

Catalog of Materials as Potential Sources of Indoor Air Pollution

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ABSTRACT

The U. S. Environmental Protection Agency (EPA) and numerous other U. S. and foreign organizations are actively involved in investigating indoor air pollution. However, little effort has been made to systematically identify potential indoor air pollution sources and summarize and evaluate existing relevant data. To address this need, the EPA is developing a series of documents summarizing available information on building materials and products brought into homes and office buildings as potential sources of indoor air pollution. The first document, a catalog, will include a list of materials that are potential sources of indoor air pollution, information on chemical constituents of these materials, and emission rates of chemicals outgassed from these products. The second document will consist of a series of handbook chapters that address groups of materials, e.g., floor coverings. The handbook chapters will include information that will help the user make informed decisions concerning indoor air impacts from materials brought into homes and office buildings.

INTRODUCTION

Material sources of indoor air pollutants have been the subject of considerable study by a variety of organizations. However, little effort has been made to analyze this segment of the total problem by systematically identifying and classifying the sources of emissions and summarizing and evaluating the results of the many diverse studies.

What few data are available are often not comparable and do not provide a clear characterization of the sources of indoor air pollution. As a result, there is a need for a systematic approach to identifying sources, their potential for emitting pollutants to the indoor air, and relative measures of exposure. To address this need, the EPA is developing a series of documents characterizing indoor air pollution sources. The documents are intended to provide a complete list of indoor air pollution sources, to indicate each source's relative importance for further research, and to assemble basic information for homeowners and consumers to use in making decisions on product selection for minimizing indoor air pollution in residential and office settings. The documents will address materials and products commonly found in homes and office buildings.

Indoor air pollution sources can be divided into five general categories: (1) materials that emit pollutants, (2) indoor combus-

tion sources, (3) outdoor sources, (4) biological sources, and (5) activities that result in emissions to the indoor air. Material sources, such as particleboard or carpeting, may emit volatile compounds or particulates by virtue of their composition. Indoor combustion sources include products or appliances that emit combustion by-products inside buildings. Outdoor sources include vehicle emissions from nearby roads and pollutants generated at nearby industries. Biological pollutants include fungi, bacteria, viruses, pollen, spores, animal hair, and other allergens generated by biotic or natural organisms and processes. Activities considered to be sources of indoor air pollutants include such activities as house cleaning or using photocopy machines. Only one of these categories, materials that emit pollutants, is addressed in this study. Subsequent studies may be performed by EPA to address the other four categories. Figure 1 presents a diagram of the five categories of sources affecting indoor air quality and schematically illustrates the focus of this study. The materials category has been further divided into three subsections corresponding to patterns of product use in homes and office buildings. Building materials include construction and finishing materials, e.g., particleboard, plywood, insulation, paint. Furnishings include those materials that would be brought in to furnish a home or office, e.g., furniture, carpeting, drapes, wall coverings. Consumer products include household cleaning products, hygienic products, and personal care products.

METHODS

The EPA's present study is designed to lay a foundation for systematic analysis of the role of materials in influencing indoor air quality. The approach involves development of a series of three documents, each with an increasing amount of information and evaluation of material sources of indoor air pollution:

- A classification system identifying the universe of materials and products brought into the indoor environment, including building materials, fixtures and furnishings, and consumer goods that are brought into buildings in the course of their normal use;
- A catalog containing chemical constituent data and emissions data on a subset of those products thought to contribute to indoor air pollution; and
- A handbook containing information on lower-emitting alternatives and remediation measures to reduce emissions from various materials, for the subset of products included in the catalog.

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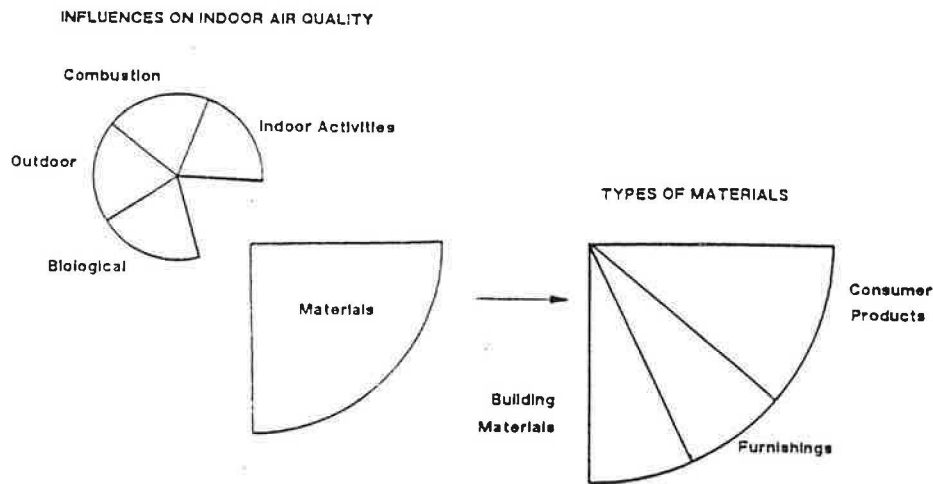


