 2014	NR	Car	TCEP	Dust	NR	See 28	Collected with a dust buster vacuum	Egypt, Assiut	NR	NR	198	NR	127	NR	572	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 28.0	See 28.0	See 28.0	See 28.0	
28.2	Abdallah and Covaci, 2014	NR	House	TCEP	Dust	NR	See 28	Collected with a dust buster vacuum	Egypt, Assiut	NR	NR	49	NR	22	NR	132	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 28.0	See 28.0	See 28.0	See 28.0	
28.3	Abdallah and Covaci, 2014	NR	Office	TCEP	Dust	NR	See 28	Collected with a dust buster vacuum	Egypt, Assiut	NR	NR	61	NR	31	NR	125	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 28.0	See 28.0	See 28.0	See 28.0	
28.4	Abdallah and Covaci, 2014	NR	Micro-environment (coffee shops, restaurants, supermarkets)	TCEP	Dust	NR	See 28	Collected with a dust buster vacuum	Egypt, Assiut	NR	NR	277	NR	234	NR	538	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 28.0	See 28.0	See 28.0	See 28.0	
29	**Ionas and Covaci, 2013 as cited in Fan et al., 2014**	**NR**	**House**	**TCEP**	**Dust**	**NR**	**Did not review original study--cited here by reference in Fan study**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**See 29.1**	**General population exposure assessment**	**Did not review original study--cited here by reference in Fan study**	**Did not review original study--cited here by reference in Fan study**	**Did not review original study--cited here by reference in Fan study**	
29.1	Ionas and Covaci, 2013 as cited in Fan et al., 2014	NR	House	TCEP	Dust	NR	See 29	Not provided in Fan et al., 2014	NR	NR	NR	NR	820	NR	NR	NR	NR	NR	ng/g (0.82 µg/g)	NR	NR	NR	NR	NR	NR	See 29.0	See 29.0	See 29.0	See 29.0	
30	**Murray et al., 2013 as cited in Fan et al., 2014**	**NR**	**House**	**TCEP**	**Dust**	**NR**	**Did not review original study--cited here by reference in Fan study**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**See 30.1**	**General population exposure assessment**	**Did not review original study--cited here by reference in Fan study**	**Did not review original study--cited here by reference in Fan study**	**Did not review original study--cited here by reference in Fan study**	
30.1	Murray et al., 2013 as cited in Fan et al., 2014	NR	House	TCEP	Dust	NR	See 30	Not provided in Fan et al., 2014	NR	NR	NR	NR	820	NR	NR	NR	NR	NR	ng/g (0.82 µg/g)	NR	NR	NR	NR	NR	NR	See 30.0	See 30.0	See 30.0	See 30.0	
31	**Stapleton et al., 2012**	**1985-2010**	**Houses**	**TCEP**	**Polyurethane foam (PUF)**	**Furniture, couches**	**Establish the pattern of FRs in furniture PUF before and after 2005 regulatory phase-out of PBDE and introduction of new BFRs nd Qps as noted in California and not California purchases.**	**See 31.1-31.6**	**United States**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**See 31.1-31.6**	**General population exposure assessment**	**Important Paper re: differences in patterns of FRs before and after key regulation. Pre/post 2005 FRs in furniture PUF (California/not California)**	**Tedious presentation of qualitative results and statistical representation of comparisons, etc. throughout text without placing into tables. Therefore precision varies with discussion in paper. Good work but poorly presented. Supporting Information available from author which may present data more completely.**	**Excellent study re: sampling strategy for noted variables.**	
31.1	Stapleton et al., 2012	1985-2004	Houses	TCEP	Polyurethane foam (PUF)	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 1985 and 2004.	United States	41	products purchased between 1985-2004	ND	NR	NR	NR	NR	NR	NR	NR	NR	0	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
31.2	Stapleton et al., 2012	2005-2010	Houses	TCEP	Polyurethane foam (PUF)	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 2005 and 2010.	United States	61	products purchased between 2005-2010	5,470,000	NR	NR	NR	NR	NR	NR	ng/g (5.47 mg/g)	NR	1	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
31.3	Stapleton et al., 2012	1985-2010	Furniture	Sum of TBB, TBPH, and TPP	PUF	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 1985 and 2004.	United States	41	products purchased between 1985-2004	19,760,000	NR	NR	5,180,000	36,850,000	NR	NR	ng/g (Mean: 19.76 mg/g) Range: (5.18 - 36.85 mg/g) Sum of TPP, TBB, and TBPH	NR	2	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
31.4	Stapleton et al., 2012	1985-2010	Furniture	Sum of TBB, TBPH, and TPP	PUF	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 2005 and 2010.	United States	61	products purchased between 2005-2010	19,760,000	NR		5,180,000	36,850,000	NR	NR	ng/g (Mean: 19.76 mg/g) Range: (5.18 - 36.85 mg/g) Sum of TPP, TBB, and TBPH	NR	11	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
31.5	Stapleton et al., 2012	1985-2010	Furniture	TDCPP	PUF	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 1985 and 2004.	United States	41	products purchased between 1985-2004	44870000	NR	NR	1,600,000.0	110,200,000.0	NR	NR	ng/g (Avg: 43.53 mg/g) Range: (2-110.2 mg/g of foam). (Sum of TPP, TBB, and TBPH levels)	NR	10	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
31.6	Stapleton et al., 2012	1985-2010	Furniture	TDCPP	PUF	Furniture, couches	See 31	Donated foam samples collected all over U.S. from couches purchased between 2005 and 2010.	United States	61	products purchased between 2005-2010	44870000	NR	NR	1,600,000.0	110,200,000.0	NR	NR	ng/g (Avg: 43.53 mg/g) Range: (2-110.2 mg/g of foam). (Sum of TPP, TBB, and TBPH levels)	NR	32	NR	NR	NR	NR	See 31	See 31	See 31	See 31	
32.0	**Stapleton et al., 2011**	**NR**	**houses, car**	**TCEP**	**Material samples**	**PUF from car seat, changing table pad, sleep positioner, portable mattress, nursing pillows, baby carrier, infant bath mats/slings**	**Determine pattern of FR use after phase-outs of PBDEs, characterize fate, exposure, health effects.**	**See 32.1-32.3**	**United States**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**See 32.1-32.3**	**population exposure assessment...primarily for infants/children in Calif/US perhaps also for EU**	**illustrates significan changes in pre/post California regulation, indicting residue values before/after 2003-2005 must be considered separately.**	**Qualitatively good pattern of FRs in baby products shown. Quantitative results presented: only mean and range, not noting which products product the data.**	**Sampling consisted of contribution of foam pieces from divergent sources "primarily" in US and from many different products/brands/ages. Analytical analysis contemporary and with NIST standards for QA.**	

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36.1	Kajwara et al., 2011	2008	houses	TCEP	dust	Laptop computer	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	1	1 laptop parts (Chassis 16 ng/g Keyboard top <4 ng/g PC boards 14 ng/g Cooling fan and speakers 120 ng/g AC adapter <4 ng/g LCD panel <4 ng/g)	NR	NR	NR	<4	120	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	individual product component contributions inferred from XFR analyses
36.2	Kajwara et al., 2011	2008	houses	TCEP		LCD TVs; purchased new in Japan in 2008	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	2	2 TVs, Rear cover 7.0 ng/g TV1 <4 ng/g TV2 Front cover 4.0 ng/g TV1 <4 ng/g TV2 Power board <4 ng/g TV1 PC board for power and fluorescent 4.0 ng/g TV1 5.5 ng/g TV2 Other PC boards 9.0 ng/g TV1 7.0 ng/g TV2 LCD panel <4 ng/g TV1 <4 ng/g TV2)	NR	NR	NR	<4	7	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	
36.3	Kajwara et al., 2011	2008	houses	TCEP	Other products: purchased new in Japan in 2008	Curtains	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	2		NR	NR	NR	4	6	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	
36.4	Kajwara et al., 2011	2008	houses	TCEP	Other products: purchased new in Japan in 2008	Electrical outlets	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	2		NR	NR	NR	4	<8	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	
36.5	Kajwara et al., 2011	2008	houses	TCEP	Other products: purchased new in Japan in 2008	Insulation boards	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	2		NR	NR	NR	<9.0	10	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	
36.6	Kajwara et al., 2011	2008	houses	TCEP	Other products: purchased new in Japan in 2008	Wallpaper	See 36	The selected components were crushed into homogeneous small pieces and then pulverized to a fine powder with a freezer mill prior to extraction for chemical analysis.	Japan	4		NR	NR	NR	<2	<20	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 36.0	See 36.0	See 36.0	See 36.0	
37	**Wensing, 1999 as cited in Malmgren-Hansen et al., 2003**	**NR**	**Houses**	**TCEP**	**Electrical and electronic products**	**10 New and old TVs**	**Survey report of chemicals and their emission characteristics from electrical/electronic products circa late 1990s and early 2000s in Denmark**	**See 37.1-37.2**	**Denmark**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**See 37.1-37.2**	**High relevance for some elements of retrospective exposure assessments considering electronic products circa 1990s and early 2000s**	**Good presentation of emission curves suggested by measurements for these types of electronics. Important profile for considering new/old product emission**	**Results only summarized in review article**	**Methodology only briefly presented in review article.**	**See exposure and risk assessment approach/logic/defining factors for population and exposure characterization**
37.1	Wensing, 1999 as cited in Malmgren-Hansen et al., 2003	NR	Houses	TCEP	Electrical and electronic products	New TVs	See 37	75% of equilibrium after 100 hours	Denmark	10	NR	NR	10	NR	NR	NR	NR	NR	ng/set-hr (0.01 µg/set-hr)	NR	NR	NR	NR	NR	NR	See 37.0	See 37.0	See 37.0	See 37.0	
37.2	Wensing, 1999 as cited in Malmgren-Hansen et al., 2003	NR	Houses	TCEP	Electrical and electronic products	Old TVs	See 37	75% of equilibrium after 100 hours	Denmark	10	NR	NR	NR	NR	10	300	NR	NR	ng/set-hr (<0.01 to 0.30 µg/set-hr)	NR	NR	NR	NR	NR	NR	See 37.0	See 37.0	See 37.0	See 37.0	
38	**Borling et al., 2006**	**NR**	**houses**	**TCEP**	**Children's products**	**1 Sword, 2 floor puzzles, 1swim board, 1 mask, 1 ball, 1 book, 1 activity carpet**	**Danish survey of chemicals in toys and childcare products made from foam plastic**	**See 38.1**	**Denmark**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**See 38.1**	**Not relevant for quantitative exposure assesment, but useful for consideration of toy types and foam content.**	**Good tabulation of many toy types, child age representativeness, construction materials (Tofoam) circa 2004**	**Not useful for quantitative analyses.**	**Toys obtained from Danish wholesalers for large array of toys for different age groups. Relatively simple extraction methods and analytical methods GC/MS made with only internal standards for QA . No methods for quantitative analysis.**	**Methods, calculations, results of Phase 3 objectives not considered in this review: toxicology profiles, exposure assessment**
38.1	Borling et al., 2006	NR	houses	TCEP	Children's products	1 Sword, 2 floor puzzles, 1swim board, 1 mask, 1 ball, 1 book, 1 activity carpet	See 38	Tested foam matrix	Denmark	NR	NR	NR	>0.1%	NR	NR	NR	NR	NR	by content (specific concentrations not reported)	NR	NR	NR	NR	NR	NR	See 38.0	See 38.0	See 38.0	See 38.0	
39	**Tonnig et al., 2008**	**NR**	**Houses**	**TCEP**	**Baby Products**	**3 Foam wash cloths, 2 feeding pillows, 2 covered mattresses, 2 nursing pillows, 2 baby carriers, 2 perambulator aprons**	**Survey of chemicals in baby products in Denmark and health assessments (exposure and risk)**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**See 39.1**	**Key importance is relevance of sweat and saliva migration studies and survey of products and material parts. Likely useful for US circa post 2007 period.**	**Sweat and Saliva migration Study important for risk assessment parameters**	**All samples (<1 µg/g) so no quantification to report for TCEP. Other analyte results reported for each item.**	**Detailed listing of material parts of baby products sampled.**	**Methods and issues related to health assessments not considered in this review. Pp16-17 contain listing of probable material composition of baby products SALIVA MIGRATION STUDY / SWEAT MIGRATION**
39.1	Tonnig et al., 2008	NR	houses	TCEP	Baby Products	3 Foam wash cloths, 2 feeding pillows, 2 covered mattresses, 2 nursing pillows, 2 baby carriers, 2 perambulator aprons	See 39	Chemical analysis of 13 different products		13	NR	NR	<1,000	NR	NR	NR	NR	NR	ng/g (<1 µg/g)	NR	NR	Detection limit = 1,000 ng/g (<1 µg/g)	NR	NR	NR	See 39.0	See 39.0	See 39.0	See 39.0	
40	**Nagase et al., 2003, as cited by ATSDR, 2012 : Section 6.4.4 page 273**	**NR**	**NR**	**TCEP**	**Poly-urethane foam**	**NR**	**NR in ATSDR, 2012**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**See 40.1**	**Limited value**	**Limited value**	**only range of values given for unknown # samples**	**not known...no details provided in ATSDR report.**	
40.1	Nagase et al., 2003, as cited by ATSDR, 2012 : Section 6.4.4 page 273	NR	NR	TCEP	Poly-urethane foam	NR	See 40	NR in ATSDR, 2012	NR	NR	NR	NR	NR	NR	800	3100	NR	NR	ng/g (0.8-3.1 µg/g)	NR	NR	NR	NR	NR	NR	See 40.0	See 40.0	See 40.0	See 40.0	
41.0	**La Guardia et al., 2015**	**NR**	**House, Gym**	**TBB**	**Air, dust, foam**	**NR**	**Measure FR in air, particulates, dust, foam from gym, coach's homes and gym foam to profile exposure opportunity to residues of existing and new FRs.**	**See 41.1-41.10**	**United States, Washington, Seattle**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**See 41.1-41.10**	**General population exposure, key to subpopulation frequenting gyms (children, coaches, workers, parents, atheletes, exercisers)**	**Illustrated preferential affinities of different analytes to different size particulates (as found in other studies), variable factors of foam type, manufacturer, microenvironment AND illustrates dynamics of emerging FRs on overall patterns of residues**	**Supplementary Data exist for details on results and methods--not available for this review. Publication reports mean values on sites, matrices, analytes and for particulate sizes.**	**Contemporary methodology.**	**Conclusions: residue pattern dependent on dust vs particulate size vs foam type. For some analytes is much greater in gym environment as compared to home. Shows residue pattern changing to new FR moieties.**

41.1	La Guardia et al., 2015	NR	House	TBB	Air	NR	See 41	8-hour samples of <4 µm particulates (ArChek 2000 pump). 4 samples for each location.	United States, Washington, Seattle	4	4 samples for each location.	NR	NR	NR	6.93	22	NR	NR	ng/m3 (range of means)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.2	La Guardia et al., 2015	NR	Gym	TBB	Air	NR	See 41	8-hour samples of <4 µm particulates (ArChek 2000 pump). 4 samples for each location.	United States, Washington, Seattle	4	4 samples for each location.	NR	NR	NR	5.41	143	NR	NR	ng/m3 (range of means)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.3	La Guardia et al., 2015	NR	House	TBB	dust	NR	See 41	Settled dust samples (~1 g) were collected from SGA gymnasium floors (bare floor and carpet) at each of the four training facilities and residences of the four coaches.	United States, Washington, Seattle	4	4 samples for each location.	NR	2,580	NR	500	7,100	NR	NR	ng/g (Mean: 2.58 µg/g) Range: (0.5-7.1 µg/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.4	La Guardia et al., 2015	NR	Gym	TBB	dust	NR	See 41	Settled dust samples (~1 g) were collected from SGA gymnasium floors (bare floor and carpet) at each of the four training facilities and residences of the four coaches.	United States, Washington, Seattle	4	4 samples for each location.	NR	40,800	NR	12,300	73,500	NR	NR	ng/g (Mean: 40.8 µg/g) Range: (12.3-73.5 µg/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.5	La Guardia et al., 2015	NR	Gymnastic pit foam block	TBB	Foam	NR	See 41	4 foam blocks from Gym #4 pit, 1 from Gym #2 pit, 1 new block from Gym #4 storage	United States, Washington, Seattle	6	4 samples for each location.	NR	NR	NR	1,400,000	13,700,000	NR	NR	ng/g (Range: 1,400-13,700 ug/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.6	La Guardia et al., 2015	NR	House	TBPH	Air	NR	See 41	8-hour samples of <4 µm particulates (ArChek 2000 pump); 4 samples for each location.	United States, Washington, Seattle	4	4 samples for each location.	NR	NR	NR	8.61	21.4	NR	NR	ng/m3 (range of means)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.7	La Guardia et al., 2015	NR	Gym	TBPH	Air	NR	See 41	8-hour samples of <4 µm particulates (ArChek 2000 pump); 4 samples for each location.	United States, Washington, Seattle	4	4 samples for each location.	NR	NR	NR	11.4	34.3	NR	NR	ng/m3 (range of means)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.8	La Guardia et al., 2015	NR	Gym	TBPH	Dust	NR	See 41	Settled dust samples (~1 g) were collected from SGA gymnasium floors (bare floor and carpet) at each of four training facilities and residences of the four coaches.	United States, Washington, Seattle	4	4 samples for each location.	NR	24,300	NR	4,800	44,900	NR	NR	ng/g (Mean: 24.3 µg/g) Range: (4.8-44.9 µg/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.9	La Guardia et al., 2015	NR	House	TBPH	Dust	NR	See 41	Settled dust samples (~1 g) were collected from SGA gymnasium floors (bare floor and carpet) at each of four training facilities and residences of the four coaches.	United States, Washington, Seattle	4	4 samples for each location.	NR	1,850	NR	700	3,100	NR	NR	ng/g (Mean: 1.85 µg/g) Range: (0.7-3.1µg/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
41.10	La Guardia et al., 2015	NR	Gymnastic pit foam block	TBPH	Foam	NR	See 41	4 foam blocks from Gym #4 pit, 1 from Gym #2 pit, 1 new block from Gym #4 storage	United States, Washington, Seattle	6	4 samples for each location.	NR	NR	NR	225,000	5,710,000	NR	NR	ng/g (Range: 225-5,710 µg/g)	NR	NR	NR	NR	NR	NR	See 41.0	See 41.0	See 41.0	See 41.0	
42	**Carignan et al., 2013a**	**NR**	**Gym**	**TBB, TBPH, TPP, TDCPP, TCPP**	**Indoor air, dust**	**PUF**	**Characterize pattern of FRs in gym environments and personal exposures to gymnasts.**	**See 42.1-42.30**	**United States, Eastern**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**See 42.1-42.30**	**Relevant for exposure assesment to athletes, and to children in activity centers in schools and private centers.**	**measurements of analytes on hands before and after practices presents data for considering dermal loading. Data relating levels in air near pits suggests rates of air loading. Other correlations useful in this paper.**	**median and ranges provided with DF. Supplemental information available from author.**	**comtemporary methodology employed**	**Biomonitoring accompanied the dust/air and handwipe data providing a continuim of personal exposure, environmental media residue concentrations and possible sources of exposure opportunities in the gym environment. Biomonitoring data and correlation methodology not considered in this review.**
42.1	Carignan et al., 2013a	NR	Gym	TBB	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to	United States, Eastern	5	Gym, within 30 cm of the loose foam in the pit	NR	NR	26.1	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.2	Carignan et al., 2013a	NR	Gym	TBB	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	5	Gym, opposite side of gym away from the pit	NR	NR	5.01	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.3	Carignan et al., 2013a	NR	Gym	TBB	dust	PUF	See 42	Gym 1- 1 dust sample from each of the women's gymnastics apparatus (vault, bars, beam, and floor) and 1 from within the loose foam pit. Collected in a cellulose extraction thimble inserted into the crevice tool of a Eureka Mighty-Mite canister vacuum cleaner.	United States, Eastern	5	apparatus	NR	NR	28,900	20,800	85,600	NR	NR	ng/g (Median: 28.9 µg/g) Range: 20.8-85.6 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.4	Carignan et al., 2013a	NR	Gym	TBB	dust	PUF	See 42	Vacuumed dust from two locations: (1) within the loose foam pit and (2) from the surface of a landing mat that covered a small portion of the pit. Vacuum cleaner bag also collected from the gym's vacuum cleaner.	United States, Eastern	3	within and near the pit	NR	NR	10	<1	350	NR	NR	ng/g (Median: 0.01 µg/g) Range: <0.001-0.35 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.5	Carignan et al., 2013a	NR	Gym	TBB	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 100% detection frequency. Median increase from before to after: 152 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples before practice	NR	NR	60.8	8.05	651	NR	NR	ng/wipe	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.6	Carignan et al., 2013a	NR	Gym	TBB	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 100% detection frequency. Median increase from before to after: 152 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples after practice	NR	NR	22	34.9	770	NR	NR	ng/wipe	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.7	Carignan et al., 2013a	NR	Gym	TBPH	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to	United States, Eastern	5	Gym, within 30 cm of the loose foam in the pit	NR	NR	16.9	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.8	Carignan et al., 2013a	NR	Gym	TBPH	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	3	Gym, opposite side of gym away from the pit	NR	NR	2.66	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.9	Carignan et al., 2013a	NR	Gym	TBPH	dust	PUF	See 42	Gym 1- 1 dust sample from each of the women's gymnastics apparatus (vault, bars, beam, and floor) and 1 from within the loose foam pit. Collected in a cellulose extraction thimble inserted into the crevice tool of a Eureka Mighty-Mite canister vacuum cleaner.	United States, Eastern	5	apparatus	NR	NR	30,000	17,300	44,900	NR	NR	ng/g (Median: 30.0 µg/g) Range: (17.3-44.9 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.10	Carignan et al., 2013a	NR	Gym	TBPH	dust	PUF	See 42	Vacuumed dust from two locations: (1) within the loose foam pit and (2) from the surface of a landing mat that covered a small portion of the pit. Collected the gym vacuum cleaner bag that had been used in all areas of the gym including the office and lobby	United States, Eastern	3	within and near the pit	NR	NR	60	<1	210	NR	NR	ng/g (Median: 0.06 µg/g) Range: (<0.001-0.21 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.11	Carignan et al., 2013a	NR	Gym	TBPH	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 91% detection frequency	United States, Eastern	11	hand wipe samples before practice	NR	NR	27.9	<3.19	264	NR	NR	ng/wipe	NR	91%	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.12	Carignan et al., 2013a	NR	Gym	TBPH	Handwipes	PUF	See 42	Median increase from before to after: 70.8 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples after practice	NR	NR	96.4	15.5	416	NR	NR	ng/wipe	NR	100%	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.13	Carignan et al., 2013a	NR	Gym	TPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to	United States, Eastern	5	Gym, within 30 cm of the loose foam in the pit	NR	NR	80.2	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	
42.14	Carignan et al., 2013a	NR	Gym	TPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	3	Gym, opposite side of gym away from the pit	NR	NR	40.5	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0	

