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Office of Chemical Safety and
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Executive Summary of the Draft Risk Evaluation for Formaldehyde

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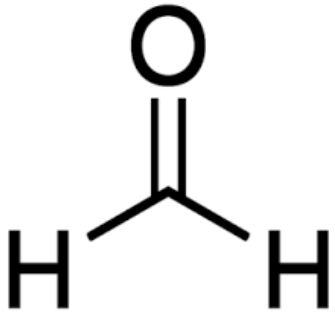

March 2024

The U.S. Environmental Protection Agency (EPA) has evaluated the health and environmental risks of formaldehyde under the Toxic Substances Control Act (TSCA). In this draft risk evaluation, **EPA preliminarily finds that formaldehyde presents an unreasonable risk of injury to human health.** However, these risks result from specific activities using, and products containing, formaldehyde and therefore may not apply to everyone, everywhere. Also, the draft risk evaluation points out uncertainties in these findings that could cast doubt on whether all risk estimates presented in this draft evaluation—even though the values are based on the best available scientific information—are reflective of real-life exposure to formaldehyde in the workplace, outdoor ambient air, and inside homes and other indoor situations. Therefore, EPA is releasing this draft risk evaluation and risk determination for public comment and independent, expert peer review. Once EPA receives comment and input from peer review, revisions will be made and the EPA will finalize and issue its assessments and risk determination (*i.e.,* risk evaluation).

EPA's TSCA existing chemical risk evaluations must determine whether a chemical substance does or does not present unreasonable risk under its *conditions of use*. The unreasonable risk must be informed by science, but the EPA, in making the finding of *presents unreasonable risk*, also considers risk-related factors as described in its risk evaluation framework rule. Risk-related factors beyond the levels of formaldehyde that can cause specific health effects include the type of health effect under consideration, the reversibility of the health effect being evaluated, exposure-related considerations (*e.g.,* duration, magnitude, or frequency of exposure), population exposed (including any susceptible subpopulation), and the confidence in the information used to inform the hazard and exposure values. Specifically, for formaldehyde, and for reasons explained below, while EPA will consider the standard risk benchmarks associated with interpreting margins of exposure and cancer risks, the EPA cannot solely rely on those risk values. This is because in addition to formaldehyde generated under the conditions of use, formaldehyde is naturally occurring and results from activities not associated with the conditions of use covered by this draft risk evaluation. These considerations must be included as part of a pragmatic and holistic evaluation of hazard and exposure to formaldehyde. If an estimate of risk for a specific scenario exceeds the standard risk benchmarks, then the formal determination of whether those risks contribute to the unreasonable risk of formaldehyde under TSCA must be both case-by-case and context-driven.

Formaldehyde is found nearly everywhere. Living things—plants, animals, and people—produce and release formaldehyde just through natural life (biogenic) processes. It is also produced when other chemicals break down in the environment and is released into the air when things burn, such as when automobiles emit exhaust, when furnaces and stoves operate, and through forest fires. Formaldehyde is also used to make many things, including composite wood products, plastics, paints, adhesives, and sealants. Over time, formaldehyde can be released from these products. The formaldehyde sources that EPA evaluates in this draft risk evaluation involve, in general, the production and use of these products that are subject to TSCA (as opposed to those products that are excluded from TSCA, such as pesticides). The unique challenge associated with this evaluation is that the formaldehyde released from these commercial activities and products that are subject to TSCA is mixed in with the naturally formed formaldehyde released from all the activities and processes mentioned above.

This draft risk evaluation attempts to understand whether the risk from specific activities subject to TSCA (*i.e.,* the conditions of use) contribute to the unreasonable risk presented by formaldehyde. And the risk estimates from some conditions of use representing workplaces clearly indicate that the direct use of formaldehyde of those conditions of use contributes to the unreasonable risk of formaldehyde. However, EPA also acknowledges that it is often difficult—if not impossible—to understand what contribution various conditions of use are making to the total level of formaldehyde to which a person is exposed in any given place at any given time.

TSCA requires the EPA to look at risks to the environment as well as to people. Formaldehyde is not expected to last long (persist) in water, sediment, or soil based on its physical and chemical properties. For this reason, in this draft evaluation EPA has been able to preliminarily conclude that formaldehyde does not pose a risk to the environment. Therefore, the rest of this executive summary focuses on EPA's evaluation of risks to people.

