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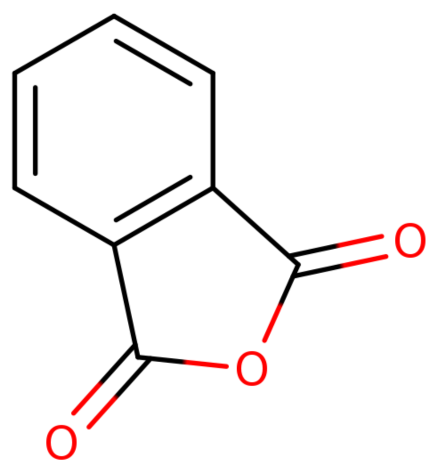
Draft Consumer and Indoor Exposure Assessment for Phthalic Anhydride

Technical Support Document for the Draft Risk Evaluation

CASRN 85-44-9



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KEY ABBREVIATIONS AND ACRONYMS

CASRN	Chemical Abstracts Service Registry Number
CDR	Chemical Data Reporting
CEM	Consumer Exposure Model
CHAD	Consolidated Human Activity Database
COU	Condition of use
DIY	Do-it-yourself
EPA	Environmental Protection Agency (U.S.)
EU	European Union
GHS	Globally Harmonised System
MCCEM	Multi-Chamber Concentration and Exposure Model
NA	Not available
NRC	National Research Council Canada
OCSPP	Office of Chemical Safety and Pollution Prevention (EPA)
OPP	Office of Pesticide Programs (EPA)
OPPT	Office of Pollution Prevention and Toxics (EPA)
POD	Point of departure
PVC	Polyvinyl chloride
SDS	Safety data sheet
TDS	Technical data sheet
TSCA	Toxic Substances Control Act
TWA	Time-weighted average
U.S.	United States
QT	Quantitative consideration
QL	Qualitative consideration
WF	Weight fraction

SUMMARY

Phthalic Anhydride – Consumer Exposure Assessment Summary:
Key Points

EPA evaluated human exposure to phthalic anhydride in consumer products resulting from conditions of use (COUs) as defined under the Toxic Substances Control Act (TSCA). These included liquid products including adhesives, sealants, paints, coatings, and crafting resins.

Exposure Approaches and Methodology Key Points

- The major routes of phthalic anhydride exposure considered were inhalation of spray products and dermal contact with liquid and spray products.
    - Phthalic anhydride is not expected to leach or migrate from solidified crafts, paints, coatings, and adhesives because the chemical is used as a retarder or scorch inhibitor in rubber articles, an inhibitor in paints and coatings, and as a plasticizer in plastics and resins. As such, it is not expected to be present in the final article that consumers would handle, or inhale, or ingest.
- The exposure duration considered was acute. Acute exposures are most relevant because phthalic anhydride rapidly hydrolyzes in the presence of moisture.
- For inhalation exposures, EPA used the Consumer Exposure Model to estimate acute exposures to consumer users and bystanders (Section 2.2).
- Dermal exposures for both liquid and spray products were calculated using dermal loading information from U.S. EPA (1992) (Section 2.3).

Exposure Dose Results Key Points

- Acute dermal – the highest dermal exposure was for large projects spray paints and coatings.
    - Weight fractions and spray product dermal loading inputs were the most sensitive inputs.
- Inhalation – The highest inhalation exposure concentration was for large projects spray paints and coatings.
    - The weight fraction for small project spray paints and coatings was over twice the weight fraction for large projects spray paints and coatings; however, the amount of product used and the duration of use during application was significantly higher for the large project spray paints and coatings. This assists in determining the sensitivity and complexity of each input and relevant contributions to exposures.

This technical support document (TSD) is part of the Toxic Substances Control Act (TSCA) *Draft Risk Evaluation for Phthalic Anhydride* (also called the "draft risk evaluation") (see also public docket, EPA-HQ-OPPT-2018-0459) (U.S. EPA, 2026e). This TSD describes the assessment of consumer and indoor exposures to phthalic anhydride resulting from relevant conditions of use (COUs). Phthalic anhydride, CASRN 85-44-9, is primarily used as a chemical intermediate for the synthesis of phthalate esters. Consumer COUs of phthalic anhydride include use of adhesives and sealants, paints and coatings, and arts, crafts, and hobby materials. EPA conducted a comprehensive information search to identify the relevant COUs for this draft assessment, as discussed in the final scope document for phthalic anhydride (U.S. EPA, 2020b) and Appendix E in the draft risk evaluation (U.S. EPA, 2026e). Table 1-1 lists the consumer COUs that are evaluated in this assessment. Some of the consumer uses also have occupational/commercial applications; the evaluation of exposure for workers can be found in the *Draft Environmental Release and Occupational Exposure Assessment for Phthalic Anhydride* TSD (U.S. EPA, 2026b).

This draft assessment considers human exposure to phthalic anhydride in consumer products and articles resulting from COUs as defined under TSCA. Examples of products containing phthalic anhydride and their variable phthalic anhydride levels are detailed in Section 2.1. The routes of exposures considered were ingestion via mouthing of articles (*e.g.,* cured crafting resins), ingestion of suspended dust, ingestion of settled dust, inhalation of suspended dust and gas phase, and dermal contact.

After consideration of physical and chemical properties of phthalic anhydride and use of the chemical in manufacturing, dermal and inhalation were found to be major routes of exposure from consumer products containing phthalic anhydride. Based on product examples and the manufacturers use instructions in addition to physical and chemical properties, oral exposures are not expected (see Section 1.1.2 for further details). Dermal exposure is possible through direct contact with products during application. See Section 1.1 for a discussion of the exposure routes considered for quantitative and qualitative assessments. The exposure duration considered was acute. Acute exposures are for an exposure duration of 1 day. Phthalic anhydride is classified (Globally Harmonised System [GHS]) in the European Union (EU) as Acute Tox. 4 (H302: Harmful if swallowed). Existing assessments have consistently identified dermal and respiratory sensitization as the most sensitive hazards associated with dermal and inhalation exposure to phthalic anhydride, respectively (Health Canada, 2019; NICNAS, 2013; OECD, 2005). As further discussed in the *Draft Human Health Hazard Assessment for Phthalic Anhydride* TSD *(*U.S. EPA, 2026c*),* skin sensitization is likely only relevant to acute exposures as a single exposure to phthalic anhydride may elicit immunological events during the induction phase of skin sensitization.

For inhalation exposures, EPA used CEM to estimate acute exposures to consumer users and bystanders. For each scenario, low-, medium-, and high-intensity use exposure scenarios were developed in which values for weight fraction, duration of use, frequency of use, and surface area were determined based on reasonably available information (see Section 2.2 for CEM parameterization and input selection). Confidence in the inhalation estimates was robust because most input parameters were based on either product-specific information reported by the manufacturers or CEM defaults and are considered representative of actual product use.

Dermal exposures for both liquid and spray products were calculated using the information from U.S. EPA (1992). See Section 2.3 and the *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* TSD (U.S. EPA, 2026a) for model description, calculations, and inputs. Low-, medium-, and high-intensity use exposure scenarios were developed for each product scenario by varying values for weight fraction and amount of product retained on the skin. Confidence in the dermal exposure estimates were robust for liquid and spray products (see Section 5).

Dermal loading values for spray paints and coatings were generally higher than for non-spray paints and coatings as well as adhesives and sealants. Weight fractions and spray product dermal loadings were the most sensitive inputs. However, when using the same liquid product dermal loading value for non-spray paints and coatings and adhesives and sealants, weight fractions were the most sensitive input driving dermal exposures. For example, the weight fraction value for the high-intensity use exposure scenario for spray paints and coatings was the same as for liquid paints and coatings, 25%. In this case, the product dermal loading was 5 times larger for spray paints; therefore, the dermal exposure was larger for spray paints. Inhalation exposure concentration time-weighted averages (TWA) were calculated for spray application paints and coatings in two scenarios: spray paints and coatings large project (sprayer gun application) and spray paints and coatings small project (spray can application). The 8-hour TWA was representative of large projects exposure duration. The 8-hour TWA results for the large project application range from 0.68 to 2.4 mg/m^3 for users and 0.22 to 1 mg/m^3 for bystanders. EPA used the 8-hour TWA results for the small project application to facilitate subsequent risk calculation using the exposure results from the analysis in this document because the inhalation point of departure (POD) value (used to calculate the margin of exposure [MOE] risk estimates) is based on an 8-hour TWA. The 8-hour TWA exposure concentrations range from 0.44 to 1.1 mg/m^3 for users and from 0.16 to 1.1 mg/m^3 for bystanders. The smallest inhalation exposure TWA concentration was for the spray can paints and coatings application (small project), indicating exposure even at the lowest available product concentrations and exposure durations. While the weight fraction for small project spray paints and coatings was over twice than the weight fraction for large projects spray paints and coatings, the amount of product used and the duration of use during application was significantly higher for the large project spray paints and coatings to result in over twice the exposure concentration over an 8-hour overall TWA exposure.

1 INTRODUCTION

Phthalic anhydride is used as a chemical intermediate in synthetic resins, which are raw materials used to formulate paints, coatings, sealants and adhesives for industrial and consumer markets. It is also used to aid the curing process to form a solid as paint dries and decreases drying times. Uses include a binding agent for paints and adhesives, corrosion inhibitors, and surface treatment agents in several spray paints and a floor polish. It can also be used as an intermediate (as an oxidizing/reducing agent) as an additive in paints and coatings as well as a plasticizer in building/construction materials such as paints and coatings and plastics and resins. Phthalic anhydride rapidly hydrolyzes to *ortho*-phthalic acid (or *o*-phthalic acid) in the presence of water. Exposure to *o*-phthalic acid from consumer products was not evaluated because all products that were quantitatively evaluated (see Section 2.1 and Table 2-2) are oil-based or non-water-based and *o*-phthalic acid is not expected to be present in the final product.

EPA assembled reasonably available information from 2020 and 2024 data reported in the Chemical Data Reporting (CDR) database and consulted a variety of other sources, including published literature, company websites, and government and commercial trade databases to identify consumer products and articles under the defined COUs of phthalic anhydride for inclusion in the draft risk evaluation (Table 1-1). Consumer products and articles were identified and matched to COUs in Section 2.1. Weight fractions of phthalic anhydride in specific items were then gathered from a variety of sources, such as safety data sheets (SDS), databases, and literature-reviewed publications (Section 2.1).

Table 1-1. Consumer Conditions of Use Table

Life Cycle Stage	Category	Subcategory of Use	Reference(s)
Consumer	Adhesives and sealants	N/A	(U.S. EPA, 2020a); EPA- HQ-OPPT-2018-0459-0004; EPA-HQ-OPPT-2018-0459-0022
Consumer	Arts, crafts, and hobby materials	Clear casting resins	Environmental Technology, 2017
Consumer	Paints and coatings	Solvent-based paints	(U.S. EPA, 2024, 2020a)

1.1 Scope of Consumer Exposure Routes in Assessment

Products are consumable liquids, aerosols, or semi-solids that are used a given number of times before they are exhausted. Articles are solids, polymers, foams, metals, or woods, which are present within indoor and outdoor environments for the duration of their useful life, which may be several years. The migration of phthalic anhydride from consumer products and articles is a potential mechanism of exposure. The identified uses can result in exposures to consumers and bystanders (non-product users that are incidentally exposed to the product). The following subsections discuss exposures to consumers from products and articles containing phthalic anhydride and whether migration is expected and which routes (inhalation, ingestion, and dermal) are expected to result in potentially significant exposures.

