



## Project Summary

# Characterization of Painted Surfaces in the United States from the Perspective of Potential Damage from Acidic Deposition

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Data are reviewed on the types and applications of exterior paints used in the United States, from the perspective of potential damage by air pollution or acidic deposition. Residential buildings are the most economically important subset of the painted structures in the United States for painting costs; this ranking is likely to continue in the future. Painting over existing finishes is an important class of situations for research, because these conditions are more common and more difficult than virgin surfaces. Automobile finishes are a high-value use of paint, but the importance of acid deposition as a reason to repaint has not been established.

Based on consumer surveys, the most important mode of paint failure is peeling, which accounts for about half of residential paint problems. Such problems often occur within two to three years after painting. Color changes (deterioration) are next in importance, followed by chalking and erosion. Painting solely to change color or to aid in the resale of the property is of minor importance. Paints containing acid-sensitive components, especially oil-based glossy paints, may be found in today's retail market in all price ranges. Trends in paint usage and performance are generally supportive

of (or not inconsistent with) the hypothesis that air pollution or acid rain may be having some adverse effects, although such data are by no means conclusive. The report recommends that selections of coatings and substrates for acid deposition research should include those combinations that are widely used (latex over wood and over previous paint) and those that are sensitive to acid deposition (paints containing  $\text{CaCO}_3$ ; alkyl paint over steel).

*This Project Summary was developed by EPA's Atmospheric Research and Exposure Assessment Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### Introduction

The National Acid Precipitation Assessment Program (NAPAP) is responsible for developing an understanding of the causes and effects of acidic deposition and for supporting decision-making on strategies to reduce acid deposition. Damage to structural materials is an important component, since the potential economic effects are large by virtue of the many structures exposed to acid deposition. The U.S. Environmental Protection Agency conducts research on

acid deposition damage to common construction materials, which include metals and painted surfaces. This research provides guidance to the EPA research program on the mechanisms of damage to painted surfaces by acid deposition.

## Results and Discussion

Data on the types and applications of exterior paints used in the United States were reviewed from the perspective of potential damage by air pollution or acidic deposition. Sources of information included data from the Census of Manufactures on factory shipments of paint and allied products, statistics on the construction industry, data on consumer expenditures for residential repairs and alterations, and data from consumer surveys. This information shows that residential buildings are the most economically important subset of the painted structures in the United States in terms of the costs of painting. The trends for new construction suggest that this ranking is likely to continue in the future.

Table 1 presents preliminary data from the 1987 Census of Manufactures including shipment volumes (million gallons), factory values (million dollars), and in-place values which include estimated mark-ups and application labor (billion dollars), for outdoor paint applications. The annual in-place value of architectural coatings is the highest category, followed by automotive (and other transportation equipment) paints. Maintenance paints, coil coatings, and traffic marking paints have substantially lower in-place values. The ranking of automotive finishes must be discounted because of the high proportion of painting done to repair body damage, rather than because of

paint failure. Considering that a car may be ten or more years old by the time its refinished paint nears failure, extending the life of this paint would appear to have only marginal value relative to the remaining value of the car. In addition, the importance of acid deposition as a cause of failure of automotive finishes has not been established.

To gain insight into the uses of architectural coatings, estimates were made for new construction, maintenance painting, residential maintenance, and painting costs for various other types of structures, based on published data. The estimate for 1977 for residential painting, including the estimated value of do-it-yourself labor, was about \$14 billion; by 1986, the estimated value had risen to about \$20-30 billion. A 1977 input-output analysis of the US construction industry estimated that \$147 million was spent for maintenance painting costs to non-buildings and \$1.1 billion for buildings, which confirmed the relatively low rank of maintenance painting. In addition, the 1979 national expenditure for corrosion protection of highway bridges was estimated at \$130-160 million (which was about half of what was needed for adequate corrosion protection). Even after accounting for inflation, this category would not rank high in Table 1. However, the costs of bridge failure due to inadequate maintenance have not been considered; a 1984 estimate of spending on new and rehabilitated bridges excluding maintenance was about \$5 billion.

According to several consumer surveys, the most important mode of paint failure appears to be peeling and flaking, which, in its various manifestations,

accounts for about half of residential paint problems. Figure 1 shows the distribution of reasons for repainting given by respondents to a large mail survey, 1975. This survey and others indicate that such problems often occur within two to three years after application, although manufacturers' test panel results seldom identify peeling as an important mode of paint film failure. Based on several surveys, color changes (deterioration) ranked next in importance. Although chalking and erosion have been observed, their roles in decisions to repaint are less apparent. Painting solely to change color or for resale of the property appears to be of minor importance.