For people, formaldehyde is a concern because it can cause health problems when inhaled and if it contacts and is absorbed into skin. Breathing formaldehyde has been associated with a range of respiratory and non-respiratory health effects in people. Inhaling formaldehyde for a short period of time, such as for 15 minutes (called an acute exposure), for example after opening a product containing formaldehyde, can cause sensory irritation such as eye irritation. Health effects that may be caused from longer-term breathing of formaldehyde (called chronic exposure) include reduced pulmonary function, increased asthma prevalence, decreased asthma control, allergy-related conditions, sensory irritation, male and female reproductive toxicity, developmental effects, and cancer. This evaluation uses the chronic hazard values calculated in EPA's *IRIS Toxicological Review of Formaldehyde – Inhalation*.

Specifically for cancer, this evaluation uses the hazard information for nasopharyngeal cancer included in EPA's IRIS assessment. Although inhaled formaldehyde is associated with myeloid leukemia, another type of cancer, the findings are not sufficient to complete a robust assessment of cancer risk for the TSCA risk determinations or for use in the IRIS assessment. TSCA risk evaluations are also required to consider risks to potentially exposed or susceptible subpopulations, such as children. Therefore, EPA modified this cancer value using age-dependent adjustment factors to account for the possibility of children's increased susceptibility to formaldehyde.

Skin (dermal) contact with formaldehyde has also been shown to cause sensitization, an allergic reaction. EPA looked at the possibility of people getting formaldehyde on their skin through liquids, such as detergents that may contain formaldehyde, as well as by getting paint and auto-care products like car wax on their skin while using those products. Workers engaged in daily activities like spraying liquids that contain formaldehyde may also have enough dermal contact with formaldehyde, particularly if they are not wearing protective equipment like gloves, to develop skin sensitization.

While there are data on the hazards of oral ingestion, such as by drinking water, EPA did not use those data because exposure is not expected. As mentioned above, formaldehyde is not expected to persist in water or soils based on the physical and chemical properties and therefore is not expected in groundwater or surface water used for drinking water.

In its evaluation of risks to people, EPA assessed exposure for 62 TSCA conditions of use of formaldehyde, using many scenarios, considering multiple human life stages (*e.g.*, childhood, adulthood) and how people might be exposed outdoors in the open air, in their homes or other buildings, and at workplaces that use formaldehyde. In some cases, EPA had data from air monitors; in other cases, EPA used models to predict air concentrations and exposures. Both measured and modeled information shows that people are exposed to formaldehyde at work, indoors, and outdoors at or above the levels where adverse health effects such as sensory irritation, reduced pulmonary function, or cancer can occur. Furthermore, multiple sources of formaldehyde—including sources not regulated under TSCA as well as sources that are not regulated under TSCA (including natural sources as well as sources that are regulated under other laws)—contribute to the total amount of formaldehyde that a person breathes outside, inside, and at work, every day.

Given this, EPA cannot solely rely on exceedances of the amounts of formaldehyde exposures known to cause specific health effects in the risk evaluation to determine if conditions of use of formaldehyde that are subject to TSCA contribute to the unreasonable risk. What that means is, for the risks described below to workers and people who use formaldehyde-containing products or have formaldehyde-containing furnishings or materials in their homes, those risks may not be any greater than (1) the risks those same people are exposed to daily from the formaldehyde created naturally by plants, animals, and people; (2) formaldehyde produced by natural and human-caused combustion; and (3) formaldehyde produced by the breakdown of other chemicals in the air. Therefore, EPA believes that, in considering whether a formaldehyde condition of use subject to TSCA contributes to unreasonable risks to people's health, any risks—and what to do about them—need to be considered within the broader context of all sources of formaldehyde, some of which people have been exposed throughout the course of human existence.

Workers who are in workplaces where formaldehyde is used are at the most risk from formaldehyde exposure. Workplace formaldehyde air concentrations are generally higher than ambient outdoor concentrations as well as residential indoor air concentrations. Workers may be exposed to formaldehyde by inhaling it after it is released into the air during processing and manufacturing of articles, particularly when respirators are not worn. Workers can also be exposed to formaldehyde by making skin contact with formaldehyde-containing materials when personal protective equipment like gloves are not worn.

Workers are most likely to be at risk for acute and chronic non-cancer inhalation effects. Workers may experience sensory eye irritation from short-term exposures (15-minute) and decreased lung function or other respiratory effects from longer-term exposures (full work shift over many years). EPA has an overall medium confidence in the reported workplace air exposure estimates because most of the values are based on recent (1992 to 2020) real workplace monitoring data from multiple sources, and therefore are expected to be reflective of current industrial practices. The reported exposure estimates, however, did not always provide supplemental information such as the specific worker activities and associated process conditions when formaldehyde was being made or used in the facilities.

