Health Consultation

Indoor Dust

Nearby Residential Houses

CABOT CARBON-KOPPERS
SUPERFUND HAZARDOUS WASTE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA

EPA FACILITY ID: FLD980709356

Prepared by
Florida Department of Health

JULY 24, 2014

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Foreword

The Florida Department of Health (DOH) evaluates the public health threat of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry in Atlanta, Georgia. This health consultation is part of an ongoing effort to evaluate health effects associated with contaminated soil from the Cabot Carbon-Koppers Superfund hazardous waste site. The Florida DOH evaluates site-related public health issues through the following processes:

■ Evaluating exposure: Florida DOH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is, and how human exposures might occur. The US Environmental Protection Agency provided the information for this assessment.

■ Evaluating health effects: If Florida DOH finds evidence that exposures to hazardous substances are occurring or might occur, Florida DOH scientists will determine whether that exposure could be harmful to human health. Florida DOH focuses this report on public health; that is, the health impact on the community as a whole, and base it on existing scientific information.

■ Developing recommendations: In this report, the Florida DOH outlines, in plain language, its conclusions regarding any potential health threat posed by indoor dust, and offers recommendations for reducing or eliminating exposure. The role of the Florida DOH is primarily advisory. For that reason, the evaluation report will typically recommend actions for other agencies, including the US Environmental Protection Agency and the Florida Department of Environmental Protection. If, however, an immediate health threat exists or is imminent, Florida DOH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

■ Soliciting community input: The evaluation process is interactive. The Florida DOH starts by soliciting and evaluating information from various government agencies, individuals or organizations responsible for cleaning up the site, and those living in communities near the site. Florida DOH shares conclusions about the site with the groups and organizations providing the information. Once they prepare a draft report, they seek feedback from the public.

If you have questions or comments about this report, please contact us.

Please write to: Public Health Toxicology Section
Bureau of Epidemiology
Florida Department Health
4052 Bald Cypress Way, Bin # A-08
Tallahassee, FL 32399-1712

Or call us at: 850 245-4299 or toll-free in Florida: 1-877-798-2772

Summary

INTRODUCTION	At the Cabot Carbon-Koppers hazardous waste site, the Florida Department of Health (DOH) and the US Agency for Toxic Substances and Disease Registry's (ATSDR) top priority is to ensure nearby residents have the best information to safeguard their health. The Koppers portion of this site is at 200 Northwest 23rd Avenue in Gainesville, Florida. Between 1916 and 2009, the Koppers facility made pressure treated wood which contaminated soil with chlorinated dioxins/furans. Nearby residents are concerned dust in their houses is a health threat. In this report Florida DOH and ATSDR evaluate EPA's indoor dust test results to determine if dioxins in indoor dust are a health threat.
CONCLUSION #1	Ingesting dust in Gainesville area background houses and houses near the Koppers facility is not likely to cause non-cancer illness. In addition, the estimated increased cancer risk of exposure to dust in these houses is very low.
BASIS FOR DECISION #1	The highest chlorinated dioxin/furan dose from accidentally ingesting (swallowing) indoor dust in13 Gainesville area background houses and 17 houses near the Koppers facility is below health guidelines. The highest estimated increased cancer risk from lifetime exposure is about1 in 100,000 or 1×10^{-5}. This estimate means that about 1 person out of 100,000 people exposed over a lifetime might develop cancer.
CONCLUSION #2	Concentrations of chlorinated dioxins/furans in dust from 17 houses near the Koppers facility are higher than concentrations in dust from Gainesville area background houses.
BASIS FOR DECISION #2	Using a basic statistical test, concentrations of chlorinated dioxins/furans in dust from 17 houses near the Koppers facility are significantly higher than 13 Gainesville area background houses.

CONCLUSION #3	The past health risk from exposures to chlorinated dioxins/furans in the dust of 17 homes near the Koppers facility prior to 2012 is unknown.
BASIS FOR DECISION #3	There was no testing of indoor dust specifically for chlorinated dioxins/furans prior to 2012.
CONCLUSION #4	This report does not assess the health risk from exposure to brominated dioxins/furans.
BASIS FOR DECISION #4	Although some studies suggest the toxicities of the brominated dioxins/furans are similar to their chlorinated counterparts, too little is known to quantify the health risk.
CONCLUSION #5	Because of the lack of indoor air testing, this report does not address inhalation of indoor dust.
BASIS FOR DECISION #5	Because of the large day to day variation in indoor air quality, the 2011 dioxin dust workgroup did not recommend indoor air testing. Also, extrapolation of indoor air dioxin levels based on levels in carpets and on floors is too uncertain to accurately assess the health risk from dust inhalation.
FOR MORE INFORMATION	If you have concerns about your health or the health of your children, you should contact your health care provider. You may also call the Florida DOH toll-free at 877 798-2772 and ask for information about the Cabot Carbon-Koppers Superfund hazardous waste site.

Background and Statement of Issues

The purpose of this health consultation report is to assess the public health threat from exposure to dioxin contaminated dust in select houses near the Koppers portion of the Cabot Carbon-Koppers Superfund hazardous waste site. The US Environmental Protection Agency (EPA) requested this assessment.

Many sources contribute to dust inside houses [Ohio 2008, Oomen, et al. 2008, Trowbridge 1997]. Sources of dust from inside the house include:

1. The breakdown of plant and animal materials including food debris, animal hairs/dander, feathers, insect parts from cockroaches and dust mites, human skin scales, and molds/mildew;
2. Cotton and wool from the disintegration of clothing, carpets, and furniture as well as stuffing in mattresses, pillows, quilts, and upholstered furniture;
3. Materials deliberately released indoors including tobacco/fireplace smoke, cosmetic/baby powders, powdered laundry detergents, cooking/food particulates, and various sprays and aerosols.

Indoor dust also comes from sources outside the house. Dust from outside the house can enter directly through open windows and doors and/or from tracking in soil from outdoors. Estimates of the contribution of outdoor soil to indoor dust range between 30 and 70% [Trowbridge 1997, EPA 1998, Layton 2009]. Outdoor sources of dioxin contaminated dust include industrial facilities such as pulp/paper mills and wood treating plants, exhaust from automobiles, lawnmowers, and other internal combustion engines and smoke from grills, fireplaces, and debris/trash fires.

Indoor sources of dioxins and dioxin-like contaminants include PCBs found in old fluorescent light capacitors, paints, caulks, and plasticizers, as well as dioxin-contaminated pesticides and home furnishings that incorporate dioxin-like chemicals [O'Conner 2005, UM 2006].

Studies of U.S. houses in background, "unpolluted" areas found average chlorinated dioxin/furan concentrations in indoor dust between 10 and 20 picograms per gram (pg/g) or parts per trillion (ppt) as measured by 2,3,7,8-tetrchlorodibenzo-p-dioxin toxicity equivalence or TCDD-TEQ [UM 2006, O'Conner 2005]. Studies of dust from living spaces in houses near dioxin sources found average chlorinated dioxin/furan (TCDD-TEQ) levels between 50 and 300 pg/g or ppt [ATSDR 2007a, 2007b, 2009b, EPA 2005, 2008, 2010b].

In April 2010, 12 nearby residents claimed their consultant found dioxin-like compounds in the dust of nine area houses using the Chemical-Activated Luciferase Expression (CALUX®) screening bioassay test [Parsons 2010]. Using this same bioassay, in February 2011 they claimed their consultant found dioxin-like compounds in the dust of another 105 area houses [Calwell 2011]. Residents wanted to know if dust in their houses was a health risk.

Florida DOH/ATSDR cannot assess the health risk based on the results of the CALUX® screening bioassay. Studies show that concentrations of dioxin-like compounds measured by the CALUX® screening bioassay tend to exceed those concentrations of chlorinated dioxins/furans measured by standard GC/MS methods. In addition to chlorinated dioxins/furans, the CALUX® bioassay responds to a variety of poly-halogenated diaromatic hydrocarbon compounds including brominated dioxins/furans, polychlorinated and polybrominated biphenyls, chlorinated and brominated naphthalenes, and others [Brown, et al. 2003 and EPA 4435].

The consultant for the 12 nearby residents analyzed 10 indoor dust samples they collected in 2010 using both the CALUX® and standard gas chromatograph/mass spectrometer (GC/MS) methods [Calwell 2012]. In these 10 samples, the concentration of dioxin-like compounds measured by the CALUX® screening bioassay over-estimated the concentration of dioxins measured by the standard GC/MS anywhere from 13% to 1,771%. This range of differences between the two tests is too large to use an average difference to reliably estimate dioxin concentrations in other dust samples based on the CALUX® results.

In July 2011, a workgroup of county/state/federal health & environmental agencies, University of Florida toxicologists, community leaders, and a health scientist funded by Beazer East, Inc. determined the documentation supporting the CALUX® screening bioassay test results was inadequate to assess the public health threat. This workgroup recommended EPA investigate the levels of chlorinated dioxins/furans in indoor dust using a standard GC/MS test [DOH 2011c].

