November 1990

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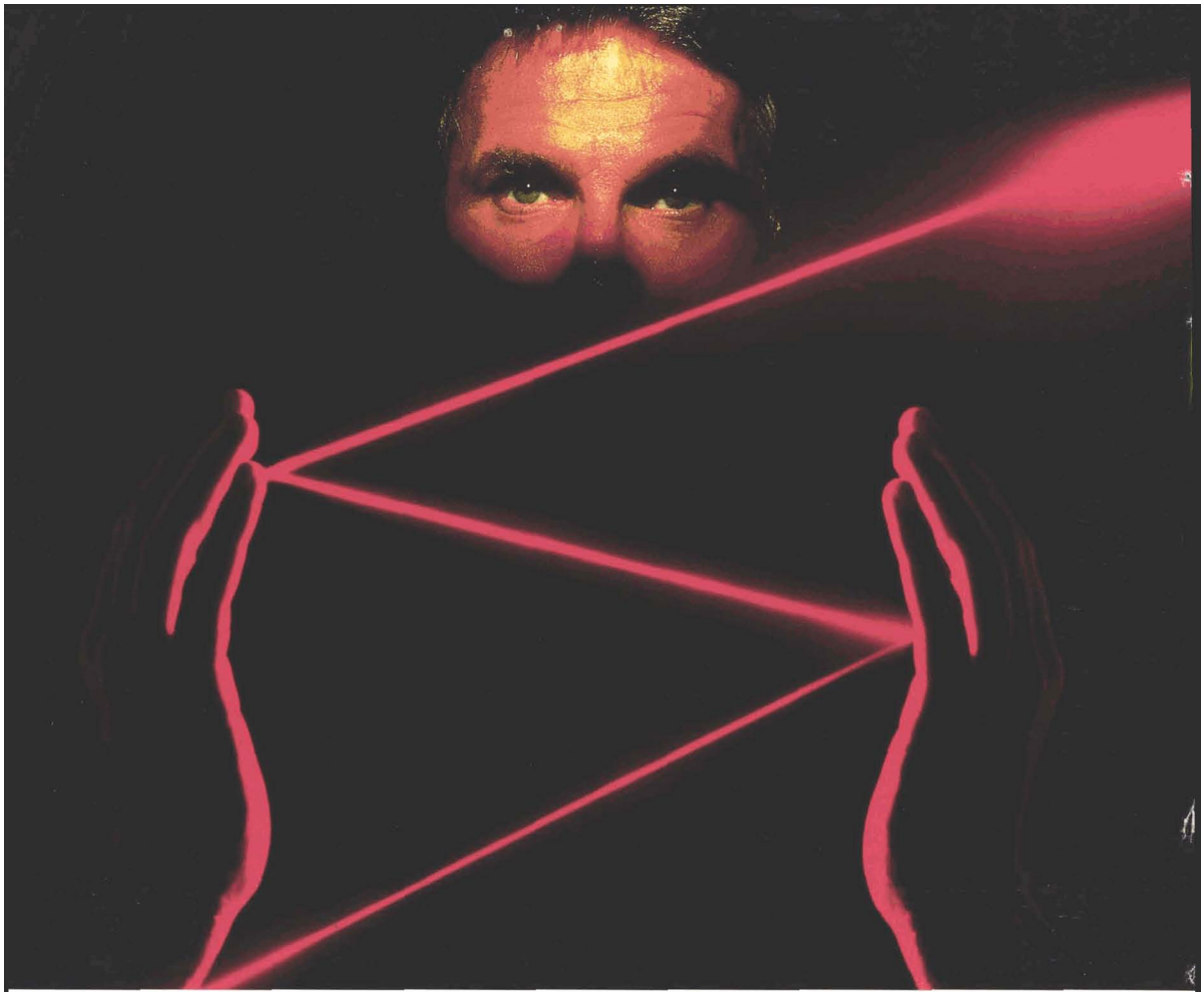
JOURNAL OF COATINGS TECHNOLOGY

Non-Osmotic, Defect-Controlled Cathodic Disbondment of a Coating from a Steel Substrate.



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NOVEMBER 1990

jct JOURNAL OF COATINGS TECHNOLOGY

VOLUME 62 NUMBER 790

THE JOURNAL OF COATINGS TECHNOLOGY (ISSN 0361-8773) is published monthly by the Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422, Phone: (215) 940-0777.

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JOURNAL OF COATINGS TECHNOLOGY

GUIDE FOR AUTHORS

GENERAL

The JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology for its membership of approximately 7,300 in 26 Constituent Societies in the United States, Canada, Great Britain, and Mexico. The JOURNAL is devoted to the advancement of knowledge in the science and technology of surface coatings, the materials comprising such coatings, and their use and performance.

The Editors invite submission of original research papers, review papers, and papers under the special headings *Open Forum* and *Back to Basics*, as well as *Letters to the Editor*. All manuscripts will be assumed to be previously unpublished writing of the authors, not under consideration for publication elsewhere. When review papers contain tables or graphs from copyrighted articles, the authors will be required to obtain permission for use from the copyright holders. When the organization with which the authors are affiliated requires clearance of publications, authors are expected to obtain such clearance before submission of the manuscript. Papers presented to associations other than the Federation must be released by written communication before they can be considered for publication in the JOURNAL OF COATINGS TECHNOLOGY. Authors are obligated to reveal any exceptions to these conditions at the time a manuscript is submitted.