42.15	Carignan et al., 2013a	NR	Gym	TPP	dust	PUF	See 42	Gym 1- 1 dust sample from each of the women's gymnastics apparatus (vault, bars, beam, and floor) and 1 from within the loose foam pit. Collected in a cellulose extraction thimble inserted into the crevice tool of a Eureka Mighty-Mite canister vacuum cleaner.	United States, Eastern	5	apparatus	NR	NR	<MDL	<MDL	<MDL	NR	NR	ng/g (<MDL)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.16	Carignan et al., 2013a	NR	Gym	TPP	dust	PUF	See 42	Vacuumed dust from two locations: (1) within the loose foam pit and (2) from the surface of a landing mat that covered a small portion of the pit. Collected the gym vacuum cleaner bag that had been used in all areas of the gym including the office and lobby	United States, Eastern	3	within and near the pit	NR	NR	22900	20100	25000	NR	NR	ng/g (Median: 22.9 µg/g) Range: (201-25 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.17	Carignan et al., 2013a	NR	Gym	TPP	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 91% detection frequency	United States, Eastern	11	hand wipe samples before oractice	NR	NR	NR	NR	NR	NR	NR	ng/wipe	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.18	Carignan et al., 2013a	NR	Gym	TPP	Handwipes	PUF	See 42	Median increase from before to after: 70.8 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples after oractice	NR	NR	NR	NR	NR	NR	NR	ng/wipe	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.19	Carignan et al., 2013a	NR	Gym	TDCPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	5	Gym, within 30 cm of the loose foam in the oit	NR	NR	12.5	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.20	Carignan et al., 2013a	NR	Gym	TDCPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	3	Gym, opposite side of gym away from the oit	NR	NR	8.41	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.21	Carignan et al., 2013a	NR	Gym	TDCPP	dust	PUF	See 42	Gym 1- 1 dust sample from each of the women's gymnastics apparatus (vault, bars, beam, and floor) and 1 from within the loose foam pit. Collected in a cellulose extraction thimble inserted into the crevice tool of a Eureka Mighty-Mite canister vacuum cleaner.	United States, Eastern	5	apparatus	NR	NR	5050	2720	22700	NR	NR	ng/g (Median: 5.05 µg/g) Range: (2.72-22.7 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.22	Carignan et al., 2013a	NR	Gym	TDCPP	dust	PUF	See 42	Vacuumed dust from two locations: (1) within the loose foam pit and (2) from the surface of a landing mat that covered a small portion of the pit. Collected the gym vacuum cleaner bag that had been used in all areas of the gym including the office and lobby	United States, Eastern	3	within and near the pit	NR	NR	13000	3190	38200	NR	NR	ng/g (Median: 13 µg/g) Range: (3.19-38.2 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.23	Carignan et al., 2013a	NR	Gym	TDCPP	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 91% detection frequency	United States, Eastern	11	hand wipe samples before oractice	NR	NR	NR	<31.8	255	NR	NR	ng/wipe	NR	10%	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.24	Carignan et al., 2013a	NR	Gym	TDCPP	Handwipes	PUF	See 42	Median increase from before to after: 70.8 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples after oractice	NR	NR	NR	<31.8	81.9	NR	NR	ng/wipe	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.25	Carignan et al., 2013a	NR	Gym	TCPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	5	Gym, within 30 cm of the loose foam in the oit	NR	NR	2.68	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.26	Carignan et al., 2013a	NR	Gym	TCPP	indoor air	PUF	See 42	Stationary air sampling pumps collected samples over a continuous 75 hour period beginning prior to practice and ending after practice.	United States, Eastern	3	Gym, opposite side of gym away from the oit	NR	NR	0.74	NR	NR	NR	NR	ng/m3	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.27	Carignan et al., 2013a	NR	Gym	TCPP	dust	PUF	See 42	Gym 1- 1 dust sample from each of the women's gymnastics apparatus (vault, bars, beam, and floor) and 1 from within the loose foam pit. Collected in a cellulose extraction thimble inserted into the crevice tool of a Eureka Mighty-Mite canister vacuum cleaner.	United States, Eastern	5	apparatus	NR	NR	2480	750	3060	NR	NR	ng/g (Median: 2.48 µg/g) Range: (0.75-3.06 µg/g)	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.28	Carignan et al., 2013a	NR	Gym	TCPP	dust	PUF	See 42	Vacuumed dust from two locations: (1) within the loose foam pit and (2) from the surface of a landing mat that covered a small portion of the pit. Collected the gym vacuum cleaner bag that had been used in all areas of the gym including the office and lobby	United States, Eastern	3	within and near the pit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.29	Carignan et al., 2013a	NR	Gym	TCPP	Handwipes	PUF	See 42	Analyzed hand wipes from gymnasts before and after 2.5 hour practice; 91% detection frequency	United States, Eastern	11	hand wipe samples before practice	NR	NR	NR	<40.2	97.4	NR	NR	ng/wipe	NR	36%	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
42.30	Carignan et al., 2013a	NR	Gym	TCPP	Handwipes	PUF	See 42	Median increase from before to after: 70.8 ng/wipe; 100% detection frequency	United States, Eastern	11	hand wipe samples after oractice	NR	NR	NR	<40.2	NR	NR	NR	ng/wipe	NR	0%	NR	NR	NR	NR	See 42.0	See 42.0	See 42.0	See 42.0
43	**Carignan et al., 2013b**	**NR**	**Houses, offices, vehicles**	**TDCPP**	**Dust**	**NR**	**Characterize exposure of adult office workers (29) to TDCPP by measuring its primary metabolite BDCPP in urine; measuring TDCPP in dust from their homes,offices, vehicles; and assessing possible predictors of exposure**	**See 43.1-43.4**	**United States, Massachussets, Boston**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**See 43.1-43.4**	**Exposure assesment to populations in offices/residences/public areas.**	**distribution of TDCPP in dust found to be approximately long-normal. May be useful for parametric distributions with data from other studies. Comparisons of data from new, newly renovated and older buildings (and presumably furnishings correlated to building age/renovation) show interesting results.**	**Limited: GM for n samples provided for each building site.**	**good sampling strategy, Contemporary sampling and analytical methods.**
43.1	Carignan et al., 2013b	NR	Houses	TDCPP	Dust	NR	See 43	Vacuum collection through cellulose extraction thimble.	United States, Massachussets, Boston	31	Main living area	NR	NR	NR	560	30,600	NR	4,210	ng/g (Geo mean: 4.21 µg/g) (Range: 0.56-30.6 ua/ai	2700	NR	NR	NR	NR	NR	See 43.0	See 43.0	See 43.0	See 43.0
43.2	Carignan et al., 2013b	NR	Houses	TDCPP	Dust	NR	See 43	Vacuum collection through cellulose extraction thimble.	United States, Massachussets, Boston	29	Bedroom	NR	NR	NR	270	18,200	NR	1,400	ng/g (Geo Mean: 1.40 µg/g) (Range: 0.27-18.2 µg/g)	2500	NR	NR	NR	NR	NR	See 43.0	See 43.0	See 43.0	See 43.0
43.3	Carignan et al., 2013b	NR	Offices	TDCPP	Dust	NR	See 43	Vacuum collection through cellulose extraction thimble.	United States, Massachussets, Boston	30		NR	NR	NR	60	72,00	NR	6,060	ng/g (Geo Mean: 6.06 µg/g) (Range: 0.06-72.0 ua/ai	5400	NR	NR	NR	NR	NR	See 43.0	See 43.0	See 43.0	See 43.0
43.4	Carignan et al., 2013b	NR	Vehicles	TDCPP	Dust	NR	See 43	Vacuum collection through cellulose extraction thimble.	United States, Massachussets, Boston	20		NR	NR	NR	<30	326,000	NR	12,500	ng/g (Geo Mean: 12.5 µg/g) (Range: <0.03-326 ua/ai	6500	NR	NR	NR	NR	NR	See 43.0	See 43.0	See 43.0	See 43.0
44	**Newton et al., 2015**	**2012**	**Various (homes, offices, schools, public spaces)**	**TBB, TBPH**	**Indoor Ventilation air and outdoor air**	**NR**	**Using PBDE FRs environmental occurance as template, Emerging FR occurrence studied in indoor environments and progression to outdoor contamination via building ventillation.**	**See 44.1-44.5**	**Sweden, Stockholm**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**See 44.1-44.5**	**Highly relevant to general population exposure, especially considering new uses of existing FRs and emerging FRs. Relevant to public space exposure opportunity (stores, schools, office, apartment)**	**Not considering outdoor air aspects of this study - insightful profile of residues from new FR uses, relative contribution of exposure opportunity in public space**	**Supporting info. made available by author. Detection Freq, GM, median, min, max reported for n samples for each analyte. Additional details on data in Supplemental Materials, but that was not available for this review**	**Contemporary methods applied. Particulates not separately assessed which could be important aspect of air in this study. Dust collection included direct contact with products explained in SM..not available for this review. May impact results.**	**Outdoor air issues and comparison to PBDE behavior not considered as part of the qualatty review.**
44.1	Newton et al., 2015	2012	various	TBB	Indoor Ventilation air	NR	See 44	Sampler configuration consisting of four sampling trains, each containing a GFF and two PUFs for collecting particle phase and gas phase contaminants	Sweden, Stockholm	12	NR	NR	NR	<0.330	<0.330	9.2	NR	NR	ng/m3 (Median: <330 pg/m3) Range: (<330-9,200 pg/m3)	NR	NR	NR	NR	NR	NR	See 44.0	See 44.0	See 44.0	See 44.0
44.2	Newton et al., 2015	2012	various	TBB	Outdoor air	NR	See 44	48-hour samples taken from April 30 to June 4, 2012 at seven locations using a high volume air pump, connected to a sampling head containing a GFF and two PUFs (samples are PUFs and GFFs combined). DF=75%	Sweden, Stockholm	7	NR	NR	NR	0.00013	<0.000029	0.00047	NR	NR	ng/m3 (Median: 0.13 pg/m3) Range: (<0.029-0.47 pg/m3)	NR	DF. 75%	NR	NR	NR	NR	See 44.0	See 44.0	See 44.0	See 44.0
44.3	Newton et al., 2015	2012	various	TBB	dust	NR	See 44	Dust samples were collected immediately after a 24 hour air sampling period. Settled dust was collected from surfaces at least one meter above the floor.	Sweden, Stockholm	27	NR	NR	NR	9.1	<2.5	65	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 44.0	See 44.0	See 44.0	See 44.0

44.4	Newton et al., 2015	2012	various	TBPH	indoor air	NR	See 44	Sampler configuration consisting of four sampling trains, each containing a GFF and two PUFs for collecting particle phase and gas phase contaminants	Sweden, Stockholm	12	NR		NR	NR	<0.035	<0.035	0.15	NR	NR	ng/m3 (Median: <35 pg/m3) Range: (<35 150 pg/m3)	NR	NR	NR	NR	NR	NR	See 44.0	See 44.0	See 44.0	See 44.0		
44.5	Newton et al., 2015	2012	various	TBPH	dust	NR	See 44	Dust samples were collected immediately after a 24 hour air sampling period. Settled dust was collected from surfaces at least one meter above the floor	Sweden, Stockholm	12	NR		NR	NR	140	<33	1,500	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 44.0	See 44.0	See 44.0	See 44.0		
45	**Ma et al., 2012**	**2005-2011; Jan-Dec**	**NR**	**TBB, TBPH**	**Ambient Air**	**NR**	**Document presence of TBB/TBPH in the environment and investigate atmospheric distributions using 507 samples collected by Integrated Atmospheric Deposition Network at 6 sites aroung shores of Great Lakes as a function of sampling location and time.**	**See 45.1-45.12**	**United States, Illinois, Ohio, New York; Canada**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**See 45.1-45.12**	**Relevant to Background exposure from ambiant air for these geographical North American regions**	**time trend analysis for these analytes in ambient air and possible relationship to measurements in other studies and possible background contamination in air sampling.**	**%detects, range, GM, average for n samples at each location for each analyte. Temporal trend analysis curves also presented.**	**Excellent sample analysis and analytical methods with certified internal standards.**	**Important paper for time-relevant atmospheric trends of FRs in ambient air.**
45.1	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	United States, Illinois, Chicago	86	NR		NR	0.0048	NR	0.0005	0.019	NR	NR	ng/m3 (Mean: 4.8 pg/m3) Range: (0.5-19 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.2	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	United States, Ohio, Cleveland	76	NR		NR	0.0057	NR	0.0005	0.055	NR	NR	ng/m3 (Mean: 5.7 pg/m3) Range: (0.5-55 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.3	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	United States , New York, Sturgeon Point	95	NR		NR	0.00072	NR	0.00011	0.041	NR	NR	ng/m3 (Mean: 0.72 pg/m3) Range: (0.11-41 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.4	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	United States , Michigan, Eagle Harbor	100	NR		NR	0.00057	NR	0.00005	0.0066	NR	NR	ng/m3 (Mean: 0.57 pg/m3) Range: (0.050-6.6 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.5	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	United States, Michigan, Sleeping bear	100	NR		NR	0.00097	NR	0.000086	0.0075	NR	NR	ng/m3 (Mean: 0.97 pg/m3) Range: (0.086-7.5 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.6	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBB	Ambient Air	NR	See 45	24 hour samples every 12 days from 1 January 2005 to 31 December 2011 using high-volume air samplers. XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles.	Canada, Ontario, Point Petre		NR		NR	0.00031	NR	0.000074	0.00082	NR	NR	ng/m3 (Mean: 0.31 pg/m3) Range: (0.074-0.82 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.7	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	United States, Illinois, Chicago	86	NR		NR	0.0062	NR	0.00036	0.076	NR	NR	ng/m3 (Mean: 6.2 pg/m3) Range: (0.36-76 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.8	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	United States, Ohio, Cleveland	76	NR		NR	0.014	NR	0.00047	0.29	NR	NR	ng/m3 (Mean: 14 pg/m3 Range: (0.47-290 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.9	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	United States , New York, Sturgeon Point	95	NR		NR	0.0009	NR	0.00014	0.017	NR	NR	ng/m3 (Mean: 0.9 pg/m3) Range: (0.14-17 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.10	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	United States , Michigan, Eagle Harbor	100	NR		NR	0.0011	NR	0.00013	0.032	NR	NR	ng/m3 (Mean: 1.1 pg/m3) Range: (0.13-32 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.11	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	United States, Michigan, Sleeping bear	100	NR		NR	0.0011	NR	0.00011	0.016	NR	NR	ng/m3 (Mean: 1.1 pg/m3) Range: (0.11-16 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
45.12	Ma et al., 2012	2005-2011; Jan-Dec	NR	TBPH	Ambient Air	NR	See 45	24 hour samples every 12 days from January 1, 2005 to December 31, 2011 using high-volume air samplers: XAD-2 resin to trap vapor phase chemicals, quartz fiber filter to collect particles	Canada, Ontario, Point Petre	45	NR		NR	0.00079	NR	0.00018	0.0037	NR	NR	ng/m3 (Mean: 0.79 pg/m3) Range: (0.18-3.7 pg/m3)	NR	NR	NR	NR	NR	NR	See 45.0	See 45.0	See 45.0	See 45.0		
46	**Schreder and La Guardia, 2014**	**NR**	**house**	**TBB, TBPH**	**dust**	**NR**	**Measure FRs in house dust and laundry wastwater to test the hypothesis that dust collecting on clothing and transferring to laundry water is a source of FRs to wastewater treatment plants and waterways.**	**See 46.1-46.2**	**United States, Massachusetts, Boston**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**See 46.1-46.2**	**US general population exposure re: surface and floor contact and uptake from furnishings directly.**	**Pathway from dust or furniture to human clothes useful as indicator of TRANSFER KINETICS for human exposure parameters. Pathway from house to aquatic life via house effluent important for ecological determinants. Suggestive of residues in seafood.**	**Tedialus discussion of results in text for median values, sometimes with ranges.**	**BFRs analized by UPLC/APPI tandem MS/MS. Validation with NIST SRM 2585.**	
46.1	Schreder and La Guardia, 2014	2011, 2012	house	TBB	dust	NR	See 46	Researchers visited homes to collect dust and laundry wastewater in 2011 and 2012. Dust was collected using a Eureka Mighty-Mite (model 3670G) vacuum fitted with a cellulose filter (Whatman 2800-199) held in the crevice tool with a stainless steel ring. Researchers collected dust from primary living areas including kitchen, living room, bedroom, office, and dining room by moving the crevice tool slowly across bare floor and carpet.	United States, Massachusetts, Boston	20	NR		NR	NR	190	NR	1430	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 46.0	See 46.0	See 46.0	See 46.0		
46.2	Schreder and La Guardia, 2014	2011, 2012	house	TBPH	dust	NR	See 46	Researchers visited homes to collect dust and laundry wastewater in 2011 and 2012. Dust was collected using a Eureka Mighty-Mite (model 3670G) vacuum fitted with a cellulose filter (Whatman 2800-199) held in the crevice tool with a stainless steel ring. Researchers collected dust from primary living areas including kitchen, living room, bedroom, office, and dining room by moving the crevice tool slowly across bare floor and carpet.	United States, Massachusetts, Boston	20	NR		NR	NR	115	NR	435	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 46.0	See 46.0	See 46.0	See 46.0		
47	**Allen et al., 2013**	**NR**	**Airplane**	**TBB, TBPH**	**Dust**	**NR**	**measurement of FRs in airplane microenvironment, transfer to human hands and comparison with other study results in homes and offices**	**See 47.1-47.4**	**United States**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**See 47.1-47.4**	**exposure opportunity of travellers, crew, cleaners, airport workers**	**transfer dynamics inferred with measurements on travellers' hands. XRF shows ubiquitous distribution in plane**	**Good presentation of results and comparisons with similar metrics (other sutdies) for residence / offices. Useful for exposure assessment/residue distributions.**	**Contemporary methodology and validatin with NIST SRM 2585 standard**	**Levels of BDEs > than in residences/offices by orders of magnitude. Residues on hands of travellers. High use of FRs in all plane components and in electronics.**
47.1	Allen et al., 2013	NR	Airplane	TBB	Dust	NR	See 47	300 mg dust samples were collected and quantified usinx GC/EIMS bv ion fraaments	United States	19	floor		NR	NR	350	200	3000	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 47.0	See 47.0	See 47.0	See 47.0		
47.2	Allen et al., 2013	NR	Airplane	TBB	Dust	NR	See 47	300 mg dust samples were collected and quantified usinx GC/EIMS bv ion fraaments	United States	19	vent		NR	NR	740	300	5000	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 47.0	See 47.0	See 47.0	See 47.0		
47.3	Allen et al., 2013	NR	Airplane	TBPH	Dust	NR	See 47	300 mg dust samples were collected and quantified usinx GC/EIMS bv ion fraaments	United States	19	floor		NR	NR	640	400	1600	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 47.0	See 47.0	See 47.0	See 47.0		
47.4	Allen et al., 2013	NR	Airplane	TBPH	Dust	NR	See 47	300 mg dust samples were collected and quantified usinx GC/EIMS bv ion fraaments	United States	19	vent		NR	NR	1200	350	3600	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 47.0	See 47.0	See 47.0	See 47.0		

48	**Hoffman et al., 2014**	**NR**	**House**	**TBB,TBPH**	**Dust**	**NR**	**Characterize human exposure to popular FR "Firemaster 550" measuring FR moieties in dust, handwipes and urine of 64 volunteers**	**See 48.1-48.4**	**United States, North Carolina**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**See 48.1-48.4**	**Highly relevant to general population exposure, especially considering new uses of existing FRs and emerging FRs. Relevant to residues in residences' dust.**	**Relationship of TBB, TBPH residues related to new additive FR products and probable urine metabolites as markers**	**Supplemental Materials made available by author--not available for this review. Data presented: mean, percentile distributions and max for n of different analytes in dust, handwipes, urine**	**Illustrated new analytical method for TBBA in urine and variability of measurements. Contemporary dust analytical methods validated against NIST SRM 2585**	**Like PBDE, FMS50 is additive with leachable components primarily TBB and TBPH**
48.1	Hoffman et al., 2014	NR	House	TBB	Dust	NR	See 48	Nylon thimble in hose attachment of home vacuum – 2 minutes.	United States, North Carolina	53	NR	NR	NR	NR	NR	NR	315.1	ng/g	NR	NR	NR	NR	NR	NR	See 48.0	See 48.0	See 48.0	See 48.0	
48.2	Hoffman et al., 2014	NR	House	TBB	Handwipes	NR	See 48	Hands wiped with sterile gauze wipe soaked in isopropyl alcohol; no range given	United States, North Carolina	53	hands	NR	NR	NR	NR	NR	31.4	ng/g	NR	NR	NR	NR	NR	NR	See 48.0	See 48.0	See 48.0	See 48.0	
48.3	Hoffman et al., 2014	NR	House	TPBH	Dust	NR	See 48	Nylon thimble in hose attachment of home vacuum – 2 minutes.	United States, North Carolina	53	main living areas	NR	NR	NR	NR	NR	364.7	ng/g	NR	NR	NR	NR	NR	NR	See 48.0	See 48.0	See 48.0	See 48.0	
48.4	Hoffman et al., 2014	NR	House	TPBH	Handwipes	NR	See 48	Hands wiped with sterile gauze soaked in isopropyl alcohol	United States, North Carolina	53	NR	NR	NR	NR	9.9	655.1	NR	23.4	ng/wipe	NR	NR	NR	NR	NR	NR	See 48.0	See 48.0	See 48.0	See 48.0	
49	**Stapleton et al., 2008**	**NR**	**House**	**TBB, TBPH**	**Dust**	**NR**	**To detect new FRs replacing PBDE FRs in indoor environments--19 Boston homes--comparing bedroom vs living area -- comparing area specific vs whole floor area residue profile**	**See 49.1-49.7**	**United States, Massachusetts, Boston**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**See 49.1-49.7**	**general population exposure opportunities. Infers source contributions.**	**∑ spatial differences in BFR profiles within a residence. Values from home vacuum cleaner not representative of ranges in single area sampling.**	**Presentation of GM/SD, range %detects for n samples of each site for each analyte. USEFUL for quantification of residue distributions**	**Contemporary methodology and validation w NIST SRM 2585 standard**	**compares sampling methodologies and area-specific sampling vs whole house residue profiles. Concentration highest in living room areas.**
49.1	Stapleton et al., 2008	NR	House	TBB	Dust	NR	See 49	Dust collected using Eureka Mighty-Mite Vacuum	United States, Massachusetts, Boston	16	main living area	NR	NR	NR	<6.6	15030	NR	322	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.2	Stapleton et al., 2008	NR	House	TBB	Dust	NR	See 49	Dust collected using Eureka Mighty-Mite Vacuum	United States, Massachusetts, Boston	14	bedroom	NR	NR	NR	<10.6	378	NR	90.4	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.3	Stapleton et al., 2008	NR	House	TBB	Dust	NR	See 49	Dust collected using home vacuum cleaner	United States, Massachusetts, Boston	7	NR	NR	NR	NR	35.7	669	NR	91.1	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.4	Stapleton et al., 2008	NR	House	TBB	Dust	NR	See 49	Dust collected on hardwood and carpeted floors using a vacuum cleaner with a cellulous thimble	United States, Massachusetts, Boston	10	NR	NR	NR	NR	6	2430	NR	97	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.5	Stapleton et al., 2008	NR	House	TBPH	Dust	NR	See 49	Dust collected using Eureka Mighty-Mite Vacuum	United States, Massachusetts, Boston	16	main living area	NR	NR	NR	3	10630	NR	234	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.6	Stapleton et al., 2008	NR	House	TBPH	Dust	NR	See 49	Dust collected using Eureka Mighty-Mite Vacuum	United States, Massachusetts, Boston	14	bedroom	NR	NR	NR	1.5	763	NR	105	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
49.7	Stapleton et al., 2008	NR	House	TBPH	Dust	NR	See 49	Dust collected using home vacuum cleaner	United States, Massachusetts, Boston	7	NR	NR	NR	NR	24.3	111	NR	65.8	ng/g	NR	NR	NR	NR	NR	See 49.0	See 49.0	See 49.0	See 49.0	
50	**Brown et al., 2014**	**NR**	**Homes, fire station quarters**	**TBB, TBPH**	**Dust**	**NR**	**measurement of 11 novel brominated FRs in house dust and dust in firestations for exposure related to children and firefighter occupational exposure.**	**See 50.1-50.4**	**United States, California, Northern**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**See 50.1-50.4**	**General population (including children) exposure and exposure contributions to firefighter/workers in fire stations**	**Standard FR residue study**	**Details presented in Supplemental Info not available for this review.**	**different sampling and sample handling methodologies between house/firestation. Validation with NIST SRM 2585 OR "contemporary house dust sample used as a lab control" Latter option not as desireable for validation process. Different methodologies compromise comparisons**	
50.1	Brown et al., 2014	NR	Homes	TBB	Dust	NR	See 50	2010 Childhood leukemia study; dust samples collected from vacuum cleaners	United States, California, Northern	59				NR	<0.64	19198	NR	310	ng/g	NR	NR	NR	NR	NR	See 50.0	See 50.0	See 50.0	See 50.0	
50.2	Brown et al., 2014	NR	Fire station quarters	TBB	Dust	NR	See 50	2010-2011 Firefighter occupational exposure study; dust samples collected from vacuum cleaners	United States, California, Northern	27				NR	<0.64	29007	NR	1400	ng/g	NR	NR	NR	NR	NR	See 50.0	See 50.0	See 50.0	See 50.0	
50.3	Brown et al., 2014	NR	Homes	TBPH	Dust	NR	See 50	2010 Childhood leukemia study; dust samples collected from vacuum cleaners	United States, California, Northern	59				NR	<0.64	3483	NR	144	ng/g	NR	NR	NR	NR	NR	See 50.0	See 50.0	See 50.0	See 50.0	
50.4	Brown et al., 2014	NR	Fire station quarters	TBPH	Dust	NR	See 50	2010-2011 Firefighter occupational exposure study; samples were collected from vacuum cleaners	United States, California, Northern	27				NR	<0.64	11422	NR	1096	ng/g	NR	NR	NR	NR	NR	See 50.0	See 50.0	See 50.0	See 50.0	
51	**Johnson et al., 2013**	**NR**	**Houses**	**TBB, TBPH**	**Dust**	**NR**	**Study association etween PBDEs in house dust and hormone levels in men being treated for infertility**	**See 51.1-51.2**	**United States, Boston, Massachusetts**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**See 51.1-51.2**	**Limited utility in general population exposure**	**Limited utility for exposure related issues**	**mean, percentiles, max and %detects noted for each analyte in n dust samples.**	**Problematic: Sample collection by mail-in of home vacuum bags. Some lab contamination suggested by high blanks and corrections for TBB and TBPH results. Does not invalidate results.Low TBB and TBPH detection frequencies atypical. Calls into question results for TBB and TBPH, especially considering sample collection methods.**	**Biomonitoring methodology and correclations to FR levels in dust not considered in this review. Conclusions: singificant positive associations between house dust concentrations of PBDEs and hormone level disruption in men.**
51.1	Johnson et al., 2013	NR	Houses	TBB	Dust	NR	See 51	Detected in 47% of home vacuum samples	United States, Boston, Massachusetts	38	NR	NR	NR	NR	NR	72460	NR	409	ng/g	NR	47%	NR	NR	NR	See 51.0	See 51.0	See 51.0	See 51.0	
51.2	Johnson et al., 2013	NR	Houses	TBPH	Dust	NR	See 51	TBPH detected in 63% of home vacuum samples	United States, Boston, Massachusetts	38	NR	NR	NR	NR	NR	47110	NR	377	ng/g	NR	63%	NR	NR	NR	See 51.0	See 51.0	See 51.0	See 51.0	
52	**Stapleton et al., 2009**	**NR**	**Houses**	**TBB, TBPH**	**Dust**	**NR**	**To investigate chemicals being used as replacements for PBDE in polyurethane foam, measured 2EHpes furniture and house dust (due to hi%detection clorinated phosphates in furniture foam)**	**See 52.1-52.5**	**United States, Boston, Massachusetts**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**See 52.1-52.5**	**Limited use for exposure assessment in US homes for issues related to methodology and uses of FRs in consumer products in great flux during era of this study.**	**Poor connections between source and dust levels.**	**Mean,ranges %detection given in text. Problems with methodology in this study and some unexpected quantitative results call these data into question.**	**Problematic issues: Dust samples NOT collected from same sites as foam samples. Problematic for showing source effect or changes in use of PBDE or alternative FRs. Validation did not use NIST standards. Blank corrections were high for TCPP, TDPP, TPP. Co-elution problems in extraction process.**	**note: Sampling focused on manufacturer claiming to not use brominated flame retardants. Dust study intended to determine if alternatives were accumulating in house dust.**
52.1	Stapleton et al., 2009	NR	Houses	TBB	dust	NR	See 52	Household vacuum cleaner bag collection	United States, Boston, Massachusetts	50	NR	NR	NR	NR	<450	75000	NR	840	NR	NR	NR	NR	NR	NR	See 52.0	See 52.0	See 52.0	See 52.0	
52.2	Stapleton et al., 2009	NR	Houses	TBB	Dust	NR	See 52	Household vacuum cleaner bag collection	United States, Boston, Massachusetts	50	NR	NR	NR	NR	<450	75000	NR	840	NR	NR	NR	NR	NR	NR	See 52.0	See 52.0	See 52.0	See 52.0	
52.3	Stapleton et al., 2009	NR	Couch	TBB	PU foam	NR	See 52	One couch tested, purchased in 2007	United States, Boston, Massachusetts	50	4.2% by weight (TBB and TBPH toeether)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 52.0	See 52.0	See 52.0	See 52.0	
52.4	Stapleton et al., 2009	NR	Houses	TBPH	House (n=50)	NR	See 52	Household vacuum cleaner bag collection; collected between 2002-2007; 60% detection	United States, Boston, Massachusetts	50	NR	NR	NR	NR	<300	47110	NR	650	NR	NR	NR	NR	NR	NR	See 52.0	See 52.0	See 52.0	See 52.0	
52.5	Stapleton et al., 2009	NR	Couch	TBPH	PU foam	NR	See 52	One couch tested, purchased in 2007	United States, Boston, Massachusetts	1	One couch tested, purchased in 2007	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 52.0	See 52.0	See 52.0	See 52.0	