In May 2012, EPA collected dust samples from 17 houses near the Koppers facility (Figure 1) and 13 Gainesville area background houses distant from the Koppers facility. EPA analyzed these dust samples using the standard GC/MS test for chlorinated dioxins/furans (EPA method 1613). Although not associated with the Koppers facility, EPA also analyzed the dust samples for brominated dioxins/furans. Lastly, they analyzed the dust samples for dioxin-like compounds using the CALUX® screening bioassay [EPA 2012]. The concentrations of chlorinated dioxins/furans in the dust of these houses prior to 2012 is unknown. In November 2012 EPA informed participating homeowners that the highest concentration of chlorinated dioxins in indoor dust was below the risk-based screening value, and no remediation is required.

This health consultation report compares the contaminant concentrations found by EPA in select houses near the Koppers facility to Gainesville area background houses. This report is based on the analysis of dust samples collected in May 2012 and analyzed using EPA's standard GC/MS test (EPA method 1613). It addresses the current health risk from incidental dust ingestion (swallowing) but not dust inhalation or skin contact. This assessment does not evaluate the health risk from past exposures to dust. This assessment calculates a traditional exposure dose based on a fixed dust ingestion rate. It also calculates an alternative exposure dose based on the amount of dust present (loading) but does not rely on this dose to estimate the health risk. Finally this assessment compares the chlorinated and brominated dioxin concentrations to the concentration of dioxin-like compounds using the CALUX® bioassay.

This assessment requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in this assessment err on the side of protecting public health and may overestimate the risk.

This assessment estimates the health risk for individuals exposed to the highest measured level of dioxins. Most nearby residents were not exposed to the highest measured level of contamination. The health risk for most nearby residents is less than the health risk estimated in this report.

Site Description

The Cabot Carbon-Koppers Superfund hazardous waste site is near the intersection of Northwest 23rd Avenue and North Main Street in Gainesville, Alachua County, Florida, 32601 (Figure 1). In September 1984, EPA listed this site on their Superfund National Priorities List.

Chemical treatment of wood to prevent rot and decay occurred on the Koppers portion of the site between 1916 and 2009. Soil on the 90-acre Koppers portion of the site is contaminated with dioxins and other chemicals. Ground water is also contaminated. In 2009, the highest concentration of dioxins (expressed as 2,3,7,8-tetrachlorodibenzo dioxin toxicity equivalents or TCDD-TEQ) was 170,635 picogram per gram (pg/g) or parts per trillion (ppt) in surface soil in the northeastern portion of the site. The highest TCDD-TEQ concentration on the site along the western boundary near the Stephen Foster neighborhood was 907 pg/g (ppt). In the past, winds likely carried dioxin-contaminated soil (dust) offsite.

Since 2009, consultants for the party responsible for the Koppers facility have tested over 90 surface soil samples (0-6 inches deep) in the adjacent neighborhood. They found TCDD-TEQ concentrations in nearby neighborhood soil from a high of 1,302 pg/g (ppt) in the easement next to the western Koppers facility boundary to between 1and 70 pg/g (ppt) in residential yards west of the of the Koppers facility. The pattern of decreasing dioxin concentration with distance from the Koppers facility suggests that wind-blown dust deposition from Koppers facility was a source of dioxins in adjacent neighborhood surface soil. The responsible party is testing more soil in the adjacent neighborhood to determine the extent of dioxin contamination. The EPA record of decision requires the responsible party to remove dioxin contaminated soil in the adjacent neighborhood and to consolidate/contain on-site soil contamination.

Ground water cleanup under the Koppers facility has been on-going for many years. Nearby residents use municipal water.

Previous Public Health Activities

In 1989, the Florida Department of Health (DOH) found the Cabot Carbon-Koppers site a potential health risk, recommended warning signs, and recommended additional environmental testing [ATSDR 1989]. In 1993, Florida DOH recommended a more comprehensive public health assessment [ATSDR 1993].

In 1995, Florida DOH found arsenic levels in Springstead Creek sediments at the Koppers facility drainage ditch outfall could cause illness and recommended additional testing. Florida DOH also recommended posting warning signs and restricting site access [ATSDR 1995].

In a series of three health consultation reports, Florida DOH reviewed soil test results from the adjacent neighborhood [ATSDR 2009b, 2010, 2011b]. They found dioxin contamination in the 30-foot wide easement just west of Koppers facility could possibly harm children's health. Florida DOH recommended parents keep children from playing in this easement. The responsible party erected a permanent fence and posted permanent warning signs along this easement. Florida DOH concluded incidental ingestion (swallowing very small amounts) of dioxin-contaminated surface soil in the adjacent neighborhood was not expected to harm children or adults. Accidentally swallowing very small amounts of this soil over a lifetime may however result in an estimated "very low" increased risk of cancer. Florida DOH recommended additional soil testing.

Florida DOH reviewed sediment test results from Springstead and Hogtown Creeks that drain the site and concluded that current contaminant levels were not a public health threat. Due to the lack of testing, Florida DOH could not conclude the risk from exposures between 1979 and 2006 [ATSDR 2011a]. Florida DOH tested eggs from nearby home grown chickens and found dioxin levels were not harmful [DOH 2011a].

Demographics

Approximately 7,170 people live within one mile of the Cabot Carbon-Koppers site. Sixty-three percent (63%) are white, 31% are African-American, 4% are Hispanic origin, and 2% are of other descent. Twenty-two percent (22%) are less than 18 years old. Forty-four percent (44%) have a high school diploma or less and 56% have at least two years of college. Ninety-one percent (91%) speak only English and 82% make less than $50,000 a year [EPA 2010a].

Land Use

Land use immediately west of the Koppers facility is residential. Further to the west, land use is mixed residential/commercial. Land use immediately to the north and south of the Koppers facility is mixed residential/commercial/industrial. Land use east of the Koppers facility (on the former Cabot Carbon portion of the site) is commercial.

Community Health Concerns

For many years nearby residents, especially those in the neighborhood west of Koppers facility, have been concerned about their health. After discovery of dioxin contaminated soil in some yards just west of Koppers facility, they were concerned that contaminated dust in their houses may be affecting their health.

Discussion

Pathway Analyses

Chemical contamination in the environment can harm your health but only if you have contact with those contaminants (exposure). Without contact or exposure, there is no harm to health. If there is contact or exposure, how much of the contaminants you contact (concentration), how often you contact them (frequency), for how long you contact them (duration), and the danger of the contaminant (toxicity) all determine the risk of harm.

Knowing or estimating the frequency with which people could have contact with hazardous substances is essential to assessing the public health importance of these contaminants. To decide if people can contact contaminants at or near a site, Florida DOH looks at human exposure pathways. Exposure pathways have five parts. They are:

1. a source of contamination like a hazardous waste site,
2. an environmental medium like air, water, or soil that can hold or move the contamination,
3. a point where people come into contact with a contaminated medium like water at the tap or soil in the yard,
4. an exposure route like ingesting (contaminated soil or water) or breathing (contaminated air),
5. a population who could be exposed to contamination like nearby residents.

Florida DOH eliminates an exposure pathway if at least one of the five parts referenced above is missing and will not occur in the future. Exposure pathways not eliminated are either completed or potential. For completed pathways, all five pathway parts exist and exposure to a contaminant has occurred, is occurring, or will occur. For potential pathways, at least one of the five parts is missing, but could exist. Also for potential pathways, exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

For this assessment Florida DOH evaluates the long-term health threat from incidental ingestion (swallowing) very small amounts of indoor dust. For this completed pathway, Florida DOH assumes dust from the Koppers facility is a source. There are, however, other sources of dioxins in indoor dust. Dust, blown by the wind from the site into the nearby neighborhood, is assumed to be the environmental medium. The exposure point is dust inside approximately 200 nearby neighborhood houses. Incidental ingestion (accidentally swallowing very small amounts of dust) is the exposure route. Ingestion of very small amounts of dust is common in children younger than 6 years old who put fingers or toys in their mouths. Ingestion of very small amount of dust also occurs in adults who do not wash their hands before cooking or eating. The exposed population is approximately 500 nearby neighborhood residents (Table 1).

Because of the lack of indoor air testing, this report does not address inhalation of indoor dust. Because of the large day to day variation in indoor air quality, the 2011 dioxin dust workgroup did not recommend indoor air testing. Also, extrapolation of indoor air dioxin levels based on levels in carpets and on floors is too uncertain to accurately assess the health risk from dust inhalation. This report also does not address skin contact with dioxins in indoor dust. Health scientists know too little about the toxicity of dioxins from skin contact to assess the health risk.