Figure 1 Categories of indoor air pollution sources

The study's primary goals are twofold. The first goal is to demonstrate the feasibility of using available information to develop a comprehensive and definitive list including all products used in the construction of buildings or brought into homes or offices and to identify a subset of products that are likely to emit pollutants that could adversely impact indoor air quality. The second goal is to evaluate and present available information on chemical constituents and emissions for products that may contribute to indoor air pollution in a manner that is useful to researchers, architects, building contractors, homeowners, and consumers.

The catalog is intended primarily as a research tool containing factual information on chemical constituents and emissions. One of the purposes of this document will be to clearly identify products where inconsistencies and data gaps exist in the current state of knowledge. The handbook is intended to provide additional information that will allow architects, building contractors, homeowners, and the general public to make informed decisions on product selection with regard to potential indoor air emissions. It will include constituent and emissions data and provide interpretation of the information presented. Information on lower emitting alternative products and remediation measures that can be taken to reduce emissions will be presented in a user-friendly format.

Classification System

A number of sources of information containing categorization or classification of materials were identified and reviewed during the first phase of this study.¹⁻⁶ The product classifications and sales information in these sources were compared as to usefulness of classification divisions and level of detail. It was concluded that the Census Bureau's *Census of Manufactures* reports present the most comprehensive list of products that covers all three categories of interest to the study and employs categories useful to a study of indoor air quality. A decision was therefore made to use data presented in the Current Industry Report series of the *Census of Manufactures* as a basis for initial studies and the initial classification scheme.² The census data are based on the Standard Industrial Classification (SIC) system, commonly used by industry and government agencies.

The first step in creating the classification involved analyzing the Current Industry Reports data to identify and classify all

industrial products of interest to the study. The classification was developed by reviewing approximately 11,000 products for which data are collected by the *Census of Manufactures* to identify products used in connection with construction of or use in homes or office buildings. The Census data group products into three divisions of interest to this study:

- **Industries** for which information on products is collected. The *Census of Manufactures* comprises 459 manufacturing industries, and 191 of these manufacture products that are included in the present study. Industries are identified with four-digit SIC codes, e.g., 2891 Adhesives and Sealants, 2421 Sawmills and Planing Mills.
- **Product Classes** are subcategories of an industry's total product slate. These are identified with a fifth digit that is added to the industry code, e.g., 2891 Adhesives and Sealants includes four product groups:
 - 28913 Natural base glues and adhesives,
 - 28914 Synthetic resin and rubber adhesives,
 - 28916 Structural sealants
 - 28917 Nonstructural caulking compounds and sealants.
- **Products** are the most detailed category for describing industry product slates. They are identified with seven-digit SIC-based codes obtained by adding two-digit product identifiers to the five-digit product class numbers, e.g., "28913 Natural base glues and adhesives" is made up of a number of products including:
 - 28913-11 Animal glues (hide, dry forms),
 - 28913-26 Flexible, nonwarp, liquid glues
 - 28913-50 Protein adhesives (casein, blood, etc.).

For the present study, a two-step procedure was used to define the universe of products used in construction or brought into homes and office buildings:

- Review of the *Census of Manufactures* industry categories to eliminate those not relevant to the study, e.g., 2813 Industrial Gases and 2911 Petroleum Refining, and
- Review of the product groups for the remaining industries to identify specific products that are components of a building (building materials), furnishings, or fixtures or that are consumer goods found in homes or office buildings as a result of activities normally conducted there.

All potential construction materials or products found in homes and office buildings are included in the classification irrespective of the probability of their contaminating indoor air. The product categories presented were tabulated, along with available data on value of annual shipments and physical units of production as defined by the *Census of Manufactures*. It was realized that the value of some of this information is limited, since many products would not be included in further studies on sources of indoor air pollution. The data available did, however, provide some insights on the relative economic importance of certain products and provided perspective on the overall completeness of the information available from this source.