For all the phthalic anhydride containing consumer products identified, the selection of exposure assessment approaches involves addressing the inherent uncertainties by modeling low-, medium-, and high-intensity use exposure scenarios. Due to the lack of specific reasonably available data on various parameters and the expected variability in exposure routes, EPA used representative inputs and approaches based on representative expected uses to obtain exposure estimates associated with phthalic anhydride across COUs and various age groups. Although some of the inputs are conservative, these are nevertheless considered realistic and representative of estimates of possible high-end exposures. High-, medium-, and low-intensity use exposure scenarios provide a sensitivity analysis with insight on the impact of the main modeling input parameters (*e.g.,* duration of use and frequency of use) in the estimates and risk estimates. See further discussion for each exposure route in the following sections.

1.1.1 Inhalation

Consumer and bystander inhalation exposure to phthalic anhydride is expected to be the most significant route of exposure through the direct inhalation of sprays. Users and bystanders are expected to inhale sprayed products via dispersion while the spray is suspended. The magnitude of inhalation exposure depends upon the concentration of phthalic anhydride in products, use patterns (including frequency, duration, amount of product used, room of use), and product application methods. EPA assumed mists containing phthalic anhydride sprayed from consumer products intake via inhalation is significantly larger, rather than the oral route because the amount of inhaled suspended mist is larger than the amount of ingested mist. Product and article specific considerations are provided in Section 2.1.

For the indoor environment, the potential sources of phthalic anhydride to the indoor air include solid articles or cured/solidified products (*e.g.,* paints and coatings and crafting resins). However, consumer exposure to phthalic anhydride via inhalation from off-gassing or evaporation from products used during do-it-yourself activities or from articles is likely negligible because of phthalic anhydride low vapor pressure (5.17×10^{-4} mmHg) and low volatility (1.70×10^{-8} atm·m^3/mol at 25 °C) (U.S. EPA, 2026d). Additionally, phthalic anhydride is mainly used as an intermediate (consumed in the production steps and not expected in the final product) or as a retarder or scorcher to promote hardening and durability (U.S. EPA, 2020c). As such, it is unlikely to leach or migrate out of the cured adhesives or paints. In summary, dust inhalation exposures are not expected from chemical migration from articles or cured products to dust. Section 4 provides a description and discussion of phthalic anhydride indoor monitoring data which corroborated EPA's qualitative discussion of physical and chemical properties and phthalic anhydride manufacturing, and production uses to conclude negligible dust inhalation exposures.

1.1.2 Oral

Oral exposures generally are possible through transfer of the chemical from hand-to-mouth, incidental ingestion during product use, or mouthing of articles. However, no oral exposure routes for consumers were evaluated for phthalic anhydride because hand-to-mouth transfer is unlikely to occur with do-it-yourself (DIY) products (*i.e.,* adhesives and sealants, paints and coatings, and arts, crafts, and hobby materials) as that would be considered a misuse of the product. Oral ingestion via mouthing of rubber articles or cured products is unlikely because phthalic anhydride is either not expected to be present in the final product or to readily migrate from product/article to saliva. Incidental mouthing from children is also considered a misuse since the identified products (Section 2.1) are not targeted for the age range of children that exhibit mouthing behavior. Mouthing behavior is typically considered for infants to 6-year-old children, as shown in Table 4-1 of U.S. EPA (2011a). Ingestion of phthalic anhydride containing dust is unlikely because migration from rubber articles is not expected to occur (Section 1.1.1). Product and article specific considerations are provided in Section 2.1. In addition, further, assessments by OECD (2005), Australia NICNAS (2013), and Health Canada (2019) have concluded that phthalic anhydride has low systemic toxicity via the oral exposure route. See Section 2.2 in the *Draft Human Health Hazard Assessment for Phthalic Anhydride* (U.S. EPA, 2026c) for a detailed explanation of human sensitization evidence.

1.1.3 Dermal

For products (consumable liquids that are used a given number of times before they are exhausted), dermal exposure may occur via direct contact with liquid products (*e.g.,* paints and adhesive) or contact with mist during use of spray products (*e.g.,* spray paints). Section 2.1 provides a description of liquid and spray product examples that contain phthalic anhydride with likely dermal exposures. Section 2.3 provides a description of the dermal exposure approaches used in this analysis.

For articles (solids that are present for the duration of their useful life), dermal exposure was qualitatively evaluated because migration to skin and sweat from the solid articles is not expected. Phthalic anhydride is not expected to leach or migrate from solidified craft, paint, coating, and adhesive because the chemical is used as a retarder or scorch inhibitor in rubber articles, an inhibitor in paints and coatings, and as a plasticizer plastics and resins (U.S. EPA, 2020c). As such, it is not expected to be present in the final article that consumers handle. Furthermore, phthalic anhydride is likely to remain chemically bonded to the solid matrix and thus not easily leach off a cured product or finished article. Product specific considerations are provided in Section 2.1.

The identified adhesives and sealants products (see Section 2.1.1 for products) SDSs recommend using nitrile gloves and aprons as necessary to prevent skin contact, and do not recommend the use of polyvinyl chloride (PVC), nylon, or cotton skin protective materials. While these recommendations are mainly for occupational settings, consumers that follow SDSs can chose to wear appropriate gloves and skin protective materials. For this assessment, EPA did not include the use of skin protective materials for the calculation of dermal exposures from adhesives and sealants. The identified paints and coatings products (see Section 2.1.3 for products) SDSs did not specify or offer skin protection requirements. As such, for this assessment, EPA did not include the use of skin protective materials for the calculation of dermal exposures from paints and coatings.

2 CONSUMER EXPOSURE APPROACH AND METHODOLOGY

The main steps in performing a consumer exposure assessment are summarized below:

1. Identification and mapping of product and article examples following the consumer COU table (Table 1-1).
2. Compilation of products and articles according to manufacturer's use instructions to determine patterns of use.
3. Selection of exposure routes and exposed populations according to product/article use descriptions.
4. Identification of data gaps and further research to fill gaps with studies, chemical surrogates, or product and article proxies.
5. Selection of appropriate modeling tools based on available information and chemical properties.
6. Gathering of input parameters per exposure scenario.
7. Parameterization of selected modeling tools and generation of exposure estimates for the relevant scenarios, and routes.
8. Evaluation of strengths and limitations and sources of uncertainty for selected inputs and approaches individually in conjunction with confidence in exposure estimate results for subsequent risk characterization.

Consumer products and articles containing phthalic anhydride were matched with COUs appropriate for the anticipated use of the item. Table 2-2 summarizes the consumer exposure scenarios by COU for each product example(s), the relevant exposure routes, and whether the analysis was done qualitatively or quantitatively. A qualitative analysis discussed exposure potential based on physical and chemical properties or monitoring data, if available, but exposure was not quantified. A quantitative analysis was conducted when the exposure route was deemed relevant based on product or article use description and there was sufficient data to parameterize the model. In a quantitative analysis, exposure from the consumer COUs was estimated by modeling. Each product or article was individually assessed to determine whether all or some exposure routes were applicable, and approaches were developed accordingly.

Exposure via inhalation routes were modeled using EPA's CEM Version 3.2 (U.S. EPA, 2023). For a detailed description of inhalation approaches, rationale for analyses conducted in CEM, and consumer-specific inhalation parameters and assumptions for exposure estimates, refer to Section 2.2. Dermal exposure to phthalic anhydride-containing consumer products was carried out using the information from U.S. EPA (1992). For a detailed description of dermal approaches and consumer-specific dermal parameters and assumptions for exposure estimates, refer to Section 2.3.

EPA used a low (minimum), average (of the reported minimum and maximum), and a high (maximum) value of critical input parameters (*e.g.,* duration of use, mass of product used, and weight fractions) where possible to characterize low, medium, and high route-specific exposures for each given condition of use. All inputs, sources of information, assumptions, and exposure scenario descriptions are available in the *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a).

EPA assessed acute exposures to phthalic anhydride from consumer COUs because the inhalation and dermal PODs used to characterize risk are inhalation and dermal sensitization, and these hazards are most relevant to acute exposures, as a single exposure to phthalic anhydride may elicit immunological events during the induction phase of sensitization (U.S. EPA, 2026c). For acute exposures, the estimated exposure is for a given day and represents the maximum 8-hour TWA over a 24-hour period in which the exposure event occurred. The 8-hour TWA was used because the inhalation POD estimate is based on an 8-hour TWA and to best align the inputs that will be used in the calculation of risk estimates. Product use descriptions from product TDSs and labels were used to estimate number of events per day.

2.1 Content of Phthalic Anhydride in Products and Exposure Routes Assessment

The preferred data sources for phthalic anhydride content in U.S. consumer goods were SDSs for specific products or articles with reported phthalic anhydride content, peer-reviewed literature providing measurements of phthalic anhydride in consumer goods purchased in the United States, and government reports originated in the United States with manufacturer reported concentrations. Phthalic anhydride weight fractions reported in the CDR database were not used in this consumer exposure analysis as it was unclear whether the weight fractions pertained to phthalic anhydride as an intermediate or in finished goods.

EPA further evaluated the products and articles identified to ensure that data represented items currently available to U.S. consumers. Where possible, SDSs were cross-checked with company websites to ensure that each product could reasonably be purchased by consumers. In instances where a product or article could not be purchased by a consumer, EPA did not evaluate the item in a DIY or application scenario but did determine whether consumers might reasonably be exposed to the specific item as part of a purchased good, including homes and automobiles.

In addition to phthalic anhydride weight fractions, EPA obtained additional information about physical characteristics and potential uses of specific products and articles from technical specifications, manufacturer websites, and vendor websites. The product use information, along with physical and chemical properties and manufacturing processes (see Section 1.1), were used to determine which routes presented a higher exposure potential. Some exposure routes were qualitatively assessed due to low expected exposures whereas other exposure routes were quantitatively assessed for consumer exposures due to high expected exposures. Products with similar phthalic anhydride content and expected use patterns were grouped together for modeling. These data were used in the assessment to define exposure scenarios. See the *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a) for product and article searches and comments. The following section provides a summary of specific products and articles with phthalic anhydride content identified for each item. Product weight fractions and exposure routes are described further in Sections 2.1.1 (Adhesives and Sealants), 2.1.2 (Clear Casting Resins), and 2.1.3 (Paints and Coatings), and summarized in Table 2-1. See Table 2-2 for a summary of exposure scenarios by product and routes of exposure qualitatively and quantitatively assessed.

Non-spray products were not assessed for inhalation exposure due to unlikely emissions to air to occur ((low vapor pressure (5.17×10^{-4} mmHg) and low volatility (1.70×10^{-8} atm·m^3/mol at 25 °C)) or short application uses ((*e.g.,* adhesives with short working times (less than a few minutes) until solidification)), and/or products used in outdoor conditions where air exchange rates are high, and product application is not expected to generate aerosols.