Environmental Data

In May 2012, EPA collected indoor dust samples from 17 houses near the Koppers facility. These houses are representative of the area bounded on the east by the Koppers facility, on the south by NW 23rd Avenue, on the west by NW 6th Street, and on the north by NW 33rd Avenue (Figure 1). EPA also collected indoor dust samples from 13 unaffected background houses two miles northwest and two miles southwest of the Koppers facility.

EPA collected composite dust samples from rugs, carpets, and hard surface floors in high traffic areas (main entrance, main living area, and bedroom). They collected these samples as prescribed by EPA Standard Operating Procedure 2040 using a Nilfisk GS-80 vacuum equipped with a high efficiency particulate air (HEPA) filter [EPA 2002]. To estimate dust loading, EPA also measured the dimensions of the dust collection surface area [EPA 2012].

In some houses, EPA also collected a dust sample from the owner's vacuum cleaner bag. Florida DOH did not consider these samples, because the source of this dust is unverifiable.

Testing of dust from inside 17 houses near the Koppers facility and 13 Gainesville area background houses is adequate for an initial assessment. EPA tested the number of houses suggested in the 2011 dust investigation/interpretation plan. Since EPA did not report the street addresses of the houses tested, it is not possible to determine whether these houses are representative of the neighborhood. Additionally, it is not possible to evaluate the relationship between indoor dust contamination and either distance from the Koppers facility or contaminant concentrations in outdoor soil.

EPA analyzed the dust samples for chlorinated dioxins/furans using standard EPA GC/MS method 1613. This long-established method is the definitive standard for determining dioxin concentrations in soil, sediment, fly ash, water, sludge (including paper pulp), still bottom, fuel oil, chemical reactor residue, fish tissue, and human adipose tissue. Florida DOH/ATSDR calculated a toxicity equivalence (TEQ) value for dioxins using the 2005 World Health Organization toxicity equivalence factors. For this investigation, the TCDD-TEQ concentration includes only those congeners with a concentration above the detection limit.

EPA also analyzed the dust samples for brominated dioxins/furans using a method similar to EPA methods 8290 and 1613. Although not associated with the Koppers facility, brominated dioxins/furans are low level (part per billion) contaminants in polybrominated diphenyl ethers. A variety of consumer products contain polybrominated diphenyl ethers to make them slow to burn. These flame retardant containing products include furniture, upholstery, electrical equipment (television cabinets), textiles, carpet padding, and other household products. Break down or physical abrasion of these household products creates dust containing polybrominated diphenyl ethers as well as low levels of brominated dioxins/furans [ATSDR 2004, Butte and Heinzow 2002].

In addition to the chlorinated and brominated dioxins/furans, EPA had a laboratory analyze the dust samples using the Chemical-Activated Luciferase Expression (CALUX®) screening bioassay test, EPA Method 4435 [EPA 2012]. CALUX® is a relatively new bio-analytical screening procedure for dioxin-like compounds in soils/sediments. EPA has not validated the CALUX method for dust samples. EPA bases this method on the ability of dioxin and related chemicals to activate the aryl hydrocarbon receptor (AhR), a chemical-responsive DNA binding protein that mediates the toxic and biological effects of these chemicals. The CALUX® method compares the bioluminescence response from dioxin-like chemicals in a sample extract to a standard response from different concentrations of 2,3,7,8-TCDD to report a CALUX® TCDD Bio-TEQ concentration in a sample.

For soil tests, there is some correlation between the CALUX® method and EPA methods 1613 and 8290. The TCDD Bio-TEQ concentrations reported by the CALUX® method, however, tend to be higher than the TCDD-TEQ concentrations reported using EPA methods 1613 and 8290. To varying degrees, the CALUX® method responds to other compounds including brominated and fluorinated dioxins/furans, biphenyls, and naphthalenes. These compounds contribute to the CALUX® TCDD Bio-TEQ method results but not standard EPA method results.

Specifically, the CALUX® test is responsive to dioxin-like chemicals associated with polybrominated diphenyl ethers (PBDEs) which are used as flame retardant in fabrics, electronic plastics (TVs and PCs), and other household products. The CALUX® test is sensitive to polybrominated dibenzo dioxins (PBDDs), polybrominated dibenzofurans (PBDFs), and polybrominated biphenyls (PBBs) which are all breakdown products of PBDEs. All of these chemicals are likely found in indoor dust. Thus CALUX® responds to many brominated compounds found in house dust potentially leading to higher estimates of dioxin concentrations than identified by standard EPA methods 8290 and 1613.

Tables 2 through 5 summarize the chlorinated dioxins/furans and brominated dioxins/furans using EPA analytical methods and the CALUX® test results for dust from Gainesville area background houses and select houses near the Koppers facility.

Compared to Gainesville area background houses, houses near the Koppers facility on average have higher concentrations of TCDD-TEQ in indoor dust. Using the non-parametric Wilcoxon Rank Sum Test [DEP 2012], there is a 95% chance that the mean/median concentrations of TCDD-TEQ in dust from the 17 houses near the Koppers facility are higher than the mean/median concentrations of TCDD-TEQ in the dust from the 13 Gainesville area background houses. This report does not, however, address whether the Koppers facility is the only or major source of dioxins in the dust of nearby houses.

In general, the concentrations of dioxin-like compounds in indoor dust measured by the CALUX® test were greater than the standard EPA test for just TCDD-TEQ. As expected, in most (9/10) background houses, the concentrations of TCDD-TEQ in indoor dust was less than the concentration of all the dioxin-like compounds measured with the CALUX® screening bioassay. In more than half (10/17) of the houses near the Koppers facility, the concentrations of TCDD-TEQ in indoor dust was less than the concentration of all the dioxin-like compounds measured with the CALUX® screening bioassay. The presence of the brominated dioxins/furans partially explains why the CALUX® concentrations were higher than the TCDD-TEQ concentrations.

Identifying Contaminants of Concern

There are no Agency for Toxic Substance and Disease Registry (ATSDR), EPA, or Florida Department of Environmental Protection (DEP) comparison values for indoor dust. Florida DOH evaluated the health risk from exposure to the levels of chlorinated dioxins/furans that were measured using standard EPA method 1613.

Although some studies suggest the toxicities of the brominated dioxins/furans are similar to their chlorinated counterparts [Mennear and Lee 1994, Birnbaum, et al 2003], too little is known about the toxicity of the brominated dioxins/furans to accurately quantify the health risk. Therefore this document includes the brominated dioxins/furans concentrations but does not assess the health risk.

Florida DOH also reports the CALUX® screening bioassay test results. Florida DOH cannot, however, assess the health risk based on the results of the CALUX® screening bioassay. Studies show that concentrations of dioxin-like compounds measured by the CALUX® screening bioassay tend to exceed those concentrations of chlorinated dioxins/furans measured by standard methods. In addition to chlorinated dioxins/furans, the CALUX® bioassay responds to a variety of poly-halogenated diaromatic hydrocarbon compounds including brominated dioxins/furans, polychlorinated and polybrominated biphenyls, chlorinated and brominated naphthalenes, and others.

Public Health Implications

Florida DOH provides site-specific public health recommendations on the basis of toxicological literature, levels of environmental contaminants, evaluation of potential exposure pathways, duration of exposure, and characteristics of the exposed population. Whether a person will be harmed depends on the type/amount of contaminant, how they are exposed, how long they are exposed, how much contaminant is absorbed, genetics, and individual lifestyles.

After identifying contaminants of concern, Florida DOH evaluates exposures by estimating daily doses for children and adults. Karmin [1988] explains the concept of dose as follows:

> "…all chemicals, no matter what their characteristics, are toxic in large enough quantities. Thus, the amount of a chemical a person is exposed to is crucial in deciding the extent of toxicity that will occur. In attempting to place an exact number on the amount of a particular compound that is harmful, scientists recognize they must consider the size of an organism. It is unlikely, for example, that the same amount of a particular chemical that will cause toxic effects in a 1-pound rat will also cause toxicity in a 1-ton elephant.
>
> Thus instead of using the amount that is administered or to which an organism is exposed, it is more realistic to use the amount per weight of the organism. Thus, 1 ounce administered to a 1-pound rat is equivalent to 2,000 ounces to a 2,000-pound (1-ton) elephant. In each case, the amount per weight is the same; 1 ounce for each pound of animal."

This amount per weight is the *dose*. Toxicology uses dose to compare toxicity of different chemicals in different animals. Florida DOH uses the units of milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day) to express doses in this assessment. A milligram is 1/1,000 of a gram; a kilogram is approximately 2 pounds.

For this report, Florida DOH estimated an incidental indoor dust ingestion dose using two different methods. First, they estimated a traditional dose based on a fixed incidental dust ingestion (swallowing) rate. This traditional method is independent of the amount of dust present. Second, they estimated an alternate dose based on the dioxin loading (weight of dioxin per surface area). This alternate method assumes the amount of dust ingested per day varies with the amount dust present. The more dust blows in or is tracked in, the higher the amount of dust ingested and the higher the dose.