The JOURNAL OF COATINGS TECHNOLOGY has first right to the publication of papers presented at the Annual Meeting of the Federation and at local regional meetings or symposia of the Constituent Societies.

Papers in which proprietary products or processes are promoted for commercial purposes are specifically nonacceptable for publication.

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...for the Journal

Four complete copies should be sent to the Editor, JOURNAL OF COATINGS TECHNOLOGY, 1315 Walnut St., Philadelphia, PA 19107. The cover letter should address copyright clearance, and release issues discussed above and should specify paper category: *Original Research, Review, Open Forum*, or *Back to Basics*.

Letters to the Editor: The JOURNAL will consider for publication all correspondence relevant to the coatings industry and to the contents of the JOURNAL. When a letter concerns an article appearing in the JOURNAL, the original author is usually given an opportunity to reply.

...by Constituent Societies For Annual Meeting Presentation

Ten complete copies of the manuscript are required for committee review. The set of copies should be addressed to the Editor at the address listed previously.

...for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1990 Roon Awards Committee, Richard Eley, The Glidden Co., 16651 Sprague Rd., Strongsville, OH 44136. (For complete details, see "Roon Awards" section of the JOURNAL in January 1990 issue.)

MANUSCRIPT PREPARATION

In general, authors are advised to use the "Handbook for Authors" published by the American Chemical Society as a guide to the preparation of manuscripts (ACS, 1155 Sixteenth St., Washington, D.C. 20036). Another excellent reference work is "How to Write and Publish a Scientific Paper," by Robert A. Day (ISI Press, 3501 Market St., University City Science Center, Philadelphia, PA 19104).

Authors are encouraged to consider submissions in several categories and to prepare their manuscripts accordingly. The categories are:

Original Research Papers: The main technical content of the JOURNAL OF COATINGS TECHNOLOGY will continue to be original research papers. Editors support the trend in scientific writing to a direct, less formal style that permits limited use of personal pronouns to avoid repetitious or awkward use of passive voice.

Review Papers: Papers that organize and compare data from numerous sources to provide new insights and unified concepts are solicited. Reviews that show how advances from other fields can beneficially be applied to coatings are also desired. Reviews that consist mainly of computer searches with little attempt to integrate or critically evaluate are not solicited.

Open Forum: Topics for this category may be nontechnical in nature, dealing with any aspect of the coatings industry. The subject may be approached informally. Editors encourage submission of manuscripts that constructively address industry problems and their solutions.

Back to Basics: Papers that provide useful guides to Federation members in carrying out their work are solicited. Topics in this category are technical but focus on the "how to" of coatings technology. Useful calculations for coatings formulation and procedures that make a paint test more reproducible are examples of suitable topics. Process and production topics, i.e., paint manufacture, will also be reviewed in the *Back to Basics* category.

If a submitted paper consists of the text of a presentation made previously to a monthly or special meeting of a Society for Coatings Technology, or to another technical group, the name of the organization and the date of the presentation should be given. If someone other than the author of the paper made the presentation, this information, too, should be noted. Papers originally composed for oral presentation will have to be revised or rewritten by the author to conform to the style described in this guide.

Manuscripts should be typed with double spacing on one side of 8 1/2 x 11 inch (22 x 28 cm) paper, with at least one-inch (2.5 cm) margins on all four sides. All paragraphs should be indented five spaces, and all pages should be numbered at the top center, or upper right corner.

Title

The title should be as brief and informative as possible. Selection of titles that are key word-indexable is a helpful and recommended practice.

Authors' Biographies and Photographs

Give complete names, company or institutional affiliations, and brief biographical sketches of all authors. If available, submit a 5 x 7 inch (13 x 18 cm) black-and-white photograph with glossy or smooth high sheen surface, for each author. See later section on photographs for further details.

Abstracts

A 75-100 word abstract must be part of the manuscript, and should be a concise description of the key findings or teachings of the work described in the paper. The abstract should not repeat the title or include reference numbers, nor should it duplicate the Conclusion or Summary.

Text

Main headings and sub-headings should be used to improve readability, and to break up typographical monotony. The text should *not* be presented as an alphanumeric outline.

The main headings usually should be INTRODUCTION, EXPERIMENTAL, RESULTS AND DISCUSSION, and SUMMARY or CONCLUSIONS. Sub-headings will be specific to the subject.

Only as much review as is necessary should be given to provide an introduction to the subject; the main burden for extensive background should be placed on the list of references.

Standard scientific and technical terminology should be used to convey clear and unambiguous meaning, but the use of technical jargon or slang should be avoided. Authors should bear in mind that the JOURNAL has an international audience, for many of whom English is a second, not native, language. Use of regional idioms or colloquialisms should be avoided. The use of obscure abbreviations is also discouraged. When appropriate, abbreviations should be made in parenthesis immediately following first mention of the term in the text, and then used alone whenever necessary.

Recent issues of the JOURNAL should be consulted for desired style and technical level.

Metric System

Metric system units should be used wherever applicable with the equivalent English units shown afterwords in parentheses. The ASTM Metric Practice Guide, E 380-72 (American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103) is a convenient reference.

Tables, Graphs, and Drawings

Tables, rather than descriptive text, should be used only when they are genuinely helpful. They should be proportioned in accordance with the height and width limitations of the JOURNAL's pages. Each table should be typed on a separate sheet, rather than included in the text, and appended to the manuscript. Each table should be numbered and have a descriptive caption. Tables should be referenced in the text (e.g., "See *Table* 1").