2.1.1 Adhesives and Sealants

Three adhesive products and their SDSs for home repair or construction bonding were identified with phthalic anhydride content and grouped into the same exposure scenario because their weight fractions, application description, and use patterns are similar. One adhesive, LOCTITE ® 426, was described as a black, gel viscosity, rubber-toughened, instant adhesive with a fixture time of 20 seconds and suitable for use on metals, elastomers, and plastics—especially where 0.05 mm bond gaps are present. The gap size coverage of 0.05 mm and the available product size for purchase of 20 g or 0.70 oz indicate that the surface area coverage is not larger than 1 m^2. The reported phthalic anhydride content was provided as a range of 0.1 to 1% (Henkel, 2025). The second adhesive, LOCTITE® 435, was described as a clear, toughened, low-viscosity (medical device grade) instant adhesive and suitable for bonding plastics, rubber, metals, magnets, porous and absorbent substrates, and acidic surfaces. The weight fraction and bond gap coverage are also 0.1 to 1% and 0.05 mm (Henkel, 2025; RS Hughes, 2019). The third adhesive, LOCTITE® 4105, was described as a black, rubber-toughened, ethyl cyanoacrylate-based instant adhesive with increased flexibility and peel strength, ideal for bonding metals, plastics, and rubbers. Product application, bond gap, and weight fraction are the same as the previous two adhesives (Henkel, 2023; Quality Bearings Online, 2019). The weight fraction range of phthalic anhydride reported for all three products was the same (0.1–1%).

In addition, to the three adhesives above, EPA included consumer use of certain specialty products that contain phthalic anhydride in amounts above 1% such as in two-part electronic encapsulant adhesives (Epoxy Technology, 2020). In two-part adhesives, phthalic anhydride is used to trigger polymerization when consumers mix a hardener containing 1 to 5% phthalic anhydride (Part A) with a separate resin material (Part B) to create a solid, durable material (Epoxy Technology, 2020). EPA used the reported weight fraction range of 1 to 5% to represent these specialty adhesive products.

Weight fractions of 0.1, 1.2, and 5% (representing the minimum, average of the midpoints, and maximum of the range) were chosen to represent the low-, medium-, and high-intensity exposure scenarios, respectively. See Table 2-1 for a summary of the reported weight fractions per product and weight fractions used in this assessment. However, due to the niche use of the epoxy product EPA also provided a sensitivity analysis that considers the highest weight fraction from the three Henkel adhesives, 1%, which is also the lowest weight fraction reported by the epoxy SDS. See Section 3.2 for details.

Inhalation exposures are not expected because the small amount of product used, and small surface product coverage area (bond gap) is not expected to result in significant gas-phase emissions in addition to phthalic anhydride low volatility and vapor pressure (Section 1.1.1). These products were grouped and modeled for dermal exposure only under the adhesives and sealants for small projects scenario.

2.1.2 Clear Casting Resins

One crafting casting resin product example and its associated SDSs from three different years were identified (Environmental Technology, 2020, 2019, 2017). The three identified SDSs provide information that indicates phthalic anhydride may be getting phased out of formulation. The 2017 SDS states that phthalic anhydride is in the product; the 2019 SDS does not list phthalic anhydride; and the 2020 SDS included a non-specific chemical name, benzenedicarboxylic acid derivative, that may or may not be inclusive of phthalic anhydride. Because past confirmation of phthalic anhydride in this product—of which EPA believes is likely to have ongoing continued use—coupled with inconclusive information from the most recent SDS about the inclusion of phthalic anhydride in the current formulation, EPA included an assessment (qualitative assessment) of this product and COU. EPA is requesting information during the public comment period related to crafting resin products current composition and use patterns. If received, this may impact this exposures assessment under this COU in the final risk evaluation.

The clear casting resin is used to embed or encase objects in crystal clear plastic. Examples of encapsulation possibilities are coins, shells, rocks, dried flowers, insects, paper, and photographs. The reported phthalic anhydride concentration for this product was 35% (Environmental Technology, 2017). The Castin' Craft Casting Resin use instructions (Environmental Technology, 2012) mentions that the resin is mixed with a catalyst, and the mixture is then transferred to a mold to cure for 24 hours or until solid. The instructions recommend minimal movement once the mixture is curing and a ventilated location with a temperature between 21 and 25 °C. The SDS recommended no skin contact among all the warnings. EPA assumes that mixing and pouring is done in a manner that avoids dermal contact entirely. As such, dermal exposure while mixing and curing was not evaluated. Inhalation exposure from off-gassing or evaporation from products or from articles is unlikely because of the low vapor pressure (5.17×10^{-4} mmHg) and volatility (1.70×10^{-8} atm·m^3/mol at 25 °C) (Section 1.1.1). In summary, this product and article (cured product) were qualitatively assessed because of very low exposure potential.

2.1.3 Paints and Coatings

Four products for painting and coating wooden or metal surfaces and their SDSs were identified and grouped in two exposure scenarios: (1) spray paints and coatings and (2) non-spray paints and coatings. The spray paints and coatings scenario was assessed for dermal and inhalation exposures. Users and bystanders are expected to inhale sprayed products via dispersion while the spray is suspended (Section 1.1.1), while dermal exposures may occur via suspended spray deposition on skin and via direct skin contact during wiping, cleaning, and application of the product on a surface (Section 1.1.3). The non-spray paints and coatings scenario was assessed for dermal exposures only. Consumer exposure to phthalic anhydride via inhalation from off-gassing or evaporation from products used during DIY activities or from articles is unlikely. Gas-phase inhalation exposures are expected to be negligible because of low vapor pressure (5.17×10^{-4} mmHg) and low volatility (1.70×10^{-8} atm·m^3/mol at 25 °C) (Section 1.1.1).

Three products have non-spray application descriptions and are available in one quarter gallon (0.95 L), 1 gallon (3.8 L) and larger volume containers (5 gallon). Junckers clear rustic oil (Junckers Industries A/S, 2023) was described as a hardening urethane oil in paraffinic solvent use to coat wooden surfaces like flooring. The product is available in several sizes ranging from 0.75 to 25 L, which confirms the application on small and large surfaces such as furniture and entire house flooring. The manufacturer use instructions in the technical safety sheet (TSD) (Junckers Industries A/S, 2024) recommend dividing the work into small areas, which can be oiled in 30 minutes. A second coat is recommended and can be applied after 30 minutes while it is still wet. It is also recommended to wipe off the excess oil to obtain a uniform coverage. The SDS reported phthalic anhydride content was provided as a range of 0.1 to less than 0.25% (Junckers Industries A/S, 2023). This product was not confirmed as a spray application and thus was only assessed for dermal exposures during the application in the liquid (non-spray) paints and coatings exposure scenario.

A second product, a T.O.V. Marine Clear Spar Varnish, was described as an oil-based product used to restore wood surfaces such as cabinets and countertops to protect from sun and water damage. The product is available in 1-gallon cans that can cover 400 ft^2 and need two coats and 4 hours between coats. The suggested application method is via brush or rollers as specified in the T.O.V. Marine Clear Spar Varnish product TDS (Harris Paints, 2017b). The concentration was reported in the SDS as a range of 10 to 25% by weight (Harris Paints, 2025b). A third product, Harris Paints Co. Metal Primer Red, was described as an oil-based primer to resist corrosion and rust, fast-drying to the touch in 45 minutes, and ready for the second coat in 4 hours. Per the TDS, this primer is designed for application on exterior metal surfaces but also can be used in interior metal surfaces; the suggested application method is via brush, rollers, or sprayer (Harris Paints, 2017a). The concentration was reported in the SDS as a range of 1 to 10% by weight (Harris Paints, 2025a). These two products, T.O.V Marine Clear Spar Varnish and Metal Primer Red, are grouped with Junckers clear rustic oil (total of 3 products) varnish in a non-spray and liquid-based paints and coatings dermal exposure scenario (Table 2-1). For the low- and high-intensity use exposure scenarios EPA used the lowest value and the highest value across the range of weight fractions reported for all three products, respectively. For the medium-intensity use exposure scenario EPA used the average of the midpoints for each reported range. The weight fractions used in modeling were 0.1, 7.7, and 25% for the low-, medium-, and high-intensity use exposure scenarios, respectively.

One Harris Paints Co. T.O.V. varnish product is available in 11-ounce spray cans. This oil-based product has an acrylic polyurethane formula, with a 5-minute drying time to promote water resistance and a high-gloss finish. It can be used on brick, concrete, galvanized metal, metal, and wood. The concentration was reported in the SDS as a range of 10 to 25% by weight (Harris Paints, 2025c). This product was assessed for dermal and inhalation exposures. For dermal exposure, EPA grouped this product in the spray paints and coatings scenario with Harris Paints Co. Metal Primer Red. For inhalation exposure, EPA assessed this spray can product separately from other spray products because the applications, use patterns, and weight fractions were different. One of Harris Paints Co. products, Metal Primer Red, can be applied with a spray gun and is not sold in spray cans. Application with a spray gun is typically for larger projects, using more mass of product and taking longer to complete. EPA assessed inhalation exposures to spray paints in two scenarios: (1) spray paints and coatings for small projects, spray can application; and (2) spray paints and coatings for large projects, spray gun application (see Table 2-1 for grouping).

Table 2-1 provides a summary of the weight fractions for each COU and product, exposure routes, and the weight fractions used in the modeling for low-, medium-, and high-intensity use exposure scenarios.

Table 2-1. Weight Fractions Reported and Used in Modeling

Consumer COU and Subcategory [a]	Product Example	Weight Fraction Reported Range (%)	Exposure Route and Scenario	Weight Fraction Used in Modeling (%)		
				Low [b]	Med [b]	High [b]
Adhesives and sealants	Loctite 426 Instant Adhesive	0.1–1	Dermal, adhesives and sealants for small projects	0.1	1.2	5
Adhesives and sealants	Loctite 435 Rubber Tough	0.1–1	Dermal, adhesives and sealants for small projects	0.1	1.2	5
Adhesives and sealants	Loctite 4105	0.1–1	Dermal, adhesives and sealants for small projects	0.1	1.2	5
Adhesives and sealants	Epoxy specialty adhesive	1–5	Dermal, adhesives and sealants for small projects	0.1	1.2	5
Paints and coatings; Solvent-based paints	Harris Metal Primer Red	1–10	Dermal, spray paints and coatings	1	11.5	25
Paints and coatings; Solvent-based paints	Harris T.O.V. Varnish	10–25	Dermal, spray paints and coatings	1	11.5	25
Paints and coatings; Solvent-based paints	Harris Metal Primer Red	1–10	Dermal, liquid paints and coatings	0.1	7.7	25
Paints and coatings; Solvent-based paints	Harris T.O.V. Marine clear spar varnish	10–25	Dermal, liquid paints and coatings	0.1	7.7	25
Paints and coatings; Solvent-based paints	Junckers Rustic Oil, Clear	0.1–0.25	Dermal, liquid paints and coatings	0.1	7.7	25
Paints and coatings; Solvent-based paints	Harris T.O.V. Varnish	10–25	Inhalation, spray paints and coatings for small projects, spray can application	10	17.5	25
Paints and coatings; Solvent-based paints	Harris Metal Primer Red	1–10	Inhalation, spray paints and coatings for large projects, spray gun application	1	5.5	10

[a] Clear casting resins were not assessed for dermal exposures because the manufacturer use instructions indicated no

Consumer COU and Subcategory [a]	Product Example	Weight Fraction Reported Range (%)	Exposure Route and Scenario	Weight Fraction Used in Modeling (%)		
				Low [b]	Med [b]	High [b]
dermal contact. Also, inhalation exposures were not assessed because of the small surface area of the solidified craft and low volatility and vapor pressure of phthalic anhydride. [b] Low-, medium- (Med), and high-intensity use exposure scenarios. EPA used the minimum value, and the maximum value across all weight fraction ranges reported for the low- and high-intensity use exposure scenarios, respectively. For the medium-intensity use exposure scenario EPA calculated the midpoint of each range and used that value when only one range was used per scenario and the average of the midpoints when more than 1 range was reported.						