EPA estimated short-term dermal exposures based on workers' skin contact with liquid formulations containing formaldehyde. The highest dermal exposure was estimated for spray application of products such as paints and automotive care products. EPA has medium confidence in the dermal exposure estimates because the estimates were derived using a standard peer-reviewed model based on measured data on the retention of liquids on the skin surface. The EPA does not have higher confidence in the reported values because EPA did not have monitored formaldehyde dermal exposure data to ground-truth these exposure estimates.

Overall, EPA determined with high confidence that most formaldehyde conditions of use can lead to adverse health outcomes based on calculated risk estimates if workers are not protected from breathing or touching formaldehyde. EPA estimated risks assuming that these protections are not in place because EPA cannot guarantee that, in all cases, personal protective equipment is provided and worn. However, EPA also is aware that many employers do take measures to protect the safety of workers in their facilities.

At the next-highest risk from formaldehyde are people who frequently use certain consumer products that contain formaldehyde. These include automotive-care products like car waxes; crafting supplies such as some glues and sealants; and fabrics, textiles, and leather goods treated with formaldehyde. However, whether there are any risks of concern from these products depends

correspondingly on the amount of time and how frequently they are used. EPA has medium confidence in the inhalation exposure estimates based on the number of monitoring data sources, use of the EPA's *Exposure Factors Handbook* and survey data on consumer behavior and activities, and chemical amounts reported on product-specific safety data sheets. EPA estimated short-term dermal exposures based on skin contact with products containing formaldehyde. The highest concentrations were estimated for exterior car waxes and polishes followed by photographic processing solutions. Monitoring data that can be tied to specific ways people use these products are not available. People using formaldehyde-containing products may experience dermal sensitization after short-term exposures to their skin. Risk estimates for these dermal exposures are based on modeled estimates. Because monitoring data are not available to determine how frequently these exposures may occur for consumers or ground-truth these estimates, EPA has medium confidence in these risk estimates.

Finally, consumer products that contain formaldehyde can contribute to the formaldehyde present in homes or other indoor places where they spend extended periods of time. There are many sources of formaldehyde within homes and vehicles. These include sources from articles such as building materials, wood flooring, paint, and fabrics as well as combustion sources like candles, fireplaces or stoves. Additionally, consumer products containing formaldehyde may also add to indoor concentrations of formaldehyde. EPA used computer-based models to estimate formaldehyde concentrations from TSCA conditions of use that cannot otherwise be distinguished from other sources of formaldehyde reflected in measured indoor concentration data. This is because the levels of formaldehyde coming from many conditions of use are the same order of magnitude as the levels of formaldehyde from other activities in the home (*e.g.*, cooking or smoking), and because the measured concentration data represent total exposure of formaldehyde from all sources at a given time and place.

The highest formaldehyde concentrations from TSCA sources in indoor environments are expected in newly constructed homes and mobile homes. In these settings, multiple sources of formaldehyde contribute to total indoor air concentrations—especially during the peak product emission period when new formaldehyde-containing articles and products are introduced. These concentrations substantially diminish within the first 2 years of the product life based on open literature data. Peak exposures to formaldehyde from these products is expected to occur within 1 year of manufacture or use. Indoor air concentrations of formaldehyde can also be high when new materials like hardwood floors or wallpaper are installed in homes. Similarly, fabric in new furniture may also release formaldehyde in indoor environments after being introduced. Therefore, formaldehyde concentrations in indoor environments are expected to vary greatly over longer time periods (*e.g.*, an individual's lifetime) and are highly dependent on a person's likelihood to move into newly constructed homes and what products they acquire while they live there. Many of the products that fall within this condition of use are also subject to EPA's 2018 emission standards under TSCA Title VI (15 U.S.C. §2697), which have not been fully implemented as of the time of publication of this draft risk evaluation. Therefore, it is reasonable to expect that less formaldehyde will be released from many wood products in the future than occurred in the past.

EPA has medium confidence in the indoor air concentration estimates because the values are based on product-specific emission rates and product-specific formulations of formaldehyde. The EPA does not have high confidence in the indoor air concentration estimates because available monitoring data could not corroborate the full range of estimates. In addition, the EPA does not have high confidence because (1) dissipation rates of formaldehyde cannot be determined for indoor air for all types of furniture, wood or other products, and (2) the available monitoring data cannot be directly tied to specific products (*e.g.*, wood and fabric products) and associated conditions of use.