In numerical data in tables, numbers less than one should have a zero before the decimal point.

Graphs should be on good quality white or nonphotographic blue-lined 8 1/2 x 11 inch paper. Each graph should be drawn on a separate sheet, numbered, and the captions listed on a *copy* of the original graph. Graph captions and legends should also be typed on a separate sheet from original for typesetting.

Drawings should conform to the guidelines given for Graphs and should be proportioned to fit the height-to-width ratio of the JOURNAL'S pages and columns.

Photographs

All photographs should be sharp, clear, black-and-white prints no larger than 8 x 10 inches in size. Photos should be clearly labeled on the reverse side, taking care not to mar the image.

Color prints and slides are unacceptable.

When illustrations are secured from an outside source, the source must be identified and the Editor assured that permission to reprint has been granted.

Nomenclature

Whenever possible, generic names should be used in preference to trade names. When trade names must be used to avoid ambiguity, and the name is a registered trademark, the symbol R, in a circle or parentheses, should be given immediately following, and the manufacturer listed as a footnote. In general, trade names should be used only in footnotes or in an appendix, rather than in the text.

If special nomenclature is used, include a nomenclature table giving definitions and dimensions for all terms.

Nomenclature of chemical compounds should conform to the style of *Chemical Abstracts* and the IUPAC rules. For oligomeric or polymeric materials, characteristics such as molecular weight, polydispersity, functional group content, etc. should be provided.

Equations

Equations must be typed, or written clearly, with equations numbered sequentially in parentheses to the right. If Greek letters are used, write out their names in the manuscript margin at the first point of use. Place superscripts[a] and subscripts$_b$ accurately. Avoid the use of superscripts in a manner that can lead to their interpretation as exponents.

Summary

The paper should be concluded with a summary which is intelligible without reference to the main text. The summary may be more complete than the abstract, listing conclusions drawn from the text. A well written summary can serve to inspire the busy reader to turn back to the paper, to read it thoroughly.

Acknowledgment

If used, it should follow the summary.

References

These should be listed in the numerical order in which they are cited in the text, and should be placed at the end of the manuscript. Names of authors may or may not be shown in the text with reference numbers. If possible, include titles of articles referenced in the literature. The following are examples of acceptable reference citations for periodicals,[1,2,3] books,[4] and patents.[5]

(1) Pascal, R.H. and Reig, F.L., "Pigment Colors and Surfactant Selection," *Official* DIGEST, *36*, No. 475 (Part 1), 839 (1964).

(2) Davidson, H.R., "Use and Misuse of Computers in Color Control," JOURNAL OF COATINGS TECHNOLOGY, *54*, No. 691, 55 (1982).

(3) Stephen, H.G., "Hydrogen Bonding—Key to Dispersion?," *J. Oil & Colour Chemists' Assoc.*, *65*, No. 5, 191 (1982).

(4) Patton, T. (Ed.), "Pigment Handbook," Vol. 1, John Wiley & Sons, Inc., New York, 1973.

(5) Henderson, W.A. Jr. and Singh, B. (to American Cyanamid Co.), U.S. Patent 4,361,518 (Nov. 30, 1982).

OTHER INFORMATION

Galley proofs will be sent to the author for checking about six weeks prior to publication.

Offprints may be purchased in quantities of 100 or more. Authors will receive price quotations. Each author will receive a complimentary copy of the JOURNAL issue in which his or her paper was published.

* * * *

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Comment

Technical Committee Activity: Alive and Well

The Federation annually sponsors a meeting of members of the Technical Advisory Committee with Society Technical Committee representatives, to review projects currently underway and to discuss suggested new programs.

Attendees at these meetings invariably express some surprise at the scope of project work going on, particularly in view of ever-growing workplace demands that limit the time coatings personnel can devote to volunteer service. Nevertheless, while there may be fewer people participating, there's no shortage of meaningful, worthwhile projects, as was evidenced by the reports submitted by representatives at their recent meeting with the Technical Advisory Committee (summaries of which will be published in a forthcoming issue).

The fruits of some of these projects were reported in papers presented by four Societies at this year's Annual Meeting—Baltimore, Cleveland (2 papers), Golden Gate, and Toronto. It's worth noting that Cleveland joins Los Angeles (1989) in presenting multiple papers in the last two years; also, Golden Gate has been represented on the Annual Meeting program for five consecutive years.

All of which confirms that Society Technical Committee activity is alive and well and contributing to the industry's well-being as it has for a goodly number of years.

Thomas A. Kocis
Contributing Editor

Abstracts of Papers in This Issue

NON-OSMOTIC, DEFECT-CONTROLLED CATHODIC DISBONDMENT OF A COATING FROM A STEEL SUBSTRATE— J.W. Martin, E. Embree, and W. Tsao

Journal of Coatings Technology, 62, No. 780, 25, (Nov. 1990)

A non-osmotic, defect-controlled cathodic disbondment model for coating failure is proposed for explaining experimental results which were inconsistent with an osmotically-controlled disbondment process. The proposed model attempts to integrate the physics of blister initiation and growth (that is, the development of internal stresses and the fracture of the coating from the substrate) with the better elucidated chemistry of blister growth. The proposed model has many features which are analogous to the buckling and stress corrosion cracking models proposed for other materials. It also provides an alternative explanation for the well-known barrier effect in coatings.