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57.3	Ali et al., 2012b	NR	Houses	TBPH	Dust	NR	See 57	Dust samples collected with brush over 4 m2 floor surface; sieved through a 500 µm mesh sieve; level of detection not reported.	Pakistan, Gujrat	31	Houses	NR	7.3	3.5	<0.2	141	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 57.0	See 57.0	See 57.0	See 57.0				
57.4	Ali et al., 2012b	NR	Mosques	TBPH	Dust	NR	See 57	Dust samples collected with brush over 4 m2 floor surface; sieved through a 500 µm mesh sieve; level of detection not reported.	Pakistan, Gujrat	12	Mosques	NR	NR	8	1	10	NR	NR	ng/g (estimated from graph)	NR	NR	NR	NR	NR	NR	See 57.0	See 57.0	See 57.0	See 57.0				
58	**Ali et al., 2014**	**NR**	**University, electronic stores, clothing**	**TBB, TBPH**	**Dust**	**NR**	**1) measure contaminants in indoor dust in 3 occupational settings,**	**See 58.1-58.6**	**Pakistan, Faisalabad**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**See 58.1-58.6**	**Not useful for US occupational assessments. Origins of**	**Not useful**	**Good presentation of results and statistical description, but not necessarily relevant for US exposure**	**Broad objectives covering multiple variables of sampling**	**major aspects of this study involving determinant of inhalation as pathway, sampling, analysis and conclusions of**	
58.1	Ali et al., 2014	NR	University	TBB	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of floor surface. Samples were sieved through a 500 µm mesh sieve	Pakistan, Faisalabad	16	University	NR	2	1.3	<0.2	16	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
58.2	Ali et al., 2014	NR	Clothing store	TBB	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of floor surface. Samples were sieved through a 500 µm mesh sieve	Pakistan, Faisalabad	15	clothing store	NR	0.6	0.7	<0.2	1.2	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
58.3	Ali et al., 2014	NR	Electronic stores	TBB	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of floor surface. Samples were sieved through a 500 µm mesh sieve	Pakistan, Faisalabad	30	Electronic stores	NR	3	1	0.2	15	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
58.4	Ali et al., 2014	NR	University	TBPH	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of the floor surface. Samples were sieved through a 500 µm mesh sieve.	Pakistan, Faisalabad	16	University	NR	35	19	3	225	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
58.5	Ali et al., 2014	NR	Clothing store	TBPH	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of the floor surface. Samples were sieved through a 500 µm mesh sieve.	Pakistan, Faisalabad	15	Clothing Store	NR	11	9	<0.2	35	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
58.6	Ali et al., 2014	NR	Electronic stores	TBPH	Dust	NR	See 58	Dust samples collected by brushing 4 m2 of the floor surface. Samples were sieved through a 500 µm mesh sieve.	Pakistan, Faisalabad	30	Electronic Store	NR	100	20	0.6	950	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 58.0	See 58.0	See 58.0	See 58.0				
59	**Ali et al., 2011b**	**NR**	**E-waste Storage Facility**	**TBB, TPBH**	**Dust**	**Electronic devices**	**Objectives: Analytical and Sample Prep Methods Development; application of new method to measurement of NBFRs in dust from e-waste storage facilities.**	**See 59.1-59.8**	**Thailand, Ayutthaya and Nonthaburi Provinces**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**See 59.1-59.8**	**Direct use of concentration values relevant to unique occupational exposure scenarios. However, patterns insightful for consideration of exposures in spaces containing electronics**	**Important contribution to understanding FR from electronic sources: Residue contributions to dust under different conditions of electronic types useful to extrapolate to relative contributions from different types of electronics.**	**Excellent presentation of results: %detect, LOQ, min, max, mean, median 95th %ile, GM and SD given for n samples of each grouping. Individual types of electronics facility space presented.**	**Excellent methodology for sample prep and analysis.**		
59.1	Ali et al., 2011b	NR	E-waste Storage Facility	TBB	Dust	Electronic devices	See 59	Dust samples were collected using 25-µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner	Thailand, Ayutthaya and Nonthaburi Provinces	21	NR	NR	18	NR	<2	59	NR	NR	ng/g	14	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.2	Ali et al., 2011b	NR	E-waste Storage Facility	TBB	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	12	PC, printer	NR	NR	NR	4	59	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.3	Ali et al., 2011b	NR	E-waste Storage Facility	TBB	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	2	TV	NR	NR	NR	<2	9	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.4	Ali et al., 2011b	NR	E-waste Storage Facility	TBB	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	7	PC, TV, fridge, washing machine, video recorder, fan, microwave, rice cooker, photocopier, tvoewriter	NR	NR	NR	5	36	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.5	Ali et al., 2011b	NR	E-waste Storage Facility	TBPH	Dust	Electronic devices	See 59	Dust samples were collected using 25-µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner	Thailand, Ayutthaya and Nonthaburi Provinces	21		NR	270	NR	79	1300	NR	NR	ng/g	265	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.6	Ali et al., 2011b	NR	E-waste Storage Facility	TBPH	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	12	PC, printer	NR	NR	NR	110	1300	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.7	Ali et al., 2011b	NR	E-waste Storage Facility	TBPH	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	2	TV	NR	NR	NR	144	181	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
59.8	Ali et al., 2011b	NR	E-waste Storage Facility	TBPH	Dust	Electronic devices	See 59	Dust samples were collected using 25µm pore size nylon sampling socks inserted in the nozzle of a vacuum cleaner in a room containing the products listed under type.	Thailand, Ayutthaya and Nonthaburi Provinces	7	PC, TV, fridge, washing machine, video recorder, fan, microwave, rice cooker, photocopier, tvoewriter	NR	NR	NR	79	419	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 59.0	See 59.0	See 59.0	See 59.0				
60	**Springer et al., 2012**	**2009, winter**	**Office, houses, cars**	**TBPH**	**Dust**	**NR**	**Objectives: 1)measure TBPH in dust collected from homes, offices, cars; isolate TBPH, metabolize with esterases in vitro, use TBMEHP in toxicology testing.**	**See 60.1-60.3**	**United States, Boston, Massachusetts**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**See 60.1-60.3**	**General population exposure assesment: consider climate conditions as sampling conductted in winter Boston 2009.**	**General principles for exposure-related issue.**	**Median, range, %detects were presented for n samples in each category. Useful for distributions for exposure assesments.**	**Very good methods employed for dust collection, analysis including QA with NIST SRM 2585 samples.**	**Methods, results and conclusions related to *in vitro* and *in vivo* studies not considered in this review.**	
60.1	Springer et al., 2012	NR	Office	TBPH	dust	NR	See 60	Dust samples were collected by investigators using a cellulose extraction thimble (Whatman International, Piscataway, NJ) inserted between the crevice tool and vacuum tube extender of a Eureka Mighty-Mite vacuum cleaner. Each main living area of the home and each office was vacuumed for approximately 10 min, capturing dust from the surface area of the room.	United States, Boston, Massachusetts	31	NR	NR	NR	410	95	15500	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	NR	See 60.0	See 60.0	See 60.0	See 60.0				
60.2	Springer et al., 2012	NR	Houses	TBPH	dust	NR	See 60	Dust samples were collected by investigators using a cellulose extraction thimble (Whatman International, Piscataway, NJ) inserted between the crevice tool and vacuum tube extender of a Eureka Mighty-Mite vacuum cleaner. Each main living area of the home and each office was vacuumed for approximately 10 min, capturing dust from the surface area of the room.	United States, Boston, Massachusetts	31	NR	NR	NR	150	<4	12400	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	NR	See 60.0	See 60.0	See 60.0	See 60.0				
60.3	Springer et al., 2012	NR	Cars	TBPH	dust	NR	See 60	Dust samples were collected by investigators using a cellulose extraction thimble (Whatman International, Piscataway, NJ) inserted between the crevice tool and vacuum tube extender of a Eureka Mighty-Mite vacuum cleaner. Cars were vacuumed for approximately 10 min, collecting dust from the entire surface of the front and back seats. The dashboard, floor, and other surfaces of the vehicles were not vacuumed.	United States, Boston, Massachusetts	20	NR	NR	NR	400	<36	4830	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	NR	See 60.0	See 60.0	See 60.0	See 60.0				

61	**Makinen et al., 2009**	**NR**	**Circuit board factory, furniture workshop, electronics dismantling facilities, computer classroom**	**TBBPA**	**Indoor air, personal patch samples and handwash**	**NR**	**Objectives: To measure occupational exposure to Ops and TBBPA by 1) air samplings 2) personal patch analysis and handwashings (for dermal exposure potential.**	**See 61.1-61.12**		**Finland**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**See 61.1-61.12**	**Occupational exposure--especially electronics related industries.**	**Illustrates important general patterns of residue in occupational areas and consequence to workers in terms of personal exposure. Quantification issues limit this but obvious importance of electronics industry exposure.**	**Small sampling size for personal monitoring (personal patches and handwashes), and analytical issues compromise quantification and reliability of comparisons. Limited use for exposure assessment BUT important highlight of high levels in electronics industries.**	**Standard methodology for analysis, but issues with recovery rates suggest problem or contamination or internal standards issues . No NIST standards available. Particle, air and small particle isolates combined. Some compromise to reliability of quantification. Three methods used, but variation and small sample numbers for personal monitoring (n=2)**	
61.1	Makinen et al., 2009	NR	Circuit board factory	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	NR	NR	NR	<3	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.2	Makinen et al., 2009	NR	Furniture workshop	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	NR	NR	NR	6	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.3	Makinen et al., 2009	NR	Electronics dismantling facility I	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	60	180	NR	100	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.4	Makinen et al., 2009	NR	Electronics dismantling facility II	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	20	170	NR	60	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.5	Makinen et al., 2009	NR	Computer classroom	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	NR	NR	NR	<6	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.6	Makinen et al., 2009	NR	Offices and social premises of factory and workshops	TBBPA	Indoor air	NR	See 61	Two samplers: a glass fiber filter placed in an IOM sampler collected the inhalable fraction of particles; an OVS sampler containing a filter collected particles. XAD resin and PU foam were used for the sampling of compounds present in the gas phase. In the analysis, the gas and particle phases were not separated.		Finland		NR	NR	NR	NR	NR	NR	NR	NR	<6	ng/m3	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.7	Makinen et al., 2009	NR	Circuit board factory	TBBPA	adiobent personal patch material	NR	See 61	Patch test: Absorbent patches affixed to worker clothing for 6 hours.		Finland	3	Patch test (n=3; chest, arm, thigh)	NR	NR	NR	NR	NR	NR	NR	<0.09	ng/cm2	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.8	Makinen et al., 2009	NR	Circuit board factory	TBBPA	ethanol hand wash	NR	See 61	Hand wash: workers rubbed hands while ethanol poured over for 30 seconds.		Finland	2	Hand wash (n=2)	NR	NR	NR	NR	NR	NR	NR	<0.09	ng/two hands	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.9	Makinen et al., 2009	NR	Furniture workshop	TBBPA	ethanol hand wash	NR	See 61	Patch test: Absorbent patches affixed to worker clothing for 6 hours.		Finland	1	Patch test (n=1; chest)	NR	NR	NR	NR	NR	NR	NR	<0.09	ng/cm2	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.10	Makinen et al., 2009	NR	Furniture workshop	TBBPA	ethanol hand wash	NR	See 61	Hand wash: workers rubbed hands while ethanol poured over for 30 seconds.		Finland	2	Hand wash (n=2)	NR	NR	NR	NR	NR	NR	NR	<0.09	ng/two hands	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.11	Makinen et al., 2009	NR	Electronics dismantling facility I	TBBPA	adiobent personal patch material	NR	See 61	Patch test: Absorbent patches affixed to worker clothing for 6 hours.		Finland	3	Patch test (n=3; chest, arm, thigh)	NR	NR	NR	0.4	17	NR	2	ng/cm2	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
61.12	Makinen et al., 2009	NR	Electronics dismantling facility II	TBBPA	adiobent personal patch material	NR	See 61	Patch test: Absorbent patches affixed to worker clothing for 6 hours.		Finland	3	Patch test (n=3; chest, arm, thigh	NR	NR	NR	<0.09	63	NR	6.7	ng/cm2	NR	NR	NR	NR	NR	NR	See 61.0	See 61.0	See 61.0	See 61.0	
62	**Abb et al., 2011**	**NR**	**Houses**	**TBBPA**	**Dust**	**NR**	**measure brominated FR in house dust in Germany and US and compare with other studies using different methods.**	**See 62.1**		**U.S. and Germany**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**See 62.1**	**Not useful for US general population exposure assessment**	**Comparisons of results against studies with different methods : extractions via different solvents--no significant difference.**	**Poor presentation of results and reference to "average 50" across a range of analytes. Quality of data presentation poor and use of two US samples (Denver, CO) as a representative sample of US dust content is unacceotable.**	**Methods used little internal or external standards and may have had contaminantion issues.**	
62.1	Abb et al., 2011	NR	Houses	TBBPA	Dust	NR	See 62	Household vacuum cleaner bag collection; detected in 20 of 26 samples		U.S. and Germany	26	House (U.S. n=2; Germany n=24)	86	NR	48	NR	470	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 62.0	See 62.0	See 62.0	See 62.0	
63	**Wanner et al., 2008, as cited in Abb et al., 2011**	**NR**	**Houses**	**TBBPA**	**dust**	**NR**	**Cited results for purpose of comparison of dust concentrations in the UK**	**See 63.1**		**Germany**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**See 63.1**	**Limited relevance to consider values in different countries by studies using slightly diff. analytical methods.**	**Comparisons not directly quantifiably comparative**	**Median, av values given for n samples in different studies. Not useful to prepare values for quantitative exposure assessment**	**Methods mostly unknown except that HRGC-MS used for analytical methods.**	
63.1	Wanner et al., 2008, as cited in Abb et al., 2011	NR	Houses	TBBPA	Dust	NR	See 63	Detection level not reported		Germany	34	NR	ND	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 63.0	See 63.0	See 63.0	See 63.0	
64	**Abdallah et al., 2008a, as cited in Abb et al., 2011**	**NR**	**Houses, Offices, cars**	**TBBPA**	**Dust**	**NR**	**Cited results for purpose of comparison of dust concentrations in Germany**	**See 64.1-64.3**		**United Kingdom, England, Birmingham**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**See 64.1-64.3**	**Limited relevance to consider values in different countries by studies using slightly diff. analytical methods.**	**Comparisons not directly quantifiably comparative**	**Median, av values given for n samples in different studies. Not useful to prepare values for quantitative exposure assessment**	**Methods mostly unknown except that LC-MS/MS used for analytical methods.**	
64.1	Abdallah et al., 2008a, as cited in Abb et al., 2011	NR	Houses	TBBPA	Dust	NR	See 64	Samples collected using nylon sample socks (25 µm pore size) that were mounted in the furniture attachment tube of vacuum cleaner.		United Kingdom, England, Birmingham	45	NR	87	NR	62	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 64.0	See 64.0	See 64.0	See 64.0	
64.2	Abdallah et al., 2008a, as cited in Abb et al., 2011	NR	Offices	TBBPA	Dust	NR	See 64	Samples collected using nylon sample socks (25 µm pore size) that were mounted in the furniture attachment tube of vacuum cleaner.		United Kingdom, England, Birmingham	28	NR	NR	NR	36	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 64.0	See 64.0	See 64.0	See 64.0	
64.3	Abdallah et al., 2008a, as cited in Abb et al., 2011	NR	Cars	TBBPA	Dust	NR	See 64	Samples collected using nylon sample socks (25 µm pore size) that were mounted in the furniture attachment tube of vacuum cleaner.		United Kingdom, England, Birmingham	20	NR	NR	NR	2	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 64.0	See 64.0	See 64.0	See 64.0	
65	**Harrad et al., 2010**	**NR**	**Daycare centers and primary schools classrooms**	**TBBPA**	**Dust**	**NR**	**characterize levels of BFRs and PCBs in primary school and daycare classrooms and use data for exposure assement to young children**	**See 65.1**		**United Kingdom West Midlands**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**See 65.1**	**Useful for exposure assessments for toddlers and young children in general population. More retrospective value since collections done 2007-2008 era.**	**no unique utility**	**Presents min, max, 5th, 50th, 95th %ile and mean for n values. Useful for quantitative assessment.**	**standard sampling and LC-MS/MS . Full floor surface vacuumed in classrooms. QS ?? May be in Suppl. Info.**	**Methods, calculations and results of exposure assessments not included in this review. Study results compared with results from US studies in homes, cars, offices**
65.1	Harrad et al., 2010	NR	Daycare centers and primary schools classrooms	TBBPA	dust	NR	See 65	Portable vacuum cleaners with 25ug mesh sock, entire floor surface		United Kingdom	43	NR	NR	200	110	17	1400	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 65.0	See 65.0	See 65.0	See 65.0	
66	**Toms et al., 2009 as cited in Abb et al., 2011**	**NR**	**Houses**	**TBBPA**	**Dust**	**NR**	**Cited results for purpose of comparison of dust concentrations in Australia**	**See 66.1**		**Australia**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**See 66.1**	**Limited relevance to consider values in different countries by studies using slightly diff. analytical methods.**	**Comparisons not directly quantifiably comparative**	**Median, av values given for n samples in different studies. Not useful to prepare values for quantitative exposure assessment**	**Methods mostly unknown except that HRGC-HRMS used for analytical methods.**	
66.1	Toms et al., 2009 as cited in Abb et al., 2011	NR	Houses	TBBPA	dust	NR	See 66	Detection level and method not reported		Australia	10	NR	NR	ND	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 66.0	See 66.0	See 66.0	See 66.0	

67	**D'Hollander et al., 2010**	**NR**	**Houses, offices**	**TBBPA**	**Dust**	**NR**		**See 67.1-67.2**	**Belgium, Flanders**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**See 67.1-67.2**	**General population exposure assessment for TBBPA from home dust. Note era and temperate climate makes this best for retrospective assesments.**	**Limited extrapolations because of era, limited ventilation, building materials and products in Flanders Belgium**	**Only mean and 95th %ile given for results – difficult for use in creating distributions or understanding pattern.**	**Standard methods for vacuum, whole area collections; for sample prep. Analalytical by MS EN/MS MRM for TBBPA. 13C internal standards used for QA**	**Methods, calculations, conclusions of exposure assessments not considered in this review. Conclusions re relative contribution to overall exposure not reviewed.**
67.1	D'Hollander et al., 2010	NR	Houses	TBBPA	dust	NR	See 67	Samples collected with a vacuum using a nylon sock mounted in the furniture attachment	Belgium, Flanders	45	NR	NR	NR	11.7	NR	NR	141	NR	ng/g	NR	NR	NR	NR	NR	NR	See 67.0	See 67.0	See 67.0	See 67.0	See 67.0
67.2	D'Hollander et al., 2010	NR	Offices	TBBPA	Dust	NR	See 67	Samples collected with a vacuum using a nylon sock mounted in the furniture attachment	Belgium, Flanders	10	NR	NR	NR	70.4	<3	419	212	NR	ng/g	NR	NR	NR	NR	NR	NR	See 67.0	See 67.0	See 67.0	See 67.0	See 67.0
68	**Geens et al., 2009**	**NR**	**Houses, offices**	**TBBPA**	**Dust**	**NR**	**Measurement of BFA, TBBPA, Triclosan in dust in Belgian homes and offices.**	**See 68.1-68.2**	**Belgium, Flanders**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**See 68.1-68.2**	**General population exposure assessment for TBBPA from home dust. Note era and temperate climate makes this best for retrospective assesments.**	**Limited extrapolations because of era, limited ventilation, building materials and products in Flanders Belgium**	**For offices, two measurements given. For homes (n=18) min, max, mean, SD, 95th %ile. Adequate for distribution.**	**Standard methods for vacuum, whole area collections; for sample prep. Analalytical by MS EN/MS MRM for TBBPA. 13C internal standards used for QA**	**Methods, calculations, conclusions of exposure assessments not considered in this review. Conclusions re relative contribution to overall exposure not reviewed. Study found levels in offices ~ 10x levels in houses.**
68.1	Geens et al., 2009	NR	Houses	TBBPA	dust	NR	See 68	Collected using a vacuum cleaner	Belgium, Flanders	18	NR	NR	NR	10	1	1480	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 68.0	See 68.0	See 68.0	See 68.0	
68.2	Geens et al., 2009	NR	Offices	TBBPA	Dust	NR	See 68	Collected using a vacuum cleaner	Belgium, Flanders	2	NR	NR	NR	75	45	100	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 68.0	See 68.0	See 68.0	See 68.0	
69	**Cunha et al., 2010 as cited in Abb et al., 2011**	**NR**	**Houses**	**TBBPA**	**Dust**	**NR**	**Cited results for purpose of comparison of dust concentrations in Portugal**	**See 69.1**	**Portugal**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**See 69.1**	**Limited relevance to consider values in different countries by studies using slightly diff. analytical methods.**	**Comparisons not directly quantifiably comparative**	**Median, av values given for n samples in different studies. Not useful to prepare values for quantitative exposure assessment**	**Methods mostly unknown except that GC-MS used for analytical methods.**	
69.1	Cunha et al., 2010 as cited in Abb et al., 2011	NR	Houses	TBBPA	Dust	NR	See 69	NR in Abb et al., 2011	Portugal	10	NR	NR	ND	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 69.0	See 69.0	See 69.0	See 69.0	
70	**Takigami et al., 2009**	**NR**	**Houses**	**TBBPA**	**Dust**	**NR**	**NR**	**See 70.1**	**Japan**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**See 70.1**	**Limited relevance: two houses/two samples/Japanese housing scenario from 2004-2006 construction.**	**limited value given limited sampling**	**only two samples for dust those values presented**	**Contemporary methods**	**methods and results for air sampling not considered in this review.**
70.1	Takigami et al., 2009	NR	Houses	TBBPA	Dust	NR	NR	Collected dust from owners' vacuum cleaners	Japan	2	NR	490	NR	520	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 70.0	See 70.0	See 70.0	See 70.0	
71	**Deng et al., 2014**	**NR**	**Dismantling and sorting workshop, Printed circuit board recycling workshop, Wire recycling workshop**	**TBBPA**	**Dust**	**TV housing, printed circuit board, wires**	**1)Study levels and distribution characteristics of PBDEs, TBBPA, 5 heavy metals; 2)assess occupational risk in recycling industry**	**See 71.1-71.6**	**China**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**See 71.1-71.6**	**Not directly relevant to general population exposure as these were measurements in a Chinese industry deconstructing 2000 TVs daily. General principles may be relevant for electronic shops, facilities restoring computers, home based work scenarios.**	**General information about BFRs and heavy metals in electronics which can migrate, volatilize or otherwise become released into the environment**	**not relevant for general exposure assessment**	**not relevant for general exposure assessment**	**excellent review and explanation of electronics recycling process in bulk.**
71.1	Deng et al., 2014	NR	Dismantling and sorting workshop	TBBPA	Dust	Electrical equipment	See 71	Waste electrical and electronic equipment recycling plant; handheld vacuum cleaner collection	China	12	NR	NR	NR	NR	206	950	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
71.2	Deng et al., 2014	NR	Printed circuit board recycling workshop	TBBPA	Dust	circuit board	See 71	Waste electrical and electronic equipment recycling plant; handheld vacuum cleaner collection	China	15	NR	NR	NR	NR	189	961	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
71.3	Deng et al., 2014	NR	Wire recycling workshop	TBBPA	Dust	wire	See 71	Waste electrical and electronic equipment recycling plant; handheld vacuum cleaner collection	China	3	NR	NR	80.4	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
71.4	Deng et al., 2014	NR	NR	TBBPA	Dust	NR	See 71	Waste electrical and electronic equipment recycling center	China	12	NR	NR	18,500,000	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
71.5	Deng et al., 2014	NR	NR	TBBPA	Dust	NR	See 71	Waste electrical and electronic equipment recycling center	China	10	NR	NR	20,500	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
71.6	Deng et al., 2014	NR	NR	TBBPA	Dust	NR	See 71	Waste electrical and electronic equipment recycling center	China	6	NR	NR	7,450	NR	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 71.0	See 71.0	See 71.0	See 71.0	
72	**Ni and Zeng, 2013**	**2009, March**	**Offices**	**TBBPA**	**Dust**	**NR**	**Research the occurrence of polybrominated diphenyl ethers (PBDEs) in central air conditioner filter dust (PFIA in the present study) from an office building in Shenzhen, China.**	**See 72.1-72.3**	**China, Shenzhen**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**See 72.1-72.3**	**Highly relevant: General population exposure in public spaces / office scenarios.Study done in China, but Shenzhen located on coast, opposite Hong Kong. Heavy industrial air pollution less prevalent than interior China areas. Study involves 56 office sites – broad sampling**	**Comparison of whole dust, PZ.5 and PZD fractions. Important for possible default extrapolation to other studies.**	**Excellent presentation of whole dust, PZ.5 and PZD content. GM,SD,min, max, median,mean presented. Useful for distributions for exposure assessment.**	**Interesting methodology, esp for large areas (offices/public spaces) Authors note liklihood of underestimation of contribution of small particles because of sampling methodology issues. Excellent analytical methodology. 56 office spaces tested.**	**Valuable study.**
72.1	Ni and Zeng, 2013	2009, March	Offices	TBBPA	Dust	NR	See 72	Central air conditioner filter dusts were collected as Particulate Phase of Indoor Air samples	China	56		NR	3,382	975	30	59,140	NR	949	ng/g	5	NR	NR	NR	NR	NR	See 72.0	See 72.0	See 72.0	See 72.0	
72.2	Ni and Zeng, 2013	2009, March	Offices	TBBPA	Indoor air, PM2.5	NR	See 72	Central air conditioner filter dusts were collected as Particulate Phase of Indoor Air samples	China	56		NR	0.465	0.507	0.0127	1.057	NR	NR	ng/m3 (Mean: 465; Median: 507; Range: 12.7-1057 oe/m3)	NR	NR	NR	NR	NR	NR	See 72.0	See 72.0	See 72.0	See 72.0	
72.3	Ni and Zeng, 2013	2009, March	Offices	TBBPA	Indoor air, PM10	NR	See 72	Central air conditioner filter dusts were collected as Particulate Phase of Indoor Air samples	China	56		NR	0.235	0.240	0.00626	0.511	NR	NR	ng/m3 (Mean: 235; Median: 240; Range: 6.26-511 oe/m3)	NR	NR	NR	NR	NR	NR	See 72.0	See 72.0	See 72.0	See 72.0	
73	**Napoli-Davis and Owens, 2013**	**NR**	**Electronic surfaces**	**TBBPA**	**Dust**	**Copier, computer towers, microwave, refrigerator, computer monitors, printers**	**The objective of this work was to develop a quantitative, highthroughput method for the analysis of TBBPA in dust from various consumer electronics (Kajiwara et al., 2011) found in offices and homes using DLLME.**	**See 73.1-73.6**	**United States**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**See 73.1-73.6**	**Useful for general population exposure assessment based on contact with dust from electronics**	**Dust contact from individual electronic types provides metrics to consider home/office scenarios with multiple components, mixes of components, and components per unit area in rooms containing the components**	**Mean of n=5 samples**	**Methods/method validations well documented.**	
73.1	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Copier	See 73	LOQ not reported. Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	<LOQ	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	
73.2	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Computer towers	See 73	LOQ not reported. Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	<LOQ	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	
73.3	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Microwave	See 73	Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	1.65	NR	NR	NR	NR	NR	ng/100 cm2	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	
73.4	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Refrigerator	See 73	Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	1.55	NR	NR	NR	NR	NR	ng/100 cm2	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	
73.5	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Computer monitors	See 73	Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	4.18	NR	NR	NR	NR	NR	ng/100 cm2	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	
73.6	Napoli-Davis and Owens, 2013	NR	Electronic surfaces	TBBPA	dust	Printers	See 73	Wipe samples using Kimwipe misted with methanol/acetone mixture. Five 100 cm2 areas were surveyed on each plastic-surface component of the electronics.	United States	NR	NR	NR	1.46	NR	NR	NR	NR	NR	ng/100 cm2	NR	NR	NR	NR	NR	See 73.0	See 73.0	See 73.0	See 73.0	