EPA did not find that people face unreasonable risks from outdoor exposure to formaldehyde created through TSCA conditions of use (such as a nearby industrial facility that makes or uses formaldehyde). The evaluation considered levels of formaldehyde within a half mile from facilities releasing formaldehyde through conditions of use. Formaldehyde concentrations are generally within the range of concentrations of formaldehyde that come from natural sources (such as decomposing leaves) or combustion sources such as car exhaust. In some locations under certain conditions, formaldehyde concentrations may be higher; however, the concentrations are below most air concentrations of formaldehyde typically found inside the home. This finding may partially be due to the fact that formaldehyde is expected to rapidly transform into other chemicals during daylight hours. Based on this knowledge, the EPA does not believe these risks to be unreasonable. That does not mean that, in specific communities, efforts should not be taken to better understand and, if necessary, reduce formaldehyde releases from facilities. EPA has high confidence in the outdoor air concentration estimates because the values are based on reported formaldehyde releases from EPA databases, uses standard risk assessment approaches, and utilizes more refined models to better understand location and populations near releasing facilities.

Therefore, in this preliminary determination of formaldehyde unreasonable risk:

1. EPA has a high level of certainty that 41 occupational conditions of use and has less certainty that 5 additional occupational conditions of use contribute to unreasonable risk due to non-cancer effects, specifically sensory eye irritation associated with **acute inhalation** of formaldehyde;
2. EPA has a high level of certainty that 7 consumer conditions of use contribute to the unreasonable risk due to non-cancer effects, specifically sensory eye irritation associated with **acute inhalation** of formaldehyde;
3. EPA has a high level of certainty that 10 occupational conditions of use and has less certainty that 35 additional occupational conditions of use contribute to the unreasonable risk due to non-cancer effects— specifically respiratory and non-respiratory health effects in workers, including reduced pulmonary function, increased asthma prevalence, reduced asthma control, allergy-related conditions, male and female reproductive toxicity, and developmental effects, associated with **chronic inhalation** exposures;
4. EPA is less certain about the contribution from 3 consumer conditions of use to the unreasonable risk due to non-cancer effects—specifically respiratory and non-respiratory health effects, including reduced pulmonary function, increased asthma prevalence, reduced asthma control, allergy-related conditions, male and female reproductive toxicity, and developmental effects associated with **chronic inhalation** exposures; and
5. EPA is less certain about the contribution from 1 occupational COU to the unreasonable risk of formaldehyde due to nasopharyngeal **cancer** from chronic inhalation exposures.

In this preliminary risk determination, EPA has high level of certainty of the contribution to the unreasonable risk of formaldehyde from a COU when the risk from such COU is much greater than the risk expected from the formaldehyde based on monitored concentrations in the indoor air, and EPA is less certain of the contribution by the COU when the risk from the COU is within the expected risk based on monitored concentrations in the indoor air. In addition, most of the occupational and consumer conditions of use (47 and 7, respectively) contribute to the unreasonable risk due to non-cancer effects, specifically dermal sensitization associated with **acute dermal** exposure, meaning that skin contact can result in an allergic response.

It is important to recognize that this is a draft risk evaluation, and in some cases, EPA's preliminary conclusions reflect uncertainties. Due to the magnitude of available scientific information on formaldehyde coupled with the complex toxicology and exposure profiles for formaldehyde, EPA

acknowledges that the evaluation of formaldehyde hazard and exposure is challenging. The EPA is at a critical point in the development of the risk evaluation, where expert peer review and public input is important. EPA is also seeking peer review and public input on the hazard data as well as, for example, its use of inputs and assumptions in the exposure assessments for consumer and indoor air scenarios, in part to understand if the approach EPA utilized compounds conservative assumptions, leading to unrealistic or un-addressable outcomes. Following the peer review and public comment period, EPA will revise the draft risk evaluation and issue a final evaluation that will include a final determination of whether, under its TSCA conditions of use of use, formaldehyde presents unreasonable risk to health and the environment.