Traditional Indoor Dust Ingestion Dose

To calculate a traditional dust ingestion dose, Florida DOH uses standard exposure factors [ATSDR 2005; EPA 1997]. Florida DOH assumes people are exposed daily to the maximum dioxin concentration measured in indoor dust. Florida DOH also makes the health protective assumption that 100% of the ingested dioxins are absorbed into the body. The percent actually absorbed into the body, however, is likely less.

The general formula for estimating a dose is:

$$D = (C \times IR \times EF) / BW$$

D = exposure dose (milligrams per kilogram per day or mg/kg/day)
C = contaminant concentration (picograms per gram or pg/g)
IR = intake rate for indoor dust (milligrams per day or mg/day)
EF = exposure factor (unitless)
BW = body weight (kilograms or kg)

$$EF = F \times ED / AT$$

EF = exposure factor (unitless)
F = frequency of exposure (days/year)
ED = exposure duration (years)
AT = averaging time (days) (ED x 365 days/year for non-carcinogens; 78 years x 365 days/year for carcinogens)

To estimate a traditional dose, Florida DOH assumes an indoor dust ingestion rate of 60 milligrams per day for children and young adults (0.5 to 21 years) and 11 milligrams per day for adults (21+ years) (Dr. Leah Stuchal, University of Florida, personal communication 2011).

For Gainesville area background houses, Table 6 lists the traditional doses by age groups for people exposed to the maximum TCDD-TEQ concentration in indoor dust. For houses near the Koppers facility, Table 7 lists the traditional doses by age groups for people exposed to the maximum TCDD-TEQ concentration in indoor dust.

Alternative Indoor Dust Ingestion Dose

In addition to the traditional fixed ingestion rate dose, this assessment considers the weight of dust per surface area. Because the rate of dust generation and frequency of cleaning varies from one house to another, the amount of dust in each house varies. To estimate an alternative incidental ingestion (swallowing) dose based on dioxin dust concentrations and the amount of dust present (dust loading), Florida DOH used the following equation (Dr. Leah Stuchal, University of Florida, personal communication 2012).

$$D = \frac{C \times SA \times FE \times ET \times FI \times DTF \times CF}{BW}$$

D = Dose from dust ingestion (mg/kg/day)

C = Dust loading concentration ($\mu g/cm^2$)
SA = Surface area, 125 cm^2/event (adult), 29.7 cm^2/event (child)
FE = Frequency, 10 events/hr (adult), 35.4 events/hr (child)
ET = Exposure time, 8 hr/day (adult), 9.83 hr/day (child daycare)
FI = Fraction ingested, 0.5 unitless
DTF = Dermal transfer factor, 0.485 (μg on hand/cm^2 dermal contact area)/(μg on surface/cm^2 of contact surface)
CF = Conversion factor, 10^{-3} mg/μg

BW = Body weight, 76 kg (adult) and 17.4 kg (2 to 6 year old child)

The mean hand surface area for an adult male is 168 cm^2 per hand [EPA 1992]. It is assumed that 37.2% ± 9.4% of the whole hand area contacted the surface with 12 pounds of applied pressure [Rodes 2001]. This resulted in a contact hand surface area for an adult of 125 cm^2 for both hands (168 cm^2 × 37.2% × 2 hands). From the Rio Bravo Healthy Children Study, the surface area for a child (25-36 months-old) for two hands combined is 99 cm^2 [Black 2005; Freeman 2005a; Freeman 2005b; Shalat 2003]. Leckie provided data on the number of fingers mouthed during a mouthing event for the December 2003 meeting of EPA's Science Advisory Panel. From these data and hand proportions obtained from children's hand drawings (Children's Dietary Lead Study), the maximum portion of the hand that is mouthed appears to be about 33%; e.g., one palm without fingers or five partial fingers. Four partial fingers or two full fingers accounted for about 28% of the hand surface area. Based upon these data, 30% is a rough estimate of the maximum fraction of the mouthed hand surface area. Combined with the estimate of hand surface area, this results in a hand surface area contributing to incidental ingestion of 29.7 cm^2 (99 cm^2 x 30% x 2 hands).

One study reported dermal transfer factors for selected contact surface types and skin wetness conditions using <80 µm fluorescein-tagged Arizona Test Dust on adult hand surfaces [Rodes 2001]. Based on information provided in this study, this model uses a dermal transfer factor of 0.485 for damp hands on vinyl linoleum. Vinyl linoleum is the surface with the most conservative (worst case) dermal transfer factor that is likely to be present at a residence. Damp conditions most accurately represent the hand-to-mouth transfer scenario. This model bases the fraction ingested (FI) on the mean to upper percentile removal efficiency of residues from fingers for a child [EPA 2000]. This fraction also accounts for the damp conditions represented in a hand-to-mouth transfer scenario.

Data on adult hand-to-mouth activity are not available. This model uses a reasonable estimate of 10 events/hr as a high-end occurrence for hand-to-mouth activity of 10-12 year-olds [Freeman 2001]. This model also uses child hand-to-mouth activity from the Rio Bravo Healthy Children Study [Black 2005; Freeman 2005a; Freeman 2005b; Shalat 2003]. A frequency of 35.4 events/hr represents the 90th percentile for children ages 36-60 months. This model uses an exposure time of 9.83 hr/day from the National Human Activity Pattern Survey. This figure represents the 90th percentile for time spent at school or in a public building by children ages 1-4 years-old [NHAPS 1996].

Table 8 lists alternative dust loading dose estimates. Estimated doses using the alternative dust loading model are similar (same order of magnitude) to estimated doses using the traditional fixed ingestion rate method (Tables 6 and 7). For this alternative dust loading model, a high degree of uncertainty exists in estimates of surface area contacted per day (SA) and frequency of hand-to-mouth events (FE). Because of these large uncertainties, Florida DOH does not rely on the alternative dose estimates from this model to judge the health risk from incidental dust ingestion.

2,3,7,8-Tetrachlorodibenzo-p-dioxins - Toxicity Equivalence (TCDD-TEQ)

Dioxins and furans are a family of chlorinated compounds with similar structures but varying toxicities. They have very low solubility in water and tend to stick to ash, soil, plants or any surface with a high organic content. Forest fires, manufacture of pentachlorophenol wood preservative, manufacture of bleached paper, and burning municipal garbage containing plastic all produce small amounts of dioxins [ATSDR 1998].

Non-Cancer Illness – Incidental ingestion (swallowing) of TCDD-TEQ in indoor dust of Gainesville area background houses and select houses near the Koppers facility is not likely to cause any non-cancer illness in adults or children. The highest estimated doses of dioxins found in both groups of houses are below the ATSDR chronic oral minimal risk level (MRL) for 2,3,7,8-TCDD of 1 x 10^{-9} mg/kg/day (Tables 6 and 7). An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without an appreciable risk of adverse non-cancer health effect over a specified route and duration of exposure. ATSDR's MRL for 2,3,7,8-TCDD is similar to the EPA chronic oral reference dose (RfD) of 0.7 x 10^{-9} mg/kg/day. An RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure of the human population to a potential hazard that is likely to be without risk of deleterious effects during a lifetime.

Cancer Risk – The estimated increased cancer risk from incidental ingestion (swallowing) of TCDD-TEQ in indoor dust of Gainesville area background houses and select houses near the Koppers facility is very low (about 1 in 100,000 or 1 x 10^{-5}) (Tables 6 and 7). This estimate means that about 1 person out of 100,000 people exposed over a lifetime might develop cancer. The American Cancer Society estimates the background cancer rate in the US is 1 in 3. That is, for every 100,000 people, on average about 33,333 will get some form of cancer during their lifetime. Exposure to this dust would, at most, increase the lifetime cancer risk from 33,333 cases in 100,000 people to 33,334 cases in 100,000 people.

This is a conservative (worst case) estimate of the increased cancer risk based on the highest concentration of TCDD-TEQ measured in indoor dust. The actual risk is likely lower.

The US Department of Health and Human Services (DHHS) has determined that it is reasonable to expect that 2,3,7,8-TCDD may cause cancer. EPA has determined that 2,3,7,8-TCDD is a probable human carcinogen. Although other oral cancer slope factors exist, for this assessment, Florida DOH used an oral cancer slope factor 1.5×10^5 per mg/kg/day. This is the same value used by EPA in their 2011 Record of Decision for this site [EPA 2011].