EVALUATION OF ADDITIVES FOR HIGH SOLIDS, LOW VOC POLYESTER-MELAMINE COATINGS—NEW YORK SOCIETY FOR COATINGS TECHNOLOGY TECHNICAL SUBCOMMITTEE

Journal of Coatings Technology, 62, No. 780, 37 (Nov. 1990)

One of the problems facing formulators today is surface imperfections in solvent-based, high solids, oil-free polyester-melamine bake enamels. The objective of this study was to focus on trends attributable to various additives used to overcome or eliminate surface imperfections in these products.

Five suppliers of polyester resin submitted samples of high gloss, white, oil-free polyester-melamine bake enamels manufactured to conform to specified formulation parameters. Samples of these additive-free, low VOC coatings were given to a cross section of additive manufacturers who then submitted a recommended additive. Participating paint manufacturers and test laboratories then evaluated both modified and unmodified coatings to assess the comparative effectiveness of additives in each submitted coating. The findings were analyzed and the relative performance was reported.

A STUDY OF STRUCTURE-PROPERTIES RELATIONSHIPS IN AUTOMOTIVE CLEARCOAT BINDERS BY STATISTICALLY DESIGNED EXPERIMENTS—K.J.H. Kruithof and H.J.W. van den Haak

Journal of Coatings Technology, 62, No. 780, 47 (Nov. 1990)

A rotatable central-composite experimental design is used to study three independent variables of an automotive clearcoat formulation. An outline of the design is described, followed by a regression analysis and an evaluation of the results by three-dimensional plots. It is shown how a limited number of experiments provides a solid base for paint development. The data obtained can also be used for the establishment of acceptable tolerances in both the resin specifications and the paint production process.

The incorporation of a monomer bearing a rigid bulky group in an acrylic automotive clearcoat binder is shown to have a positive effect on the balance between hardness and solids content of the product.

MEASUREMENT AND ANALYSIS OF COATINGS PROPERTIES—T.K. Rehfeldt

Journal of Coatings Technology, 62, No. 790, 53 (Nov. 1990)

Many evaluations in coatings research and development depend upon the positions of test materials on a rating scale of performance. Such properties as solvent and stain resistance, corrosion protection, weathering, blistering, and many criteria of appearance and color are evaluated by rating scale methods. By nature, these evaluations are subjective. Presented here is a procedure, the Rasch method, for converting subjective evaluations into quantitative measurements. The technique is illustrated with an application to a completely balanced experimental design, in which stain resistance was evaluated.

Appearing in December:

1990 Annual Index of the *Journal of Coatings Technology*

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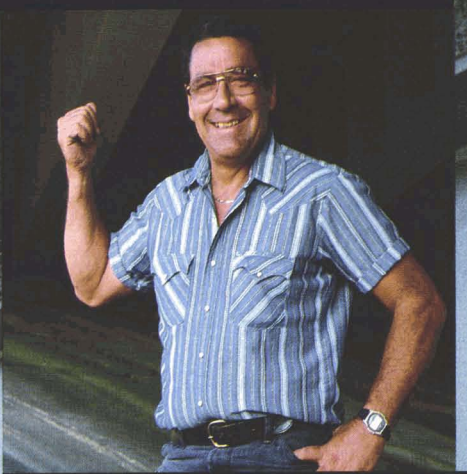
Frank Castjohn didn't believe a waterborne enamel could outperform a solvent coating.



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Study Reports Paints and Coatings Market To Reach $20 Billion Mark by 1995

Growth in the U.S. paints and coatings industry will average slightly more than 8% annually, for a total market value of $20 billion by the year 1995, according to a study conducted by Leading Edge Reports, Cleveland, OH.

"Market Trends for Paints and Coatings" disclosed that the U.S. paints and coatings industry grew 6.4% annually during 1987 and 1989, from slightly over $11 billion to $12.6 billion. In gallons, growth was 3.6% per year for the industry. By comparison, the U.S. economy—as measured by gross national product—grew 7.6% annually during this period.

The marketing study is expecting the total market for paints and coatings to grow at a steady rate—from $12.7 billion to nearly $16 billion. This will represent average annual growth of more than 7% for 1989-1992.

The Leading Edge report discusses the industry in terms of four broad product groups: architectural coatings, product coatings for original equipment manufacturers, special purpose coatings, and miscellaneous allied paint products. Of the four market segments, growth was highest for special purpose coatings, which rose nearly 8% annually during 1987-89. Product coatings enjoyed the next highest growth rate in 1987-89—7.5% per year, followed by architectural coatings with average annual growth of slightly more than 5% annually. The average annual growth rate of approximately 4% experienced by miscellaneous allied paint products was the lowest among the four product groups during the 1987-89 period.

Projected growth for product coatings will average approximately 9% during the years 1992-95. An increase in automobile production, anticipated in the early 1990s, will contribute to its growth. Currently, the two largest end-users of product coatings are the automotive and container and closure industries.

Growth in the special purpose coatings market is expected to average better than 8% per year through 1995. This will be supported by increased expenditures for rebuilding or repairing the U.S.'s very old bridges, power plants, and other public utilities in the 1990s.

The architectural coatings market will improve enough during the next two years to support average annual growth in excess of 7%, supported partly by continued vigor in home remodeling and maintenance, and by the anticipated recovery of new residential construction. Growth beyond 1992 will average more than 8% per year in this market segment.

Although 5% annual growth is expected for miscellaneous allied paint products during 1989-92, this market will nonetheless remain the industry's poorest performer throughout the forecast period. Since the majority of the products in this market are complementary to paints and coatings, their demand is directly proportional to the demand for coatings.