Table 2-2 provides a summary of COUs determined for each item and exposure routes modeled.

Table 2-2. Summary of Consumer COUs, Exposure Scenarios, and Exposure Routes

Consumer Condition of Use Category	Consumer Condition of Use Subcategory	Product/Article	Exposure Scenario and Route	Evaluated Routes				
						Ingestion		
				Inhalation[a]	Dermal	Suspended Dust	Settled Dust	Mouthing
Adhesives and sealants	NA	Adhesive for small DIY projects	Direct contact during use	*QL*	**QT**	*QL*	*QL*	*QL*
Arts, crafts, and hobby materials	Clear casting resins	Castin' Craft Casting Resin DIY	Dermal, inhalation, and ingestion exposures are not expected	*QL*	*QL*	*QL*	*QL*	*QL*
Arts, crafts, and hobby materials	Clear casting resins	Castin' Craft Casting Resin cured	Direct contact with cured solid for subsequent craft (*e.g.,* painting)	*QL*	*QL*	*QL*	*QL*	*QL*
Paints and coatings	Solvent-based paints	Liquid paints and coatings (brush application)	Use of product in DIY home repair and hobby activities. Direct contact during use.	*QL*	**QT**	*QL*	*QL*	*QL*
Paints and coatings	Solvent-based paints	Spray paints and coatings small project (aerosol can application)	Use of product in DIY home repair and hobby activities. Direct contact during use; inhalation of emissions during use of sprays	**QT**	**QT**	*QL*	*QL*	*QL*
Paints and coatings	Solvent-based paints	Spray paints and coatings large project (sprayer gun application)	Use of product in DIY home repair and hobby activities. Direct contact during use; inhalation of emissions during use of sprays	**QT**	**QT**	*QL*	*QL*	*QL*

DIY= do-it-yourself
[a] Inhalation scenario considered suspended product aerosol spray
QT = Quantitative consideration
QL = Qualitative consideration

2.2 Inhalation Modeling for Products Approaches

The CEM Version 3.2 (U.S. EPA, 2023) was selected for the consumer exposure modeling as the most appropriate model based on the type of input data available for phthalic anhydride-containing consumer products. The advantages of using CEM to assess exposures to consumers and bystanders are as follows, CEM:

- has been peer-reviewed (ERG, 2016);
- accommodates the distinct inputs available for the products and articles containing phthalic anhydride, such as weight fractions, product density, room of use, frequency and duration of use, see Section 2.2.1 for specific product and article scenario inputs;
- uses the same calculation engine to compute indoor air concentrations as the higher-tier Multi-Chamber Concentration and Exposure Model (MCCEM) but does not require measured chamber emission values (which are not available for phthalic anhydride); and
- allows for calculation of inhalation exposure for product users in close proximity to products.
- has capabilities to model exposure to phthalic anhydride from both products and articles containing the chemical.

For this draft assessment, CEM Version 3.2 estimates acute TWA rates for inhalation exposures of consumer spray products; acute exposures are for an 8-hour TWA.

CEM's estimated emission rates are used in a deterministic mass balance model to calculate indoor air concentrations. CEM employs different models for products and articles. For products, CEM Version 3.2 uses a two-zone representation of the building of use when predicting indoor air concentrations. Zone 1 represents the room where the consumer product is used. Zone 2 represents the remainder of the building. Each zone is considered well-mixed. The model allows for further division of Zone 1 into a near-field and far-field component to accommodate situations where a higher concentration of product is expected very near the product user during the period of use. Zone 1 near-field represents the breathing zone of the user at the location of the product use, while Zone 1 far-field represents the remainder of the Zone 1 room. The modeled concentrations in the two zones are a function of the time-varying emission rate in Zone 1, the volumes of Zones 1 and 2, the air flows between each zone and outdoor air, and the air flows between the two zones. Following product use, the user and bystander may follow one of three pre-defined activity patterns: full time worker, part time worker, and stay-at-home. The activity use pattern determines which zone is relevant for the user and bystander and the duration of the exposures. The user and bystander inhale airborne concentrations within these zones, which can vary over time, resulting in the overall estimated exposure for each individual. The stay-at-home activity pattern was selected for this assessment for all scenarios as the behavior pattern that provides upper bound exposures. Using the stay-at-home activity pattern results in an upper bound inhalation exposure concentration. For a sensitivity analysis using the CEM full-time worker activity pattern see Section 4.3.3 in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e). The full-time worker activity patterns provides a lower-bound inhalation exposure concentration.

EPA calculated 8-hour TWA for inhalation exposures to spray paints because it aligns with the POD which was based on 8-hour TWA information. For the 8-hour TWA, CEM generates a time series of exposure point concentrations. This time series is created by combining the time series of raw concentrations in each zone from the differential equation solver with the activity pattern data so that the exposure point concentration time series contains concentrations experienced by the exposed person in the zone they are present at each time step of the modeled period. A series of rolling average across the exposure point concentration time series is computed for each exposed person. In this assessment the exposures to users occur during product application using the near-field calculations and for bystanders using the stay-at-home and full-time worker activity patterns from zone 1 and 2 calculations. Product application durations are shorter than the 8-hour TWA period, as such EPA expects some dilution of the inhalable phthalic anhydride concentrations during periods when the product is not applied. Thus, the 8-hour TWA exposures calculated for this assessment are expected to be lower than when considering exposure only during the duration of product application.

CEM default air exchange rates for the building are from the *Exposure Factors Handbook* (U.S. EPA, 2011b). The default interzonal air flows are a function of the overall air exchange and volume of the building as well as the openness of the room, which is characterized in a regression approach for closed rooms and open rooms (U.S. EPA, 2023). See Section 2.2.1 for product scenario specific selections of environment such as living room versus whole house, or indoor versus outdoor and the air exchange rate used per environment selection. Kitchens, living rooms, and the garage area are considered more open, with an interzonal ventilation rate of 109 m^3/hour. Bedrooms, bathrooms, laundry rooms, and utility rooms are considered less open, and an interzonal ventilation rate of 107 m^3/hour is applied. In instances where the whole house is selected as the room of use, the entire building is considered zone 1, and the interzonal ventilation rate is therefore equal to the negligible value of 1×10^{-30} m^3/hour. In instances where a product might be used in several rooms of the house, air exchange rate was considered in the room of use to ensure that effects of ventilation were captured.

2.2.1 CEM Modeling Inputs and Parameterization

The COUs that were evaluated for inhalation exposure of phthalic anhydride consisted of spray products. The embedded models within CEM Version 3.2 that were used for phthalic anhydride are listed in Table 2-3.

Table 2-3. CEM Version 3.2 Model Codes and Descriptions

Model Code	Description
E3	Emission from Product Sprayed
PINH1	Calculation of Inhalation TWA from Product Usage: Well-mixed Room
P_INH2	Calculation of Inhalation TWA from Product Usage: Near-field Option

Table 2-4 presents a crosswalk between the COU subcategories with either a predefined or generic scenario. Models were generated to reflect specific use conditions as well as physical and chemical properties of identified products. In some cases, one COU was mapped to multiple scenarios, and in other cases one scenario was mapped to multiple COUs. Table 2-4 provides data on emissions models and exposure routes modeled for each exposure scenario. Emissions models were selected based upon physical and chemical properties of the product and application use method for products. Exposure routes were selected to reflect the anticipated use of each product.

Table 2-4. Crosswalk of COU Subcategories, CEM Version 3.2 Scenarios, and Relevant CEM Models Used for Consumer Modeling

Consumer COU	Sub COU	Product	Emission Model and Exposure Route(s)	CEM Saved Analysis
Paints and coatings	Solvent-based paints	Spray paints and coatings for large projects (spray gun application)	Generic E3, inhalation	E3, P_INH2 (Near-field, users), P_INH1 (bystanders)
Paints and coatings	Solvent-based paints	Spray paints and coatings for small projects (spray can application)	Generic E3, inhalation	E3, P_INH2 (Near-field, users), P_INH1 (bystanders)

In total, the specific products representing three COUs for phthalic anhydride were mapped to six exposure scenarios (Table 2-2). One of the COUs was modeled in CEM for inhalation exposures in two exposure scenarios: spray paints and coatings for small projects and spray paints and coatings for large projects. Relevant consumer behavioral pattern data*,* use patterns) and product-specific characteristics were applied to each of the CEM scenarios and are summarized in Section 2.2.1.1.

2.2.1.1 Key Parameters for Spray Products Modeled in CEM

CEM was used to evaluate inhalation exposures of products with spray applications. Only the Paints and coatings COU had products with spray applications.

High concentrations of phthalic anhydride in air increase inhalation exposure. This may occur due to product formulation or use patterns that allow for higher emissions of phthalic anhydride to air and/or environment specific characteristics such as smaller room volume and lower ventilation rates. Key parameters that control phthalic anhydride emission rates from products in CEM Version 3.2 models are weight fraction of phthalic anhydride in the formulation, duration of product use, mass of product used, and frequency of use. Any increase in these parameters results in higher chemical exposure from product use.

CEM default values for key parameters including product mass used, duration of use, and frequency of use are product/article specific. For example, the same paint product can be used for a small piece of furniture or for the entirety of a house's wooden floors. As such, values for these parameters were based on manufacturer use instructions for product mass for duration of use and frequency. See *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a) for product research. This information was synthesized to better understand how consumers use these products and was applied to develop specific values expected to capture a realistic range of values for each parameter. Product densities were taken from product specific technical specifications and SDS sheets when possible. In instances where no data were available for a product type, a density obtained for a similar product was used as a proxy. For example, only one paint product SDS reported a density range of 0.87 to 1 g/cm^3 (Junckers Industries A/S, 2023). EPA used the average of the range, 0.935 g/cm^3, as a proxy for all paints and coatings. A detailed description of derivations of key parameter values used in CEM Version 3.2 models for liquid and paste products is provided below, and a summary of values be found in Table 2-5.

Amount of Product Used

Several products were identified that may be used in a wide variety of DIY home improvement and repair projects (Section 2.1). For these products, the mass of product applied in each scenario was based on the reasonable assumption that the volume in which products are sold is adequate for the tasks they are intended for. Mass of product used was based on product use descriptions provided on manufacturers' or sellers' websites. See General Inputs Tab in *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a). This section summarizes the identified information for each product.

For the small paints and coatings spray application scenario, only one product was identified and sold in 11-ounce cans (Harris Paints, 2025c). The high-intensity use exposure scenario assumed that the entire container was used. For the medium- and low-intensity use scenarios it was assumed that half (5.5 oz) and a quarter (2.75 oz) of the entire container were used, respectively. The total mass of product used (assuming 2 coats of product) were 76, 152, and 304 g for the low-, medium-, and high-intensity use exposure scenarios, respectively. The mass of product in grams was obtained using the ounces to cm^3 conversion factor of 29.57 cm^3/oz and product density, 0.935 g/cm^3.

For the large paints and coatings spray application scenario, one product was identified to potentially be applied with a sprayer gun (Harris Paints, 2025a). The largest available container volume was a 1-gallon can. For this product, the high-intensity use exposure scenario assumed that the entire 1-gallon container was used. For the medium- and low-intensity use scenarios it was assumed half of the 1-gallon can and a quarter of the 1-gallon can were used respectively. This approach is consistent with observations of consumer reviews for individual products on vendor websites, which indicated diverse usage patterns among consumers including small, medium, and large projects.