For cancer, Florida DOH quantifies the increased risk by using the general formula:

$$\text{Risk} = D \times SF$$

Risk = Cancer risk
D = Dose (mg/kg/day)
SF = Slope factor $(\text{mg/kg-day})^{-1}$

To put the cancer risk into perspective, Florida DOH uses the following descriptors for the different numeric cancer risks:

1 in 10 (10^{-1})	"very high" increased risk
1 in 100 (10^{-2})	"high" increased risk
1 in 1,000 (10^{-3})	"moderate" increased risk
1 in 10,000 (10^{-4})	"low" increased risk
1 in 100,000 (10^{-5})	"very low" increased risk
1 in 1,000,000 (10^{-6})	"extremely low" increased risk

Florida DOH recommends action to protect public health when the estimated increased cancer risk is "moderate" or higher. Because of the health protective assumptions in their assessments, Florida DOH does not usually recommend action when the estimated increased health risk is "very low" or lower. When the estimated increased cancer risk is "low," Florida DOH recommends action on a case-by-case basis considering the strength of the cancer data, human vs. animal data, extent of contamination, likelihood of exposure, etc.

Multiple Chemical Exposure

Health scientists know too little to estimate the health risk from simultaneous exposure to chlorinated dioxins/furans and brominated dioxins/furans.

Health Outcome Data

In two previous reports, Florida DOH epidemiologists analyzed cancer disease rates for the area around the Koppers facility using data from the Florida Cancer Data System. They were unable to identify an increase in overall area cancer rates between 1981 and 2010 [DOH 2011b, 2012].

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometime engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body system of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

This assessment takes into account the special vulnerabilities of children. It specifically calculates a dose for children and young adults exposed to indoor dust by assuming a higher dust ingestion rate and age-specific body weights.

Community Health Concerns Evaluation

For many years nearby residents, especially those in the neighborhood west of the Koppers facility, have been concerned about their health. After discovery of dioxin contaminated soil in some yards just west of the Koppers facility, they were concerned that contaminated dust in their houses may be affecting their health.

Based on the data evaluated for this report, levels of chlorinated dioxins/furans in the dust of select houses near the Koppers facility are not likely to cause illness. Too little is known, however, about the toxicity of **brominated** dioxins/furans to quantify the health risk.

Conclusions

1. Incidental ingestion (swallowing) of chlorinated dioxins/furans in indoor dust of 13 Gainesville area background houses and 17 houses representative of the area near the Koppers facility is not likely to cause non-cancer illness in adults or children. The estimated increased cancer risk from incidental ingestion (swallowing) the highest measured concentration of chlorinated dioxins/furans in indoor dust of these houses is very low (about 1 in 100,000 or 1×10^{-5}). This estimate means that, at most, about 1 person out of 100,000 people exposed over a lifetime might develop cancer.

2. Concentrations of chlorinated dioxins/furans in dust from selected houses near the Koppers facility are higher that concentrations in the dust from Gainesville area background houses.

3. The health risk from chlorinated dioxins/furans in the dust of these houses prior to 2012 is unknown.

4. This report does not assess the health risk from exposure to brominated dioxins/furans. Brominated dioxins/furans are not associated with the Koppers facility. Although some studies suggest the toxicities of the brominated dioxins/furans are similar to their chlorinated counterparts, too little is known to quantify the health risk.

5. Because of the lack of indoor air testing, this report does not address inhalation of indoor dust. Because of the large day to day variation in indoor air quality, the 2011 dioxin dust workgroup did not recommend indoor air testing. Also, extrapolation of indoor air dioxin levels based on levels in carpets and on floors is too uncertain to accurately assess the health risk from dust inhalation.

Recommendations

Florida DOH/ATSDR have no recommendations.

Public Health Action Plan

Actions Completed

1. On May 13, 2013, Florida DOH posted a draft of this repot on its web site.
2. On May 24, 2013, the Florida DOH in Alachua County distributed a community update to approximately 500 nearby residents and other interested parties. This update summarized the draft report, solicited public comment, and announced an open house meeting.

3. On June 10, 2013 the Florida DOH and Florida DOH in Alachua County hosted an open house meeting from 3:00 to 8:00 PM at the Stephen Foster Elementary School.

Actions Planned

1. Florida DOH will continue to keep nearby residents informed of their findings.

Report Preparation

The Florida Department of Health, Public Health Toxicology section prepared this health consultation report under a cooperative agreement with the US Agency for Toxic Substances and Disease Registry. Florida DOH followed approved methodologies and procedures existing at the time it began its assessment. Florida DOH completed an editorial review of this document.

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References

[ATSDR 1989] Agency for Toxic Substances and Disease Registry. Health Assessment for Cabot Carbon/Koppers Site. U.S. Department of Health and Human Services. Atlanta, GA. April 24, 1989.

[ATSDR 1993] Agency for Toxic Substances and Disease Registry. Site Review and Update for Cabot Carbon/Koppers Site. U.S. Department of Health and Human Services. Atlanta, GA. September 24, 1993.

[ATSDR 1995] Agency for Toxic Substances and Disease Registry. Health Consultation for Cabot Carbon/Koppers Superfund Site. U.S. Department of Health and Human Services. Atlanta, GA. November 15, 1995.

[ATSDR 2004] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers (Update). Atlanta: US Department of Health and Human Services; September 2004.

[ATSDR 2005] Agency for Toxic Substance and Disease Registry. Public Health Assessment Guidance Manual (Update). U.S. Department of Health and Human Services, Atlanta, GA. January 2005.

[ATSDR 2007a] Agency for Toxic Substances and Disease Registry. Health Consultation. Exposure Investigation Report. A Pilot Exposure Investigation: Dioxin Exposure in Adults Living in the Tittabawassee River Floodplain, Saginaw County Michigan. November 1, 2007.

[ATSDR 2007b] Agency for Toxic Substances and Disease Registry. Health Consultation. Dioxin in Dust in Schools and Community Center, Nitro School Dioxin Site, Nitro, Kanawha County, West Virginia. April 18, 2007.

[ATSDR 2009a] Agency for Toxic Substances and Disease Registry. Health Consultation Off-Site Surface Soil, Koppers Hazardous Waste Site. Gainesville, Alachua County, Florida. U.S. Department of Health and Human Services. Atlanta, GA. July 17, 2009.

[ATSDR 2009b] Agency for Toxic Substances and Disease Registry. Health Consultation. Dioxin Contamination on Residential Property in the Tittabawassee River Floodplain, Saginaw County Michigan. August 19, 2009.

[ATSDR 2010] Agency for Toxic Substances and Disease Registry. Health Consultation Additional Off-Site Surface Soil, Koppers Hazardous Waste Site. Gainesville, Alachua County, Florida. U.S. Department of Health and Human Services. Atlanta, GA. June 17, 2010.

[ATSDR 2011a] Agency for Toxic Substances and Disease Registry. Health Consultation, Springstead and Hogtown Creek Sediments, Cabot Carbon-Koppers Hazardous Waste Site. Gainesville, Alachua County, Florida. U.S. Department of Health and Human Services. Atlanta, GA. May 24, 2011.

[ATSDR 2011b] Agency for Toxic Substances and Disease Registry. Health Consultation, Surface Soil in Stephen Foster Neighborhood Yards and Areas North, East, and South of the Koppers Hazardous Waste Site. Gainesville, Alachua County, Florida. U.S. Department of Health and Human Services. Atlanta, GA. December 9, 2011.

[Black 2005] Black, K., Shalat, S.L., Freeman, N.C.G., Jimenez, M. Donnelly, K.C., and Calvin, J.A. Children's mouthing and food handling behavior in an agricultural community on the US-Mexico border. Journal of Exposure Analysis and Environmental Epidemiology. 15: 244-251.

[BOC 2002] Bureau of the Census. 2000 Census Population. Washington: US Department of commerce, 2002.

[Brown, et al. 2003] D.J. Brown, I. VanOvermeire, L. Goeyens, M.S. Denison, M.J. DeVito, and G.C. Clark. Analysis of Ah Receptor Pathway Activation by Brominated Flame Retardants. Chemosphere 55 (2004) 1509-1518. Elsevier Ltd.

[Butte and Heinzow 2004] Butte, Werner and Heinzow, Birger. Pollutants in House Dust as Indicators of Indoor Contamination. Review of Environmental Contamination Toxicology. Volume 175: pages 1-46. Springer-Verlag.

[Birnbaum, et al 2003] Birnbaum, L.S., Staskal, D.F., and Diliberto, J.J. Health Effects of Polybrominated Dibenzo-p-dioxins (PBDDs) and Dibenzofurans (PBDFs). Environment International. Volume 29, Issue 6, Pages 855-860. September 2003.

[Calwell 2011] The Calwell Practice, PLLC. Letter to E. Randall Merchant from Stuart Calwell concerning dust testing in Gainesville, Florida. February 15, 2011.

[Calwell 2012] The Calwell Practice, PLLC. Letter to Randy Merchant from Stuart Calwell commenting on the September 13, 2012 Health Consultation: Surface Soil in Stephen Foster Neighborhood and Surrounding Areas. December 14, 2012.