As a group, architectural coatings constitute the largest component of the total market for paints and coatings, accounting for approximately 37% and 44%, respectively, of the value and volume of the total in 1989.

The next largest product group is product coatings for original equipment manufacturers, which in 1989 accounted for roughly 35% of the total market value and 30% of total volume in 1989.

With nearly 20% and 13% of market value and volume, respectively, special purpose coatings were the third largest market segment in 1989. This group includes coatings for the transportation aftermarket, industrial maintenance coatings, and miscellaneous specialty coatings such as those used in metallic, traffic, marine, automotive, and aerosol applications.

Miscellaneous allied paint products is the fourth and last category and consists of products that are related to paints and coatings, but which cannot be grouped as such. It includes wood and textile preservatives, such as wood fillers and sealers, putty and glazing compounds, paint and varnish removers, brush cleaners, thinners for dopes, lacquers, paint and varnish driers, pigment dispersions, and bleached shellac. This market accounted for the remaining 8% and 13%, respectively, of the total value and volume of the paints and coatings market in 1989.

The market trends study reports that the U.S. market for paints and coatings is exceedingly mature and is characterized mainly by low but stable growth rates. Demand in this market is directly dependent on the fortunes of the construction and industrial manufacturing sectors of the economy—for example, automobiles, appliances, aircraft construction, and furniture—which are subject to cyclical fluctuations. In addition, the study states the demand for architectural coatings, currently the largest market segment of the coatings industry, is also highly seasonal; demand in this segment peaks during spring and summer when climatic conditions become most favorable for exterior painting.

The "Market Trends for Paints and Coatings" report was published in August 1990. For more information on the study, write Leading Edge Reports, 12417 Cedar Rd., Suite 29, Cleveland Heights, OH 44106.

Suit Filed in Court Over EPA's Superfund Decision

The Chemical Manufacturers Association (CMA), Washington, D.C., has reported that a group of industry organizations filed suit, on September 18, in federal court challenging the Environmental Protection Agency's decision to prohibit companies from conducting risk assessments at federal Superfund sites.

The petitioners, comprised of the CMA, the U.S. Chamber of Commerce, the National Association of Manufacturers, and the American Iron and Steel Institute contest EPA's directive, claiming it "interferes with the efficient and successful implementation of the Superfund program."

The suit charges that EPA's directive constitutes an unlawful rulemaking by not providing advance notice and opportunity for public comment. According to CMA, EPA's June action makes the Agency solely responsible for conducting risk assessments at Superfund sites. Previously, companies performing site cleanups ("potentially responsible parties") had conducted many of their own risk assessments.

Risk assessments are an integral part of the Remedial Investigations/Feasibility Studies performed at all Superfund sites to help determine the appropriate cleanup measures taken at those sites.

It is the belief of officials at CMA that "EPA's recent action undermines the statute" which authorizes and encourages PRPs to perform RI/FSs under governmental oversight.

Annual Paint Contest Begins Ninth Season

The ninth annual "Picture It Painted Professionally" contest is underway. Projects will be judged on the creative use of color, use of special painting techniques and unusual treatments, overall creativity, and skill and execution.

Projects can be entered in five categories: "Interior Residential," "Exterior Residential," "Interior Commercial/Institutional," "Exterior Commercial/Institutional," and "Industrial." Contestants can submit as many projects as they wish, with entries limited to jobs completed in 1989 or 1990.

Judges will select first and second prize winners and honorable mentions in each category. Winners will be announced at the 1991 Painting and Decorating Contractors of America (PDCA) Annual Awards Luncheon, in Atlanta, GA, in 1991.

The contest is sponsored by the National Paint and Coatings Association (NPCA), Washington, D.C., and the PDCA to recognize PDCA members for their outstanding work.

For more information, contact Katrina Norfleet, NPCA, 1500 Rhode Island Ave., NW, Washington, D.C. 20005.

Wisconsin Coatings Corp. Acquires Briner Paint

Wisconsin Protective Coatings Corporation, Green Bay, WI, has announced the acquisition of Briner Paint and Manufacturing Company, Corpus Christi, TX.

There are no immediate plans for any changes within the Briner organization. Paul Laudadio, President of Briner, and his entire staff will remain with the company.

Bohlin Reologi Relocates To New Facility in Lund

Bohlin Reologi AB, Science Park Ideon, Sweden, has moved to new offices near Ideon in Lund. Bohlin's move comes after nearly seven years at the Science Park Ideon site.

The new facilities provide additional space for application laboratories, product development, courses, and consultation.

Opening ceremonies were held on September 3 at the new building.

Realignment Announced by Ashland Chemical Co.

A number of changes in reporting relationships within the Ashland Chemical Company, Columbus, OH, have been announced.

In anticipation of the retirement of Group Vice President Donald L. Coticchia, the following company moves have been announced. All distribution divisions now report to Group Vice-President Phillip D. Ashkettle. These divisions include Industrial Chemicals & Solvents, General Polymers, Thermoplastic Services, and FRP Supply. All specialty divisions now report to Group Vice President Robert E. Gottlieb. Those divisions include Foundry Products, Composite Polymers, Drew Industrial, Drew Marine, Specialty Polymers and Adhesives, and Electronic and Laboratory Products. The Petrochemical Division reports to Scotty B. Patrick, Group Vice-President, Petrochemicals and Technical.

In addition, the Licensing and Public Relations departments report to D.S. Boston, Administrative Vice President.