For the large paints and coatings spray application exposure scenario, a floor or wooden surfaces refinishing simulation was used. Consumer reviews and technical specifications did not indicate that these products are often used for small repair or patching projects. A more specific scenario was developed in which a total of one room was assumed to be refinished. The room was assumed to be 50 m^3 (CEM default value for living room), with a square footage of approximately 200 ft^2. Technical specifications for these products indicated that each gallon of product would cover between 350 to 400 ft^2 per gallon, depending upon floor conditions, and application of two coats was recommended. Assuming two coats and that the 1-gallon container product coverage is 400 ft^2 the selected room specifications can be covered with one container. Based on this information, the total mass of product used (assuming 2 coats of product) was 885, 1770, and 3539 grams for the low-, medium-, and high-intensity use exposure scenarios, covering 100 ft^2 (1/4 of the square footage of the floor of the room, 2 coats), 200 ft^2 (1/2 the floor of the room, 2 coats), 400 ft^2 (2 coats on the full floor of the room), respectively. The mass of product in grams was obtained using the gallon to cm^3 conversion factor of 3785.41 cm^3/gal and product density, 0.935 g/cm^3.

Duration of Use

For large paints and coatings spray application exposure scenario, EPA reviewed public forums dedicated to Do-It-Yourself home renovation projects and determined that most consumers spend between 30 minutes and 1 hour applying each coat when refinishing floors. Refer to the Product Research tab in U.S. EPA (2026a). EPA assumed that mixing and product preparation for spray applications takes approximately 30 minutes for each coat, this activity includes spraying the product to prime the sprayer and adjusting the sprayer nozzle to the desired setting. The removal of product excess after application was recommended in the product use instructions by the manufacturer (Harris Paints, 2017a). After application the user is expected to examine the surface of the applied paint and spray more to even and smooth the surface. Once the work is done, the user is expected to empty the sprayer tubing and reservoir via spraying. EPA assumed that touchups after the application and excess of product removal after each applied coat takes approximately 45 minutes. Based on this information, the total time to apply 2 coats plus additional time for preparation of the product (*e.g.,* mixing and removing excess product with a rag after application) was estimated to be 270 minutes for the high-intensity use exposure scenario. For the low- and medium-intensity use exposure scenarios, EPA scaled the duration of use from the high intensity use duration to include 30 to 60 minutes of spraying for each coat, preparation prior application in less than 30 minutes, and post-application touchups and cleaning in less than 45 minutes for two coats using less product. While the selected durations of use for the low- and medium-intensity use exposure scenarios, 90 and 120 minutes, are not specifically broken down by discrete times like the high-intensity use scenario, they are representative of expected application durations. To understand the impact of duration of product use on the overall exposures, EPA performed a sensitivity analysis using a shorter exposure duration of 30 minutes while all other inputs remain the same as those used in the low-intensity use exposure scenario and another 30-minute scenario scaling down the amount of product used. This sensitivity analysis provides a wider resolution at the lower bound of the exposure range. See Table 3-1 for exposure concentrations and Section 4.3.3 for risk estimates in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e) for further details of the sensitivity analysis. Some products may result in relatively higher and shorter-lived exposure concentrations during use. For this product, an average time of less than 24 hours seemed appropriate. A per event average of an 8-hour TWA was considered for the large project paints and coatings sprayer application. This means that while the total duration of product use during application was 90, 120, and 270 minutes of intermittent use, the overall project was performed during an 8-hour period. The use of the 8-hour TWA exposure estimate is in alignment with the inhalation POD that is based on an 8-hour estimate.

The small paints and coatings spray application products are expected to be used in comparatively smaller scale projects and were thus modeled at use durations of 5, 10, and 15 minutes in the low-, medium-, and high-intensity use scenarios. The duration of use selected time values agree with the total volume use for one spray can. For the small project paints and coatings, EPA used the estimated high, medium-, and low-intensity use exposures for an overall project duration of 8-hour TWA inhalation exposure concentrations. This means that while the total duration of product use during application was 5, 10, and 15 minutes of intermittent use, the overall project was performed during an 8-hour period. The use of the 8-hour TWA exposure estimate is in alignment with the inhalation POD that is based on an 8-hour estimate.

Frequency of Use

For large paints and coatings spray application products, the frequency is not anticipated to be routine because of the large level of work required to prepare and clean up after each use, as well as the relatively niche purposes. The one room was also assumed to be finished in a single day. Small paints and coatings spray application projects were assumed to be finalized the same day. EPA assumed 2 events per day to consider painting either multiple items or the same item from various angles. For example, a wooden door can be painted on one side first and then the other side, resulting in 2 events.

Environmental Parameters

The room of use selected for modeling affects the time occupants spend in the environment while products are actively being sprayed, the total volume of air in the room, and ventilation rates. Default values are provided in CEM for use environment and ventilation rates in each room, but these may be modified by the user. Time spent in each environment is defined by activity patterns as described in Section 2.2 and cannot be modified for individual environments within CEM. As such, it is sometimes required to select an environment of use based on the activity pattern required and modify the environmental parameters to reflect conditions in the home in which a product is expected to be used.

For this assessment, EPA used the CEM stay-at-home and full-time worker activity patterns summarized in Table_Apx A-1. The stay-at-home activity pattern results represent a bystander upper bound inhalation exposure concentration, and the full-time worker activity pattern represents a bystander lower bound inhalation exposure concentration. For a sensitivity analysis using the CEM full-time worker activity pattern see Table 3-1 for exposure concentrations and Section 4.3.3 for risk estimates in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e). The stay-at-home activity pattern assumes that occupants are inside the home for a total of 21 hours per day, in an automobile 1 hour per day, and outside 2 hours per day. Of the hours spent in the home, 10 hours are spent in the bedroom, 7 hours are spent in the living room, 2 hours are spent in the kitchen, and 1 hour is spent in both the utility room and bathroom. However, normal activity patterns can be overridden by the selected duration and room of product used; and any age group selected as a user remains in zone 1 (or near-field if specified) for the duration of product use.

Table_Apx A-1 provides the time spent in the room of product application for the assessment of user exposures and the time spent in the vicinity of the room of application for bystander exposures. In this assessment, the small project (aerosol can application) scenario was modeled using CEM defaults for all parameters in the specified room of use, garage. The garage is an appropriate environment for spraying small (*e.g.,* picture frames) and medium-sized (*e.g.,* doors, furniture) items that can be easily removed from the interior of the home and sprayed in the garage. However, for the large project (sprayer gun) scenario, the garage environment was used in lieu of the living room because CEM activity patterns for garages do not include additional time other than the time spent applying the product. The living room environment in CEM default spent time includes additional time in the room than product application. This was chosen to reflect the fact that occupants are not expected to spend time in rooms with recently refinished floors outside of time spent actively applying the products. For this model, room volume and ventilation rates were changed from CEM default values for a garage to CEM default values for a living room as shown in Table 2-5 below.

Table 2-5. Summary of Key Parameters for Products Modeled in CEM Version 3.2

Product	Exposure Scenario Level	Weight Fraction [a]	Density (g/cm^3) [b]	Duration of Use (min) [c]	Product Mass Used (g) [d]	Acute Freq. of Use (day^{-1})	Use Environ. Volume (m^3) [e]	Air Exchange Rate, Zone 1 and Zone 2 (hr^{-1}) [f]	Interzone Ventilation Rate (m^3/h) [f]
Spray paints and coatings, small project (aerosol can application)	L	0.1	0.935	5	77	2	Garage; 90	0.45	108.978
	M	0.175		10	154				
	H	0.25		15	307				
Spray paints and coatings, large project (sprayer gun)	L	0.01	0.935	90	894	1	Living room, 50	0.45	108.978
	M	0.055		180	1,789				
	H	0.1		270	3,577				

[a] See Section 2.1 and Table 2-1 for details about weight fraction references and use in this assessment.
[b] Only one SDS reported a density range, 0.87–1.0 g/cm^3 (Junckers Industries A/S, 2023). EPA used the average of the reported range as a proxy for all paints and coatings.
[c] Based on product use descriptions in product labels and online retailer, available in phthalic anhydride Product Research tab in U.S. EPA (2026a).
[d] Based on product use descriptions, available in phthalic anhydride Product Research tab in U.S. EPA (2026a).
[e] Use environment was determined based on product manufacturer use description.
[f] CEM default. For all scenarios, the near-field modeling option was selected to account for a small personal breathing zone around the user during product use in which concentrations are higher, rather than employing a single well-mixed room. A near-field volume of 1 m^3 was selected.

2.3 Dermal Modeling Approach

This section summarizes the available dermal loading data related to phthalic anhydride, the interpretation of the dermal loading data, and the dermal loading modeling approach. Uncertainties associated with the dermal exposure estimates are discussed in Section 5. Dermal exposure to phthalic anhydride primarily occurs via direct contact with liquids applied via brush or cloth or mists sprayed during product use (*e.g.,* getting some liquid adhesive or paint product on hands while spraying or spreading with a brush or roller). Phthalic anhydride has been identified as a dermal sensitizer. As further discussed in the *Draft Human Health Hazard Assessment for Phthalic Anhydride (*U.S. EPA, 2026c*),* skin sensitization is likely only relevant to acute exposures, as a single exposure to phthalic anhydride may elicit immunological events during the induction phase of skin sensitization. As such this exposure assessment uses dermal loading as an appropriate approach to evaluate dermal exposures to phthalic anhydride from consumer products that have contact with the skin.

2.3.1 Dermal Loading Data for Dermal Exposure to Phthalic Anhydride from Liquids and Sprays

For phthalic anhydride-containing products, EPA estimated dermal exposure using the dermal loading information from U.S. EPA (1992). The information from the U.S. EPA (1992) study was identified as the most appropriate tool to assess dermal exposures to phthalic anhydride from use of various consumer products, including liquid and spray paints and coatings and liquid adhesives and sealants. Because dermal exposures in this assessment are based on singular contact with the product to result in sensitization, the dermal loading calculated with the information from U.S. EPA (1992) is most appropriate for phthalic anhydride dermal exposures. This means that minimal dermal contact with phthalic anhydride may result in adverse health effects. The U.S. EPA (1992) study provides data on how much phthalic anhydride is deposited onto the surface of hands during product application. The dermal loading values from the U.S. EPA (1992) study are considered a surrogate for direct dermal contact with liquid products like those identified in this assessment. See Section 4.2 in the *Draft Human Health Hazard Assessment for Phthalic Anhydride* (U.S. EPA, 2026c) for a detailed explanation of human skin sensitization evidence.

The concentration (weight fraction) was based on the weight fraction (content of phthalic anhydride reported in Section 2.1) and expressed in ppm. The liquid product dermal loading is the experimentally obtained (U.S. EPA, 1992) amount of non-aqueous liquids deposited onto the surface of hands (mg/cm^2). The experimental immersion liquid product dermal loading was used for the spray products dermal exposure assessment (Section 2.3.3) and the experimental wipe liquid product dermal loading was used for the non-spray liquid products dermal exposure assessment (Section 2.3.2). Liquid product dermal loading data specific to phthalic anhydride were not identified in the literature. However, EPA identified one study that reported data collected in three laboratory trials designed to quantify the amount of non-aqueous liquids deposited onto the surface of hands (U.S. EPA, 1992). The non-aqueous liquids correspond to three different types of oil products with various viscosities and densities. Three sets of experiments were performed applying various oil-based liquids to the hands of volunteer human subjects. The amount of liquid retained, or liquid product dermal loading, on the subjects' hands and the density of the liquid were measured to determine the liquid film thickness. The amount of liquid retained was measured as a function of the hand surface area of the experimental subject, the type of liquid applied, and the method of experimental application and subsequent removal. For each subject-liquid combination, three different methods of liquid application, or testing, were employed: initial wipe, secondary wipe, and immersion. The initial wipe test consisted of the subjects wiping their hands with a cloth saturated in the liquid. Secondary wipe tests were conducted directly after initial wipe tests with no hand washing. The secondary wipe tests were thus designed to measure decreased retentions caused by the skin being saturated with liquid from the initial wipes. Immersion consisted of dipping the subjects' hands into a container of the liquid. The amount of liquid retained on the hands was measured indirectly immediately after immersion by weighing the jar of liquid before and after immersion. Sections 2.3.2 and 2.3.3 specify the data used for liquids and spray products.