In Figure 2, the 1975 consumer survey data have been segregated by Census Region and according to whether or not there was prior peeling, which is seen to have a major influence on the percentage of respondents with new paint peeling. The West region had the fewest peeling problems. The probability of new peeling was increased by about a factor of three if peeling had occurred previously, in all regions and for all types of paint. The performance of a given type of paint was dependent on the type of paint already on the surface. In the absence of previous peeling, latex paint applied over an oil-based paint was usually the most likely to peel, especially in the North Central or Northeast Regions. With previous peeling, the differences were smaller but latex over latex was often the worst, suggesting that a deteriorated oil-based paint surface may provide better adhesion for repainting.

Although the Northeast and North Central Regions rank highest in acid deposition and had the poorest paint

**Table 1.** 1987 Paint Shipments and Associated Costs (exterior uses)

Classification	Shipments million gal.	Factory Cost million \$	In-place Value billion \$
<b>Architectural Coatings (exterior)</b>			
Oil-based	80	\$807	\$ 9.5
Water-based	123	944	14.6
<b>Automotive Finishes</b>			
new vehicles	73	1323	6.0
refinishing	44	904	11.0
Coil Coating	20	303	2.0
Industrial Maintenance Paints	28	313	2.8
Traffic Marking Paints	19	95	0.7

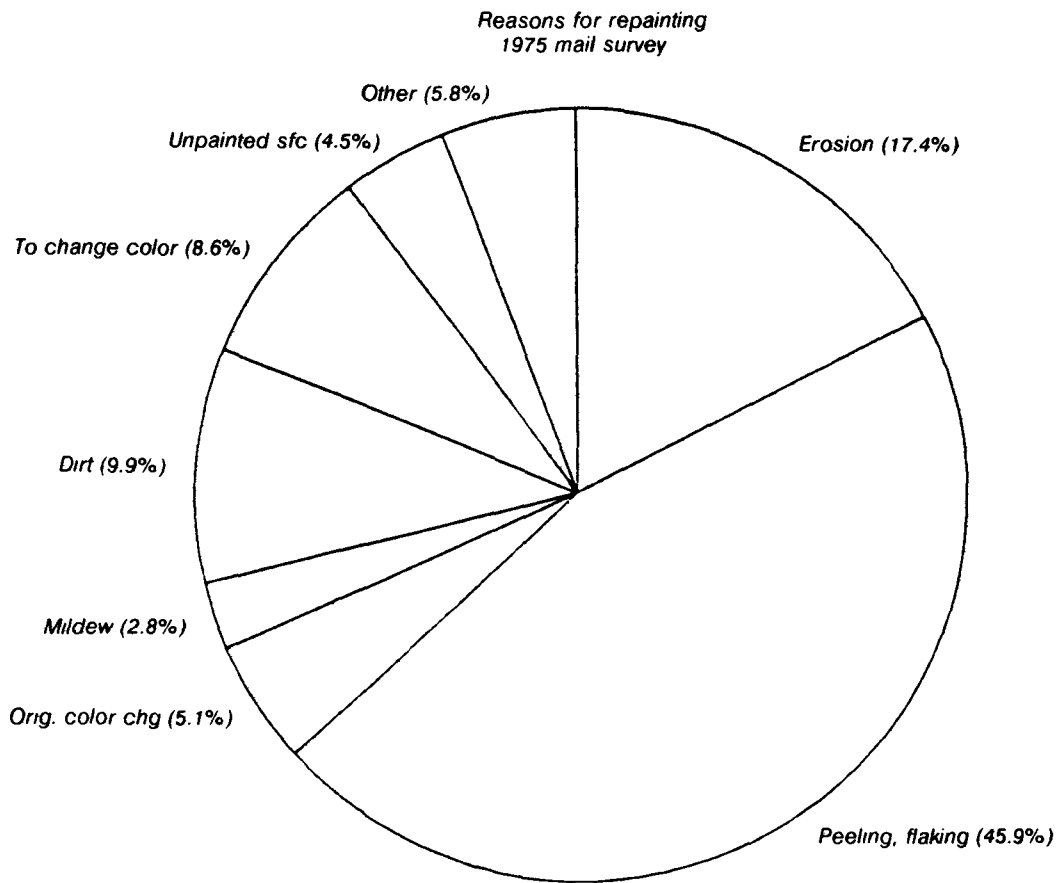


Figure 1. Distribution of reasons for repainting (1975 mail survey).