Mr. Coticchia will continue to represent the company as Chairman of the Chemical Manufacturers Association's Chemical Diversion Task Group.

Construction Contracting Declines 3% in August

The F.W. Dodge Division of McGraw-Hill, New York, NY, has reported that construction contracting declined 3% in August to 146 (1982=100).

In August, the value of both nonresidential and residential building eased four percent from their July rates of contracting, while nonbuilding construction (public works and utilities) edged up one percent. For the year to date, 1990 construction contracting trailed the value for the year-ago period by 8%.

Office building contracting continued its steep drop-off, while sewer and water projects rebounded sharply. Housing remained weak in August, as a decline of one-family home building more than offset a modest gain in multifamily construction.

Through eight months of 1990, most major regions of the nation showed declines from their 1989 totals, led by the Northeast with its 24% shortfall. The Southeast, at -14%, also reported an above-average drop in newly started construction, while the South Central, at -6%, and the West, at -2%, held closer to last year's levels. The North Central, with the only year-to-date gain, 3%, has recently been losing some of its earlier lead over 1989.

Battelle Researchers Study Nonlinear Optical Materials

Researchers at Battelle, Columbus, OH, are predicting innovative new devices based on nonlinear optical materials are likely to replace many traditional electronic devices in the automotive, telecommunications, and consumer electronics industries during the coming years. The findings are part of a recently completed multiclient program at Battelle called "Advances and Opportunities in Nonlinear Optical Materials."

The 700-page report from Battelle provides detailed information about the properties of nonlinear optical materials, as well as market information relating to potential applications of these materials.

At the present, 37 companies—31 from Japan, three from Europe, and three from the U.S., are using the information gathered during 18 months of research. The results of the program are available to new subscribers for the price of $15,000 per subscription.

For more information about the program, contact Robert E. Schwerzel, Battelle, 505 King Ave., Columbus, OH 43201-2693.

Construction Underway on New Reichhold Headquarters

Reichhold Chemical Inc., Research Triangle Park, NC, is consolidating its corporate headquarters, three division headquarters, and laboratories for three divisions in a new headquarters/laboratory complex in Research Triangle Park.

Construction on the new complex currently is underway. The office portion of the building is scheduled for completion by the end of 1991. The laboratory is expected to be ready for occupancy in January 1992.

The three divisions relocating to the new building are the Coating Polymers & Resins Division, Emulsion Polymers Division, and Reactive Polymers Div. Headquarters staff of the divisions, as well as corporate headquarters, are now located in temporary offices at Alston Technical Park, in Durham, NC, just outside Research Triangle Park.

Minneapolis Hosts FSCT Educational Steering Committee Meeting with Society Educational Committee Chairmen

Representatives of Society Educational Committees met recently with members of the Federation Educational Steering Committee in Minneapolis, MN. Topics of discussion included Society-sponsored educational activities; scholorship programs of the Federation and individual Societies; status of the A.L. Hendry Award competition; report on the Professional Developments Committee; and suggestions on how to assist Societies in enriching educational activities.

The meeting was chaired by Sid Lauren, of the New England Society, Chairman of the FSCT Educational Steering Committee.

In addition to the Chairman, the following Steering Committee members attended: Paul Baukema (Louisville); Don Boyd (Pittsburgh); John Gordon (Los Angeles); Berger Justen (Southern); Carl Knauss (Cleveland); Gerry Mattson (Southern); and John Oates (New York).

The Society Educational Committee representatives in attendance included: Mary Somerville (Baltimore); Bryn Irvine (CDIC); DeVilla Moncrief (Cleveland); Gabriel Gabriel (Detroit); William Porter (Kansas City); Eduardo Villegas (Mexico); Alex Vignini (Montreal); Don Brody (New York); Ed Erickson (Northwestern); Dave Pasin (Pacific Northwest); Richard Granata (Philadelphia); Craig Schweiger (Rocky Mountain); Howard Jerome (St. Louis); Walter Fibiger (Toronto); and Ed Walker (Western New York).

Guest attending was Lowell Wood, Past-President and Honorary Member of the Northwestern Society.

Also attending was Tom Kocis, FSCT Director of Field Services.

Chairman Lauren extended welcoming remarks, introduced Lowell Wood and the members of the Steering Committee, then called for self-introductions by the Society Representatives.

Minutes of the previous meeting (June 13, 1989, in Montreal, Canada) were then approved as submitted.

Society Reports on Activities

Society representatives had been asked to prepare brief summaries of their educational activities for presentation at the meeting, and Chairman Lauren had scheduled their reports as the first order of business. The following capsules the written and/or verbal reports submitted and discussed.

Baltimore

Continued sponsorship of 10-week Basic and Intermediate Coatings Technology course at Catonsville Community College; arrangements underway to again present the course this fall . . . Federation videotape, "The Choice," was shown at two local high schools, as part of their Career Day activities; was also shown to U.S. Navy research personnel, as reference source for their summer co-op students, to build awareness of coatings career opportunities in corrosion prevention . . . Distributed notices to six institutions of higher learning in the Baltimore area, promoting A.L. Hendry Award competition . . . Arranged for technical presentations at two Society meetings . . Scholarship awards continuing; these are made to children of Society members.