74	**Gallen et al., 2014**	**NR**	**Plastic surfaces**	**TBBPA**	**Actual products as listed.**	**Electronic TV, Electronic small household appliances , Electronic large household appliances , electronic other, plastic toys, plastic other, TV, computer, baby accessories**	**Development of rapid method to id BFRs in plastics using Comparitive methodologies involving XFR, surface wipes and destructive chemical analysis.**	**See 74.1-74.15**	**Australia**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**See 74.1-74.15**	**Highly relevant to exposure assesments for many population subgroups.**	**Highly representative for comparison of or linking of results of other studies where different testing methods used . Also illustrates high probability of BFRs in these products and the mobility of the BFR to surface where it is transferrable. (75% detects in wipe tests)**	**Excellent presentation of results across all methods and comparisons for Type II error**	**Comparitive methodologies involving XFR, surface wipes and destructive chemical analysis. Set up as tiered experiment so all 3 methods used on each sample. 1714 plastic products tested**	**Results: XFR = 92% confirmation, surface wipes = >75 % confirmation compared to actual chem analysis for BFRs.**
74.1	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Electronic TV	See 74	55% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	20	NR	NR	NR	NR	75	160000	NR	NR	ng/wipe	NR	55%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.2	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Electronic small household appliances	See 74	47% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	75	NR	NR	NR	NR	2.7	20000	NR	NR	ng/wipe	NR	47%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.3	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Electronic large household appliances	See 74	22% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	9	NR	NR	NR	NR	4.7	220	NR	NR	ng/wipe	NR	22%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.4	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Electronic other	See 74	58% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	19	NR	NR	NR	NR	6.1	22000	NR	NR	ng/wipe	NR	58%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.5	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Toys plastic	See 74	33% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	3	NR	NR	NR	20000	NR	NR	NR	NR	ng/wipe	NR	33%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.6	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Plastic other	See 74	67% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	5	NR	NR	NR	NR	3.9	2600	NR	NR	ng/wipe	NR	67%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.7	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Baby accessories	See 74	0% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	3	NR	NR	NR	ND	NR	NR	NR	NR		NR		NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.8	Gallen et al., 2014	NR	Plastic surfaces	TBBPA	Wiped product	Electronic computer	See 74	33% detects, wipe samples: 90 mm glass filter paper wetted with isopropanol firmly wiped over a 100 cm2 area	Australia	3	NR	NR	NR	75	NR	NR	NR	NR	ng/wipe	NR	33%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.9	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Electronic TV	See 74	83% detects, destructive chemical analysis with GC-MS	Australia	12	NR	NR	NR	NR	110,000	150,000,000	NR	NR	ng/g (110-150,000 µg/g)	NR	83%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.10	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Electronic small household appliances	See 74	59% detects, destructive chemical analysis with GC-MS	Australia	17	NR	NR	NR	NR	26,000	160,000,000	NR	NR	ng/g (26-160,000 µg/g)	NR	59%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.11	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Electronic large household appliances	See 74	50% detects, destructive chemical analysis with GC-MS	Australia	4	NR	NR	NR	NR	12,000	110,000	NR	NR	ng/g (12-110 µg/g)	NR	50%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.12	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Electronic other	See 74	70% detects, destructive chemical analysis with GC-MS	Australia	10	NR	NR	NR	NR	59,000,000	164,000,000	NR	NR	ng/g (59,000-164,000 µg/g)	NR	70%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.13	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Toys plastic	See 74	100% detects2, destructive chemical analysis with GC-MS	Australia	2	NR	NR	NR	NR	150,000	143,000,000	NR	NR	ng/g (150-143,000 µg/g)	NR	100%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.14	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Plastic other	See 74	100% detects, destructive chemical analysis	Australia	1	NR	NR	NR	2,700,000	NR	NR	NR	NR	ng/g (2,700 µg/g)	NR	100%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
74.15	Gallen et al., 2014	NR	Plastic	TBBPA	Destructive analysis of product	Electronic computer	See 74	50% detects, destructive chemical analysis with GC-MS	Australia	2	NR	NR	NR	150,000	NR	NR	NR	NR	ng/g (150 µg/g)	NR	50%	NR	NR	NR	NR	See 74.0	See 74.0	See 74.0	See 74.0	
75	**Choi et al., 2009**	**NR**	**TV housing**	**TBBPA**	**Material sample**	**Premolded plastic**	**Characterize rate of leaching of BFR from polymers in presence of Dissolved humic matter as indicator of degree of ecological contamination by consumer products in landfills and open dumps**	**See 75.1**	**Australia**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**See 75.1**	**Significant findings to estimate potential ecological contamination by BFRs leaching from plastics such as casings of TVs in landfills and open dumps**	**Relative leaching rates under these conditions inferred for all plastics of similar makeup where BFRs thought to be used. Concentration in plastic measured.**	**Single value for concentration in plastic.**	**Contemporary methodology with isotopic recovery measurments, quantification by HRGC, HRMS.**	**Conclusions: Leaching of BFRs including TBBPA accellerated under Humis conditions. Concentration in plastic component measured. Methodology and results for leachate not evaluated in this review.**
75.1	Choi et al., 2009	NR	TV housing	TBBPA	Material sample	Premolded plastic	See 75	Raw material for TV housing from a TV manufactured in 2002	Australia	NR	NR	NR	NR	8,100	NR	NR	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 75.0	Single value for concentration of TBBPA in plastic casing may or may not be representative of concentrations in other plastics or other TV casings from other manufacturers	See 75.0	See 75.0	concentration in plastic...not in leachates.
76	**Takigami et al., 2008**	**NR**	**TV**	**TBBPA**	**Material sample and DUST**	**Circuit board, front and rear cabinet**		**See 76.1-76.4**	**Japan**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**See 76.1-76.4**	**Retrospective exposure assesments (pre 2008 considering consumer products (cathode ray TV and similar electronics)**	**Transfer kinetics inferred from components/materials in electronic consumer products. Can be extrapolated to other products**	**Mean and ranges presented for component parts, dust for each analyte**	**Contemporary methodology**	**Dust collecting in/around electronic products provide opportunity for kinetics demonstrated here to exist for other scenarios. Specific example of cathode-ray TV not relevant in today's market.**
76.1	Takigami et al., 2008	NR	TV	TBBPA	Pulverized circuit board	Circuit board	See 76	Component parts pulverized	Japan	5	NR	NR	280,000	NR	7,900	1,300,000	NR	NR	ng/g (Mean: 280 µg/g) (Range: 7.9–1100 µg/g)	NR	NR	NR	NR	NR	NR	See 76.0	See 76.0	See 76.0	See 76.0	
76.2	Takigami et al., 2008	NR	TV	TBBPA	Pulverized cabinet material	Front cabinet	See 76	Component parts pulverized	Japan	5	NR	NR	20,000	NR	240	67,000	NR	NR	ng/g (Mean: 20 µg/g) (Range:0.24–67 µg/g)	NR	NR	NR	NR	NR	NR	See 76.0	See 76.0	See 76.0	See 76.0	
76.3	Takigami et al., 2008	NR	TV	TBBPA	Pulverized cabinet material	Rear cabinet	See 76	Component parts pulverized	Japan	5	NR	NR	19,000,000	NR	120	97,000,000	NR	NR	ng/g (Mean:19,000 µg/g) (Range: 0.12–97,000 µg/g)	NR	NR	NR	NR	NR	NR	See 76.0	See 76.0	See 76.0	See 76.0	
76.4	Takigami et al., 2008	NR	TV	TBBPA	DUST	TV Component parts	See 76	Collected by vacuuming the inside of each TV set until sufficient mass (>200 mg) was collected on a glass fiber filter.	Japan	5	NR	NR	240,000	NR	5,500	680,000	NR	NR	ng/g (Mean:240 µg/g) (Range: 5.5-680 µg/g)	NR	NR	NR	NR	NR	NR	See 76.0	See 76.0	See 76.0	See 76.0	
77	**Rani et al., 2014**	**NR**	**Packaging material, food containers, insulation, buoys**	**TBBPA**	**material samples**	**Polystyrene products (PS)**	**measure flame retardants added to polystyrene products, some of which present human exposure opportunities and ecological concern**	**See 77.1**	**Korea**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**See 77.1**	**PS products used in homes, with foods, storage containers, forks, etc contain BFRs. Relevant for oral exposure assesment contribution.**	**Unique study: BFR in PS presents new route and source for exposure assessment consideration**	**mean +-SD for each product type, for each analyte given. Non-detects important for TBBPA**	**BFR quantification done with isotopic dilution technique based on additionl of 13C labeled IS solutions. Tandem MS/MS -APCI negative ion mode. No BFR found in blanks.**	
77.1	Rani et al., 2014	NR	Packaging material, food containers, insulation, buoys	TBBPA	material samples	Polystyrene products (PS)	See 77	3 types of PS: expanded PS, extruded PS and extruded PS foam; detected in 7 of 34 samples; detection level not reported	Korea	34	NR	NR	NR	NR	ND	545	NR	NR	ng/g	NR	NR	NR	NR	NR	NR	See 77.0	See 77.0	See 77.0	See 77.0	

78	**Majestic et al., 2012**	**NR**	**Elementary school**	**ATO**	**Indoor air (PM1), dust**	**Carpet**	**Determine indoor/outdoor sources of metals and trace-metals by comparing size-resolved mass and elemental composition, esp. antimony in elementary schools.**	**See 78.1-78.2**	**United States, Arizona, Flagstaff**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**See 78.1-78.2**	**Useful for exposure assesment: general population including children.**	**Important guidance for considering data in literature: Sb in particulates does not show crustal characteristics (indoor and outdoor sources). Sources primarily from indoor factors. Using Cu:Sb ratios, illustrates importance of PM 1 differentiated from PM 1-10 fractions in terms of Sb content. Enrichment Factors near 1 likely of crustal origin and EF>10 likely anthropogenic sources. Important "rule of thumb"**	**Av +- SD for Sb concentrations.**	**Excellent methodology and study strategy. Study based on 11 size fractions from <0.056 um to >18 um.**	**Only a few Sb measurements BUT good methodolgy guides and underlying calculations explored which are useful for overall consideration of Sb measurements reported in literature.**
78.1	Majestic et al., 2012	NR	Elementary school	ATO	Indoor air (PM1)	Carpet		2 MOUDI samplers used to sample PM1 from approximately 8 am to 6 pm; Antimony measured usine HR-ICP-MS.	United States, Arizona, Flagstaff	NR	NR	17	NR	NR	NR	NR	NR	NR	NR	ng/m3	7	NR	NR	NR	NR	NR	See 78.0	See 78.0	See 78.0	See 78.0	Outdoor Sb concentratin in PM1 was 0.208 +- 0.019 ng/m3
78.2	Majestic et al., 2012	NR	Elementary school	ATO	Dust	carpet		The authors correlate school air Antimony concentrations with emission and/or resuspension from carpet (FR use)	United States, Arizona, Flagstaff	NR	NR	NR	6,000	NR	NR	NR	NR	NR	NR	ng/g (6.0 µg/g)	NR	NR	NR	NR	NR	NR	See 78.0	See 78.0	See 78.0	See 78.0	
79	**Kawamura et al., 2006**	**NR**	**NR**	**ATO**	**Tested PVC toys**	**Orange animal toy**	**Method comparison of results between ISO 8124-3 and Japanese official methods for migration test protocols. Measurement of elements in baby toys and 10 paints.**	**See 79.1**	**Japan**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**See 79.1**	**Unsure...details of study in Japanese.**	**Unsure...details of study in Japanese.**	**Individual results given for Sb content and migrations from toys and paints.**	**Presumably methods of ISO 8124-3 and Japanese official methods ?? Used for these measurements. Results published in English but all narrative is in Japanese.**	
79.1	Kawamura et al., 2006	NR	NR	ATO	Tested PVC toys	Orange animal toy	See 79	Japanese article with only abstract and tables available in English; not clear if FR use	Japan	2	2 trials	NR	5,300	NR	NR	NR	NR	NR	NR	ng/g (5.3 mg/kg)	NR	NR	NR	NR	NR	NR	See 79.0	See 79.0	See 79.0	See 79.0	
80	**Rivas et al., 2014**	**NR**	**School**	**ATO**	**Indoor air (PM2.5)**	**NR**	**Measure air pollutants in schools in/near Barcelona**	**See 80.1**	**Spain, Barcelona**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**See 80.1**	**Useful for exposure assesment: general population including children. May be especially relevant to areas of high traffic, high diesel motors.**	**Outdoor Sb levels found to be better indicator of traffic emissions than PM 2.5 levels.**	**Mean, min/max, median, SD provided**	**Only PM 2.5 collected in this study. Collection done at breathing zone height for children age 7-9.**	**Urban background and outdoor (near schools) also monitored in this study. Good discussion of contaminant distributions in PM 2.5 fractions.**
80.1	Rivas et al., 2014	NR	School	ATO	Indoor air (PM2.5)	NR	See 80	PM2.5 samples obtained with high volume sampler MCV CAV-A/mb using an inlet with a nozzle plate for PM2.5 (MCV), and then collected on Pallflex quartz fiber filters; Antimony measured using ICP-AES	Spain, Barcelona	77	NR	NR	0.83	NR	0.13	1.6	NR	NR	NR	ng/m3	0.35	NR	NR	NR	NR	NR	See 80.0	See 80.0	See 80.0	See 80.0	
81	**Huang et al., 2014**	**NR**	**Houses**	**ATO**	**Indoor air (PM2.5)**	**NR**	**1) measure contamination and distribution of metaloids and metals in road dust, household AC filter dust andd PM 2.5; 2)evaluate bioaccessibility of metaloids via ingestion and inhalation; 3) estimate chronic daily intakes and characterize risk.**	**See 81.1-81.2**	**China, Guangzhou**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**See 81.1-81.2**	**Limited utility for US general population BUT May be especially relevant to areas of high traffic, high density populations and high pollution.**	**Distribution of contaminants near road dust sites (different types of road use) interesting for consideration of contaminants in high traffic areas. Note EF values comparing road dust and house dust.**	**Mean, median values presented. EF values included.**	**Enrichment Factors calculated for contaminants in PM 2.5 fractions.**	**Study location: Guangzhou (aka Canton) is 3rd largest Chinese city (population > 14 million), transportation hub and trading port 75 miles NE of Hong Kong in one of densest overall population areas. Methods, results and calculations for bioaccessibility and exposure/risk not considered in this review.**
81.1	Huang et al., 2014	NR	Houses	ATO	Indoor air (PM2.5)	NR	See 81	Sampled in urban areas. Active SLC PM2.5/PM10 sampler and PM2.5 air monitoring membrane; Antimony quantified using ICP-MS	China, Guangzhou	7	NR	NR	29.78	25.4	NR	NR	NR	NR	NR	ng/m3 (Mean: 2.79 mg/kg) (Median: 2.35 mg/kg)	NR	NR	NR	NR	NR	NR	See 81.0	See 81.0	See 81.0	See 81.0	
81.2	Huang et al., 2014	NR	Houses	ATO	Household AC filter dust	NR	See 81		China, Guangzhou	10	NR	NR	7280	4650	NR	NR	NR	NR	NR	ng/g (Mean: 7.28 mg/kg) (Median: 4.65 ma/kg)	NR	NR	NR	NR	NR	NR	See 81.0	See 81.0	See 81.0	See 81.0	
82	**Gonzales et al., 2004**	**NR**	**Houses**	**ATO**	**Surface wipes**	**Dust**	**Quantify metals in dust samples from jewelers' homes, compare with background levels from homes not of jewelers. Note: in-home industry**	**See 82.1**	**United States, New Mexico, Zuni reservation**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**See 82.1**	**Highly relevant to any home-workshop environment and exposure assesments where Sb may be in work materials.**	**??? Could not see data**	**??? Could not see data**	**Surface wipe sampling for dust loading in/near work areas (sometimes were also eating areas). Natural log-transformed parametric analysis used since data distributions were right-skewed.**	**Study also considered efficacy of personal protective measures, ventillation and inventoried home-based workshop setups in Native American (Zuni) community. Inventoried chemicals, metals, stones, materials used to make jewelry.**
82.1	Gonzales et al., 2004	NR	Houses	ATO	Surface wipes	Dust	See 82	Study looked at concentrations of surface-dust metals in Native American jewelry making homes. Data reported here are from non-jewelry making control homes; surface dust samples were collected by wiping Whatman 41 70-mm filter paper on 715 cm2 surface areas; Antimony measured using ICP-MS and AAS.	United States, New Mexico, Zuni reservation	8	Indoor surface dust, control homes	NR	NR	NR	5	9	NR	7	ng/ sample (Geo mean: 0.007 µg/sample) (Range: 0.005-0.009 µg/sample)	NR	NR	NR	NR	NR	NR	See 82.0	See 82.0	See 82.0	See 82.0	
83	**Fergusson et al., 1986**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**investigate multi-element composition of house dust over city-wid area [Christchurch, New Zealand]**	**See 83.1**	**New Zealand, Christchurch**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**See 83.1**	**Limited utility as methodology dated and building materials and goods from 1986 unlikely to exist in US for prospective exposure assesment. May be useful for retrospective exposure assessments**	**no unique features.**	**mean, SD, range presented.**	**Old methodology for sampling (1977-84) and analytical determinations (1968). Method details not available for review.**	
83.1	Fergusson et al., 1986	NR	Houses	ATO	dust	NR	See 83	Samples were taken from the carpet in the main living area using a small diaphragm vacuum pump from a 0.25 m2 area of carpet onto a 37 mm filter; authors suggested concentrations similar to that in local soils	New Zealand, Christchurch	11	NR	NR	10	NR	1.83	30.6	NR	NR	ng/g (Mean: 10 µg/kg) (SD: 9.64 µg/kg) (Range: 1.83-30.6 µg/kg)	9.64	NR	NR	NR	NR	NR	See 83.0	See 83.0	See 83.0	See 83.0	
84	**Davis and Gulson, 2005**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**Investigation of ceiling and attic dust as indirect measure of air pollution integrated over varying time periods. Assessed metals in ceiling dusts from 38 houses in city of Sydney, Australia circa 2004**	**See 84.1-84.3**	**Australia, Sydney**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**See 84.1-84.3**	**General population exposure assesment in home environments.**	**Houses in industrial settings have >Sb than in non-industrial settings. Roof types not a factor, house age not a factor. As with other studies, Sb has high EF (x26 in this study) showing primary source is anthropomorphic..**	**mean, SD, median, GM, min, max given for n samples in each grouping. Good presentation of particulate distribution. EF and EF background shown forall groupings.**	**Multiple factors considered: house age, roof types, industrial, semi-industrial and non-industrial areas. Enrichment Factors calculated via comparison with local rocks and soils. ICP-AES, XRF, NAA analytical methods used. Particle size distribution.**	**Study shows particulate distributions and volume of dust below 250 microns.**
84.1	Davis and Gulson, 2005	NR	Houses	ATO	Dust	NR	See 84	Sampling was performed by brushing a measured area of dust (100 cm2 if possible) into polyethylene containers. The authors suggest potential contributions from vehicular traffic, combustion, chemical oxidation, building and construction material, and probably the dispersion of particulates carried by winds	Australia, Sydney	10	Ceiling dust/attic dust in homes not near industry	NR	7,000	6,800	2,000	14,700	NR	5,500	ng/g (Mean: 7.0 mg/kg) (SD: 4.6 mg/kg) (Median: 6.8 mg/kg) (Geo-mean: 5.5 mg/kg) (Range: 2.0-14.7 mg/kg)	4,600	NR	NR	NR	NR	NR	See 84.0	See 84.0	See 84.0	See 84.0	