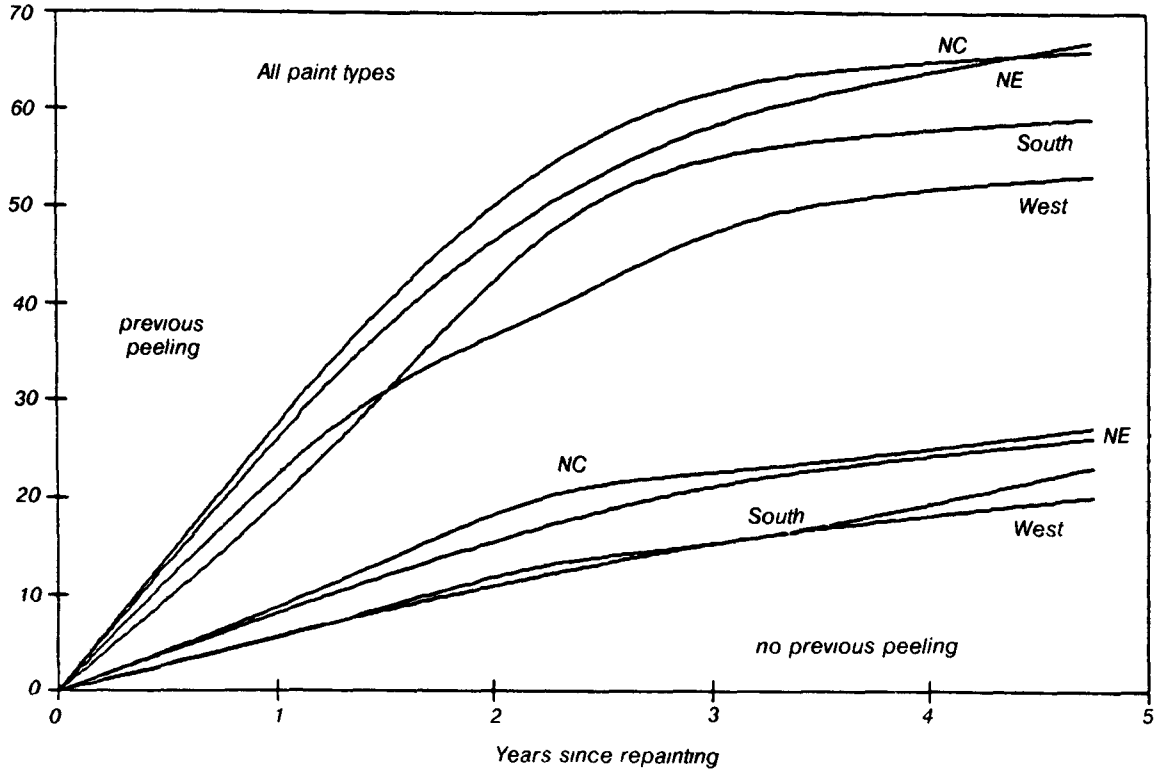


Figure 2. Percent of respondents with paint peeling or flaking (1975 mail survey).

performance, there are many other regional environmental differences to consider besides acid deposition in evaluating differences in paint performance. For example, the North Central Region suffers more from weather extremes because of its continental climate; also the winter ultraviolet radiation exposure of a vertical wall may be higher in more northern latitudes because of the low sun angles and reflection from snow covered ground surfaces. Nevertheless, the trends in paint usage and performance are generally supportive of (or at least not inconsistent with) the hypothesis that air pollution or acid rain may be

manifesting some adverse effects, although such data are by no means conclusive.

Not all paint formulations are expected to be sensitive to acid deposition. Previously it was thought that the cheapest paints might be the most sensitive, but acid-sensitive paint components may be found in today's retail market in all price ranges, especially in oil-based glossy paints. These components include calcium carbonate ( $\text{CaCO}_3$ ), which is an inexpensive pigment used as an extender (thickener), and zinc oxide ( $\text{ZnO}$ ), which is used as a pigment and in conjunction with mildewcides.

## Recommendations

The report recommends that selections of coatings and substrates for research on the effects of acid deposition should include both those combinations that are most widely used (latex over wood and over previous paint) and those that are sensitive to acid deposition (paints containing  $\text{CaCO}_3$ , alkyd paint over steel). Although both new construction and maintenance painting are economically important, the more difficult conditions involved in painting over existing finishes make this an important class of situations for research.

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*The complete report, entitled "Characterization of Painted Surfaces in the United States from the Perspective of Potential Damage from Acidic Deposition," (Order No. PB 89-181 226/AS; Cost: \$15.95, subject to change) will be available only from:*

*National Technical Information Service*

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