C-D-I-C

Continuing sponsorship of educational after-dinner presentations as part of Society monthly programming (technical presentation precedes dinner). Current program year presentations included: slide/narrative travelogue on Borneo; discussion by attorney of general legal matters; statistical process control applications in the chemical industry; computer, fiber-optics, and cellular telephone technology; review of investment management techniques; discussion of fire department's responsibilities in event of chemical spill, as well as dealing with hazardous waste, right-to-know, and other environmental considerations . . . Developing guidelines for implementing recently authorized fund to supplement expenses for selected recipient to attend coatings short course.

Chicago

Jointly sponsor educational activities with local Paint and Coatings Association . . Held two-day SYMCO seminar on regulatory affairs and compliance; first day pertained to trade sales, second day to industrial coatings . . . Presented 16-week introductory coatings course at DePaul University; topics covered included formulating techniques, raw materials, basic calculations, quality assurance, application methods, manufacturing, problem solving, and environmental considerations . . . Administered scholarships/grants-in-aid to several students enrolled in polymer/coatings technology programs at various colleges.

Cleveland

Expanding support for Northeast Ohio Science Fair; promotional mailing sent to 70 area high schools advising of Society awards for coatings-related projects, as well as listing suggested topics and offer to provide "advisors" for interested students. Twenty-seven students were sponsored, seven of whom received cash prize awards from Society . . . Eight presentations were made at three area high school "Career Days," at which the videotape, "The Choice" was shown; efforts greatly assisted by liaison with Northeast Ohio Science Teachers Association . . . Considering participation in local Junior Achievement program for 1990-1991 . . . Major activity continues to be development of Annual Advances in Coatings Technology Conference; 1990 event scheduled for June 6-7, at NASA Lewis Research Center.

Detroit

Sponsorship of evening courses at University of Detroit continues. Six courses are currently offered: Coatings Laboratory; Surface Coatings Technology; Fundamental of Automotive Paint Systems; Polymer Technology for Coatings; Principles of Color Technology; and Electrodeposition . . . Cooperating with University of Detroit's Dept. of Continuing Education to offer in-house training courses, designed specifically for companies participating; two courses being offered this year . . . Annual FOCUS conference, held April 25, had as its theme, "Pollution: Prevention, Control, Elimination" . . . Again donated funds in support of Eastern Michigan University's workshop for high school teachers . . . Committee Chairman accompanied Steering Committee member John Oates on his visit to University of Detroit, to review coatings program

there . . . Contributed $4,000 to University of Detroit Polymer Institute, for research underway on paint-related resins . . . Continue to make available Federation A/V programs on a loan basis to area paint companies and students in coatings courses . . . Plan to continue holding Education Night; next event to feature speaker from local university.

Kansas City

Main activity is continuing participation in local Science Fair. Committee members judge coatings-related projects; winning students are awarded saving bonds and their high school science departments receive checks in matching amounts. These are presented at Society monthly meeting, to which parents and teachers are also invited . . . Contributed $500 to University of Missouri-Rolla scholarship fund, for students pursuing degrees in polymer science and coatings.

Los Angeles

Development of undergraduate coatings program at California Polytechnic State University at San Luis Obispo is proceeding on schedule, with first group of students to be enrolled this fall. Incoming freshman will attend June 20-29 introductory short course. The students will be subsequently employed in summer jobs at local paint companies to gain hands-on experience. Special effort is being made to recruit disadvantaged students; committee has been formed for this effort, and will include assignment of a mentor for each student, to serve as a role model . . . Sponsorship of evening basic coatings technology course continues, as does scholarship program (funded by Society for students planning to major in some aspect of coatings technology).

Louisville

Major activity is continuing education courses offered in Surface Coatings Technology at University of Louisville, co-sponsored with Department of Chemical Engineering. Students are offered an integrated overview of the composition, formulation, manufacture, and end-use and application of surface coatings. The courses, offered in four semesters, are designed to complement one another, but can be taken independently . . . Annual symposium topic this year was Hazardous Waste Reduction . . . Society committee developed programming for 1990 Federation Spring Seminar, held in Louisville, May 16-17.

Mexico

Sponsored course, presented by John Gordon, on "Philosophy of Paint Formulation," held April 24-27, in Guadalajara, with 95 technicians attending; event was videotaped, with simultaneous translation to Spanish, and will be offered to Latin American market . . . Holding third annual technical symposium in Puebla; because of increase in number of lectures, concurrent sessions will be held . . . Seeking closer liaison with U.S. and overseas colleges, to promote interest among instructors to present lectures in Mexico . . . Planning to produce Spanish translation version of "The Choice."

Montreal

Continuing sponsorship of bilingual 15-week course on coatings technology; students successfully completing course are awarded certificates . . . Distributed notices to six local colleges, promoting A.L. Hendry Award competition . . . Assisting in judging entries in Science Fair.

New England

Continue support and promotion of coatings and adhesives program at the University of Lowell. The M.S. program in the Plastics Engineering Dept. has approximately 40 students attending evening classes, and last year granted three degrees. New B.S. program in applied chemistry with an option in coating is being offered as an evening program for technicians in the coatings industry . . . Awarded scholarships to four full-time college students who authored best coatings-related essays.