84.2	Davis and Gulson, 2005	NR	Houses	ATO	Dust	NR	See 84	Sampling was performed by brushing a measured area of dust (100 cm2 if possible) into polyethylene containers. The authors suggest potential contributions from vehicular traffic, combustion, chemical oxidation, building and construction material, and probably the dispersion of particulates carried by winds	Australia, Sydney	9	Ceiling dust/attic dust in homes near industry	NR	30100	28300	7200	66400	NR	25500	ng/g (Mean: 30.1 mg/kg) (StD: 17.21 mg/kg) (Median: 28.3 mg/kg) (Geo mean: 25.5 mg/kg) (Range:7.2-66.4 mg/kg)	17200	NR	NR	NR	NR	NR	See 84.0	See 84.0	See 84.0	See 84.0		
84.3	Davis and Gulson, 2005	NR	Houses	ATO	Dust	NR	See 84	Sampling was performed by brushing a measured area of dust (100 cm2 if possible) into polyethylene containers. The authors suggest potential contributions from vehicular traffic, combustion, chemical oxidation, building and construction material, and probably the dispersion of particulates carried by winds	Australia, Sydney	15	Ceiling dust/attic dust in homes semi-near industry	NR	17900	12600	5400	58400	NR	14200	ng/g (Mean: 17.9 mg/kg) (StD: 15.1 mg/kg) (Median: 12.6 mg/kg) (Geo mean: 14.2 mg/kg) (Range: 5.4-58.4 mg/kg)	15100	NR	NR	NR	NR	NR	See 84.0	See 84.0	See 84.0	See 84.0		
85	**Rasmussen et al., 2001**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**Profile multi-elements of indoor house dust across areas of Ottawa, Canada.**	**See 85.1**	**Canada, Ottawa, Ontario**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**See 85.1**	**General population exposure assesment in home environments.**	**Sb measurements for houses in non-industrial areas, showing soil and road dust comparisons for WINTER study conditions.**	**Good presentation of results and local background EF. % detects, Arithmetic mean, GM, median, min, max, 90th and 95th %iles provided. Good for creating parametric distributions.**	**Vacuum collection. EF measured using local soils as background for Sb, Stadard ICP-MS analytical method. Data compared to 2 NIST dust samples**	**Ottawa is relatively small city with very little industry in or nearby. Survey conducted for factors including house age, heat source, distance from roadway, etc.**
85.1	Rasmussen et al., 2001	NR	Houses	ATO	Dust	NR	See 85	Residents collected indoor dust by vacuuming; antimony measured with ICP-MS. Authors note that mean concentration in dust was greater than concentration in soil from same houses, suggesting there could be additional sources of antimony in the homes.	Canada, Ottawa, Ontario	48	NR	NR	7,280	NR	1,160	57,410	15,380	NR	ng/g (Mean: 7.28 mg/kg) (Range: 1.16-57.41 mg/kg) (95th percentile: 15.38 mg/kg)	NR	NR	NR	NR	NR	NR	See 85.0	See 85.0	See 85.0	See 85.0	See 85.0	
86	**McDonald et al., 2010**	**NR**	**Houses**	**ATO**	**Surface wipes**	**Dust**	**Methodology: 1) develop and expand EPA wipe method for dust load for metals including Sb ; 2) set typical background loadings for urban Canadian homes.**	**See 86.1-86.2**	**Canada, Ontario, Barrie, Greater Sudbury, Thunder Bay**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**See 86.1-86.2**	**General population exposure assesment in home environments.**	**This study sets up Canadian Standards for the wipe method for dust--metals loading for Canadian homes.**	**Excellent presentation of all factors for setting up methods and standards.**	**Methods good for establishing methodology comparison and setting standards. Large sampling: 932 samples, 220 field blanks, 230 duplicate from 222 homes in 3 CA cities. ASTM 1728 standard used and ASTM 1644 modified standard for Pb comparison used.**	**Methodology and background study.**
86.1	McDonald et al., 2010	NR	Houses	ATO	Surface wipes	Dust	See 86	Wipe samples collected from January to March 2008. Samples taken with Ghost Wipes(TM) brand within a 30 cm2 plastic template area (ASTM E 1728 protocol; measured antimony using ICP-MS. No minimum or mean reported. Entry areas 57% < LOQ; interior areas 74% < LOQ; LOQ – 0.60 µ/m2	Canada, Ontario, Barrie, Greater Sudbury, Thunder Bay	208	Household wipe samples; entry area of homes (n=208)	NR	500	NR	NR	23,000	4,800	NR	ng/m2 (50th percentile: 0.5 µg/m2) (95th percentile: 4.8 µg/m2) (Max: 23 µg/m2)	NR	NR	NR	NR	NR	NR	See 86.0	See 86.0	See 86.0	See 86.0		
86.2	McDonald et al., 2010	NR	Houses	ATO	Surface wipes	Dust	See 86	Wipe samples collected from January to March 2008. Samples taken with Ghost Wipes(TM) brand within a 30 cm2 plastic template area (ASTM E 1728 protocol; measured antimony using ICP-MS. No minimum or mean reported. Entry areas 57% < LOQ; interior areas 74% < LOQ; LOQ – 0.60 µ/m2	Canada, Ontario, Barrie, Greater Sudbury, Thunder Bay	498	Household wipe samples; interior areas of homes (498 samples from 228 homes)	NR	200	NR	NR	18,000	2,700	NR	ng/m2 (50th percentile: 0.2 µg/m2) (95th percentile: 2.7 µg/m2) (Max: 18 µg/m2)	NR	NR	NR	NR	NR	NR	See 86.0	See 86.0	See 86.0	See 86.0		
87	**Barbieri et al., 2014**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**Assess correlations of metallic content between dust and children's hair for two housing conditions: near mining/ non-mining suburbia. Also, influences of children's activities on content.**	**See 87.1-87.2**	**Bolivia, Oruro**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**See 87.1-87.2**	**Limited value to Sb levels in dust near mining industries for general population exposures in mining industry communities. This study suggests that Sb levels as measured in dust of homes in suburban areas may not be relevant to all housing scenarios.**	**Elevated Sb levels in house dust in mining industry areas. Note importance of environmental factors for consideration...as with high traffic areas or other possible environmental scearios.**	**Median, 5th and 95th %iles presented but without measurements of background or particulate differentials.**	**Unspecified collection methods. Contemporary analysis of Sb but without direct EF measurements or consideration of particulate sizes and content, especially for proximity to mines. Correlations on data for conclusions can be challenged as to relationships to children's activity profiles, correlation with hair concentrations.**	**Sb concentrations in childrens' hair also reported and correlated to house dust levels for housing near mining and housing in suburban (non-mining) areas. Methods, results and correlations for behaviour and hair Sb content not considered in this review.**
87.1	Barbieri et al., 2014	NR	Houses	ATO	Dust	NR	See 87	Roughly 1 g dust collected from the top surfaces of furniture or windowsills using a 1.5 inch brush.	Bolivia, Oruro	41	Suburban non-mining district	NR	NR	33,960	NR	NR	84,310	NR	ng/g (Median: 33.96 ppm) (range of 95th percentiles: 23.47-84.31 ppm)	NR	NR	NR	NR	NR	NR	See 87.0	See 87.0	See 87.0	See 87.0		
87.2	Barbieri et al., 2014	NR	Houses	ATO	Dust	NR	See 87	see 87.1	Bolivia, Oruro	56	mining district	NR	NR	108,700	NR	NR	2,770,280	NR	ng/g (Median: 108.70 ppm) (range of 95th percentiles: 27.08-2770.28 ppm)	NR	NR	NR	NR	NR	NR	See 87.0	See 87.0	See 87.0	See 87.0		
88	**Fontúrbel et al., 2011**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**Measure metallic content between dust from homes near mines and not near mines. Correlate with results from surveys about behaviors.**	**See 88.1-88.2**	**Bolivia, Oruro**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**See 88.1-88.2**	**Limited value to Sb levels in dust near mining industries for general population exposures in mining industry communities. This study suggests that Sb levels as measured in dust of homes in suburban areas may not be relevant to all housing scenarios**	**Elevated Sb levels in house dust in areas near mine are suggestive of the mine as a source for the Sb, but route of the source not tested...assumptions about track back vs air-born vs other explanations not addressed in this study.**	**Mean, GM, min-max values given for Wb concentrations in dust for n samples in two groups. However, limitations of methodology should be noted.**	**Collection methodology uses brushing instead of vacuuming which may not include smaller particle sizes, skewing overall Sb content. Apparently no official standards used and background, blanks, area soil samples not included. Therefore, no EF calculated making**	**Survey, activity profiles and correlations to behaviour and contaminant levels not considered in this review, but correlations seem unproven, though reasonable assumptions.**
88.1	Fontúrbel et al., 2011	NR	Houses	ATO	Dust	NR	See 88	Roughly 1 g dust collected from the top surfaces of furniture or windowsills using a 1.5 inch brush. The authors suggest that exposure is related to proximity to the mine.	Bolivia, Oruro	41	peripheral district, 1.5 km from mine	NR	46,430	NR	18,110	203,650	NR	39,230	ng/g (Arithmetic mean: 46.43 ppm) (StD: 5.93 ppm) (Geo mean: 39.23 ppm) (Range: 18.11-203.65 ppm)	5,930	NR	NR	NR	NR	NR	See 88.0	See 88.0	See 88.0	See 88.0		
88.2	Fontúrbel et al., 2011	NR	Houses	ATO	Dust	NR	See 88	Roughly 1 g dust collected from the top surfaces of furniture or windowsills using a 1.5 inch brush. The authors suggest that exposure is related to proximity to the mine.	Bolivia, Oruro	57	mining district	NR	494,440.00	NR	21,500.00	6,199,350.00	NR	152,910.00	ng/g (Arithmetic mean: 494.44 ppm) (StD: 138.5 ppm) (Geo mean: 39.23 ppm) (Range: 21.5-6199.35 ppm)	138,500.00	NR	NR	NR	NR	NR	See 88.0	See 88.0	See 88.0	See 88.0		

89	**Glorennec et al., 2012**	**NR**	**Houses**	**ATO**	**Surface wipes**	**Dust**	**Assess metal contamination of soils and dust throughout France.**	**See 89.1-89.3**	**France, Various areas**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**See 89.1-89.3**	**Sb contamination levels in households and playgrounds. Suitable for exposure assessments to general populations and children activity scenarios.**	**Limited extrapolation opportunities for these results because of some methodology issues, but important areas of children's environments considered.**	**Detailed presentation of data for n samples of indoor dust, playground dust, and playground soil: Min, max and distributions at 10, 25, 50, 75, 90, 95th %iles.**	**Broad national study with room specific sampling as per US HUD protocol using dust loading wipe method (as per US EPA compared to ASTM blank wipe standard. Playground soils and house dust collected. Analyses used MS with quadrupole ICP-MS and compared to US NIST SRM 2583 and CRM 552 official dust standards.**	**Note: Playground soils are relevant exposure opportunity sources for children BUT playground soils are not necessarily composed of area soils making the dust/soil ratios questionable to be used as EF ratios. No "natural area soils" included in sampling for this. Nor were particulate distributions measured in these compared matrices. Elements of the research re leachability and children's exposure/risk were not considered in this review.**
89.1	Glorennec et al., 2012	NR	Houses	ATO	Surface wipes	Dust	See 89	A floor area of 0.1 m^2 was sampled with a moist lead-free wipe. LOQ=800 ng/m2 (0.8 $\mu g/m^2$)	France	473	surface wipes	NR	NR	<LOQ	<LOQ	8,600	2400	NR	ng/m2 (median: <LOQ (Range: <LOQ-8.6 $\mu g/m^2$) (95th: 2.4 $\mu g/m^2$)	NR	NR	NR	0.8	NR	NR	See 89.0	See 89.0	See 89.0	See 89.0	
89.2	Glorennec et al., 2012	NR	Houses	ATO	Surface wipes	Dust	See 89	Playground dust: the soil was sampled using a ring (2 cm deep) or a wipe (0.1 m^2) for hard surfaces, with the same collection and packaging procedure as for indoor dust. For hard surfaces, a composite soil sample was constituted from 10 subsamples in the 0–2 cm layer and was prepared according to the Nf ISO 11464 standard	France	53	playground dust	NR	NR	<LOQ	<LOQ	31,000	13000	NR	ng/m2 (median: <LOQ (Range: <LOQ-31 $\mu g/m^2$) (95th: 11 $\mu g/m^2$)	NR	NR	NR	0.8	NR	NR	See 89.0	See 89.0	See 89.0	See 89.0	
89.3	Glorennec et al., 2012	NR	Houses	ATO	Surface wipes	Dust	See 89	Playground soil: the soil was sampled using a ring (2 cm deep) or a wipe (0.1 m^2) for hard surfaces, with the same collection and packaging procedure as for indoor dust. For hard surfaces, a composite soil sample was constituted from 10 subsamples in the 0–2 cm layer and was prepared according to the Nf ISO 11464 standard	France	315	playground soil	NR	NR	<LOQ	<LOQ	41,000	4000	NR	ng/m2 (median: <LOQ (Range: <LOQ-41 $\mu g/m^2$) (95th: 4 $\mu g/m^2$)	NR	NR	NR	0.7	NR	NR	See 89.0	See 89.0	See 89.0	See 89.0	
90	**Turner and Hefzi, 2010**	**NR**	**House**	**ATO**	**Dust**	**NR**	**Measure the levels and bioaccessibilities of trace metals in dusts from arid environments and determine the dilution of anthropogenic particulates by fine, baseline sand.**	**See 90.1**	**Saudi Arabia, Dhahran**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**See 90.1**	**General household Sb residues in households in dry, sandy environments.**	**Method for normalizing Enrichment Factors for grain size given fine sand can skew results. Important concept for other studies as well. As with most other studies, Sb source primarily anthropomorphic, highest values indoors.**	**AM, GM, SD given for n samples with baseline and sand baseline.**	**Good, contemporary methodology for sampling and analysis. Complex environment studied by collection of house dust (vacuum), roadside dust, area soils and desert fine sand. EF calculated for all samples, noting dilution factors for fine sands.**	
90.1	Turner and Hefzi, 2010	NR	House	ATO	Dust	NR	See 90	Dust collected by vacuuming entire accessible floor space using an upright, bagless vacuum cleaner and passed through 63 µm Nylon mesh; Antimony measured using ICP-MS	Saudi Arabia, Dhahran	9	NR	NR	NR	5,860	NR	NR	NR	NR	5,450	ng/g (Geo mean: 5.45 µg/g) (SID: 2.65 µg/g) (Arithmetic mean: 5.86 µg/g)	2,650	Mean: 10,100 ng/g (10.1 mg/kg) SID: 2,060 ng/g (2.06 mg/kg) Range; 1,930-439,000 ng/g (1.93-439 mg/kg)	NR	NR	NR	NR	See 90	See 90	See 90	See 90	
91	**Yoshinaga et al., 2014**	**NR**	**Houses**	**ATO**	**Dust**	**NR**	**Measure 25 elements iin house dust (and soils) collected from 100 Japanese residences and consider the potential exposure and risk to children via dust ingestion**	**See 91.1**	**Japan, Several regions**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**See 91.1**	**General household Sb residues in households in large, non-industrial city (Tokyo) scenarios.**	**Comparisons to similar work in Canada suggests similar results (same order of magnitude).**	**Detailed presentation of data for n samples of indoor dust, playground dust, and playground soil: Min, max, Mean, SD and distributions at 5, 25, 50, 75, 95th %iles.**	**Vacuum sampling and good contemporary analysis methods, using US NIST SRM 2583 standards. EF calculated.**	**Calculated exposure and risk to children not considered in this review.**
91.1	Yoshinaga et al., 2014	NR	Houses	ATO	Dust	NR	See 91	Study investigating source of lead from house dust measured other elements, including Antimony. Volunteered samples from 100 residences collected 2006-2012; vacuum cleaner dust passed through 250 µm –mesh; Antimony measured using ICP-MS.	Japan	100	NR	NR	NR	10,100	NR	1,930	439,000	NR	NR	ng/g (Mean: 10.1 mg/kg) (SID: 2.06 mg/kg) (Range; 1.93-439 mg/kg)	2,060	NR	NR	NR	NR	NR	See 91.0	See 91.0	See 91.0	See 91.0	
92	**Bi et al., 2011**	**NR**	**House**	**ATO**	**Dust**	**NR**	**Measure and compare Sb and As distributions in indoor dust from 13 e-waste recycling villages vs. villages not involved in this industry.**	**See 92.1-92.2**	**China, Guiyu town in Shantou, Guangdong province**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**See 92.1-92.2**	**Limited but important utility: E waste contaminant potential for unique scenarios where e waste process not controlled by waste reduction methods.**	**Environmental contamination from e waste via recycling is global issue for which exposure assessments have not traditionally considered. These villages had extreme conditions: 60 employment of waste facilities in family business structures with little or no environmental controls operating over decade or more.**	**Individual Sb concentrations given for house dust. Data not presented in detail for soil samples or EF calculations.**	**Collection methodology uses brushing instead of vacuuming which may not include smaller particle sizes, skewing overall Sb content. Compartive soil samples included and EF considered.**	**Authors suggest these contaminant sources could be associated with surprising Sb levels increasing in the Arctic.**
92.1	Bi et al., 2011	NR	House	ATO	Dust	NR	See 92	5 control sites and 5 non-e-waste; dust samples were collected inside from the floor using a brush and plastic spatula	China, Guiyu town in Shantou, Guangdong province	5	House Dust, control	NR	NR	NR	660	2,450	NR	NR	ng/g (0.66-2.45 mg/kg)	NR	NR	NR	NR	NR	NR	See 92.0	See 92.0	See 92.0	See 92.0	
92.2	Bi et al., 2011	NR	House	ATO	Dust	NR	See 92	5 control sites and 5 non-e-waste; dust samples were collected inside from the floor using a brush and plastic spatula	China, Guiyu town in Shantou, Guangdong province	5	House Dust, non-e-waste	NR	NR	NR	6,100	9,200	NR	NR	ng/g (6.1-9.2 mg/kg)	NR	NR	NR	NR	NR	NR	See 92.0	See 92.0	See 92.0	See 92.0	
93	**Lincoln et al., 2007**	**NR**	**Cell phones**	**ATO**	**Shredded and digested samples**	**Cell phones**	**Methodology comparison of three methods to measure leachate from cell phones.**	**See 93.1**	**United States**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**See 93.1**	**N/A**	**N/A**	**N/A**	**N/A**	
93.1	Lincoln et al., 2007	NR	Cell phones	ATO	Shredded and digested samples	Cell phones	See 93	Brominated FR were absent as reported by authors. This may be suggestive that ATO was not used as a FR synergist.	United States	NR	NR	NR	1,023,000	NR	860,000	1,290,000	NR	NR	ng/g (Mean: 1,023 mg/kg) (Range: 860-1,290 mg/kg)	NR	NR	NR	NR	NR	NR	See 93.0	See 93.0	See 93.0	See 93.0	
94	**CPSC, 2006a**	**NR**	**NR**	**ATO**	**Mattress barriers/fabric**	**Cotton batting, Nonwoven modacrylic/Viril, Modacrylic knit, Coated foam/melamine, Coated poly-cotton ticking/melamine, Coated poly-cotton/melamine, Coated knit/melamine**	**Testing mattress barriers to assess compliance with CPSC draft final standard for FRC content. Several migration scenarios tested for use in consumer exposure assessment.**	**See 94.1-94.7**	**United States**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**See 94.1-94.7**	**General population exposure assessment and factors for use in selected subpopulation exposure assessment.**	**Illustrates influence of human factors on migration and different responses (changes in load) for different FRs.**	**Individual or AV +- SD presented for n samples in each scenario tested.**	**Total ATO load testing uses contemporary ICP methods.**	**Features exposure factors used by CPSC for exposure analysis. Exposure assessment methodology and results not considered as part of this review.**
94.1	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Cotton batting	See 94	FR use, as reported by authors	United States	NR	NR	NR	2.4	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
94.2	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Nonwoven modacrylic/Viril	See 94	FR use, as reported by authors	United States	NR	NR	NR	3.8	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
94.3	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Modacrylic knit	See 94	FR use, as reported by authors	United States	NR	NR	NR	4.5	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
94.4	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Coated foam/ melamine	See 94	FR use, as reported by authors	United States	NR	NR	NR	4.1	NR	NR	NR	NR	NR	% (Mean: 4.1 x 107 ng/g) (41,000 mg/kg or 4.1%)	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
94.5	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Coated poly-cotton ticking/ melamine	See 94	FR use, as reported by authors	United States	NR	NR	NR	2.7	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	

94.6	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Coated poly-cotton/ melamine	See 94	FR use, as reported by authors	United States	NR	NR	NR	3.1	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
94.7	CPSC, 2006a	NR	NR	ATO	Mattress barriers/fabric	Coated knit/ melamine	See 94	FR use, as reported by authors	United States	NR	NR	NR	4.4	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 94.0	See 94.0	See 94.0	See 94.0	
95	**EURAR, 2008 as cited by Health Canada, 2010**	**NR**	**NR**	**ATO**	**Fabrics, plastics**	**Fabrics, polymers, PET**	**Health Canada's document summarizes evidence on ATO for compliance with CEPA 1999 standards for products on the Canadian market.**	**See 95.1-95.3**	**Canada**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**See 95.1-95.3**	**General exposure assessment and assessments for children.**	**Study details not available.**	**Only ranges of concentration given for categories of products.**	**Methodology details not available in HC publication.**	**Table 7 (p 10) presents listing of anthropogenic sources as noted globally for industry, media. Exposure assessment detailed for general population and children with discussion of uncertainty, but not reviewed here.**
95.1	EURAR, 2008 as cited by Health Canada, 2010	NR	NR	ATO	Fabrics	Fabrics	See 95	FR use, as reported by Health Canada	Canada	NR	NR	NR	NR	NR	2,000,000	60,000,000	NR	NR	ng/g (2,000-60,000 mg/kg)	NR	NR	NR	NR	NR	NR	See 95.0	See 95.0	See 95.0	See 95.0	
95.2	EURAR, 2008 as cited in Health Canada, 2010	NR	NR	ATO	Plastics	Polymers	See 95	FR use, as reported by Health Canada	Canada	NR	NR	NR	NR	NR	<80,000,000	250,000,000	NR	NR	ng/g (<80,000-250,000 g/kg)	NR	NR	NR	NR	NR	NR	See 95.0	See 95.0	See 95.0	See 95.0	
95.3	EURAR, 2008 as cited in Health Canada, 2010	NR	NR	ATO	Plastics	PET	See 95	FR use, as reported by Health Canada	Canada	NR	NR	NR	NR	NR	180,000	200,000	NR	NR	ng/g (180-200 mg/kg)	NR	NR	NR	NR	NR	NR	See 95.0	See 95.0	See 95.0	See 95.0	
96	**Jenkins et al., 1998**	**NR**	**NR**	**ATO**	**PVC cot (crib) mattress covers**	**Bedding**	**Measure the generation of gaseous antimony from cots/bedding as function of microbial action on Sb based FR.**	**See 96.1**	**United Kingdom**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**See 96.1**	**No real value to exposure assessments for ATO in gen population of infants.**	**Illustrated that gaseous Sb not likely to be released due to microbial action on original Sb based FR materials.**	**Average Sb content with no other detail**	**Methods focused on SB capture from bioactivity on materials. Not traditional methodology for Sb ATO residue measurement.**	**Part of search for cause of SIDS**
96.1	Jenkins et al., 1998	NR	NR	ATO	PVC cot (crib) mattress covers	Bedding	See 96	FR use, as reported by authors	United Kingdom	NR	NR	NR	NR	NR	230,000	310,500,000	NR	NR	ng/g (0.23-31.05 mg/g)	NR	NR	NR	NR	NR	NR	See 96.0	See 96.0	See 96.0	See 96.0	
97	**Jenkins et al., 2000**	**NR**	**NR**	**ATO**	**Cot (crib) mattress covers**	**Bedding**	**Measure the generation of gaseous antimony from mattress foams as function of microbial action on Sb based FR.**	**See 97.1-97.2**	**United Kingdom**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**See 97.1-97.2**	**No real value to exposure assessments for ATO in gen population of infants.**	**N/A**	**Total Sb content range reported for each SIDS and control group. Matrices of concern in this paper was # mattresses in control vs SIDS cases.**	**Contemporary ICP-MS used to assess total Sb content.**	**Part of search for cause of SIDS**
97.1	Jenkins et al., 2000	NR	NR	ATO	Cot (crib) mattress covers	Bedding	See 97	FR use, as reported by authors	United Kingdom	NR	NR	NR	NR	NR	<200	220,600	NR	NR	ng/g (<0.2 - 220.6 µg/g)	NR	NR	NR	NR	NR	NR	See 97.0	See 97.0	See 97.0	See 97.0	
97.2	Jenkins et al., 2000	NR	NR	ATO	PU foam samples	Bedding	See 97	FR use, as reported by authors	United Kingdom	NR	NR	NR	NR	NR	<200	>3,300	NR	NR	ng/g <0.2 ->3.3 µg/g)	NR	NR	NR	NR	NR	NR	See 97.0	See 97.0	See 97.0	See 97.0	
98	**Morf et al., 2005**	**NR**	**e-waste recycling plant, Small electrical and electronic equipment waste materials**	**TBBPA**	**Component parts**	**NR**	**Substance flow analysis: characterize flow of TBBPA (and other) from the bulk WEEE input into the output products.**	**See 98.1-98.3**	**Switzerland**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**See 98.1-98.3**	**No real value for general population exposure assessment.**	**Presents mechanics of recycling process that incorporates FRs into new products. Important concept.**	**Mean and 95% confidence interval of Mean presented**	**Standard methodology for analysis using GC/MS with EI.**	
98.1	Morf et al., 2005	NR	e-waste recycling plant	TBBPA	Printed circuit boards	NR	See 98	Materials from an e-waste recycling plant; some FR use expected, as reported by authors	Switzerland	NR	NR	NR	2,100,000	NR	NR	NR	NR	NR	ng/g (Mean: 2,100 ± 100 mg/kg)	100,000	NR	NR	NR	NR	NR	See 98.0	See 98.0	See 98.0	See 98.0	
98.2	Morf et al., 2005	NR	e-waste recycling plant	TBBPA	TV housings (wood)	NR	See 98	Materials from an e-waste recycling plant; some FR use expected, as reported by authors	Switzerland	NR	NR	NR	57,000	NR	NR	NR	NR	NR	ng/g (Mean: 57 ± 1 mg/kg)	1,000	NR	NR	NR	NR	NR	See 98.0	See 98.0	See 98.0	See 98.0	
98.3	Morf et al., 2005	NR	e-waste recycling plant	TBBPA	TV/PC housings (plastic)	NR	See 98	Materials from an e-waste recycling plant; some FR use expected, as reported by authors	Switzerland	NR	NR	NR	16,000,000	NR	NR	NR	NR	NR	ng/g (Mean: 16,000 ± 5000 mg/kg)	5,000,000	NR	NR	NR	NR	NR	See 98.0	See 98.0	See 98.0	See 98.0	
99	**Schlummer et al., 2007**	**NR**	**e-waste recycling plant**	**TBBPA**	**Housing shredder residues**	**From TV sets and monitors**	**Monitor hazardous compounds in polymer types in WEEE polymer fractions. Summary data for polymer type., elemental composition, BFR over four year period.**	**See 99.1-99.3**	**Germany**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**See 99.1-99.3**	**Not useful for general population exposure assessment but may be very relevant for consideration of waste management and ecological assessments.**	**Good summation of polymer types and elements/FRs associated with each.**	**N/A**	**Contemporary methods including analysis with HPLC-UV/MS for TBBPA.**	
99.1	Schlummer et al., 2007	NR	e-waste recycling plant	TBBPA	Housing shredder residues	From TV sets and monitors	See 99	Analyzed shredder samples from an e-waste recycling plant.	Germany	8	Housing shredder residues	NR	NR	NR	0.25	11.04	NR	NR	% (estimated from graph)	NR	NR	NR	NR	NR	NR	See 99	See 99	See 99	See 99	
99.2	Schlummer et al.,2007	NR	e-waste recycling plant	TBBPA	Mixed WEEE shredder residues	Residues from WEEE recycling plants processing unsorted WEEE	See 99	Analyzed shredder samples from an e-waste recycling plant.	Germany	7	Mixed WEEE shredder residues	NR	NR	NR	0.3	0.95	NR	NR	% (estimated from graph)	NR	NR	NR	NR	NR	NR	See 99	See 99	See 99	See 99	
99.3	Schlummer et al., 2007	NR	e-waste recycling plant	TBBPA	Single housing Samples	Single TV set and monitor housings	See 99	Analyzed shredder samples from an e-waste recycling plant.	Germany	45	Single housing Samples	NR	ND	NR	NR	NR	NR	NR	% (estimated from graph)	NR	NR	NR	NR	NR	NR	See 99	See 99	See 99	See 99	
100	**Butterman and Carlin, 2004**	**NR**	**NR**	**ATO**	**Not specified**	**Flexible PVC, polyolefins, polystyrene, PET, acrylonitrile-butadiene-styrene (ABS), and polyurethanes**	**Comprehensive review of Sb from mining, uses globally and products in which it is used directly or subsequent to a process or as an FR**	**See 100.1-100.5**	**United States**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**See 100.1-100.5**	**No value for quantitative exposure assessment**	**N/A**	**Percent content of antimony oxide in groups of materials, as presented in this table. No other data or statistics given.**	**no methodology presented**	**Extensive history and facts on Sb global use**
100.1	Butterman and Carlin, 2004	NR	NR	ATO	Not specified	Flexible PVC, polyolefins, polystyrene, PET, acrylonitrile-butadiene-styrene (ABS), and polyurethanes	See 100	This is a review paper - this information is cited secondarily - page 21 of PDF. Citation given at the end of this section is: U.S. Antimony Corp., undated.	United States	NR	NR	NR	NR	NR	1.5	12	NR	NR	%	NR	NR	NR	NR	NR	NR	See 100.0	See 100.0	See 100.0	See 100.0	See 100.0
100.2	Butterman and Carlin. 2004	NR	NR	ATO	Not specified	Rubber and other elastomers	See 100	See 100.2	United States	NR	NR	NR	NR	NR	5	30	NR	NR	%	NR	NR	NR	NR	NR	NR	See 100.0	See 100.0	See 100.0	See 100.0	See 100.0
100.3	Butterman and Carlin, 2004	NR	NR	ATO	Not specified	PVC insulation on electrical wires and cables	See 100	See 100.2	United States	NR	NR	NR	3	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 100.0	See 100.0	See 100.0	See 100.0	See 100.0
100.4	Butterman and Carlin, 2004	NR	NR	ATO	Not specified	Canvas, carpets, carpet padding, drapes, tenting, and other (usually heavier) textiles	See 100	See 100.2	United States	NR	NR	NR	7	NR	NR	NR	NR	NR	%	NR	NR	NR	NR	NR	NR	See 100.0	See 100.0	See 100.0	See 100.0	See 100.0
100.5	Butterman and Carlin. 2004	NR	NR	ATO	Not specified	Paper	See 100	See 100.2	United States	NR	NR	NR	NR	NR	5	25	NR	NR	%	NR	NR	NR	NR	NR	NR	See 100.0	See 100.0	See 100.0	See 100.0	See 100.0
101	**HealthyStuff.org, 2014**	**NR**	**NR**	**ATO**	**NR**	**Consumer products, fabrics, foams, holiday decorations**	**NR**	**See101.1**	**United States**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**See101.1**	**Not relevant for quantitative population exposure assessment.**	**Interesting listing of retail items that may contain Sb, possibly some as a result of ATO FR.**	**Single value presented for "Sb" for each item per state. Unknown n, unknown methods for these values.**	**No methodology or discussion of monitoring strategy presented. Results show measurements (analytical methods unknown) for Sb, but not known if Sb was from ATO or part of material content as a metal.**	
101.1	HealthyStuff.org, 2014	NR	NR	ATO	NR	Consumer products, fabrics, foams, holiday decorations	NR	FR use not specified; consumer products from U.S. stores	United States	NR	NR	NR	NR	NR	15,000	12,714,000	NR	NR	ng/g (15-12,714 ppm)	NR	NR	NR	NR	NR	NR	See 101.0	See 101.0	See 101.0	See 101.0	
102	**Vasile, 2000 as cited in Health Canada, 2010**	**NR**	**NR**	**ATO**	**Plastics**	**PP, HDPE**	**Health Canada's document summarizes evidence on ATO for compliance with CEPA 1999 standards for products on the Canadian market.**	**See 102.1-102.2**	**Canada**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**See 102.1-102.2**	**General exposure assessment and assessments for children.**	**Study details not available.**	**Only ranges of concentration given for categories of products. (See p 21)**	**Methodology details not available in HC publication.**	
102.1	Vasile, 2000 as cited in Health Canada, 2010	NR	NR	ATO	Plastics	PP	See 102	This is an authoritative review - and secondarily cite "Vasile C. 2000. Handbook of polyolefins. 2nd ed. Revised and expanded. New York (NY): Marcel Dekker" for this information. No additional information on methods is provided.	Canada	NR	NR	NR	20,000,000	NR	NR	NR	NR	NR	ng/g (20,000 mg/kg)	NR	NR	NR	NR	NR	NR	See 102.0	See 102.0	See 102.0	See 102.0	