2.3.2 Dermal Loading for Liquid Products

Dermal exposure for phthalic anhydride from liquid products was calculated using Equation 2-1. Phthalic anhydride dermal exposures (µg phthalic anhydride/cm^2) were calculated by using the liquid product dermal loading (µg product/cm^2) onto skin during product use. Because the dermal POD is defined as a per surface area unit (*i.e.,* per cm^2), the total surface area in contact is not an input parameter when calculating dermal exposures. Also, dermal exposures in this assessment are based on singular contact with the product to result in sensitization.

Equation 2-1. Liquid Products Dermal Exposure Equation

$$Phthalic\ Anhydride\ Dermal\ Exposure\ \left(\frac{\mu g\ phthalic\ anhydride}{cm^2}\right) = Weight\ Fraction\left(\frac{mg\ phthalic\ anhydride}{mg\ Product}\right) \times Wipe\ Dermal\ Loading\ \left(\frac{mg\ Product}{cm^2}\right) \times Conversion\ Factor\left(\frac{1000\mu g\ phthalic\ anhydride}{mg\ phthalic\ anhydride}\right)$$

The weight fraction values obtained for adhesives and sealants for small projects, and non-spray paints and coatings, also known as liquid paints and coatings, for the low-, medium-, and high-intensity use exposure scenarios are available in Table 2-1. For these two scenarios, EPA relies on the default liquid product dermal loading values published in the *ChemSTEER User Guide – Chemical Screening Tool for Exposures and Environmental Releases* (also called the "ChemSTEER Manual") (U.S. EPA, 2015) for scenarios aligned with dermal contact with liquids based on the experiments in U.S. EPA (1992). The wipe experiment in U.S. EPA (1992) consisted of each subjects' hands were first thoroughly washed and then the liquids (oils with varying viscosities) were applied to their hands from a cloth saturated in the liquid oils. The liquid oils used in the U.S. EPA (1992) study viscosities are similar to the adhesive and paint products viscosities in this assessment. The wipe experiment setup was selected to represent how non-spray liquid products like paints and coatings and adhesives and sealants are in direct contact with the skin. Empirical dermal loading from the U.S. EPA (1992) wipe experiment is used as a surrogate to represent direct dermal contact with a liquid paint or coating product that is applied with a brush or roller, and during cleaning of application tools (*e.g.,* cleaning of brush/roller). Values from the U.S. EPA (1992) study correspond to recommended defaults in the ChemSTEER Manual for contact with liquid products (U.S. EPA, 2015). The lower and upper bound of the empirical dermal loadings (surrogate for direct dermal contact with liquids) presented in U.S. EPA (1992) is represented by the low- and high-intensity use exposure scenarios in this assessment. A single contact with the liquid product with the highest phthalic anhydride content using the highest reported liquid product dermal loading yields the upper bound of the expected dermal exposures.

For contact with liquids in consumer settings, EPA selected the range of liquid product dermal loading values of 0.7 to 2.1 mg/cm^2 (U.S. EPA, 1992) for tasks such as product cleaning and wiping expected to result in direct contact with product as shown in the ChemSTEER Manual (U.S. EPA, 2015). The ChemSTEER manual recommends *2.1 mg product/cm^2* for high-intensity use exposure scenarios and *0.7 mg product/cm^2* for the low-intensity use exposure scenario. The medium- intensity use exposure scenario EPA used the average value of the high- and low-intensity use exposure scenarios dermal loadings, *1.4 mg product/cm^2*.

The use of the wipe test liquid product dermal loading value for dermal contact with liquid (non-spray) paints and coatings is used as a surrogate for direct contact with the product. The user may have direct contact with the product during product application or during cleaning of application tools (*e.g.,* cleaning of paint brush or roller). In addition, the product use instructions recommend wiping excess product from the surface after application, which may result in some direct contact of the product with the skin. The dermal exposure to phthalic anhydride from direct contact with product during application and cleaning of product after application was calculated using the range of dermal loading values provided by the wipe experiment (surrogate for direct dermal contact with the product) from U.S. EPA (1992). The low- and high-intensity exposure scenarios for dermal exposure to liquid products (adhesives and paints) consider the lower and upper bounds, respectively, of the range of empirical dermal loading values.

The use of the wipe test liquid product dermal loading values for dermal contact with adhesives is used as a surrogate for the direct contact with the product during application. These products are used in small amounts for small surfaces, and the application volume is expected to be small. Contact with the skin is expected to be for a small surface area like fingertips, sides of finger, and spots in hands. Although this dermal exposure assessment is based on single contact with the liquid product a sensitivity analysis discussion considering the amount of phthalic anhydride in contact with the skin is provided in Section 4.3.3 in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e). This sensitivity analysis was performed with the product that is expected to be used in lower volume like adhesives.

2.3.3 Dermal Loading for Spray Products

Spray paints and coatings scenarios may lead to significant dermal exposure represented by the immersion scenarios investigated in U.S. EPA (1992) and empirically supported by Marquart et al. (2006). Marquart et al. (2006) reported a spray liquid dermal loading range of 4.15 mg product/cm^2 (typical) to 16.6 mg product/cm^2 (worst case) based on 25 data points for spraying marine anti-fouling paint, which is similar to spray products within this assessment. Therefore, liquid product dermal loading values from immersion measurements are used to estimate dermal exposure for tasks such as spray coating as described by the EPA/OPPT 2-Hand Dermal Immersion in Liquids Model in the ChemSTEER Manual (U.S. EPA, 2015). The ChemSTEER Manual dermal loading recommendations for spray paint tasks are based on the immersion experiments in U.S. EPA (1992). That study (1992) used high viscosity liquids (mineral oil, cooking oils, and bath oil) in the experiments that are all good proxies for products like paints and varnishes in this assessment. The recommended spray paint task dermal loading range by the ChemSTEER Manual and the alignment with the experimental dermal loadings reported by Marquart et al. (2006) support the use of the U.S. EPA (1992) immersion experiment dermal loading range for this assessment.

Dermal exposure to phthalic anhydride from spray products was calculated using Equation 2-2. Phthalic anhydride dermal exposures (µg phthalic anhydride/cm^2) were calculated by using the liquid product dermal loading (µg product/cm^2) onto skin during product use.

Equation 2-2. Spray Products Dermal Exposure Equation

$$\begin{aligned} &\mathit{Phthalic\ Anhydride\ Dermal\ Exposure}\left(\frac{\mu g\ phthalic\ anhydride}{cm^2}\right) \\ &= \mathit{Weight\ Fraction}\left(\frac{mg\ phthalic\ anhydride}{mg\ Product}\right) \times \mathit{Immersion\ Dermal\ Loading}\left(\frac{mg\ Product}{cm^2}\right) \\ &\times \mathit{Conversion\ Factor}\left(\frac{1000 \mu g\ phthalic\ anhydride}{mg\ phthalic\ anhydride}\right) \end{aligned}$$

The weight fraction values obtained for spray paints and coatings for the low-, medium-, and high-intensity use exposure scenarios are available in Table 2-1. For this paint spraying scenario, EPA selected the range of liquid spray product dermal loading values of 1.3 (lower bound) to 10.3 (high bound) mg/cm^2, which align with the empirical data from Marquart et al. (2006) that reported dermal loading from spraying of marine anti-fouling varnish of 4.15 to 16.6 mg product/cm^2. More specifically, EPA has utilized the raw data of the U.S. EPA (1992) study to determine a 50th percentile value of *3.8 mg product/cm^2* and a 95th percentile value of *10.3 mg product/cm^2* for scenarios aligned with the dermal immersion in liquids. The 50th and 95th percentiles were used in the medium-, and high-intensity use exposure scenarios for spray products. For the low-intensity use exposure scenario, EPA used the lowest spray product dermal loading value from the U.S. EPA (1992) range for immersion test after partial removal, *1.3 mg product/cm^2*.

Dermal loading calculation inputs are summarized in Table 2-6 for all evaluated dermal exposure scenarios.

Table 2-6. Summary of Dermal Exposure Modeling Inputs

Consumer COU Category and Subcategory	Exposure Scenario	Exposure Level	Weight Fraction [a]	Liquid/Spray Product Dermal Loading [b] (mg product/cm^2)
Adhesives and sealants	Adhesives and sealants for small projects	Low	0.1	0.7
		Medium	1.2	1.4
		High	5	2.1
Paints and coatings; Solvent-based paints	Liquid paints and coating	Low	0.1	0.7
		Medium	7.7	1.4
		High	25	2.1
	Spray paints and coating	Low	1	1.3
		Medium	12	3.8
		High	25	10.3

[a] Based on the identified weight fraction in Section 2.1 and Table 2-1 and assuming no usage of personal protective equipment (PPE).
[b] Liquid and spray product dermal loading is the amount of oil-based liquid product deposited on the skin. Values were from U.S. EPA (1992). Liquid product dermal loading values for liquid paints and coatings and adhesives and sealants were based on hand wiping experiments. The immersion experiments dermal loading value was used for spray products. The 1992 EPA study used mineral, cooking, and bath oils wipe and immersion experiments to consider high viscosity liquids and higher content of product during wiping and immersion activities. The high viscosity liquid experiments are a good proxy for products like paints, varnishes, and adhesives in this assessment.

3 CONSUMER EXPOSURE MODELING RESULTS

This section summarizes the exposure estimates from inhalation (TWA) and dermal (loading) exposure to phthalic anhydride in consumer products. Exposure via the inhalation route occurs from inhalation of spray applications of phthalic anhydride-containing products like paints and coatings. Exposure via the dermal route occurs from direct contact with products during application and sprays depositing on the skin during application.

The *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a) summarizes all inputs and results. Acute inhalation TWA results from modeling in CEM are summarized in Section 3.1 and dermal loading calculated outside of CEM are summarized in Section 3.2.

3.1 Acute Inhalation Time-Weighted Average Exposure Results

Time-weighted averages were modeled in CEM for 8 hours for users and bystanders. The 8-hour TWA was selected for the large and small project spray paints and coatings while using a sprayer as the overall project duration period. This means that a per event average of an 8-hour TWA was considered for all inhalation exposure scenarios. This means that while the total duration of product use during application was 90, 120, and 270 minutes (spray paints and coatings large project) and 5, 15, and 30 minutes (spray paints and coatings small project) of intermittent use, the overall project was performed during an 8-hour period. Bystanders are people that are not in direct use or application of a product but can be exposed to phthalic anhydride by proximity to the use of a sprayed product via inhalation in zone 1 far-field and zone 2 of CEM (see Section 2.2). The paints and coatings sprayed product scenarios were assessed for bystanders. The acute inhalation TWA results are provided in Table 3-1.