Subset of Potential Material Sources of Indoor Air Emissions

The next step involved screening out all products that, despite their physical presence as building components or location within buildings, have little or no potential as sources of emissions. This was a subjective process, based on consideration of three factors:

- The quantity found in buildings: how pervasive is the product in the indoor environment?
- Compositional information: based on readily available published information, how harmful are the emissions likely to be?
- The nature of its use: what is the likelihood of human exposure to materials emitted?

A group of researchers familiar with the current state of knowledge concerning indoor air pollution provided input for this screening step. Decisions were made with the realization that this was a preliminary screening and with the understanding that the important consideration was showing the differ-

ence in the scope and nature of the products to be given further study.

Information on chemical constituents of this subset of products, as well as measured emissions under controlled conditions, will be compiled in a tabular data base format. The purpose of this cataloged information is to present available information in a format that allows for easy comparison of different studies and clearly identifies where data gaps exist.

Development of Handbook on Material Sources of Indoor Air Emissions

Development of a handbook containing information useful to architects, building contractors, homeowners, and the general public will be the third step in EPA's current program. Work is currently underway to design an organizational scheme and format for presenting information in a logical manner for the intended user groups. The intent of the handbook is to provide information that will help the user make informed decisions on materials brought into homes and office buildings.

Figure 2 presents an example of a decision tree outlining some of the decisions that a person who is building or remodeling a home would need to consider when installing floor coverings. Each decision node identified in the figure represents a decision where the choice of material used may impact indoor air quality. The handbook will provide information on the emission potential of the various choices of materials with each step in the decision process. The EPA is working in coordination with the American Institute of Architects and other potential user groups to ensure that the final product of this project will meet their needs. Draft handbook chapters on particleboard, vinyl flooring, sealants, and household pesticides are being prepared in 1991 as prototype documents to demonstrate the