102.2	Vasile, 2000 as cited in Health Canada, 2011	NR	NR	ATO	Plastics	HDPE	See 102	This is an authoritative review - and secondarily cite "Vasile C. 2000. Handbook of polyolefins. 2nd ed. Revised and expanded. New York (NY): Marcel Dekker" for this information. No additional information on methods is provided.	Canada	NR	NR	NR	NR	NR	35,000,000	100,000,000	NR	NR	ng/g (35,000 - 100,000 mg/kg)	NR	NR	NR	NR	NR	NR	See 102.0	See 102.0	See 102.0	See 102.0	
103	**CPSC, 2006a**	**NR**	**NR**	**ATO**	**Fabrics**	**Poly-cotton blend fabrics , coated foam**		**See 103.1-103.2**	**Canada**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**	**See 103.1-103.2**					
103.1	CPSC, 2006a	NR	NR	ATO	Fabrics	Poly-cotton blend fabrics	See 104	FR use not specified	Canada	NR	NR	NR	NR	NR	27,000,000	38,000,000	NR	NR	ng/g (27,000-38,000 mg/kg)	NR	NR	NR	NR	NR	NR					
103.2	CPSC, 2006a	NR	NR	ATO	Not specified	Coated foam	See 104	FR use not specified	Canada	NR	NR	NR	41,000,000	NR	NR	NR	NR	NR	ng/g (41,000 mg/kg)	NR	NR	NR	NR	NR	NR	See 103.0	See 103.0	See 103.0	See 103.0	
104	**Mansson et al., 2009**	**NR**	**NR**	**ATO**	**Not specified**	**Packaging, textiles**	**Assess societal sources of Sb in urban area (Stockholm) and SFA for Sb**	**See 104.1-104.2**	**Sweden**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**See 104.1-104.2**	**Not useful for quantitative exposure assesment for general population**	**N/A**	**Little detail on Sb -- only averages with no further detail.**	**Analysis with graphite furnace atomic absorption spectrophotometer (GFAAS) but no details provided.**	**SFA methods used combining estimates from accounting for sources and analysis of product stock. SFA methodology and results not considered in this review.**
104.1	Mansson et al., 2009	NR	NR	ATO	Not specified	Packaging	See 105	FR use not specified	Sweden	NR	NR	287,000	NR	NR	NR	NR	NR	NR	ng/g (Avg: 287 mg/kg ± 27 mg/kg)	27,000	NR	NR	NR	NR	NR	see 104.0	see 104.0	see 104.0	see 104.0	
104.2	Mansson et al., 2009	NR	NR	ATO	Not specified	Textiles	See 105	FR use not specified	Sweden	NR	NR	134,000 ng/g	NR	NR	NR	NR	NR	NR	ng/g (Avg: 134 mg/kg ± 29 mg/kg)	29,000	NR	NR	NR	NR	NR	see 104.0	see 104.0	see 104.0	see 104.0	
105	**Huisman et al., 2007 as cited in Chancerel et al., 2013**	**NR**	**NR**	**ATO**	**PCBS of information and communication s technology equiomemt**	**Electrical and electronic equipment**	**Huisman cited in Chancere's review of metals in tech, telecommunication equipment**	**See 105.1**	**Germany**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**See 105.1**	**Not useful for quantitative exposure assesment for gen. population.**	**N/A**	**Range of Sb concentrations noted in text. No other details presented**	**no methodology distussed**	
105.1	Huisman et al., 2007 as cited in Chancerel et al., 2013	NR	NR	ATO	PCBS of information and communication s technology equipment	Electrical and electronic equipment	See 106	Tested ATO in PCBs	Germany	NR	NR	NR	NR	NR	0.04	0.35	NR	NR	%	NR	NR	NR	NR	NR	NR	See 105.0	See 105.0	See 105.0	See 105.0	
106	**Sorensen et al., 2005**	**NR**	**NR**	**ATO**	**Not specified**	**Toys**	**Danish Ministry Study: 1) survey of market, screening of material composition of products, 2) chemical analyses of analytes in products and 3) comparison to existing legislation.**	**See 106.1**	**Netherlands**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**See 106.1**	**Not useful for any exposure assesment because of methodological limitations and poor data reporting.**	**Products sold on internet likely to be same as sold in retail shops (circa 2004-2005 in Denmark).**	**Presentation only of resilts for 7 of 35 samples where results "show content of heavy metal exceeding requirements for migration by Danish regulation". No statistical characterization of results.**	**Poor Methodology for many aspects of the study. Methodology included only XRF analysis for "heavy metals".**	**Toys for animals studied because many look like children's toys and are likely to be played with by children. Animal toys not regulated as children's toys so are likely to contain different chemicals**
106.1	Sorensen et al., 2005	NR	NR	ATO	Not specified	Toys	See 107	Not clear as to FR use	Netherlands	NR	NR	NR	NR	NR	400	47,000	NR	NR	ng/g (0.4-47 ppm)	NR	NR	NR	NR	NR	NR	See 106.0	See 106.0	See 106.0	See 106.0	
107	**Isama et al., 2011**	**NR**	**NR**	**ATO**	**Household products made of synthetic resin that infants may swallow**	**Decorations part – acrylic; PVC strap – orange and yellow**	**Measure elements, including Sb, in household items that children could swallow by mistake.**	**See 107.1-107.3**	**Japan**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**See 107.1-107.3**	**Unsure...details of study in Japanese.**	**Unsure...details of study in Japanese.**	**Individual results given for Sb content and migrations from these items.**	**Iso 8124-3 and ICP-MS analytical methods employed. Text was Japanese so details were not available for review.**	**Items included key covers, decorative parts, hairpins, erasers, shoe charm, and other such accessories. These are not classified as children's toys and thus not regtated for children's risk.**
107.1	Isama et al., 2011	NR	NR	ATO	Household products made of synthetic resin that infants may swallow	Decorations part – acrylic	See 108	Japanese article with only abstract and tables available in English; not clear if FR use. Only single values reported; ND level not specified	Japan	NR	NR	NR	NR	ND	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	See 107.0	See 107.0	See 107.0	See 107.0	
107.2	Isama et al., 2011	NR	NR	ATO	Household products made of synthetic resin that infants may swallow	PVC strap – orange	See 108	Japanese article with only abstract and tables available in English; not clear if FR use. Only single values reported; ND level not specified	Japan	NR	NR	NR	NR	389	NR	NR	NR	NR	ng/g (0.389 mg/kg)	NR	NR	NR	NR	NR	NR	See 107.0	See 107.0	See 107.0	See 107.0	
107.3	Isama et al., 2011	NR	NR	ATO	Household products made of synthetic resin that infants may swallow	PVC strap – yellow	See 108	Japanese article with only abstract and tables available in English; not clear if FR use. Only single values reported; ND level not specified	Japan	NR	NR	NR	NR	722	NR	NR	NR	NR	ng/g (0.722 mg/kg)	NR	NR	NR	NR	NR	NR	See 107.0	See 107.0	See 107.0	See 107.0	

For ease of comparison, all units are converted to ng equivalent. Original study units, if different, are shown in parentheses.

TDCPP Concentrations in Water

Country	Location	Media	TDCPP Concentrations	Reference	Notes
United States	25 States and Puerto Rico	Ground and surface water; 74 raw, untreated drinking water sources	All measured below 500 ng/L Reporting limit: 500 ng/L (0.5 µg/L)	Focazio et al., 2008; Barnes et al., 2008	USGS – sites known or suspected to have some human and/or animal wastewater sources upstream or up gradient
	Kansas, Johnson County 2002-2003	Streams	500 ng/L (0.5 µg/L)	Lee and Rasmussen, 2006	
		Downstream from WWTF	Mean: 400 ng/L (0.4 µg/L) Max: 600 ng/L (0.6 µg/L)		< 500 m downstream from the facility
	Geo Survey 30 states	Streams	Median: 100 ng/L (0.1 µg/L) Max: 160 ng/L (0.16 µg/L)	Kolpin et al., 2002	
	Iowa	Streams	Range: ND-400 ng/L (ND-0.4 µg/L)	Kolpin et al., 2004	
	Urbanized area	Stream	Range: 60-250 ng/L (0.06-0.25 µg/L)	Stackelberg et al., 2004	
Canada	12 municipalities	Finished drinking water	Range: 0.1-15.7 ng/L	Williams et al., 1982	Water from the Great Lakes
Canada	6 Ontario municipalities	Finished drinking water	Range: 0.2-1.8 ng/L	Lebel et al., 1981 as cited in HSDB, 2013	Ontario water treatment plants
	29 municipalities	Finished drinking water	Range: 0.3-23 ng/L	Williams et al., 1981	Water treatment plants, sources include rivers, lakes and ground water
Germany	Hessen - Schwarzbach, Modau, Winkelbach, Weschnitz	Fresh water	Mean: 117 ng/L Median: 80 ng/L Max: 1284 ng/L	Quednow and Puttman, 2008	
	Elbe estuary plume	River estuary plume	~3 ng/L	Andresen et al., 2007	
	Kleiner Feldberg	Rain	Median: 24 ng/L Max: 31 ng/L	Regnery and Puttmann, 2009	
		Snow	Median: 40 ng/L Max: 113 ng/L		
	Wasserkuppe	Rain	Median: 2 ng/L Max: 2 ng/L		
		Snow	Median: 5 ng/L Max: 23 ng/L		
	Bekond	Rain	Median: 9 ng/L Max: 53 ng/L		
		Snow	Median: 17 ng/L Max: 83 ng/L		
	Schmuecke	Rain	Median: 17 ng/L Max: 25 ng/L	Regnery and Puttmann, 2009	
		Snow	Median: 12 ng/L Max: 52 ng/L		
	Frankfurt	Rain	Median: 7 ng/L Max: 32 ng/L		
			Polluted area Range: 100-900 ng/L		

Japan	Yodo River	River	(0.1-0.9 µg/L) Less polluted area Range: 0-700 ng/L (0-0.7 µg/L)	Fukushima et al., 1992	Trend of concentration from 1976-1990
Netherlands	Rhine Delta	River	Range: 0-55 ng/L (0-0.055 µg/L)	Hendricks et al., 1994	
	Ruhr, Mohne, Lenne Rivers, and tributaries	River	~50 ng/L	Andresen et al., 2004	
	Rhine	River	Range: 13-36 ng/L		
	Lippe	River	17 ng/L		
	Meuse River and tributaries	River	Range: 150-450 ng/L (0.15-0.45 µg/L)	Jeuken and Barreveld, 2004	
Sweden	Finland Municipal airport	Snow	12 ng/L Road 1	Marklund et al., 2005b	Collected 2 m from major intersection
		Snow	230 ng/L Road 2		Collected 100 m from major intersection
		Snow	8 ng/L Road 3		Collected 250 m from major intersection
		Snow	5 ng/L Airport 1		Collected at the side of runway
		Snow	4 ng/L Airport 2		Collected at the side of runway
		Snow	15 ng/L Airport 3		Collected in parking lot
Italy	Albano - Volcanic Lake	Surface water	Monthly means Range: 5-60 ng/L Range: 20-1335 ng/L Large range in March	Bacaloni et al., 2008	
	Vico - Volcanic Lake	Surface water	Monthly means Range: 2-35 ng/L		
	Martignano - Volcanic Lake	Surface water	Monthly means Range: 2-23 ng/		

TEP Concentrations in Water

Country	Location	Media	TEP Concentrations	Reference	Notes
Canada	12 municipalities	Finished drinking water	Range: 10.3-13.0 ng/L	Williams et al., 1982	Source water from the Great Lakes
	6 Ontario municipalities	Finished drinking water	Range: 17.2-27.1 ng/L	Lebel et al., 1981 as cited in HSDB, 2013	Detected in 2 of the 6 Ontario water treatment plants
	29 municipalities	Finished drinking water	Range: 1.1-23 ng/L	Williams et al., 1981	Water treatment plants, sources include rivers, lakes and ground water
Netherlands	Rhine River	Bank-filtered water	Max: 1,000 ng/L	Piet and Morra, 1983 as cited in HSDB, 2013	Surface water
Spain	Northwest area	Surface water	Median: 3 ng/L	Rodil et al., 2012	
Italy	River Tiber	River	Mean: 45 ng/L (June) Mean: 27 ng/L (Nov)	Bacaloni et al., 2007	
Japan	Osaka	Surface water	Mean: 1,500 ng/L (1.5 µg/L)	Fukushima et al., 1992	Trend of concentration from 1976-1990
Europe	River Rhine and tributaries	Surface water	Range: <100-6500 ng/L (<0.1-6.5 µg/L)	OECD, 2005	Highest concentrations recorded between 1987 and 1992. DL = 100 ng/L (0.1 µg/L)

TPP Concentrations in Water

Country	Location	Media	TPP Concentrations	Reference	Notes

United States	Arkansas	Surface Water	Median: 34 ng/L (0.034 µg/L) (estimated)	Haggard et al., 2006	Levels estimated at or below the reporting limit
			Range: 9-63 ng/L (0.009-0.063 µg/L)		
	Mississippi Rive	Surface Water	ND-11 ng/L	DeLeon et al., 1986	Detection limit not specified
	USGS, 18 States	Groundwater	<RL	Barnes et al., 2008	RL = 0.5 µg/L; found in 4.3% of 47 samples
	Johnson County, Kansas	Surface water	ND	Lee and Rasmussen, 2006	LOD = 0.5 µg/L
United States	30 states	Surface water	Median: 40 ng/L (0.04 µg/L)	Kolpin et al., 2002	139 streams sampled in 30 states 1999-2000
	New Orleans	Finished drinking water	30 ng/L (0.03 µg/L) 120 ng/L (0.12 µg/L)	Keith et al., 1976 as cited in HSDB, 2013	Study details not available
	Rivers in MO, MS, WV, CA	Surface water	Range: 100-7,900 ng/L (0.1-7.9 µg/L)	Mayer et al., 1981 as cited in HSDB, 2013	Study details not available
	Delaware River	Surface water	Range: 0.1-0.4 ppb	Sheldon et al., 1978 as cited in HSDB, 2013	Study details not available
Canada	6 Ontario municipalities	Finished drinking water	Range: 0.2-2.6 ng/L	Lebel et al., 1981 as cited in HSDB, 2013	Detected in 2 of the 6 Ontario water treatment plants
	29 municipalities	Finished drinking water	Range: 0.2-2.6 ng/L	Williams et al., 1981	Water treatment plants, sources include rivers, lakes and ground water
Germany	River Ruhr	Surface Water	Range: < LOQ - 80 ng/L	Andresen et al., 2004	LOQ = 10 ng/L; July and Sept 2002 sampling
	River Ruhr	Surface Water, reservoir	Source Mean: 7.2 ng/L Finished water mean: <0.3 ng/L	Andresen and Bester, 2006	
Italy	Volcanic Lakes	Surface water	Means: 2-21 ng/L	Bacaloni et al., 2008	Detection limit not reported
	Near Vico Lake	Well Water	Range: ND-164 ng/L		
	River Tiber	Surface water	Mean: 11,165 ng/L	Bacaloni et al., 2007	
Japan	Well Water	Surface water	Mean: 500 ng/L (< 0.5 µg/L)	Fukushima et al., 1992	Trend of concentration from 1976-1990
China	Various cities, inland and coastal, developed and less developed	Tap water	Mean: 40 ng/L Range: 19.8-84.1 ng/L	Li et al., 2014	Boiling water increased the TPP concentration by 5.72 ng/L
	Various brands (n=8)	Bottled water	Range: 2.57-14.8 ng/L		
Poland, Gliwice, Ruda Slaska, Zabrze	Klodnica River	Surface water	300 ng/L (0.30 µg/L)	Kowalski et al., 2014	New method to identify flame retardants using ultra-HPLC equipment and UV detection
	Kokotka Lake	Surface water	120 ng/L (0.12 µg/L)		
	Pileckiego Lake	Surface water	30 ng/L (0.03 µg/L)		

TBPH Concentrations in Water

Country	Location	Media	TBPH Concentrations	Reference	Notes
Spain	Western Coast	Sea	Mean: 2.1 ng/L	Valls-Cantenys et al., 2013	"Several" samples taken
		River	Mean: 2.2 ng/L		

		Ria (an inlet)	Mean: 1.3 ng/L	2015	taken

TBBPA Concentrations in Water

Country	Location	Media	TBBPA Concentrations	Reference	Notes
United Kingdom	England	Freshwater lake	Range: 0.14-3.2 ng/L (140-3200 pg/L)	Harrad et al., 2009	3 samples taken from each of 7 lakes
China	Lake Chaohu	Freshwater lake	Max: 4.87 µg/L	Yang et al., 2012	7 lakes sampled in July, September, November

TCPP Concentrations in Water

Country	Location	Media	TCPP Concentrations		Reference	Notes
	California, Santa Ana River	Surface water	Range: 0-34 ng/L		Gross et al., 2004	4-8 L samples collected every 4 months from April- December 2002
United States	California: Los Angeles and San Gabriel Rivers	Surface water	Max: 2,150 ng/L (July)	Max: 2,900 ng/L (October)	Sengupta 2014	Samples collected below discharge points in July and October 2011.
Germany	Rhine River	Surface water	Range: 80-100 ng/L		Andresen et al., 2004	
	Lippe River		100 ng/L			
	River Elbe	Surface Water	Range: 40-250 ng/L		Bollman et al., 2012	
	German Bight	Surface water	Range: 3-28 ng/L			
	Rhine River	Surface water	Range: 75-160 ng/L			
	Rhine River	Surface water	Range: 30-150 ng/L (0.03-0.15 µg/L)		Knepper et al., 1999	
	Hesse Streams	Surface water	502 ng/L	Median: 417 ng/L	Quednow and Puttman, 2008	
	Ruhr River	Surface water, reservoir	Mean: 54±7.6 ng/L	Max: 65 ng/L	Andresen and Bester 2006	
Germany	Hessian Ried	Groundwater (preciptiation infiltration)	Median: <LOQ	Max: 6 ng/L	Regnery et al., 2011	LOQ = 4 ng/L
	Hessian Ried	Groundwater (riverbank filtration)	Meidan: 38 ng/L	Max: 1,795 ng/L		
	Oder River	Surface Water	Range: 217-2353 ng/L		Stepien et al., 2013	
		Groundwater wells	Range: 14-406 ng/L			
Austria	Danube River	Surface water	Range: 33-43 ng/L		Martinez-Carballo et al., 2007	
	Schwechat River		170 ng/L			
	Liesig River		110 ng/L			
Japan	Yamato River	Surface water	Mean: 13,100 ng/L (13.1 µg/L)		Fukushima et al., 1992	Trend of concentration from 1976-1990
Spain	Iberia	Groundwater	Median: 47 ng/L		Rodil et al., 2012	
		Llobregat River (Surface water)	1,100 ng/L (estimated from graph)		Gorga, 2015	77 samples collected during two monitoring campaigns conducted 2010-2011
		Ebro River (Surface water)	Max: 6,500 ng/L (estimated from graph)			
		Jucar River (Surface water)	300 ng/L (estimated from graph)			
Spain		Guadalquivir River (Surface	600 ng/L (estimated from graph)			
Not Specified	River (4)	Surface water	3 rivers known discharge:24-64 ng/L	1 river downstream of sewage plant: 430 ng/L	Garcia Lopez, 2010	Single samples from 4 rivers
South Korea	Seoul	Han River (Surface water)	Mean: 197 ng/L	Range: 100-310 ng/L	Yoon et al., 2010	
		Creek (Surface water)	Mean: 403 ng/L	Range: 210-590 ng/L		
Italy	Volcanic Lake	Albano Lake (Surface water)	Means: 6-62 ng/L (monthly)		Bacaloni et al., 2008	Detection limit not reported
		Vico Lake (Surface water)	Means: 2-27 ng/L (monthly)			

Italy	Well. Near Vico Lake	Ground water	Range: ND-12 ng/L		
	River Tiber	Surface water	54 ng/L and117 ng/L	Bacaloni et al., 2007	2 samples, June 2006, November 2006

TCEP Concentrations in Water

Country	Location	Media	TCEP Concentrations	Reference	Notes
United States	19 Drinking water treatment plants	Source, finished, and distribution water	*Median values* Source: 120 ng/L Finished: 120 ng/L Distribution:150 ng/L *Max values* Source: 530 ng/L Finished: 470 ng/L Distribution:200 ng/L	Benotti et al., 2009	
	Cape Cod public wells	Water	Max: 20 ng/L	Schaider et al., 2010	
	Cape cod	Monitoring wells; drinking water	Monitoring wells: 81-240[a] ng/L Private well: 110[a] ng/L	Zimmerman, 2004	
	Drinking water supplies	Surface water: raw and finished	Max Source: 260 ng/L (estimated) Max Finished 220 ng/L (estimated)	Kingsbury et al., 2008	
	Kansas	Streams	Avg: 500 ng/L	Lee and Rasmussen, 2006	
	Multiple locations	Streams	Max: 540 ng/L	Kolpin et al., 2002	
	Multiple locations	Groundwater	Max: 737 ng/L	Barnes et al., 2008	Untreated drinking water sources
	Drinking water supplies	Groundwater and surface water	<500[b] ng/L	Focazio et al., 2008	Untreated drinking water sources
	Drinking water treatment plants	Drinking water	*Max values* Source:120 ng/L Finished: 50 ng/L	Stackelberg et al., 2007	
United States	Drinking water treatment plant	Surface water and finished drinking water	*Median values* Source: 5.6 ng/L Finished: 3.7 ng/L *Range values* Source: 0-51.7 ng/L Finished: 0-20.4 ng/L	Padhye et al., 2014	Large urban treatment plant in southeast United States.
Germany	Oder River	Municipal waste water influent and effluent, river water, groundwater	*Mean* Effluent:352 ng/L Influent: 986 ng/L *Range* River: ND-1,036 ng/L Ground: ND-312 ng/L	Fries and Puttmann, 2003 as cited by ATSDR, 2012	ND = 1 ng/L
	N/A	River water untreated and finished	Untreated:10-130 ng/L Finished:0.3-30 ng/L	Andresen and Bester, 2006	
Spain	Northwest area	Surface water	Median: 5 ng/L	Rodil et al., 2012	
Italy	N/A	Volcanic lakes	Mean monthly range: ND-64 ng/L	Bacaloni et al., 2008	Detection limit not reported
South Korea	Rivers and lakes	Surface water	Mean: 42 ng/L Range: 14-81 ng/L	Kim et al., 2007	
		Waste water treatment	Mean Influent: 284 ng/L Effluent Means: MBR method: 283-303 ng/L		MBR system was not effective for TCEP. Adding UV radiation to the RO and NF method did not

			RO method: 14 ng/L NF method: 13 ng/L		increase effectiveness.