Occupational Conditions of Use that Support the Preliminary Unreasonable Risk Determination

✓ EPA has high level of certainty of the contribution to the unreasonable risk

♦ EPA has less certainty of the contribution to the unreasonable risk

ONU stands for occupational non-user, or someone in a workplace who is not using the chemical but is nearby

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Manufacturing	Domestic Manufacturing	Domestic Manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
	Import	Import	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
Processing	Processing – reactant	Use in adhesives and sealant chemicals	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Use as an intermediate	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Use as a functional fluid	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Processing aids, specific to petroleum production in all other basic chemical manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Processing		Bleaching agent in wood product manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Agricultural chemicals in agriculture, forestry, fishing, and hunting	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
	Processing – incorporation into an article	Finishing agents in textiles, apparel, and leather manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Paint additives and coating additives not described by other categories in transportation equipment manufacturing (including aerospace)	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
			General Population	Inhalation – Ambient Air			
		Additive in rubber product manufacturing	Worker	Dermal			
				Inhalation	✓		
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
		Adhesives and sealant chemicals in wood product manufacturing	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation	✓	✓	
			General Population	Inhalation – Ambient Air			
	Processing – incorporation into formulation, mixture, or reaction product	Petrochemical manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
			Worker	Dermal	✓		

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Processing	Processing – incorporation into formulation, mixture, or reaction product	Asphalt, paving, roofing, and coating materials manufacturing		Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Solvents (which become part of a product formulation or mixture) in paint and coating manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Processing aids, specific to petroleum production	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Paint additives and coating additives not described by other categories	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Processing for use as an intermediate	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Solid separation agents in miscellaneous manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Agricultural chemicals (nonpesticidal)	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Surface active agents in plastic material and resin manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Processing	Processing – incorporation into formulation, mixture, or reaction product		ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Ion exchange agents in adhesive manufacturing and paint and coating manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Lubricant and lubricant additive in adhesive manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Plating agents and surface treating agents in all other chemical product and preparation manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Soap, cleaning compound, and toilet preparation manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Laboratory chemicals	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Adhesive and sealant chemical in adhesive manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		
			General Population	Inhalation – Ambient Air			
		Bleaching agents in textile, apparel, and leather manufacturing	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation	✓		

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Processing			General Population	Inhalation – Ambient Air			
	Repackaging	Sales to distributors for laboratory chemicals	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
	Recyling	Recycling	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
Distribution in Commerce	Distribution in Commerce	Distribution in commerce	Worker	Dermal			
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
			General Population	Inhalation – Ambient Air			
Industrial Use	Non-incorporative activities	Process aid in: Oil and gas drilling, extraction, and support activities; process aid specific to petroleum production, hydraulic fracturing	Worker	Dermal	✓		
				Inhalation		✓	
			ONU	Inhalation		✓	
			General Population	Inhalation – Ambient Air			
		Use in construction	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
			General Population	Inhalation – Ambient Air			
		Oxidizing/reducing agent; processing aids, not otherwise listed	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
			General Population	Inhalation – Ambient Air			
	Industrial products	Paints and coatings; adhesives and sealants; lubricants	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
			General Population	Inhalation – Ambient Air			

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Commercial Use	Furnishing treatment/ care products	Floor coverings; foam seating and bedding products; furniture & furnishings including stone, plaster, cement, glass and ceramic articles; metal articles; or rubber articles; cleaning and furniture care products; leather conditioner; leather tanning, dye, finishing impregnation and care products; textile (fabric) dyes; textile finishing and impregnating/ surface treatment products.	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
	Treatment products	Water treatment products	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
	Treatment/ care products	Laundry and dishwashing products	Worker	Dermal	✓		
				Inhalation			
			ONU	Inhalation			
	Construction, paint, electrical, and metal products	Adhesives and sealants; Paint and coatings	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
	Furnishing treatment/care products	Construction and building materials covering large surface areas, including wood articles; construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
	Electrical products	Machinery, mechanical appliances, electrical/electronic articles; other machinery,	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
Commercial Use		mechanical appliances, electronic/electronic articles					
	Metal products	Construction and building materials covering large surface areas, including metal articles	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
	Automotive and fuel products	Automotive care products; lubricants and greases; fuels and related products	Worker	Dermal	✓		
				Inhalation	✓	✓	♦
			ONU	Inhalation		✓	♦
	Agriculture use products	Lawn and garden products	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
	Outdoor use products	Explosive materials	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
	Packaging, paper, plastic, hobby products	Paper products; plastic and rubber products; toys, playground, and sporting equipment	Worker	Dermal			
				Inhalation			
			ONU	Inhalation			
	Packaging, paper, plastic, hobby products	Arts, crafts, and hobby materials	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation		♦	
	Packaging, paper, plastic, hobby products	Ink, toner, and colorant products; photographic supplies	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			
	Products not described by other codes	Laboratory chemicals	Worker	Dermal	✓		
				Inhalation	✓	✓	
			ONU	Inhalation		✓	
Disposal	Disposal	Disposal	Worker	Dermal	✓		
				Inhalation	✓	♦	
			ONU	Inhalation			