[DEP 2012] Florida Department of Environmental Protection. Guidance for Comparing Background and Site Chemical Concentrations in Soil. Bureau of Waste Cleanup. Tallahassee, FL. January 2012.

[D'Silva, et al 2004] D'Silva K. Fernandes A. and Rose M. Critical Reviews in Environmental Science and Technology, 34 (2) p141-207.

[DOH 2011a] Florida Department of Health. Letter to Anthony Dennis from Susan Skye and Randy Merchant concerning Stephen Foster neighborhood chicken egg dioxin evaluation. Tallahassee, Florida. April 14, 2011.

[DOH 2011b] Florida Department of Health. Stephen Foster Neighborhood Cancer Review, Alachua County. Division of Environmental Health, Bureau of Environmental Public Health Medicine. June 2011.

[DOH 2011c] Florida Department of Health. Indoor Dust Investigation Plan, Stephen Foster Neighborhood, Gainesville, Florida. Prepared by the Indoor Dust Dioxin Workgroup. July 2011.

[DOH 2012] Florida Department of Health. Alachua County Report, Review of Cancer Rates for Census Tract 3 (Containing Stephen Foster Neighborhood). Division of Environmental Health. March 2012. Tallahassee, Florida.

[EPA 1992] US Environmental Protection Agency. Dermal Exposure Assessment: Principles and Applications. Exposure Assessment Group. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-91/011B.

[EPA 1995] US Environmental Protection Agency, Office of Research and Development. Exposure Factors Handbook. Volumes I, II, and III. EPA/600/ P-95/002F (a, b, and c).

[EPA 1998] US Environmental Protection Agency. Short Sheet: IEUBK Model Mass Fraction of Soil in Indoor Dust (MSD) Variable. EPA #540-F-00-008, OSWER #9285.7-34. June 1998.

[EPA 2000] US Environmental Protection Agency. Draft standard operating procedures for residential exposure assessments.

[EPA 2002] US Environmental Protection Agency. Response, Engineering, and Analytical Contract. Standard Operating Procedure 2040: Collection of Indoor Dust Samples from Carpeted Surfaces for Chemical Analysis Using a Nilfisk GS-80 Vacuum Cleaner. 5/17/02.

[EPA 2005] US Environmental Protection Agency. Unilateral Administrative Order for St. Regis Paper Company Site, Cass Lake, MN -Interim Remedial Action. December 2, 2005.

[EPA 2008] US Environmental Protection Agency. In the Matter of Dow Chemical Company, Midland, Michigan, 48667. Administrative Settlement Agreement and Order on Consent for Removal Action, EU001, Docket V-W-’08-C-906. July 15, 2008.

[EPA 2007] US Environmental Protection Agency. Remedial Investigation and Feasibility Study, XYZ Company, Anytown, Florida. Atlanta, GA [updated August 21, 2007; accessed October 20, 2007].
http://www.epa.gov/swerosps/bf/pubs/st_res_prog_report.htm

[EPA 2010a] US Environmental Protection Agency. Envirofacts. Washington, DC. [Updated March 28, 2010; accessed April 1, 2010]. Available from http://www.epa.gov/envirofacts.htm

[EPA 2010b] US Environmental Protection Agency. Region 5 Superfund NPL Fact Sheet. St. Regis Paper Co. EPA ID # MND057597940. November 2010.

[EPA 2011] US Environmental Protection Agency. Record of Decision. Summary of Remedial Alternative Selection. Cabot Carbon/Koppers Superfund Site. Gainesville, Alachua County, Florida. Atlanta, Georgia. February 2011.

[EPA 2012] US Environmental Protection Agency. Report on Indoor Dust Testing in the Stephen Foster Neighborhood, Gainesville, Florida.

[EPA 4435] US. Environmental Protection Agency. Method 4435. Method for Toxic Equivalents (TEQs) Determinations for Dioxin-Like Chemical Activity with the CALUX® Bioassay. Accessed May 2014 at: www.epa.gov/osw/hazard/testmethods/pdfs /4435.pdf.

[Freeman 2001] Freeman, N.C.G., Jimenez, M., Reed, K.J., Gurunathan, S., Edwards, R.D., Roy, A., Adgate, J.L., Pellizzari, E.D., Quackenboss, J., Sexton, K. and Lioy, P.J. Quantitative analysis of children's microactivity patterns: The Minnesota Children's Pesticide Exposure Study. Journal of Exposure Analysis and Environmental Epidemiology. 11: 501-509.

[Freeman 2005a] Freeman, N.C.G., Black, K, Jimenez, M., Donnelly, K.C., Shalat, S.L. Characterizing variations in indoor/outdoor mouthing activity of young children. EPA Colloquium on Soil/Dust Ingestion Rates and Mouthing Behavior for Children and Adults. Arlington, VA. May 24-25, 2005.

[Freeman 2005b] Freeman, N.C.G., Black, K, Jimenez-Rodriquez, M., Donnelly, K.C., Shalat, S.L. Characterizing variations in indoor/outdoor mouthing activity of young children. International Society for Exposure Analysis, Tucson, AZ. November 2, 2005.

[Karmin 1988] Toxicology – A Primer on Toxicology Principles and Applications. Lewis Publications. Chelsea MI. 1988.

[Layton 2009] D.W. Layton and P. I. Beamer. Migration of Contaminated Soil and Airborne Particulates to Indoor Dust. Environmental Science & Technology. 43 (21), pp 8199-8205. September 24, 2009. ACS Publications.

[Mennear and Lee 1994] Mennear, J.H. and Lee, Cheng-Chun. Polybrominated Dibenzo-p-Dioxins and Dibenzofurans: Literature Review and Health Assessment. Environmental Health Perspectives Supplements, Volume 102 Supplement1, Pages 265-274. 1994.

[NHAPS 1996] National Human Activity Pattern Survey. Descriptive statistics tables from a detailed analysis. Table DLN-80. EPA Office of Research and Development. July 1996. EPA/600/R-96/148.
[O'Conner 2005] Rod O'Connor and Justin Sabrsula. Background Dioxins in House Dust. Environmental Forensics. Taylor & Francis, Inc. 6:283-287, 2005.

[Ohio 2008] The Ohio State University Extension. Community Development Fact Sheet CDFS-191-08. The Invisible Environment Fact Sheet Series. Indoor Air Quality: Dust and Molds. Jackie LaMuth. 2008.

[Oomen, et al. 2008] A.G. Oomen, P.J.C.M. Janssen, A. Dusseldorp, C.W. Noorlander. Exposure to Chemicals via House Dust. RIVM Report 609021064/2008. National Institute for Public Health and the Environment. Ministry of Housing, Spatial Planning and the Environment of the Netherlands. P.O. Box 1, 3720 BA Bilthoven. 2008.

[Parsons 2010] Parsons, et al v Koppers Inc., et al. Case 1:10-cv-00071-MP-AK, Document 1. Filed 4/20/10. United States District Court, Northern District of Florida, Gainesville Division.

[Rodes 2001] Rodes, C.E., Newsome, J.R., Vanderpool, R.W., Antley, J.T. and Lewis, R.G. Experimental methodologies and preliminary transfer factor data for estimation of dermal exposure to particles. Journal of Exposure Analysis and Environmental Epidemiology 11: 123-139.

[Shalat 2003] Shalat, S.L., Donnelly, K.C., Freeman, N.C.G., Calvin, J.A., Ramesh, S. Jimenez, M., Black, K., Coutinho, C., Needham, L.L., Barr, D.B., Ramirez, J. Non-dietary ingestion of pesticides by children in an agricultural community on the US/Mexico border: preliminary results. Journal of Exposure Analysis and Environmental Epidemiology. 13: 42-50.

[Trowbridge 1997] P.R. Trowbridge and D.E. Burmaster. A Parametric Distribution for the Fraction of Outdoor Soil in Indoor Dust. Journal of Soil Contamination. Volume 6, Issue 2. Taylor & Francis.

[UM 2006] University of Michigan. Measuring People's Exposure to Dioxin Contamination Along the Tittabawassee River and Surrounding Areas: Finding from the University of Michigan Dioxin Exposure Study. Ann Arbor, MI: University of Michigan. August 2006.

Appendices

Tables and Figures

Table 1. Completed Human Exposure Pathway

COMPLETED PATHWAY NAME	COMPLETED EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	ENVIRONMENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Indoor Dust	Contaminated soil on the Koppers site*	Dust	Inside about 200 nearby houses	Ingestion	About 500 residents of the adjacent neighborhood	Past, Present, and Future

* Florida DOH and ATSDR assume windblown soil (dust) from the Koppers facility is a source. There are, however, other sources of dioxins in indoor dust.