For ease of comparison, all units are converted to ng equivalent. Original study units, if different, are shown in parentheses.

TCPP Concentrations in Food

Country	Study Type	Food	TCPP Concentrations	Reference	Notes
United States	Market-basket survey	Pear	9.3 ng/g (0.0093 µg/g)	U.S. FDA Total Diet Study , as cited by ATSDR 2009	234 food items were
		Apple	0.82 ng/g (0.00082 µg/g)		
		Tomato juice	0.30 ng/g (0.00030 µg/g)		
		Baby food	0.18 ng/g (0.00018 µg/g)		
		Prunes	0.15 ng/g (0.00015 µg/g)		
		Apple juice	0.05 ng/g (0.00005 µg/g)		

TEP Concentrations in Food

Country	Study Type	Food	TEP Concentrations		Reference	Notes
UK	Pesticide residue analysis	Oatmeal	Food: 270 ng/g (0.27 µg/g)	Package: 470 ng/g (0.47 µg/g)	Tomizawa et al., 2004	Japanese study measured TEP values in products and their packaging from various countries
Italy		Pasta	Food: 90 ng/g (0.09 µg/g)	Package: 150 ng/g (15 µg/g)	Tomizawa et al., 2004	
France		Pasta	Food: 80 ng/g (0.08 µg/g)	Package: 4,700 ng/g (4.7 µg/g)	Tomizawa et al., 2004	
France		Pasta	Food: 90 ng/g (0.09 µg/g)	Package: 130 ng/g (13 µg/g)	Tomizawa et al., 2004	

TPP in Food and Food Packaging

Country	Food	TPP Concentrations	Reference	Notes
United States	Caramel	40 ng/g (0.04 ppm)	U.S. FDA, 2006 as cited by ATSDR 2009	U.S. FDA's Total Diet Study, market basket survey, 234 food items evaluated over a 10-year period from 1982-1991
	Margarine	40 ng/g (0.04 ppm)		
	Baby food	20 ng/g (0.02 ppm)		
United	Taco tray	98.4 ng/g	Bradley, 2013	Study of migration of inks in packaging to foods. 350 foods packaged in printed

Kingdom	Taco tray	(98.4 µg/kg) in packaging	Bradley, 2013	printed paper/board from UK retail outlets. TPP in one packaging material

TBB Concentrations in Food

Country	Location	Media/Area	TBB Concentrations	Reference	Notes
China	Eastern China	Foods from control town	Range: <0.20-11.7 ng/g lipid weight	Labunska et al., 2015	Foods included: vegetable oil; fish; chicken, shrimp, duck, and pork muscles; chicken and duck livers; and, chicken and duck eggs.
		Foods acquired near e-waste facilities	Range: <3.09-62.2 ng/g lipid weight		

TBPH Concentrations in Food

Country	Location	Media/Area Area	TBPH Concentrations	Reference	Notes
China	Eastern China	Foods from control town	Range: <0.25-9.32 ng/g lw	Labunska et al., 2015	Foods included: vegetable oil; fish; chicken, shrimp, duck, and pork muscles; chicken and duck livers; and, chicken and duck eggs.
		Foods acquired near e-waste facilities	Range: 0.81-16.3 ng/g lw		

TBBPA Concentrations in Food

Country	Location	Food	TBBPA Concentrations	Reference	Notes
United Kingdom	9 English lakes	Freshwater fish	Range: <LOQ-1.7 ng/g lw	Harrad et al., 2009	LOQ=0.29 ng/g lw
	Not specified	Oils and fats, nuts, eggs, other vegetables, milk	<LOD	Driffield et al., 2008	LOD=0.11-0.19 ng/g (0.11-.19 µg/kg)
	Not specified	Canned vegetables, potatoes, fresh fruit, sugars and preserves	<LOD		LOD=0.017-0.036 ng/g (0.017-0.036 µg/kg)

United Kingdom	Not specified	Fruit, meat and dairy products, green vegetables, carcass meat, offal, fish, poultry, bread, miscellaneous cereals	<LOD	Driffield et al., 2008	LOD=0.043-0.084 ng/g (0.043-0.084 µg/kg)
	Scotland	Oysters	<LOD		LOD=<0.020-<0.050 ng/g
		(n=5 locations, 1 value per location)			(<0.020-<0.050 µg/kg). Samples from 5 different locations were below the LOD for each location. Multiple samples from each location were homogenized together for one value per location.
		Mussels	<LOD		LOD=<0.010-<0.12 ng/g (<0.010-<0.12 µg/kg). Multiple samples from each location were homogenized together for one value per location.
		(n=10 locations, 1 value per location)			
United Kingdom	Scotland	Scallops	<LOD	Driffield et al., 2008	LOD=<0.010-<0.35 ng/g (<0.010-<0.35 µg/kg). Multiple samples from each location were homogenized together for one value per location.
		(n=20 locations, 1 value per location)			
	7 locations around Scotland	Mussels, oysters and scallops (n=35 pooled)	ND	Fernandes et al., 2008	LOD=0.01 ng/g (0.01 µg/kg)
European Countries (Ireland, Norway, Spain and the United Kingdom)	Not specified	Fish and other seafood (including amphibians, reptiles, snails and insects) (n=465)	<LOQ		LOQ=1.00 ng/g

	Not specified	Meat and meat products (including edible offal) (n=49)	<LOQ	EFSA, 2011	LOQ=0.14 ng/g
	Not specified	Milk and dairy products (n=40)	<LOQ		LOQ=0.65 ng/g
	Not specified	Animal and vegetable fats and oils (n=41)	<LOQ		LOQ=4.99 ng/g
	Not specified	Products for special nutritional use (n=10)	<LOQ		LOQ=0.34 ng/g
	Not specified	Snacks, desserts, and other foods, eggs and egg products (n=30)	<LOQ		LOQ=0.08-0.10 ng/g
European Countries (Ireland, Norway, Spain and the United Kingdom)	Not specified	Fruit and fruit products, grains and grain-based products, vegetables and vegetable products (including fungi), starchy roots and tubers (n=17)	<LOQ	EFSA, 2011	LOQ=0.01-0.02 ng/g
Europe	Not specified	Milk	Mean: <0.005 ng/g ww Range: <0.005-0.006 ng/g ww	Papke et al., 2010 as cited in EFSA 2011	
	Not specified	Fish, shellfish and crustacean	Range: <0.005-<0.26 ng/g ww		
Netherlands	Not specified	Fish, shellfish and crustacean	Range: <0.1-245 ng/g lw	Morris et al., 2004	
	Not specified	Fish, shellfish and crustacean	Range: <0.1-5.3 ng/g ww	Van Leeuwen, 2009 as cited in EFSA 2011	
Norway	Not specified	Fish, shellfish and crustacean	Range: 1.0-13.7 ng/g lw	Schlabach et al., 2004 as cited in EFSA 2011	
	Not specified	Milk	0.013 ng/g lw (13 pg/g lw)	Thomsen et al., 2002b	Lipid content was 3.9%, equivalent to a whole milk concentration of $5.1x10^{-4}$ ng/g ($5.1x10^{-4}$ µg/kg)
China	Guangdong Province in southern China	Meat	Mean: 0.263 ng/g lw (263 pg/g lw) Range: <LOD-1.386 ng/g lw (<LOD-1,386 pg/g lw)	Shi et al., 2009	LOD^2 = 0.07 ng/g ww (70 pg/g ww)

China	Guangdong Province in southern China	Aquatic food group	Mean: 0.738 ng/g lw	Shi et al., 2009	LOD = 0.1 ng/g ww
			(738 pg/g lw)		(100 pg/g ww)
			Range: <LOD-2.044 ng/g lw		
			(<LOD-2,044 pg/g lw)		
	Not specified	Eggs	Mean: 0.194 ng/g lw		LOD=0.06 ng/g
			(197 pg/g lw)		(60 pg/g ww)
			Range: <LOD-0.692 ng/g lw		
			(<LOD-692 pg/g lw)		
		Milk	Mean: 0.211 ng/g lw		LOD=0.05 ng/g
			(211 pg/g lw)		(50 pg/g ww)
			Range: <LOD-0.848 ng/g lw (<LOD-848 pg/g lw)		
	Anhui Province in Eastern China	Four fish species (*Culter alburnus, Cyprinus carpio, Carassius auratus, and Silurus asotus*)	Means: 28.5-39.4 ng/g	Yang et al., 2012	
Japan	Nagoya (N)	Fish	N region Mean: 0.01 ng/g	Ashizuka et al., 2008	Detected in 29 fish samples from Japanese food markets in 3 different regions, 2004-2005
			S region Mean: 0.01 ng/g		
	Seto Inland Sea(S)		K region Mean: 0.02 ng/g		
			Range: 0.01-0.11 ng/g ww		
	Kyushu (K)				

TCEP Concentrations in Food

Country	Study Type	Food	TCEP Concentrations	Reference	Notes
United	Total Diet Study Market Baskets 1991-	Peas, green, frozen, boiled	1.82 ng/g[a]	U.S. FDA, 2006 as cited by ATSDR	234 food items were evaluated over a 10-year
		Oatmeal, plain, cooked	0.02 ng/g[b]		
		Cream of wheat (farina), enriched, cooked	2.59 ng/g[a]		
		Rolls, white, soft, enriched	0.08 ng/g[b]		
		Broccoli, fresh/frozen, boiled	0.14 ng/g[a]		
		Green beans, fresh/frozen, boiled	1.59 ng/g[a]		
		BF turkey and rice	0.48 ng/g[a]		
		BF peas	0.02 ng/g[b]		

States	1993, 2003-2004	Bread, cracked wheat	0.02 ng/g[b]	2009	period between 1982 and 1991.
		Eggplant, fresh, peeled, boiled	1.75 ng/g[a]		
		Candy, hard, any flavor	0.02 ng/g[b]		
		Sweet cucumber pickles	0.05 ng/g[b]		
		BF teething biscuits	0.06 ng/g[b]		
		Soup, Oriental noodles (ramen noodles), prepared with water	7.25 ng/g[a]		
		BF pears, and pineapple	0.02 ng/g[b]		
United States	Total Diet Study Market Baskets 2004-2005	BF custard/pudding	28 ng/g[a]	U.S. FDA, 2006 as cited by ATSDR, 2009	
		BF, juice, apple-banana	1.05 ng/g[a]		
		BF, juice, apple-cherry	4.63 ng/g[a]		
		BF, oatmeal w/fruit	2.37 ng/g[a]		
		BF, veg w/turkey	0.88 ng/g[a]		

[a]Only one sample >=LQ; [b]Trace amounts only; BF – baby food

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Mean	Median	Min	Max	95th	Concentration units (original study value if not ng)	Detection Frequency	Comments
Dodson et al., 2014	Urinary biomonitoring of phosphate flame retardants: levels in California adults and recommendations for future studies	BCEP (metabolite)	Urine	No	United States, California	16	non-smoking adults living in northern California	0.76	0.63	NR	2.1	NR	ng/l	NR	Creatinine corrected levels were not reported.
Fromme et al., 2014	Polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD) and "novel" brominated flame retardants in house dust in Germany	DCEP (metabolite)	Urine	Yes (air and dust)	Germany	312	spot samples of daycare children	400	200	100	13,100	1,600	ng/l; Mean: (0.4 µg/l) Median: (0.2 µg/l) Range: (<0.1-13.1 µg/l 95th: (1.6 µg/l)	NR	Spot urine samples from 312 children attending daycare centers that were also measured for air and dust concentrations. Creatinine corrected levels were not reported.
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TCEP	Breast milk	No	Philippines, Payatas	22	dumping site	NR	41	ND	512	NR	ng/g	NR	Detection limits were between 0.01 (2.7%) and 0.08 (7.9%) ng/g lipid weight.
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TCEP	Breast milk	No	Philippines,Malate	19	Urban area	NR	42	ND	153	NR	ng/g	NR	Detection limits were between 0.01 (2.7%) and 0.08 (7.9%) ng/g lipid weight.
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TCEP	Breast milk	No	Japan, Kanagawa	20	Urban area	NR	0.14	ND	20	NR	ng/g	NR	Detection limits were between 0.01 (2.7%) and 0.08 (7.9%) ng/g lipid weight.
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TCEP	Breast milk	No	Vietnam, Hanoi, Bui Dau, Trang Minh	26	suburban and e-waste recycling site	NR	ND	NR	NR	NR	ng/g	NR	Detection limits were between 0.01 (2.7%) and 0.08 (7.9%) ng/g lipid weight
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TCEP	Breast milk	No	Vietnam, Bui Dau, Trang Minh	19	e-waste recycling site	NR	NR	ND	18	NR	ng/g	NR	Detection limits were between 0.01 (2.7%) and 0.08 (7.9%) ng/g lipid weight

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Geo Mean	Mean	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Hudec et al., 1981	Tris(dichloropropyl)phosphate, a mutagenic flame retardant: frequent occurrence in human seminal plasma	TDCPP	Human seminal fluid	No	United States	NR	NR	NR	NR	NR	5,000	50,000	ng/mL (5-50 µg/mL)	NR	
Sundkvist et al., 2010	Organophosphorus flame retardants andplasticizers in marine and fresh water biota and in human milk	TDCPP	Human milk lipids	No	United States	NR	NR	NR	NR	4.3	NR	5.3	ng/g	NR	
Hoffman et al., 2014	Urinary metabolites of organophosphate flame retardants and their variability in pregnant women	BDCPP	Urine (metabolite)	No	United States, North Carolina	NR	pregnant women	1.9	NR	NR	NR	37.3	ng/mL	NR	Creatinine corrected levels were not reported.
Hoffman et al., 2014	Urinary metabolites of organophosphate flame retardants and their variability in pregnant women	DPP	Urine (metabolite)	No	United States, North Carolina	NR	pregnant women	1.3	NR	NR	NR	19.9	ng/mL	NR	Creatinine corrected levels were not reported.
Meeker et al., 2013	Urinary Metabolites of Organophosphate Flame Retardants: Temporal Variability and Correlations with House Dust Concentrations	BDCPP	Urine (metabolite)	Yes (dust)	United States	NR	Male volunteers from a reproductive study	0.13	NR	NR	NR	25	ng/mL	NR	house dust levels also measured. Creatinine corrected levels were not reported.
Meeker et al., 2013	Urinary Metabolites of Organophosphate Flame Retardants: Temporal Variability and Correlations with House Dust Concentrations	DPP	Urine (metabolite)	Yes (dust)	United States	NR	Male volunteers from a reproductive study	0.31	NR	NR	NR	9.84	ng/mL	NR	house dust levels also measured. Creatinine corrected levels were not reported.
Carignan et al., 2013b	Predictors of tris(1,3-dichloro-2-propyl) phosphate metabolite in the urine of office workers	BDCPP	Urine (metabolite)	Yes (dust)	United States	NR	Male and female volunteers	0.408	NR	NR	0.0621	1.76	ng/mL Geo mean: (408 pg/mL) Range: (62.1-1,760 pg/mL)	NR	house, car and office dust levels also measured. Metabolite values in urine were adjusted for specific gravity. Creatinine corrected levels were not reported.
Dodson et al., 2014	Urinary biomonitoring of phosphate flame retardants: levels in California adults and recommendations for future studies	BDCPP	Urine (metabolite)	No	United States, Northern California	16	non-smoking adults	NR	0.46	0.09	NR	3.9	ng/mL	NR	Creatinine corrected levels were not reported.
LeBel et al., 1989	Triaryl/alkyl phosphate residues in human adipose autopsy samples from six Ontario municipalities	TDCPP	Human adipose	No	Canada, Ontario	NR	Greater omentum tissue harvested from cadavers	NR	NR	NR	ND	32	ng/g	NR	detection limit = 1 ng/g; samples from six municipalities
LeBel and Williams, 1983 as cited in HSDB, 2013	Determination of organic phosphate triesters in human adipose tissue	TDCPP	Human adipose	No	Canada, Ontario	NR	NR	NR	NR	NR	0.5	110	ng/g	NR	

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Fromme et al., 2014	Polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD) and "novel" brominated flame retardants in house dust in Germany	TCPP	Urine	No	Germany	312	NR	<20	<20	8400	ng/l; Median: (<0.02 µg/L) Range: (<0.2-8.4 µg/L)	NR	Metabolites of TCPP were found in 21% of urine samples collected from 312 children exposed to multiple flame retardants. Creatinine corrected levels were not reported.
Sundkvist et al., 2010	Organophosphorus flame retardants andplasticizers in marine and fresh water biota and in human milk	TCPP	Human milk lipids	No	Sweden	285	5 Pooled samples with 285 individuals	45	22	82	ng/g	NR	285 individuals from 1997-2003, 1 individual sample 2006, 4 towns

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Kim et al., 2014		TEP	Breast milk	No	Philippines, Payatas	22	Dumping site	ND	ND	1.2	ng/g	NR	MDL = 0.01-0.08 ng/g lipid weight (2.7-7.9% lipid weight)
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TEP	Breast milk	No	Philippines,Malate	19	Urban area	ND	ND	1.5	ng/g	NR	MDL = 0.01-0.08 ng/g lipid weight (2.7-7.9% lipid weight)
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TEP	Breast milk	No	Japan, Kanagawa	20	Urban area	ND	ND	15	ng/g	NR	MDL = 0.01-0.08 ng/g lipid weight (2.7-7.9% lipid weight)
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TEP	Breast milk	No	Vietnam, Bui Dau	10	e-waste recycling site	ND	ND	0.8	ng/g	NR	MDL = 0.01-0.08 ng/g lipid weight (2.7-7.9% lipid weight)
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TEP	Breast milk	No	Vietnam, Hanoi, Trang Minh	16	Suburban area and e-waste recycling site	ND	ND	ND	ng/g	NR	MDL = 0.01-0.08 ng/g lipid weight (2.7-7.9% lipid weight)

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Geo Mean	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Meeker et al., 2013	Urinary Metabolites of Organophosphate Flame Retardants: Temporal Variability and Correlations with House Dust Concentrations	DPP	Urine (metabolite)	Yes (dust)	United States	9	9 repeated urine samples from 7 men over 3 months	0.31	NR	0.07	9.84	ng/ml	96%	House dust levels also measured. Creatinine corrected levels were not reported.
LeBel and Williams, 1983 as cited in HSDB, 2013	Determination of organic phosphate triesters in human adipose tissue	TPP	Human adipose	No	Canada, Ontario	2	two samples reported	NR	NR	11.2	13.6	ng/g	NR	Two samples reported in HSDB, 2013
Sundkvist et al., 2010	Organophosphorus flame retardants andplasticizers in marine and fresh water biota and in human milk	TPP	Breast milk	No	United States	NR	NR	NR	8.5	3.2	11	ng/g	NR	Based on average lipid content

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Average	Mean	Median	Min	Max	95th	Concentration units (original study value if not ng)	Detection Frequency	Comments
Carignan et al., 2012	Predictors of Tetrabromobisphenol-A (TBBP-A) and hexabromocyclododecanes (HBCD) in milk from Boston mothers	TBBPA	Breast milk	No	United States, Massachussetts, Boston	34	34 first time mothers	NR	NR	NR	0.03	0.55	NR	ng/g lw; Range: (<30-550 pg/g lw)	35%	
Johnson-Restrepo et al., 2008 as cited in Abdallah and Harrad, 2011	Tetrabromobisphenol A (TBBPA) and hexabromocyclododecanes (HBCDs) in tissues of humans, dolphins, and sharks from the United States	TBBPA	Human adipose tissue	No	United States	NR	Number of samples not reported	0.048	NR	NR	NR	NR	NR	ng/g lw	NR	
Abdallah and Harrad, 2011	Tetrabromobisphenol-A, hexabromocyclododecane and its degradation products in UK human milk: relationship to external exposure	TBBPA	Breast milk	No	United Kingdom, Birmingham	34	NR	0.06	NR	<0.04	<0.04	0.65	NR	ng/g lw	36%	
Cariou et al., 2008	Exposure assessment of French women and their newborns to Tetrabromobisphenol-A: occurrence measurements in maternal adipose tissue, serum, breast milk and cord serum	TBBPA	Breast milk	No	France, Toulouse	77	NR	NR	4.11	0.48	0.06	37.34	NR	ng/g lw	56%	
Cariou et al., 2008	Exposure assessment of French women and their newborns to Tetrabromobisphenol-A: occurrence measurements in maternal adipose tissue, serum, breast milk and cord serum	TBBPA	Human adipose tissue	No	France, Toulouse	44	NR	NR	ND	NR	NR	NR	NR	ND	NR	
Cariou et al., 2008	Exposure assessment of French women and their newborns to Tetrabromobisphenol-A: occurrence measurements in maternal adipose tissue, serum, breast milk and cord serum	TBBPA	Maternal serum	No	France, Toulouse	91	NR	NR	19.87	16.14	0.23	93.22	NR	ng/g lw	32%	
Cariou et al., 2008	Exposure assessment of French women and their newborns to Tetrabromobisphenol-A: occurrence measurements in maternal adipose tissue, serum, breast milk and cord serum	TBBPA	Umbilical cord serum	No	France, Toulouse	90	NR	NR	103.52	54.76	2.09	649.45	NR	ng/g lw	30%	
Antignac et al., 2008	Exposure assessment of fetus and newborn to brominated flame retardants in France: preliminary data	TBBPA	Breast milk	No	France, Toulouse	23	26 mother/newborn pairs	NR	NR	0.172	0.034	9.4	NR	ng/g lw; Median: (172 pg/g lw) Range: (34-9,400 pg/g lw)	NR	Samples obtained from volunteer women during caesarean deliveries
Antignac et al., 2008	Exposure assessment of fetus and newborn to brominated flame retardants in France: preliminary data	TBBPA	Maternal serum	No	France, Toulouse	26	26 mother/newborn pairs	0.054	NR	0.007	0.002	0.783	NR	ng/g fw; Median: (7 pg/g fw) Avg: (54 pg/g fw) Range: (2-783 pg/g fw)	NR	Samples obtained from volunteer women during caesarean deliveries
Antignac et al., 2008	Exposure assessment of fetus and newborn to brominated flame retardants in France: preliminary data	TBBPA	Umbilical serum	No	France, Toulouse	26	26 mother/newborn pairs	0.152	NR	0.01	0.002	1.012	NR	ng/g fw; Median: (10 pg/g fw) Avg: (152 pg/g fw) Range: (2-1,012 pg/g fw)	NR	Samples obtained from volunteer women during caesarean deliveries
Hagmar et al., 2000a as cited in EURAR, 2006	Computer technicians are occupationally exposed to polybrominated diphenyl ethers and Tetrabromobisphenol A	TBBPA	Blood serum	No	Sweden	19	computer technicians	NR	NR	NR	<0.5	1.8	NR	ng/g lw; Range: (<0.5-1.8 µg/kg lw)	4	
Hagmar et al., 2000b as cited in EURAR, 2006	Biological half-lives of polybrominated diphenyl ethers and Tetrabromobisphenol A in exposed workers	TBBPA	Blood serum	No	Sweden	4	electronic equipment dismantling workers	NR	NR	NR	1.1	3.8	NR	ng/g lw; Range: (1.1-3.8 µg/kg lw)	NR	Concentrations measured in electronic equipment dismantling workers decreased during vacation. Half-life of 2.2 days in blood serum.
Hagmar and Bergman, 2001 as cited in EURAR, 2006	Human exposure to BFRs in Europe. Second International Workshop on Brominated Flame Retardants	TBBPA	Blood plasma	No	Sweden	9	a single detection	NR	0.76	NR	NR	NR	NR	ng/g lw; (0.76 µg/kg lw)	1	
Jakobsson et al., 2002 as cited in EURAR, 2006	Exposure to polybrominated diphenyl ethers and Tetrabromobisphenol A among computer technicians	TBBPA	Blood plasma	No	Sweden	10	NR	NR	NR	<0.54	<0.54	1.8	NR	ng/g lw; Median: (<0.54 µg/kg lw) Range : (<0.54-1.8 µg/kg lw)	4	
Thomsen et al., 2001a,c as cited in EURAR, 2006	Brominated flame retardants in plasma sample as from three different occupational groups in Norway & Plasma concentrations of brominated flame retardants in three Norwegian occupational groups	TBBPA	Blood plasma	No	Norway	NR	Electronic equipment dismantlers	NR	1.3	NR	0.64	1.8	NR	ng/g lw; Mean: (1.3 µg/kg lw) Range: (0.64-1.8 µg/kg lw)	NR	LOQ = 400 ng/g