Chemical Life Cycle Stage	Category	Subcategory	Population	Exposure Route[a]	Human Health Effects[b]		
					Acute Non-cancer	Chronic Non-cancer	Cancer
			General Population	Inhalation – Ambient Air			

[a] Only Inhalation exposure routes were assessed for ONUs and General Population. Additionally, General Population inhalation exposure routes were assessed using the ambient air pathway and are labeled to reflect the specific route.
[b] Grayed-out boxes indicate certain exposure routes that were not assessed because it was determined that there was no viable exposure pathway.

Consumer Conditions of Use that Support the Preliminary Unreasonable Risk Determination

✓ EPA has high level of certainty of the contribution to the unreasonable risk
♦ EPA has less certainty of the contribution to the unreasonable risk

Life Cycle Stage	Category	Subcategory	Population[a] [b]	Exposure Route	Human Health Effects[c]	
					Acute Non-cancer	Chronic Non-cancer
Consumer Use	Furnishings treatment/ care products	Floor coverings; foam seating and bedding products; cleaning and furniture care products; furniture & furnishings including stone, plaster, cement, glass and ceramic articles; metal articles; or rubber articles	Consumer	Dermal	✓	
				Inhalation	✓	
			Bystander	Inhalation	✓	
			General Population	Inhalation – Indoor Air		
	Furnishing treatment/ care products	Fabric, textile, and leather products not covered elsewhere (clothing)	Consumer	Dermal		
				Inhalation	✓	
			Bystander	Inhalation	✓	
			General Population	Inhalation – Indoor Air		
	Treatment products	Water treatment products	Consumer	Dermal		
				Inhalation		
			Bystander	Inhalation		
	Treatment/ care products	Laundry and dishwashing products	Consumer	Dermal	✓	
				Inhalation		

Life Cycle Stage	Category	Subcategory	Population[a b]	Exposure Route	Human Health Effects[c]	
					Acute Non-cancer	Chronic Non-cancer
Consumer Use			Bystander	Inhalation		
	Construction, paint, electrical, and metal products	Adhesives and sealants; paint and coatings	Consumer	Dermal	✓	
				Inhalation	✓	♦
			Bystander	Inhalation	✓	
	Construction, paint, electrical, and metal products	Construction and building materials covering large surface areas, including wood articles; construction and building materials covering large surface areas, including paper articles; metal articles; stone, plaster, cement, glass and ceramic articles	Consumer	Dermal	✓	
				Inhalation	✓	
			Bystander	Inhalation	✓	
			General Population	Inhalation – Indoor Air		
	Electrical products	Machinery, mechanical appliances, electrical/ electronic articles; other machinery, mechanical appliances, electronic/ electronic articles	Consumer	Dermal		
				Inhalation		
			Bystander	Inhalation		
	Automotive and fuel products	Automotive care products; lubricants and greases; fuels and related products	Consumer	Dermal	✓	
				Inhalation	✓	
			Bystander	Inhalation	✓	
	Agriculture use products	Lawn and garden products	Consumer	Dermal		
				Inhalation		
			Bystander	Inhalation		
	Packaging, paper, plastic, hobby products	Paper products; plastic and rubber products; toys, playground, and sporting equipment	Consumer	Dermal		
				Inhalation	✓	
			Bystander	Inhalation	✓	
			General Population	Inhalation – Indoor Air		
		Arts, crafts, and hobby materials	Consumer	Dermal	✓	

Life Cycle Stage	Category	Subcategory	Population[a] [b]	Exposure Route	Human Health Effects[c]	
					Acute Non-cancer	Chronic Non-cancer
	Hobby products			Inhalation		♦
			Bystander	Inhalation		
	Packaging, paper, and plastic	Ink, toner, and colorant products; photographic supplies	Consumer	Dermal	✓	
				Inhalation	✓	♦
			Bystander	Inhalation	✓	

[a] Only inhalation exposure routes were assessed for Bystander.
[b] Typically, "Consumer" represents "Adult" or "Youth" age groups; "Bystander" typically represents "Child" and "Infant" age groups. "Infant" represents ages 0–2; "Child" represents ages 3–10; "Youth" represents ages 11–20; and "Adult" represents ages >21.
[c] Grayed-out boxes indicate certain exposure routes that were not assessed because it was determined that there was no viable exposure pathway.

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