Table 3-1. Acute Inhalation Time-Weighted Average Exposure Concentrations

Consumer COU Category: Subcategory	Product Exposure Scenario	Exposure Level	Weight Fraction (WF) (%)	Exposure Duration for 8-Hour TWA [a] (min)	User [b] TWA [a] Exposure Concentration mg/m^3	Bystander [c] TWA [a] Exposure Concentration mg/m^3
Paints and coatings: Solvent-based paints	Spray paints and coatings large project, sprayer gun application	Low	1	90	0.68	0.22
		Medium	5.5	180	1.7	1.03
		High	10	270	2.4	1.03
		Sensitivity full-time-worker activity pattern [d]	1	90	0.68	0.24
			5.5	180	1.6	0.65
			10	270	2.1	0.65
		Low WF Sensitivity [e]	1	30	0.33	0.10
	Spray paints and coatings small project, spray can application	Low	10	5	0.44	0.16
		Medium	17.5	10	0.87	0.55
		High	25	15	1.11	1.06
		Low WF Sensitivity [e]	10	1	0.23	0.077

WF = weight fraction
[a] Time-weighted average
[b] User is the consumer directly applying the product.
[c] Bystander is a person that is not in direct use or application of a product but can be exposed to phthalic anhydride by

Consumer COU Category: Subcategory	Product Exposure Scenario	Exposure Level	Weight Fraction (WF) (%)	Exposure Duration for 8-Hour TWA [a] (min)	User [b] TWA [a] Exposure Concentration mg/m³	Bystander [c] TWA [a] Exposure Concentration mg/m³
proximity to the use of a sprayed product via inhalation. [d] Full-time worker activity pattern sensitivity analysis for bystanders inhalation exposures (not to be confused with occupational exposures). This analysis provides the expected exposures lower-bound range using the same inputs used for the stay-at-home activity pattern. [e] Shorter application time and exposure duration sensitivity analysis. This analysis explores lower application times using the lowest WF and only changing the exposure duration and amount of product used.						

3.2 Acute Dermal Exposure Results

Dermal exposure results were calculated using the approach summarized in Section 2.3. Calculations were performed in *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a). Table 3-2 shows the dermal exposure results per COU and product example.

Table 3-2. Acute Dermal Exposure Results

Consumer COU Category and Subcategory	Exposure Scenario	Exposure Level	Weight Fraction (%)	Dermal Loading (µg Product/cm²)	Acute Dermal Exposure (µg Phthalic Anhydride/cm²)
Adhesives and sealants	Adhesives and sealants for small projects	Low	0.1	7.0E02	0.7
		Medium	1.2	1.4E03	16
		High	5	2.1E03	105
Paints and coatings; Solvent-based paints	Liquid paints and coating	Low	0.1	7.0E02	0.7
		Medium	7.7	1.4E03	108
		High	25	2.1E03	525
	Spray paints and coating	Low	1	1.3E03	13
		Medium	12	3.8E03	437
		High	25	1.03E04	2,575

4 INDOOR AIR AND DUST MONITORING

EPA did not identify reasonably available U.S.-based monitoring studies that measured phthalic anhydride concentrations in indoor environments. The Health Canada (2019) study is a screening assessment of carboxylic acid anhydride group including phthalic anhydride. The systematic review rating of the Health Canada study was medium. The screening assessment used a 2010 National Research Council Canada (NRC) study involving indoor air and dust samples from 115 homes with asthmatic children in Quebec City. Phthalic anhydride was identified during a re-examination of chromatograms from the original study. Concentrations of phthalic anhydride ranged from 0.23 to 2.54 $\mu g/m^3$ in indoor air and 0.26 to 112.66 µg/g of indoor dust. The assessment identified uncertainties in the phthalic anhydride values due to potential dehydration of phthalate esters during chemical analysis that can result in overestimations. The screening assessment listed 10 studies (part of the 2010 NRC study) that had measured phthalic anhydride in indoor environments. However, all were published between 1994 and 2005. The age of the listed studies is considered a source of uncertainty since manufacturing practices may have changed and it is unknown if the studies provide a representative measure of phthalic anhydride in current indoor environments. Additionally, the indoor air and dust concentrations from the monitoring study are not representative of product use/application. This assessment calculated exposures to users and bystanders during spray product application. A comparison between modeled and monitoring data therefore cannot be performed.

5 CONSUMER EXPOSURE ANALYSIS WEIGHT OF SCIENTIFIC EVIDENCE

This section describes the sources of variability and uncertainty, strengths and weaknesses, as well as the overall confidence in the modeled consumer exposure analysis. Variability refers to the inherent heterogeneity or diversity of data in an assessment. It is a description of the range or spread of a set of values. Uncertainty refers to a lack of data or an incomplete understanding of the context of the risk evaluation decision. Variability cannot be reduced, but it can be better characterized while uncertainty can be reduced by collecting more or better data. Uncertainty is addressed qualitatively by including a discussion of factors such as data gaps and subjective decisions. Uncertainties associated with approaches and data used in the evaluation of consumer exposures are described below.

The exposure assessment of chemicals from consumer products has inherent challenges due to many sources of uncertainty in the analysis, including variations in product formulation, patterns of consumer use, frequency, duration, and application methods. Variability in environmental conditions may also alter physical and/or chemical behavior of the product or article. Key sources of uncertainty for evaluating exposure to phthalic anhydride in consumer goods and strategies to address those uncertainties are described in this section.

Generally, designation of robust confidence suggests thorough understanding of the scientific evidence and uncertainties. The supporting weight of scientific evidence outweighs the uncertainties to the point where it is unlikely that the uncertainties could have a significant effect on the exposure estimate. The designation of moderate confidence suggests some understanding of scientific evidence and uncertainties. More specifically, the supporting scientific evidence weighed against the uncertainties is reasonably adequate to characterize exposure estimates, but there are some unknowns. The designation of slight confidence is assigned when the weight of the scientific evidence may not be adequate to characterize the scenario, and when the assessor is making the best scientific assessment possible in the absence of complete information and there are additional uncertainties that may need to be considered.

Product Formulation and Composition

Variability in the formulation of consumer products, including changes in ingredients, concentrations, and chemical forms can introduce uncertainty in exposure assessments. In addition, data were sometimes limited for weight fractions of phthalic anhydride in consumer goods. EPA obtained phthalic anhydride weight fractions in various products from SDSs (Section 2.1 and Table 2-1). The four SDSs for Adhesives and sealants COU were published in 2018, 2019, and 2020. The SDSs used for the Paints and coatings COU exposure scenarios were published in 2015, 2024, and 2025. Where possible, EPA obtained multiple values for weight fractions for similar products. The minimum reported value was used in the low-intensity use exposure scenario, the maximum reported value in the high-intensity use exposure scenario. The midpoint of each reported range and the average of all midpoint values when more than one range was used in a specific exposure scenario was used for the medium-intensity use exposure scenario. EPA decreased uncertainty in exposure and subsequent risk estimates in the low-, medium-, and high-intensity use scenarios by capturing the weight fraction variability and obtaining a better characterization of the varying composition of products and articles within one COU. Overall, weight fraction confidence is robust for all products in the Adhesives and sealants, and Paints and coatings COUs with more than one source and recently updated SDS. Moderate confidence was assigned for weight fraction data for crafting resins because only one source was identified and confirmed one reported value.

Product Use Patterns

Consumer use patterns such as frequency of use, duration of use, method of application, and dermal loading are expected to differ. Low-, medium-, and high-intensity use inhalation exposure scenario input values used for CEM Version 3.2 modeling like mass of product used, duration of use, and frequency of use were based on the manufacturers' product descriptions. In this assessment, EPA consulted product specific TSDs and SDSs, and online retailer product use recommendations to build scenarios that represent the upper and lower bounds of the potential exposure range. EPA decreased uncertainty by selecting use pattern inputs that represent product use descriptions and furthermore capture the range of possible use patterns in the high to low- intensity use scenarios, see Section 2.2.1.1 for CEM parameterization and discussion of use patterns. Exposure and risk estimates are considered representative of product use patterns and well characterized. All use patterns' overall confidence is rated robust. However, it is important to note that EPA does not have information to select which consumer exposure scenario (low-, medium-, or high-intensity use); are more likely to represent most of the consumers using the specific products.

Human Behavior

For inhalation exposures CEM Version 3.2 has three different activity patterns—stay-at-home; part-time out-of-the home (daycare, school, or work); and full-time out-of-the-home—though for all products modeled for inhalation, the stay-at-home activity pattern was chosen as an upper bound exposure. The activity patterns were developed based on the Consolidated Human Activity Database (CHAD). One of the main inputs for the estimation of user inhalation exposure is the duration of use, which is a value based on manufacturer and online retailer product application specifications. The user is modeled using the near-field CEM calculations, while the bystander exposure concentration is based on zone 1 and zone 2 CEM inhalation exposure calculations. Users and bystanders can leave their residences to go to work, school, or recreational activities. However, the current stay-at-home activity pattern is representative of a population that spends most of their time at home when performing DIY activities. Using the stay-at-home activity pattern results in an upper bound inhalation exposure concentration, for a sensitivity analysis using the CEM full-time worker activity pattern that provides the lower bound of possible exposures, see Section 4.3.3 in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e).

Inhalation Modeling Tool

Confidence in the model used considers whether the model has been peer reviewed, as well as whether it is being applied in a manner appropriate to its design and objective. The model used, CEM Version 3.2, has been peer reviewed (ERG, 2016), is publicly available, and has been applied in the manner intended by estimating exposures associated with uses of household products. This also considers the default values data source(s) such as building and room volumes, interzonal ventilation rates, and air exchange rates. Overall confidence in the proper use of CEM for consumer exposure modeling is robust.

Dermal Modeling of Phthalic Anhydride Exposure for Liquids and Sprays

Only one applicable exposure study was identified for the consumer exposure assessment, U.S. EPA (1992). That study, published by EPA's Office of Pollution Prevention and Toxics (OPPT), has been used extensively in previous dermal exposure assessments by OPPT and EPA's Office of Pesticide Programs (OPP). It was used to estimate potential phthalic anhydride dermal loading following the use of a relevant consumer product.

Several amount-of-liquid-retained values, dermal loading values (U.S. EPA, 1992), were used to approximate dermal exposure to spray and liquid paints and coatings and liquid adhesives and sealants. See Sections 2.3.2 and 2.3.3 for selection of liquid and spray product dermal loading values and rationale. The experiments used oil-based products expected to have longer residence times on the skin relative to water-based products. All adhesives and paints assessed for dermal exposures were identified as oil-based by the manufacturers. Thus, the use of oil-based liquid and spray product dermal loading values provide a representative potential residence time for the products assessed in this evaluation. Dermal exposures are only reasonably foreseen for consumers but not bystanders. It is possible that the expected occlusion scenarios (*i.e.,* if gloves are used) might not occur in certain circumstances. However, EPA believes the quantitatively assessed scenarios are representative of most expected dermal exposures to phthalic anhydride. This is because EPA identified additional references that support the use of the selected product dermal loading values. For example, for the use of the immersion experiment from the U.S. EPA (1992) study for the spray paints dermal loading was supported by Marquart et al. (2006) experiment on similar products to those in this assessment. For the liquid products dermal loading value, EPA used the suggestion from the ChemSTEER Manual for tasks like cleaning and wiping liquid products with similar viscosities to those in this assessment which are in direct dermal contact. In general, based upon the applicability of the approach described in Section 2.3 and supporting evidence discussed above, the overall confidence in the dermal exposure assessment is moderate for spray applications and moderate for non-spray applications.