Thomsen et al., 2001a,c as cited in EURAR, 2006	Brominated flame retardants in plasma sample as from three different occupational groups in Norway & Plasma concentrations of brominated flame retardants in three Norwegian occupational groups	TBBPA	Blood plasma	No	Norway	NR	Circuit board producers,	NR	0.54	NR	ND	0.8	NR	ng/g lw; Mean: (0.54 µg/kg lw) Range: (ND-0.80 µg/kg lw)	NR	LOQ = 400 ng/g
Thomsen et al., 2001a,c as cited in EURAR, 2006	Brominated flame retardants in plasma sample as from three different occupational groups in Norway & Plasma concentrations of brominated flame retardants in three Norwegian occupational groups	TBBPA	Blood plasma	No	Norway	NR	Laboratory personnel	NR	0.34	NR	ND	0.52	NR	ng/g lw; Mean: (0.34 µg/kg lw) Range: (ND-0.52 µg/kg lw)	NR	LOQ = 400 ng/g
Thomsen et al., 2001b as cited in EURAR, 2006	A simplified method for determination of Tetrabromobisphenol A and polybrominated diphenyl ethers in human plasma and serum	TBBPA	Blood plasma	No	Norway	NR	NR	NR	400	NR	NR	NR	NR	ng/g plasma; (0.4 ng/kg plasma)	NR	
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	34	5 pools of 10-14 individuals per pool, Archived samples for 1977	NR	ND	NR	NR	NR	NR	ND	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	17	5 pools of 10-14 individuals per pool, Archived samples for 1981	NR	ND	NR	NR	NR	NR	ND	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	24	5 pools of 10-14 individuals per pool, Archived samples for 1986	NR	0.44	NR	NR	NR	NR	ng/g lw; (0.44 µg/kg lw)	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	20	5 pools of 10-14 individuals per pool, Archived samples for 1990	NR	ND	NR	NR	NR	NR	ND	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	19	5 pools of 10-14 individuals per pool, Archived samples for 1995	NR	ND	NR	NR	NR	NR	ND	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	29	5 pools of 10-14 individuals per pool, Archived samples for 1999	NR	0.65	NR	NR	NR	NR	ng/g lw; (0.65 µg/kg lw)	NR	LOQ = 400-1600
Thomsen et al., 2002a as cited in EURAR, 2006	Brominated flame retardants in archived serum samples from Norway: A study on temporal trends and the role of age	TBBPA	Blood serum	No	Norway	93	8 pools of 10-14 individuals per pool, Archived samples Archived samples of all age groups for 1998	NR	NR	NR	0.31	0.71	NR	ng/g lw; Range: (0.34-0.71 µg/kg lw)	NR	LOQ = 400-1600
Thomsen et al., 2002b	A new method for determination of halogenated flame retardants in human milk using solid-phase extraction	TBBPA	Breast milk	No	Norway	NR	NR	NR	0.067	NR	NR	NR	NR	ng/g lw; (67 pg/g lw)	NR	Lipid content was 2.6%, equivalent to a whole milk concentration of 0.0017 ng/g (0.0017 µg/kg)
Thomsen et al., 2003	Brominated flame retardants in breast milk from Norway	Dimethyl-TBBPA	Breast milk	No	Norway	3	One sample from each of 3 different geographic areas (pools of 10-12 individuals)	NR	NR	NR	~0.010	0.1	NR	ng/g lw; Range: (~10-100 pg/g/lw)	NR	
Dirtu et al., 2008	Simultaneous determination of bisphenol A, triclosan, and Tetrabromobisphenol A in human serum using solid-phase extraction and gas chromatography-electron capture negative-ionization mass spectrometry	TBBPA	Blood	No	Belgium	7	individual data	NR	NR	0.08	NR	NR	NR	ng/mL	NR	
Dirtu et al., 2008	Simultaneous determination of bisphenol A, triclosan, and Tetrabromobisphenol A in human serum using solid-phase extraction and gas chromatography-electron capture negative-ionization mass spectrometry	TBBPA	Blood	No	Belgium	24	pooled data	NR	NR	0.096	NR	NR	NR	ng/mL	NR	

Dirtu et al., 2010	Distribution of PCBs, their hydroxylated metabolites and other phenolic contaminants in human serum from two European countries	TBBPA	Blood	No	Belgium	20	NR	NR	NR	<LOQ	<LOQ	0.0025	NR	ng/mL Range: (<LOQ-2.5 pg/mL)	NR	LOQ = 0.002 ng/mL (2 pg/mL)
Kicinski et al., 2012	Neurobehavioral function and low-level exposure to brominated flame retardants in adolescents: a cross-sectional study	TBBPA	Serum	No	Belgium	515	NR	NR	NR	<LOQ	NR	186	22	ng/L	NR	LOQ = 15 ng/L. Cross-sectional data on 515 adolescents (13.6-17 yrs, mean of 14.9 yrs) were used for analysis. Neurobehavioral test found no significant association between TBBPA level and the finger tapping test.
Pratt et al., 2013	Brominated and fluorinated organic pollutants in the breast milk of first-time Irish mothers: is there a relationship to levels in food?	TBBPA	Breast milk	No	Ireland	109	11 pools of 10-11 individuals were collected from 109 first-time mothers at four centers across Ireland	NR	0.33	NR	<0.29	0.17	NR	ng/g (all values are upperbound range)	NR	Lower bound mean: 0.05 ng/g
Dirtu et al., 2010	Distribution of PCBs, their hydroxylated metabolites and other phenolic contaminants in human serum from two European countries	TBBPA	Blood	No	Romania	53	NR	NR	NR	<LOQ	<LOQ	0.013	NR	ng/mL; Range: (<LOQ-13 pg/mL)	NR	LOQ = 0.002 ng/mL (2 pg/mL).
Shi et al., 2009	Dietary exposure assessment of Chinese adults and nursing infants to Tetrabromobisphenol-A and hexabromocyclododecanes: occurrence measurements in foods and human milk	TBBPA	Breast milk	No	China	1237	1,237 individual samples were collected from 12 different locations in 2007. Individual samples from each area were pooled into one sample for analysis.	NR	0.961	NR	ND	5.124	NR	ng/g lw; Range: (ND-5124 pg/g lw)	NR	Mean was reported as a range: 0.933-0.961 ng/g lw (933-961 pg/g lw)
Yang et al., 2014b	Urinary levels of bisphenol analogues in residents living near a manufacturing plant in south China	TBBPA	Urine	No	China	94	spot urine samples collected from 94 individuals living near a Bisphenol AF manufacturing plant; 50 females (aged 26–79 years) and 44 males (aged 26–84 years	NR	ND	NR	NR	NR	NR	ND	NR	LOQ was 0.04 ng/mL
Nagayama et al., 2001 as cited in EURAR, 2006	Contamination levels of brominated flame retardants, dioxins and organochlorine compounds in the blood of Japanese adults	TBBPA	Blood	No		54	54 volunteers (27 males and 27 females) in the age range 37 to 49 years old in 1998	NR	NR	2.4	NR	12	NR	ng/g lw; Median: (2.4 µg/kg lw) Max: (12.0 µg/kg lw)	NR	
Nagayama et al., 2000, as cited in EURAR, 2006	Comparison between brominated flame retardants and dioxins or organochlorine compounds in blood levels of Japanese adults	TBBPA	Blood	No		14	NR	NR	1.35	NR	NR	NR	NR	ng/g (1.35 µg/kg)	NR	
Watanabe and Tatsukawa, 1989 as cited in EURAR, 2006	Anthropogenic brominated aromatics in the Japanese environment. Proceedings of the Workshop on Brominated Aromatic Flame Retardants	Dimethylated TBBPA	Human adipose tissue	No		5	NR	NR	ND	NR	NR	NR	NR	ND	NR	LOD=20 ng/g fat (20 µg/kg fat)
Fujii et al., 2014a	Temporal trend and age-dependent serum concentration of phenolic organohalogen contaminants in Japanese men during 1989-2010	TBBPA	Blood	No	Japan, Kyoto	20	1989	NR	NR	NR	<LOQ	0.94	NR	ng/g ww; Range: (<LOQ-940 pg/g/ww)	NR	LOQ = 0.05 pg/g ww; Means were not reported due to low detection frequency
Fujii et al., 2014a	Temporal trend and age-dependent serum concentration of phenolic organohalogen contaminants in Japanese men during 1989-2010	TBBPA	Blood	No	Japan, Kyoto	20	1999	NR	NR	NR	<LOQ	0.95	NR	ng/g ww; Range: (<LOQ-950 pg/g ww)	NR	LOQ = 0.05 pg/g ww; Means were not reported due to low detection frequency
Fujii et al., 2014a	Temporal trend and age-dependent serum concentration of phenolic organohalogen contaminants in Japanese men during 1989-2010	TBBPA	Blood	No	Japan, Kyoto	20	2010	NR	NR	NR	<LOQ	0.42	NR	ng/g ww; Range: (<LOQ-420 pg/g ww)	NR	LOQ = 0.05 pg/g ww; Means were not reported due to low detection frequency
Fujii et al., 2014a	Temporal trend and age-dependent serum concentration of phenolic organohalogen contaminants in Japanese men during 1989-2010	TBBPA	Blood	No	Japan, Kyoto	30	no year specified, 20 yr olds	NR	NR	NR	<LOQ	0.95	NR	ng/g ww; Range: (<LOQ-950 pg/g ww)	NR	LOQ = 0.05 pg/g ww; Means were not reported due to low detection frequency

Fujii et al., 2014a	Temporal trend and age-dependent serum concentration of phenolic organohalogen contaminants in Japanese men during 1989-2010	TBBPA	Blood	No	Japan, Kyoto	30	no year specified, >50 yr olds	NR	NR	NR	<LOQ	0.42	NR	ng/g ww; Range: (<LOQ-420 pg/g ww)	NR	LOQ = 0.05 pg/g ww; Means were not reported due to low detection frequency
Fujii et al., 2014b	Dietary exposure to phenolic and methoxylated organohalogen contaminants in relation to their concentrations in breast milk and serum in Japan	TBBPA	Breast Milk	No	Japan, Okinawa	9	no year specified	NR	1.04	0.72	0.39	2.22	NR	ng/g lw	NR	LOQ not reported
Fujii et al., 2014b	Dietary exposure to phenolic and methoxylated organohalogen contaminants in relation to their concentrations in breast milk and serum in Japan	TBBPA	Blood	No	Japan, Okinawa	3	no year specified	NR	40.5	1	<LOQ	238	NR	ng/g ww	NR	
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TBBPA	Mother blood serum	No	Korea	12	NR	NR	10.93	NR	<MDL	73.96	NR	ng/g lipid	NR	MDL = 0.072 ng/g Study also sampled blood serum from 26 mother/infant pairs of infants with congenital hypothyroidism
Kim et al., 2014	Organophosphorus flame retardants (PFRs) in human breast milk from several Asian countries	TBBPA	Infant blood serum	No	Korea	12	NR	NR	77.65	NR	<MDL	457.4	NR	ng/g lipid	NR	MDL = 0.072 ng/g Study also sampled blood serum from 26 mother/infant pairs of infants with congenital hypothyroidism
Kemmlein, 2000, as cited in EURAR, 2006	Polybrominated flame retardants : Development of an analytical procedure and investigation and assessment of the exposure of selected environmental compartments	TBBPA	Breast Milk	No	Germany, West Berlin	4	25-37 year old); 1998/1999	NR	NR	NR	0.29	0.94	NR	ng/g lw; Range: (0.29-0.94 µg/kg lw)	2	
Kemmlein, 2000, as cited in EURAR, 2006	Polybrominated flame retardants : Development of an analytical procedure and investigation and assessment of the exposure of selected environmental compartments	TBBPA	Breast Milk	No	Faroe Islands	NR	NR	NR	11	NR	NR	NR	NR	ng/g lw; (11.0 µg/kg lw)	NR	
Lankova et al., 2013	The determination of perfluoroalkyl substances, brominated flame retardants and their metabolites in human breast milk and infant formula	TBBPA	Breast Milk	No	Czech Republic	50	20-43 years	NR	NR	NR	<2	688	NR	ng/g lw	NR	LOQ = 2 ng/g lw. TBBPA detected above LOQ in less than 30% of samples. Mean and median levels were not calculated because less than 30% of samples were above the LOQ.

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Geo Mean	Mean	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Hoffman et al., 2014	Urinary metabolites of organophosphate flame retardants and their variability in pregnant women	TBBA	Urine (metabolite)	Yes (hand wipes, dust)	United States, North Carolina	53	adults	5.6	NR	NR	NR	340	ng/g	77%	Household dust, hand wipes and urine samples from adults in North Carolina. 76.9% had TBBA levels detected. Levels of TBB in hand wipes positively correlated with urinary TBBA. 1 urine sample had insufficient volume. Levels of TBB (and TBPH) in dust were positively correlated with corresponding levels of each in the hand wipes. Creatinine corrected levels were not reported.
Butt, 2014	Metabolites of organophosphate flame retardants and 2-ethylhexyl Tetrabromobenzoate in urine from paired mothers and toddlers	TBBA	Urine (metabolite)	No	United States	22	mothers	NR	NR	NR	<3.0	62.2	ng/mL	27%	MDL = 3.0 ng/mL; 21 mother/toddler pairs (some mothers had 2 children) recruited between August 2013 and January 2014. TBBA detected in 27% of adults and 70% of children. Geo mean was not available because the detection frequency was < 50%. Creatinine corrected levels were not reported.
Butt, 2014	Metabolites of organophosphate flame retardants and 2-ethylhexyl Tetrabromobenzoate in urine from paired mothers and toddlers	TBBA	Urine (metabolite)	No	United States	23	children	7.4	NR	NR	<3.0	84.9	ng/mL	70%	MDL = 3.0 ng/mL; 21 mother/toddler pairs (some mothers had 2 children) recruited between August 2013 and January 2014. TBBA detected in 27% of adults and 70% of children. Creatinine corrected levels were not reported.
Johnson et al., 2013	Associations between brominated flame retardants in house dust and hormone levels in men	TBB	Serum hormone T3	Yes (dust)	United States	38	62 men, aged 18-54 years recruited from couples seeking infertility treatment	NR	NR	NR	NR	NR	NR	NR	TBPH (but not TBB) exposure (estimated from donated home vacuum bag dust) positively associated with T3 for subset of 38 men. TBB was detected in 47% (409 ng/g) of dust samples.
Zhou et al., 2014	Measurements of selected brominated flame retardants in nursing women: implications for human exposure	TBB	Maternal serum	No	Canada, Sherbrooke, Quebec	100	100 paired samples from nursing women	NR	5.4	1.6	5.4	68	ng/g lw	56.90%	
Zhou et al., 2014	Measurements of selected brominated flame retardants in nursing women: implications for human exposure	TBB	Breast milk	No	Canada, Sherbrooke, Quebec	100	100 paired samples from nursing women	NR	1.3	0.41	<0.03	24	ng/g lw	78.10%	

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Mean	Median	Min	Max	Concentration units (original study value if not ng)	Detection Frequency	Comments
Johnson et al., 2013	Associations between brominated flame retardants in house dust and hormone levels in men	TBPH	Serum hormone T3	Yes (dust)	United States	38	62 men, aged 18-54 years recruited from couples seeking infertility treatment	NR	NR	NR	NR	NR	NR	TBPH (but not TBB) exposure (estimated from home vacuum bag dust) positively associated with T3 for subset of 38 men. TBPH was detected in 63% (geometric mean 377 ng/g) of dust samples.
Zhou et al., 2014	Measurements of selected brominated flame retardants in nursing women: implications for human exposure	TBPH	Maternal serum	No	Canada, Sherbrooke, Quebec	102	100 paired samples from nursing women	NR	NR	ND	164	ng/g lw	16.70%	LOD = 7.3 ng/g
Zhou et al., 2014	Measurements of selected brominated flame retardants in nursing women: implications for human exposure	TBPH	Breast milk	No	Canada, Sherbrooke, Quebec	105	100 paired samples from nursing women	NR	NR	ND	6.6	ng/g lw	32.40%	LOD = 0.15 ng/g
He et al., 2013	Concentrations and trends of halogenated flame retardants in the pooled serum of residents of Laizhou Bay, China	TBPH	Serum	No	China	NR	30-39 year old female group	260	NR	NR	NR	ng/g lw	NR	TBPH detected in 30-39 year old female group only (pooled sample)
Ali et al., 2014	Levels and profile of several classes of organic contaminants in matched indoor dust and serum samples from occupational settings of Pakistan	TBPH	Serum	Yes (dust)	Pakistan	NR	Clothing store and university employees	<1	<1	NR	NR	ng/g lw	NR	
Ali et al., 2014	Levels and profile of several classes of organic contaminants in matched indoor dust and serum samples from occupational settings of Pakistan	TBPH	Serum	Yes (dust)	Pakistan	NR	Electronic store employees	1.5	NR	1	18	ng/g lw	NR	

Reference	Reference Title	Chemical	Tissue/fluid	Associated Residue Monitoring Study (media)	Country (city/region)	n =	n details	Geo Mean	Mean	Median	Min	Max	Other	Concentration units (original study value if not ng)	Detection Frequency	Comments
CDC, 2015	Antimony Trioxide	antimony	Urine	NR	United States	2847	NR	56	NR	NR	53	59	NR	ng/L; Geo mean: (0.056 µg/L) Range: (0.053-0.059 µg/L)	NR	NHANES Survey: 2009-2010. Values are not creatinine corrected.
CDC, 2015	Antimony Trioxide	antimony	Urine	NR	United States	2847	NR	60	NR	NR	56	64	NR	ng/L; Geo mean: (0.060 µg/L) Range: (0.056-0.064 µg/L)	NR	NHANES Survey: 2009-2010. Values are creatinine corrected.
Cooper and Harrison, 2009	The exposure to and health effects of antimony	antimony	Urine	NR	United States	148	NR	NR	NR	NR	<20	500	NR	ng/L; Range: (<0.02-0.5 µg/L) in 97.5% of samples; Range: >1000 ng/L (1 µg/L) in 3.5%	NR	Children from pre-term infants until 2 years of age, part of cot (crib) study; 122 term and 26 pre-term infants; LOD=20 ng/L. Creatinine corrected levels were not reported.
NIOSH, 2010 as cited in Shyam and Jaya, 2010	Antimony toxicity	antimony	Urine	NR	United States	NR	NR	NR	NR	NR	120	364	NR	ng/g creatinine Range: (0.120-0.364 µg/g) creatinine	NR	Ranges for urinary antimony levels in the general population. Only creatinine corrected levels were reported.
ICRP, 1981, as cited in ATSDR, 1992	Metabolic data for antimony	antimony	Total body burden	NR	United States	NR	NR	NR	NR	NR	NR	NR	7900000	ng (7.9 mg)	NR	
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Skin	NR	Various Countries	NR	NR	NR	96	NR	NR	NR	NR	ng/g (0.096 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Hair	NR	Various Countries	NR	NR	NR	NR	NR	96	120		ng/g; Range: (0.096-0.12 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Adrenal gland	NR	Various Countries	NR	NR	NR	73	NR	NR	NR	NR	ng/g (0.073 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Lung	NR	Various Countries	NR	NR	NR	62	NR	NR	NR	NR	ng/g (0.062 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Large intestine	NR	Various Countries	NR	NR	NR	47	NR	NR	NR	NR	ng/g (0.047 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.

Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Trachea	NR	Various Countries	NR	NR	NR	45	NR	NR	NR	NR	ng/g (0.045 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Cerebellum	NR	Various Countries	NR	NR	NR	30	NR	NR	NR	NR	ng/g (0.030 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Kidney	NR	Various Countries	NR	NR	NR	NR	NR	ND	43	NR	ng/g; Range: (ND-0.043 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Small intestine	NR	Various Countries	NR	NR	NR	39	NR	NR	NR	NR	ng/g (0.039 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Heart	NR	Various Countries	NR	NR	NR	32	NR	NR	NR	NR	ng/g (0.032 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Pancreas	NR	Various Countries	NR	NR	NR	30	NR	NR	NR	NR	ng/g (0.030 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Spleen	NR	Various Countries	NR	NR	NR	29	NR	NR	NR	NR	ng/g (0.029 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.

Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Liver	NR	Various Countries	NR	NR	NR	NR	NR	ND	23	NR	ng/g (ND-0.023 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Ovary	NR	Various Countries	NR	NR	NR	21	NR	NR	NR	NR	ng/g (0.021 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Testicle	NR	Various Countries	NR	NR	NR	17	NR	NR	NR	NR	ng/g (0.017 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1992	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Cerebrum	NR	Various Countries	NR	NR	NR	16	NR	NR	NR	NR	ng/g (0.016 µg/g)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1993	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Blood	NR	Various Countries	NR	NR	NR	NR	NR	0.016	0.34	NR	no units reported	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1994	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Saliva	NR	Various Countries	NR	NR	NR	0.003	NR	NR	NR	NR	no units reported	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Sumino et al., 1975; Muramatsu and Parr, 1988; Takagi et al., 1986; Mansour et al., 1967; Olmez et al., 1978; as cited in ATSDR, 1995	Heavy metals in normal Japanese tissues. Concentrations of some trace elements in hair, liver and kidney from autopsy subjects - Relationship between hair and internal organs. Brominated flame retardants and other polyhalogenated compounds in indoor air and dust from two houses in Japan. Anti-bilharzial antimony drugs. Trace substances in human saliva.	antimony	Mean body burden	NR	Various Countries	NR	NR	NR	700	NR	NR	NR	NR	ng/g (0.7 mg/kg)	NR	Autopsy data from unexposed Japanese and Swedish adults; hair samples from North America (USA, Canada), Europe (Poland), and Asia (Japan and India). Detection limit not reported. Not clear whether the reported single values are one measurement or an average.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Blood	NR	Nordic Countries	NR	NR	NR	700-85,000	NR	ND	33000000	NR	ng/L; Mean: (0.7-85 µg/L) Range: (ND-33,000 µg/L)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.

Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Urine	NR	Nordic Countries	NR	NR	NR	<1000-6,200	NR	ND	11000	NR	ng/L; Mean: (<1.0-6.2 µg/L) Range: (ND-11 µg/L)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified. Creatinine corrected levels were not reported.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Serum	NR	Nordic Countries	NR	NR	NR	<600-5,200	NR	ND	15000	NR	ng/L; Mean: (<0.6-5.2 µg/L) Range: (ND-15 µg/L)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Liver	NR	Nordic Countries	NR	NR	NR	6-23	NR	<10	70	NR	ng/g; Mean: (0.006-0.023 mg/kg) Range: (<0.01-0.07 mg/kg)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Lung	NR	Nordic Countries	NR	NR	NR	17-95	NR	<10	200	NR	ng/g; Mean: (0.017-0.095 mg/kg) Range: (<0.01-0.20 mg/kg)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Hair	NR	Nordic Countries	NR	NR	NR	41	NR	ND	2640	NR	ng/g; Mean: (0.041 mg/kg) Range: (ND-2.64 mg/kg)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Teeth	NR	Nordic Countries	NR	NR	NR	NR	NR	5	670	NR	ng/g; Range: (0.005-0.67 mg/kg)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Nordic Council of Ministers, 1998	The Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals, 123 Antimony	antimony	Bone	NR	Nordic Countries	NR	NR	NR	NR	7	7	100	NR	ng/g; Median: (0.007 ppm) Range: (0.007-0.1) ppm)	NR	Background levels in human biological material (wet weight) from non-occupationally exposed. Detection level not specified.
Clemente et al., 1982 as cited in Snedeker et al., 2014	The concentration of some trace elements in human milk from Italy	antimony	Breast milk	NR	Italy	NR	NR	NR	NR	NR	<1.0	50	NR	ng/g	NR	
Schulz et al., 2009, as cited in Snedeker et al., 2014	Revised and new reference values for environmental pollutants in urine or blood of children in Germany derived from the German environmental survey on children 2003–2006 (GerES IV)	antimony	Urine	NR	Germany	NR	Children aged 3 to 14 years old	NR	300	NR	NR	NR	NR	ng/L (0.3 µg/L)	NR	Creatinine corrected levels were not reported.
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Urine, males	NR	Germany	NR	NR	NR	1530	NR	<500	4740	NR	ng/24 hrs; Mean: (1.53 µg/24 hrs) Range: (<0.5-4.74 µg/24 hrs)	NR	Creatinine corrected levels were not reported.
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Urine, females	NR	Germany	NR	NR	NR	980	NR	500	5350	NR	ng/24hrs; Mean: (0.98 µg/24 hrs) Range: (<0.5-5.35 µg/24 hrs)	NR	Creatinine corrected levels were not reported.
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Blood, males	NR	Germany	NR	NR	NR	970	NR	NR	7540	NR	ng/L; Mean: (0.97 µg/L) Max: (7.54 µg/L)	NR	
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Blood, females	NR	Germany	NR	NR	NR	700	NR	NR	3580	NR	ng/L; Mean: (0.70 µg/L) Max: (3.58 µg/L)	NR	
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Scalp hair, males	NR	Germany	NR	NR	NR	47	NR	5	140	NR	ng/g; Mean: (0.047 µg/g) Range: (<0.005-0.14 µg/g)	NR	
Gebel et al., 1998 (Also stratified by exposed and reference groups)	Human biomonitoring of antimony	antimony	Scalp hair, females	NR	Germany	NR	NR	NR	51	NR	<5	840	NR	ng/g; Mean: (0.051µg/g) Range: (<0.005-0.84 µg/g)	NR	

Abreviations and notations

µg/L	microgram(s) per liter
µg/g	microgram(s) per gram
ATO	Antimony trioxide
ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CEH	Center for Environmental Health
CEPA	Canadian Environmental Protection Act
CPSC	U.S. Consumer Product Safety Commission
ECHA	European Chemicals Agency
EFSA	European Food Safety Authority
EURAR	European Union Risk Assessment Report
FDA	Food and Drug Administration
FSA	Food Standards Agency
FM550	Firemaster 550
FR	Flame retardant
g/mL	gram(s) per milliliter(s)
g/mol	gram(s) per mole
HSDB	Hazardous Substance Database
IARC	International Agency for Research on Cancer
ICRP	International Commission on Radiological Protection
IPCS	International Programme on Chemical Safety
LOD	Level of Detection
LOQ	Level of Quantification
m	meter
max	Maximum
MDL	Maximum detection limit
mg/kg	milligram(s) per kilogram(s)
mg/kg/day	milligram(s) per kilogram(s) per day
mg/L	milligram (s) per liter
Min	minimum
ng	nanogram(s)
ng/mL	nanogram(s) per milliliter(s)
NRC	National Research Council
NSC	National Safety Council
NTP	National Toxicology Program
PC	Personal computer
PBDE	Polybrominated diphenyl ether
ppm	parts per million
PU	Polyurethane
PUF	Polyurethane foam
PVC	Polyvinylchloride
SC	Stratum corneum
SPE	Solid phase extraction
SPME	Solid-phase microextraction

TBB	2-Ethylhexyl 2,3,4,5-tetrabromobenzoate
TBBA	2,3,4,5-Tetrabromobenzoic acid
TBBPA	Tetrabromobisphenol A
TBMEHP	Mono(2- ethylhexyl) tetrabromophthalate
TBPH	Di(2-ethylhexyl) tetrabromophthlate
TCEP	Tris(2-Chloroethyl) Phosphate
TCPP	Tris(chloropropyl) phosphate
TDCPP	Tris(1,3-dichloro-2-propyl) Phosphate
TEP	Triethyl Phosphate
TERA	Toxicology Excellence for Risk Assessment
TV	Television
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WWTF	Waste water treatment facility
XFR	X-ray fluorescence