Table 2. Gainesville Area Background Houses: Contaminant Concentrations in Indoor Dust

Background House	TCDD-TEQ Concentration (pg/g)	Brominated Dioxin & Furan-TEQ* Concentration (pg/g)	CALUX® Screening Bioassay Concentration (pg/g)
A	34.0	5.7	11.5
B	5.37	1159.9	47.51
C	35.1	104.6	51.97
D	2.66	33.8	27.93
E	6.34	19.9	30.49
F	6.45	3.4	12.03
G	47.6	62.4	84.45
H	6.69	12.2	24.16
I	18.3	below detection limits	insufficient sample size
J	6.52	635	8.32
K	77.3	below detection limits	insufficient sample size
L	18.2	206.3	200.73
M	15.3	18.9	insufficient sample size
median	15.3	33.8	29.21
geometric mean	13.6	47.8	31.59

TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents CALUX® = Chemical-Activated Luciferase Expression bioassay
pg/g = picograms per gram (parts per trillion, ppt) *Brominated Dioxin & Furan TEQ concentration based on relative potency factors in D'Silva, et al 2004. Source of data: EPA 2012

Table 3. Select Houses Near the Kopper Facility: Contaminant Concentrations in Indoor Dust

House	TCDD-TEQ Concentration (pg/g)	Brominated Dioxin & Furan-TEQ* Concentration (pg/g)	CALUX® Screening Bioassay Concentration (pg/g)
A	11.4	0.5	15.30
B	72.3	1.1	22.15
C	29.2	6.2	33.46
D	38.1	161.8	74.36
E	8.92	27.8	42.39
F	13.4	36.0	42.54
G	27.6	32.1	7.06
H	50.6	605.2	39.21
I	42.9	0.4	53.55
J	60.3	10.2	53.87
K	17.5	28.6	55.03
L	37.6	0.3	25.02
M	44.9	1.2	29.24
N	6.78	7.7	8.45
O	27.7	2.8	16.38
P	90.9	3.9	149.58
Q	19.0	5.7	33.97
median	29.2	6.2	33.97
geometric mean	27.9	7.0	31.78

TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents CALUX® = Chemical-Activated Luciferase Expression bioassay pg/g = picograms per gram (parts per trillion, ppt) *Brominated Dioxin & Furan concentration based on relative potency factors in D'Silva, et al 2004. Source of data: EPA 2012

Table 4. Gainesville Area Background Houses: Contaminant Loading in Indoor Dust

Background House	Dust Load (mg/m^2)	TCDD-TEQ Load (pg/m^2)	Brominated Dioxin & Furan-TEQ* Load (pg/m^2)	CALUX® Screening Bioassay Load (pg/m^2)
A	43	1.46	0.25	0.49
B	58	0.31	67.27	2.73
C	55	1.93	5.75	2.88
D	56	0.15	1.89	1.57
E	411	2.61	8.18	12.54
F	274	1.77	0.93	3.30
G	188	8.95	11.73	15.88
H	9	0.06	0.11	0.21
I	52	0.95	below detection limits	insufficient sample size
J	66	0.43	41.91	0.55
K	47	3.63	below detection limits	insufficient sample size
L	22	0.40	4.54	4.38
M	64	0.98	1.21	insufficient sample size
median	56	0.98	4.54	2.81
geometric mean	64	0.88	3.24	2.14

TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents
CALUX® = Chemical-Activated Luciferase Expression bioassay
mg/m^2 = milligrams per square meter
pg/m^2 = picograms per square meter
*Brominated Dioxin & Furan TEQ concentration based on relative potency factors in D'Silva, et al 2004.
Source of data: EPA 2012

Table 5. Select Houses Near the Koppers Facility: Contaminant Loading in Indoor Dust

House	Dust Load (mg/m^2)	TCDD-TEQ load (pg/m^2)	Brominated Dioxin & Furan-TEQ* Load (pg/m^2)	CALUX® Screening Bioassay Load (pg/m^2)
A	1,003	11.43	0.50	15.35
B	78	5.64	0.09	1.72
C	34	0.99	0.21	1.15
D	741	28.23	119.89	55.08
E	32	0.29	0.89	1.35
F	265	3.55	9.54	11.25
G	816	22.52	26.19	5.76
H	1,108	56.06	670.56	43.45
I	182	7.81	0.07	9.76
J	110	6.63	1.12	5.95
K	497	8.70	14.21	27.36
L	901	33.88	0.27	22.54
M	1,240	55.68	1.49	36.26
N	970	6.58	7.47	8.20
O	25	0.69	0.07	0.40
P	157	14.27	0.61	23.45
Q	85	1.62	0.48	2.88
median	265	7.81	0.89	9.76
geometric mean	249	6.96	1.73	7.90

TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents CALUX® = Chemical-Activated Luciferase Expression bioassay mg/m^2 = milligrams per square meter pg/m^2 = picograms per square meter *Brominated Dioxin & Furan TEQ concentration based on relative potency factors in D'Silva, et al 2004. Source of data: EPA 2012

Table 6. Gainesville Area Background Houses: Maximum TCDD-TEQ Dust Concentration and Mean Traditional Dose/Cancer Risk by Age Group

Age Group (years)	Body Weight (kg)	Maximum TCDD-TEQ Dust Concentration (mg/kg)	Dust Ingestion Rate (mg/day)	Exposure Factor (unit less)	Mean Dose (mg/kg/day)	ATSDR Chronic Oral MRL (mg/kg/day)	Cancer Slope Factor (per mg/kg/day)	Mean Cancer Risk (unit less)
Child 0.5 - 1	9.2	7.73×10^{-5}	60	0.96	4.84×10^{-10}	1×10^{-9}	1.5×10^{5}	4.65×10^{-7}
Child 1 - 2	11.4	7.73×10^{-5}	60	0.96	3.91×10^{-10}	1×10^{-9}	1.5×10^{5}	7.51×10^{-7}
Child 2 - 6	17.4	7.73×10^{-5}	60	0.96	2.56×10^{-10}	1×10^{-9}	1.5×10^{5}	1.97×10^{-6}
Child 6 - 11	31.8	7.73×10^{-5}	60	0.96	1.40×10^{-10}	1×10^{-9}	1.5×10^{5}	1.35×10^{-6}
Child 11 - 21	64.2	7.73×10^{-5}	60	0.96	6.94×10^{-11}	1×10^{-9}	1.5×10^{5}	1.33×10^{-6}
Adult 21 - 65	80	7.73×10^{-5}	11	0.96	1.02×10^{-11}	1×10^{-9}	1.5×10^{5}	8.63×10^{-7}
Adult 65+	76	7.73×10^{-5}	11	0.96	1.07×10^{-11}	1×10^{-9}	1.5×10^{5}	3.10×10^{-7}
Child 0.5 - 21	---	---	---	---	---	---	---	5.86×10^{-6}
Adult 21 - 78	---	---	---	---	---	---	---	1.17×10^{-6}
Lifetime (child+adult)	---	---	---	---	---	---	---	7.04×10^{-6}

kg = kilograms mg/kg = milligrams per kilogram mg/day = milligrams per day mg/kg/day = milligrams per kilogram per day
TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents ATSDR = Agency for Toxic Substances and Disease Registry

Table 7. Select Houses Near the Koppers Facility: Maximum TCDD-TEQ Dust Concentration and Mean Traditional Dose/Cancer Risk by Age Group

Age Group (years)	Body Weight (kg)	Maximum TCDD-TEQ Dust Concentration (mg/kg)	Dust Ingestion Rate (mg/day)	Exposure Factor (unit less)	Mean Dose (mg/kg/day)	ATSDR Chronic Oral MRL (mg/kg/day)	Cancer Slope Factor (per mg/kg/day)	Mean Cancer Risk (unit less)
Child 0.5 - 1	9.2	9.09×10^{-5}	60	0.96	5.69×10^{-10}	1×10^{-9}	1.5×10^{5}	5.47×10^{-7}
Child 1 - 2	11.4	9.09×10^{-5}	60	0.96	4.59×10^{-10}	1×10^{-9}	1.5×10^{5}	8.83×10^{-7}
Child 2 - 6	17.4	9.09×10^{-5}	60	0.96	3.01×10^{-10}	1×10^{-9}	1.5×10^{5}	2.31×10^{-6}
Child 6 - 11	31.8	9.09×10^{-5}	60	0.96	1.65×10^{-10}	1×10^{-9}	1.5×10^{5}	1.58×10^{-6}
Child 11 - 21	64.2	9.09×10^{-5}	60	0.96	8.16×10^{-11}	1×10^{-9}	1.5×10^{5}	1.57×10^{-6}
Adult 21 - 65	80	9.09×10^{-5}	11	0.96	1.20×10^{-11}	1×10^{-9}	1.5×10^{5}	1.02×10^{-6}
Adult 65+	76	9.09×10^{-5}	11	0.96	1.26×10^{-11}	1×10^{-9}	1.5×10^{5}	3.64×10^{-7}
Child 0.5 - 21	---	---	---	---	---	---	---	6.90×10^{-6}
Adult 21 - 78	---	---	---	---	---	---	---	1.38×10^{-6}
Lifetime (child+adult)	---	---	---	---	---	---	---	8.28×10^{-6}

kg = kilograms mg/kg = milligrams per kilogram mg/day = milligrams per day mg/kg/day = milligrams per kilogram per day
TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents ATSDR = Agency for Toxic Substances and Disease Registry MRL = minimal risk level