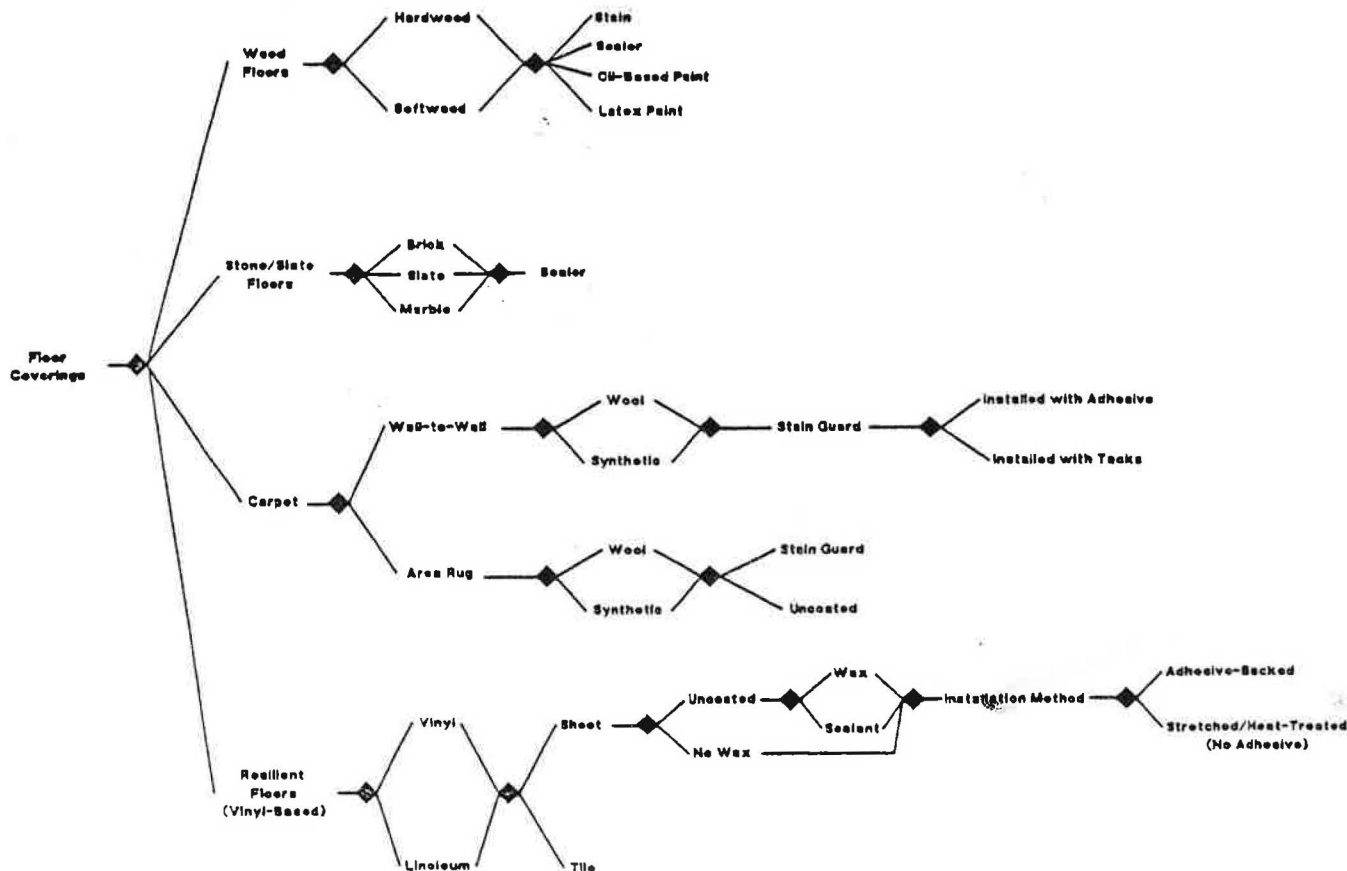


Figure 2 Decision tree outlining decisions on floor coverings that may influence indoor air quality

format of the documents being prepared, the availability of pertinent information, and the potential usefulness of the proposed handbook.

DISCUSSION OF RESULTS

The complete classification of products found in homes and office buildings was published in 1990⁷ and contains about 1,000 of the 11,000 products that the *Census of Manufactures* uses to describe the industrial output of the United States. The classification is believed to constitute a viable definition of the universe of products used in building construction or brought into homes and office buildings. This all-inclusive list will be used to further define the materials contributing to indoor air pollution. It describes each product and lists its SIC number. This links the products, as defined for present purposes, with backup information in the Bureau of the Census statistics. For further work it will be possible to access additional data or update existing data as more recent information on production becomes available. Where applicable, *Masterspec* codes used by the American Institute of Architects have been provided as a cross-reference.¹

A subset of approximately 250 products thought to have a significant impact on indoor air quality has been tentatively identified for further study. The EPA's 1991 work involves systematically evaluating these products by product group to determine the chemical constituents that may be emitted from each and emission rates or emission factors of various chemicals of concern. The studies will include evaluation of emissions data as well as evaluation of the manufacturing processes used to produce the products of interest. Study of the manufacturing processes will provide insight into the emission potential of various products as well as the variability of emissions that can be expected from similar products.

The first three building material categories under investigation are particleboard, vinyl flooring, and sealants. The consumer product categories currently being studied include household pesticides and specialty cleaning and sanitation products.

It has been found that data exist to characterize these products in terms of their potential to emit pollutants to the indoor air. However, in many cases, quantitative data from different studies are difficult to compare. For example, data from 11 studies present formaldehyde emissions from particleboard ranging from 0.02 to 0.74 mg/m² per hour depending on test conditions.⁸⁻¹⁸ Similarly, five studies on vinyl flooring resulted in gas chromatography/mass spectroscopy (GC/MS) scans showing different chemical constituents identified in each study.¹⁹⁻²²

For the purposes of this study, available data on constituents in products and emissions measured from test chamber studies will be compiled in a tabular data base format that will allow for easy comparison of different studies. Data on test conditions as well as test results will be included. Similarly, information on chemical constituents of products from numerous data sources will be compiled in a logical format that will allow for comparisons of similar products.

CONCLUSIONS AND RECOMMENDATIONS

The overall EPA program to catalog material sources of indoor air pollution is a multi-year project. The first phase of the project—development of a classification system identifying the universe of products found in homes and office buildings—was completed in 1990.⁷ This classification system and the corresponding subset of materials thought to contribute to indoor

air emissions demonstrate that a systematic approach to evaluating sources of indoor air pollutants will result in a valuable tool for researchers as well as homeowners and consumers.

Initial evaluation of select product group categories indicates that data exist to characterize chemical constituents and potential emissions from many products of interest using the classification system. Summarizing and incorporating this information into a data base format that allows for easy comparison of different studies and different products will allow researchers to identify conflicting data and data gaps and help prioritize future research efforts.

The handbook, providing more detailed information and interpretation and evaluation of data on sources of indoor air emissions, will be a more intensive data-gathering effort. Working with the intended user groups to plan and organize the presentation of information will ensure that a useful final product will be developed.

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