Table 5-1 summarizes the overall uncertainty per COU, and a discussion of rationale used to assign the overall uncertainty. The confidence to use the results for risk characterization ranges from moderate to robust. The basis for the moderate to robust confidence in the overall exposure estimates is a balance between using parameters that represent various populations use patterns, and inputs that represent potential actual values that are not outliers, excessive, or unreasonable.

1067 **Table 5-1. Weight of Scientific Evidence Summary Per Consumer COU**

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
Adhesives and sealants	One exposure scenario was assessed under this COU. The exposure scenario utilized information from 3 products with similar use patterns. The exposure scenario was labeled adhesives for small repairs based on manufacturer description of use for each product. Adhesives for small repairs were assessed for dermal exposures only due to the small product amount and surface area used in each application. Inhalation would have low exposure potential for this scenario because of phthalic anhydride's low volatility and vapor pressure. For dermal exposure, EPA used the product weight fraction and experimental amount of liquid retained on the skin (dermal loading) for oil-based liquid products for wiping applications. The wipe experiment in U.S. EPA (1992) consisted of each subject's hands were first thoroughly washed and then the liquids were applied to their hands from a cloth saturated in the liquid. This experiment setup was selected to represent how non-spray liquid products like adhesives and sealants are applied. The application of adhesives can be done using a small brush, cloth, or directly spreading with finger/hand. The liquid product dermal loading values used in this assessment are representative of direct dermal contact and thus the dermal exposure concentrations are considered representative of direct contact with the adhesive. Weight fractions were from the product SDSs and reported as a range. The confidence in these parameters, liquid product dermal loading values and weight fraction is robust. The only limitations noted are related to the study of liquid chemical handling. Specifically, the type of liquid materials and activities investigated may introduce uncertainty when used for surrogate chemicals and uses. Therefore, based on the strengths and limitations of the assessment, EPA concluded that the weight of scientific evidence for this assessment is moderate for consumer exposures. The overall confidence considers confidence in the approach and the inputs used in the calculations. The overall confidence in dermal loading for this COU is moderate.	Dermal – Moderate
Paints and coatings: Solvent-based paints	Four different scenarios were assessed under this COU for 4 product examples with various use patterns. The product examples were matched to each scenario according to exposure route (inhalation and dermal) and application approach (spray can, sprayer gun, or brush/roller). Scenarios assessed for dermal exposures were labeled as the following: spray paints and coatings (can and sprayer application), and liquid paints and coatings (brush or roller application). Scenarios assessed for inhalation exposures were labeled spray paints and coating for small projects (spray can applications) and spray paints and coatings for large projects (sprayer gun application). For dermal exposure, EPA used the product weight fraction and liquid/spray product dermal loading for oil-based products for wiping (non-spray products) and immersion (spray products) applications. The wipe experiment in U.S. EPA (1992) consisted of each subject's hands were first thoroughly washed and then the liquids were applied to their hands from a cloth saturated in the liquid. This experiment setup was selected to represent how non-spray liquid products like paints and coatings are applied and in direct dermal contact. The use of the wiping dermal loading values was supported by ChemSTEER Manual (U.S. EPA, 2015); which reported similar range of liquid product dermal loading with similar viscosity. The paints and coatings evaluated in this assessment can have direct dermal contact during application and cleaning after application. For this scenario the selected experimental dermal loading is an upper bound estimate within the range of potential exposures for the high-intensity use exposure scenario and a lower bound estimate for the low-intensity use exposure scenario. This is because the inputs used are considered representative of actual dermal loading and weight fractions in products. The spray product dermal loading values used for spray paints and coatings scenarios were experimentally determine from the	Inhalation– Robust Dermal spray application – Moderate Dermal non-spray application – Moderate

Consumer COU Category and Subcategory	Weight of Scientific Evidence	Overall Confidence
	immersion experiments in U.S. EPA (1992). The use of the experimental immersion dermal loading values was supported by Marquart et al. (2006); which reported similar spray paint dermal loading values. Weight fractions were from the product SDSs and reported as a range. The confidence in these parameters, dermal loading rate, and weight fraction is robust for liquid paints and coatings and spray paints and coatings. The only limitations noted are related to the study of liquid chemical handling. Specifically, the type of liquid materials and activities investigated may introduce uncertainty when used for surrogate chemicals and uses. Therefore, based on the strengths and limitations of the assessment, EPA concluded that the weight of scientific evidence for this assessment is moderate for consumer exposures. The overall confidence considers confidence in the approach and the inputs used in the calculations. The overall confidence in dermal loading for spray and non-spray applications this COU is moderate. Inhalation of spray paints was assessed in two scenarios: spray paints and coatings for small projects via spray can application, and spray paints and coatings for large projects via spray gun application. The overall confidence in the inhalation exposure estimates is robust because the CEM input parameters represent typical use patterns and location of use. The stay-at-home activity input parameter is considered a high-intensity use input that, although representative of actual uses for some populations, is also believed to result in an upper bound exposure relevant for bystanders and users after they have finalized application of product tasks. Using the stay-at-home activity pattern results in an upper bound inhalation exposure concentration. For a sensitivity analysis using the CEM full-time worker activity pattern that provides the lower bound of possible exposures, see Section 4.3.3 in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e).	
Arts, crafts, and hobby materials: Clear casting resins	Two different scenarios were qualitatively assessed under this COU for one product example with different use patterns. The identified product was a crafting casting resin (Environmental Technology, 2017) used to embed or encase objects in crystal clear plastic. Examples of encapsulation possibilities are coins, shells, rocks, dried flowers, insects, paper, and photographs. Both scenarios are casting resin DIY and casting resin cured. The casting resin use instructions (Environmental Technology, 2012) recommend no dermal contact during mixing of catalyst and resin and when the mixture is transferred to a mold and allowed to cure for 24 hours or until solid. Therefore, dermal exposure while mixing and curing was not modeled. Inhalation of phthalic anhydride from off-gassing or evaporation from products used during DIY activities (mixing resin and catalyst) or from articles (cured resin) is unlikely because of its low vapor pressure (5.17×10^{-4} mmHg) and low volatility (1.70×10^{-8} atm·m^3/mol at 25 °C). Additionally, phthalic anhydride is mainly used as an intermediate (consumed in the production steps and not expected in final product) or as a retarder or scorcher to promote hardening and durability. Based on the role of phthalic anhydride in the finished product, it is unlikely to leach or migrate out of the cured products. EPA has a robust confidence in the qualitative exposure assessment of this COU and the rationale to conclude negligible to no exposure.	Qualitative – Robust

6 CONCLUSION AND STEPS TOWARD RISK CHARACTERIZATION

All COU exposure results summarized in Section 3 and shown in the *Draft Consumer Exposure Analysis and Risk Calculator for Phthalic Anhydride* (U.S. EPA, 2026a) have moderate to robust confidence. They can therefore be used to estimate risks for consumers. The consumer assessment has low, medium, and high exposure scenarios which represent use patterns of low-, medium-, and high-intensity uses. The high exposure scenarios capture use patterns for high exposure potential from high frequency and duration use patterns, and higher weight fractions. Low and medium exposure scenarios represent less intensity in use patterns and weight fractions, capturing a range of different use patterns and available product options. The application of these estimates for risk characterization can be found in the *Draft Risk Evaluation for Phthalic Anhydride* (U.S. EPA, 2026e).

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APPENDICES

APPENDIX A CONSUMER EXPOSURE MODEL ACTIVITY PATTERNS

Table_Apx A-1 provides the time spent in the room of product application for the assessment of user exposures and the time spent in the vicinity of the room of application for bystander exposures.

Table_Apx A-1. Summary of Stay-At-Home and Full-Time Worker Activity Pattern Durations in Hour Per Exposure Scenario

<table>
<tr><th>Product</th><th>Exposure Scenario Level</th><th>Bedroom Hours</th><th>Automobile Hours</th><th>Garage Hours</th><th>Living Room Hours</th><th>Kitchen Hours</th><th>Office / School Hours</th><th>Utility Room Hours</th><th>Outside Hours</th></tr>
<tr><td colspan="10">Stay-at-home activity pattern</td></tr>
<tr><td rowspan="3">Spray paints and coatings, small project (aerosol can application)</td><td>L</td><td rowspan="3">11</td><td rowspan="3">1</td><td rowspan="3"><1 [a]</td><td rowspan="3">>6</td><td rowspan="3">2</td><td rowspan="3">NA</td><td rowspan="3">1</td><td rowspan="3">2</td></tr>
<tr><td>M</td></tr>
<tr><td>H</td></tr>
<tr><td rowspan="3">Spray paints and coatings, large project (sprayer gun)</td><td>L</td><td rowspan="3">11</td><td rowspan="3">1</td><td><2 [b]</td><td>>5 [c]</td><td rowspan="2">2</td><td rowspan="3">NA</td><td rowspan="3">1</td><td rowspan="2">2</td></tr>
<tr><td>M</td><td><3 [b]</td><td>>4 [c]</td></tr>
<tr><td>H</td><td><5 [b]</td><td>>4 [c]</td><td>1</td><td>1</td></tr>
<tr><td colspan="10">Full-time worker [f]</td></tr>
<tr><td rowspan="3">Spray paints and coatings, small project (aerosol can application)</td><td>L</td><td rowspan="3"><10 [d]</td><td rowspan="3">1</td><td rowspan="3">>1 [d]</td><td rowspan="3">2</td><td rowspan="3">1</td><td rowspan="3">8</td><td rowspan="3">NA</td><td rowspan="3">1</td></tr>
<tr><td>M</td></tr>
<tr><td>H</td></tr>
<tr><td rowspan="3">Spray paints and coatings, large project (sprayer gun)</td><td>L</td><td>12</td><td rowspan="3">1</td><td rowspan="3">0 [e]</td><td>< 2 [b]</td><td rowspan="3">0 [e]</td><td rowspan="3">8</td><td rowspan="3">0 [e]</td><td rowspan="3">1</td></tr>
<tr><td>M</td><td>11</td><td>< 3 [b]</td></tr>
<tr><td>H</td><td>9</td><td>< 5 [b]</td></tr>
</table>

L, M, and H are for low-, medium-, and high-intensity use exposure scenarios.
[a] Time in hours spent in environment of product application. The duration of use considered for each scenario was less than 1 hour for low-, medium-, and high-intensity exposure scenarios equal to the values presented in Table 2-5.
[b] EPA used the garage environment in lieu of any indoor environment because CEM activity patterns for garages do not include additional time other than the time spent applying the product. The garage hours are equal to the duration of use presented in Table 2-5.
[c] Time spent in an indoor environment that is equivalent to the living room where the product is not being applied.
[d] Time spent in the garage during product application added to the time spent in the garage before product application takes away for time spent in the bedroom by the time spent applying the product. For the stay-at-home scenarios product application starts at 9:00 am.
[e] For the full-time worker scenario the product application starts after work, 6:00 pm, per CEM default activity patterns time in the garage, kitchen, and utility room are spent during these hours when the user is applying the product. Since the user is spending time in the room of application (living room) they cannot spend time in other environments.
[f] Full-time worker refers to the activity pattern within CEM for people that spend time in an office/school outside of the home. The time spent in the office/school is therefore time not exposed as a bystander in any indoor environment/room in the home where the product is in use.