Table 8. Maximum TCDD-TEQ Dust Loading and Maximum Alternative Dose Estimates for Gainesville Area Background Houses and Houses Near the Koppers Facility

	Maximum TCDD-TEQ Dust Loading ($\mu g/cm^2$)	Hand Surface Area per Event (cm^2/event)	Frequency (events/hour)	Exposure Time (hours/day)	Fraction Ingested (unit less)	Dermal Transfer Factor (unit less)	Body Weight (kg)	Maximum Alternative Dose (mg/kg/ day)
Area Background Child	8.95×10^{-10}	29.7	35.4	9.83	0.5	0.485	17.4	1.3×10^{-10}
Area Background Adult	8.95×10^{-10}	125	10	8	0.5	0.485	76	2.9×10^{-11}
Child Near Koppers Facility	56.06×10^{-10}	29.7	35.4	9.83	0.5	0.485	17.4	8.1×10^{-10}
Adult Near Koppers Facility	56.06×10^{-10}	125	10	8	0.5	0.485	76	1.8×10^{-10}

$\mu g/cm^2$ = micrograms per square centimeter cm^2 = square centimeter kg = kilogram mg/kg/day = milligrams per kilogram per day

TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents

Figure 1. Koppers Site and Area of Indoor Dust Testing

[Florida Department of Health] Disclaimer: This map is intended for display purposes only. It was created using data from different sources collected at different scales, with different levels of accuracy, and/or covering different periods of time.

Glossary

Absorption
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with **chronic**].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate duration exposure** and **chronic exposure**].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with **antagonistic effect** and **synergistic effect**].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems.

Ambient
Surrounding (for example, *ambient* air).

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Cancer
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate duration exposure**].

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see **exposure pathway**].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as **Superfund**, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see **route of exposure**].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink

contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose-response relationship
The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and **biota** (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The **environmental media and transport mechanism** is the second part of an **exposure pathway**.

EPA
United States Environmental Protection Agency.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through groundwater); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching), and a **receptor population** (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a **completed exposure pathway**.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

mg/kg
Milligram per kilogram.

mg/cm2
Milligram per square centimeter (of a surface).

mg/m3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see **National Priorities List for Uncontrolled Hazardous Waste Sites**]

Point of exposure
The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are **no public health hazard, no apparent public health hazard**, **indeterminate public health hazard**, **public health hazard**, and **urgent public health hazard**.

Public health statement
The first chapter of an ATSDR **toxicological profile**. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Receptor population
People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

RfD
See **reference dose**.

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [**inhalation**], eating or drinking [**ingestion**], or contact with the skin [**dermal contact**].

Safety factor [see **uncertainty factor**]

SARA [see **Superfund Amendments and Reauthorization Act**]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see **population**]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or environment.

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an **exposure pathway**.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see **prevalence survey**].

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a

NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Response to Public Comment

On May 13, 2013, Florida DOH posted a draft of this repot on its web site. On May 24, 2013, the Florida DOH in Alachua County distributed a community update to approximately 500 nearby residents and other interested parties. This update summarized the draft report, solicited public comment, and announced an open house meeting. On June 10, 2013 the Florida DOH and Florida DOH in Alachua County hosted an open house meeting from 3:00 to 8:00 PM at the Stephen Foster Elementary School. The public comment period closed June 24, 2013.

Florida DOH received written comments from the City of Gainesville, the Protect Gainesville Citizens technical advisor, a health scientist funded by Beazer East, Inc., and five nearby residents. Florida DOH also received verbal comments from open house meeting participants. Below is a summary of these comments and the Florida DOH/ATSDR response.

City of Gainesville

Comment #1: Shift the focus of the report from just the houses sampled to the neighborhood in general.
Response #1: Added text characterizing the 17 houses tested as representative of the area in Figure 1.

Comment #2: Are the TEF values used to calculate the TCDD-TEQ concentration in this report consistent with the 2005 World Health Organization TEFs?
Response #2: Yes, the top of page 9 explains the use of the 2005 World Health Organization's TEFs to calculate TCDD-TEQs.

Protect Gainesville Citizens Technical Advisor

Comment #3: Shift the focus of the report from just the houses sampled to the neighborhood in general.
Response #3: Added text characterizing the 17 houses tested as representative of the area in Figure 1.

Comment #4: The CALUX bioassay responds to brominated dioxins and dioxin-like compounds associated with polybrominated diphenyl ethers (PBDEs) but not to the PBDEs themselves.
Response #4: Corrected text.

Health Scientist Funded by Beazer East, Inc.

Comment #5: Clarify that the cause for the difference in dioxin dust concentrations between houses near the Koppers facility and distant background houses is unknown and that it is incorrect to assume that proximity to the Koppers facility is the cause.
Response #5: This report focusses on the health risk from exposure to dioxins in indoor dust. It does not address possible reasons for the difference in dioxin concentrations in dust from houses adjacent to and distant from the Koppers facility. Because EPA did not disclose the addresses or map of the houses tested, it is not possible to determine if the pattern of dioxin concentrations in indoor dust is similar to the pattern of decreasing dioxin concentrations with distance evident in surface soil.

Comment #6: The report should be clear that identifying the Koppers facility as the source of dioxins in the dust of nearby houses is an assumption, not a fact.
Response #6: Revised the report to state clearly that it is a Florida DOH/ATSDR assumption that the Koppers facility is a likely source of dioxins in the dust of nearby houses.

Comment #7: The report should discuss the health risk from exposure to brominated dioxins/furans.
Response #7: The indoor dust workgroup recommended analysis of indoor dust samples for brominated dioxins/furans to determine if they were contributing to the CALUX bioassay response. The workgroup did not envision assessing the health risk from exposure to the brominated dioxins/furans. Too little is known about the toxicity of the brominated dioxins/furans to accurately quantify the health risk.

Comment #8: Remove discussion of the alternative ingestion dose methodology.
Response #8: Page 9 of the July 2011 Indoor Dust Investigation/Interpretation Plan discusses the importance of considering the weight of contaminant per surface area (dust loading). The report includes an alternative ingestion dose estimate based on dust loading. However, because of large uncertainties, the report does not rely on the alternative dose estimate to evaluate the health threat but rather relies on the more traditional ingestion dose methodology (concentration).

Comment #9: In the *Next Steps* section of the Summary, delete the sentence "EPA will consider this report before deciding on any cleanup inside houses near the Koppers facility."
Response #9: Deleted the *Next Steps* section of the Summary. Added the following sentence to the *Background and Statement of Issues* section: "In November 2012 EPA informed participating homeowners that the highest concentration of dioxins in indoor dust was below the risk-based screening value and no remediation is required."

Comment #10: "*Actions Completed*" and "*Actions Underway*" are not related to the indoor dust testing.
Response #10: Revised these sections to just those actions related to indoor dust testing.

Nearby Residents

Comment #11: Since the community update did not define "nearby" I do not know if the dust in my house is contaminated.
Response #11: Figure 1 of this full report shows the area tested.

Comment #12: Please add information about recent testing of the Cabot portion of the site.
Response #12: In a separate report Florida DOH will evaluate recent soil gas and indoor air testing on the Cabot portion of the site.

Comment #13: EPA has not done enough testing.
Response #13: EPA tested the number of houses recommended by the indoor dust workgroup made up of health/environmental agency scientists, community representatives, UF toxicologists, and a health scientist funded by Beazer East, Inc. The indoor dust test results do not support additional testing.

Comment #14: I would like to have the dust in my attic tested.
Response #14: Because the attics of houses near the Koppers facility are typically small and the amount of time people spend in their attics is limited, the indoor dust workgroup did not recommend EPA test attic dust. Homeowners, however, can always choose to test attic dust at their own expense.

Open House Meeting Participants

Comment #15: Give higher profile to the fact the report does not assess the health risk from dust inhalation.
Response #15: The indoor dust workgroup did not recommend indoor air testing or assessing the health risk from dust inhalation. We have added a conclusion, however, to the report stating that it does not address the health risk from inhalation.

Comment #16: State clearly that the report only addresses current exposures and is unable to address the risk from past exposures.
Response #16: The existing report conclusion #3 clearly states that the past health risks from chlorinated dioxins/furans in the dust of houses prior to 2012 is unknown.

Comment #17: What cancer risk levels usually prompt Florida DOH to recommend protective action?
Response #17: We have added a description of the increase cancer risk levels at which Florida DOH usually recommends action.