New York

Educational activities jointly sponsored with local Paint and Coatings Association. Course on Simplified Organic Chemistry for Coatings Technologists, which had been offered every other year, has been merged into the course, Understanding the Basics of Coatings I & II. This is a two-year, four-semester curriculum; each one year, two-semester module is a complete course in itself and may be taken independently—a certificate of completion is issued to students who achieve a grade of "B" or better. Each of the four semesters qualifies for three CEU's of credit . . . Laboratory Course for Paint Technicians is designed for newcomers to the industry, and combines basic theory with demonstrations and "hands-on" lab exercises; course is offered when survey of membership indicates sufficient interest . . . Ongoing effort continues toward establishing Coatings Center at Fairleigh Dickinson University (East Rutherford, NJ), where Understanding the Basics course is presented; underway currently is development of teaching outline, to be followed by a laboratory exercise curriculum . . . Assisted in presentation of continuing series of seminars preceding regular Society monthly meetings, at which expert speakers update members on regulatory matters . . . Seeking teaching outlines for college level lab experiments on coatings technology, as well as support literature to supplement member presentations of "The Choice" . . . Continuing scholarship funding.

Northwestern

Held third annual Education Night, attended by several local high school students and their science teachers, as well as 25 students from North Dakota State University. Federation representatives joined industry speakers in promoting coatings career opportunities . . . Topic of Annual Spring Symposium was "Coatings and the Environment"; featured presentations were on formulation, waste clean-up, regulations, and ramifications of EPA rules . . . Members visited several area high schools to promote awareness of career opportunities in the coatings industry and to show "The Choice" videotape . . . Continuing funding support of NDSU scholarship program . . . Planning to establish cash award for best paper(s) authored by local science students on some aspect of coatings technology . . . Assisted in development of programs for monthly Society meetings, which feature two speakers—one on a technical subject, and one on a general topic.

Pacific Northwest

Continuing funding support for scholarship program . . . Members presented "The Choice" videotape at various local high schools . . . Vancouver Section sponsoring introductory and advanced coatings technology courses at Kwantlen College, as well as advanced course for applicators at the British Columbia Institute of Technology.

Philadelphia

Sponsored introductory coatings technology course, held at Northeastern Christian Junior College; course was designed for new coatings formulators, as well as sales and marketing personnel in coatings and allied industries, and qualified for 3.6 CEU credits . . . Annual spring seminar had as its topic, "Advances in Technology to Meet New VOC Regulations."

Piedmont

Initiated scholarship program for local college undergraduate chemistry students who expressed interest in pursuing coatings career . . . Continuing sponsorship of summer co-op programs for local college chemistry majors; have placed three students in this year's program.

Rocky Mountain

Little activity due to diminished Society membership and lack of ability to maintain

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continuity. Donated $1,000 to Cal Poly for new coatings program.

St. Louis

Hosted annual Education Night; 53 high school mathematics, chemistry, and science teachers from Central Missouri and Southern Illinois attended. "The Choice" video tape was shown, and number of teachers requested subsequent presentations to their students; program included demonstration of some typical coatings lab chemical reactions, and teachers were presented with copies of procedures for their use in duplicating the reactions in their classrooms. Also scheduling several field trips for local high school science classes; will visit participating paint and resin plants in the St. Louis area . . . Announced availability of scholarship funding to attend University of Missouri-Rolla short course, for personnel currently employed in local coatings industry; qualification criteria currently being developed for awards, which are to be presented this fall.

Southern

Close liaison continues to be maintained with University of Southern Mississippi through support of scholarship program and sponsorship of annual Water-Borne and Higher Solids Coatings Symposium . . . Sponsor A.L. Hendry Award for best undergraduate student-authored paper on some aspect of coatings technology . . . Continuing sponsorship of one-day seminars on various topics at Society Sections.

Toronto

Continuing to promote and support coatings courses offered at George Brown College, through Industry Advisory Committee and providing industry lecturers; currently reviewing curriculum and lecture notes to assure students are presented "state-of-the-art" material. Lecture notes will be compiled to serve as course text; considering videotape of test procedures to supplement the new text.

Western New York

Scholarship program was expanded as result of matching funds provided by Buffalo PCA; three scholarships ($800 each) were awarded to full-time college students who are dependents of Society members . . . Distributed promotional material on A.L. Hendry Award competition to area colleges/universities . . . Presented "The Choice" videotape at 17 local high schools, and at Science Exploration Day at State University of New York at Buffalo; presentation was supplemented with commentary and experiments provided by Society members . . . Continuing participation in local science fair, judging and providing cash awards.

Survey of Society Financial Support for Educational Activities

As noted in the reports, many Societies have ongoing scholarship programs; these provide substantial funding which makes a significant contribution to the effort to recruit students into the coatings industry and are deserving of due and proper recognition.

Accordingly, a tabulation of funds contributed by Societies to subsidize education-related activities is being compiled for publication.

The tabulation, to be published in JCT, is proposed as an annual effort.

Hendry Award Competition

The Southern Society A.L. Hendry Award competition is administered by the Educational Steering Committee.

The Award ($1,000) is for the best undergraduate student-authored paper on some aspect of coatings technology; deadline for receipt of manuscripts is July 1.

Rules of eligibility for the competition were changed this year, to include review-type papers, and to reflect the contributions of the faculty advisor to a student paper based on original research, by including his/her name as co-author.

Increased promotional efforts have broadened awareness of the competition, and Chairman Lauren thanked the Society representatives for their cooperation in this regard.

Review of Federation Scholarship Program

Federation scholarship funding for the 1990-91 academic year totals $43,000 (up from $40,000 appropriated for 1989-90), distributed among six schools: University of Detroit—$2,000; Eastern Michigan University—$9,000; Kent State University—$7,000; University of Missouri-Rolla—$9,000; North Dakota State University—$10,000; and University of Southern Mississippi—$6,000.

The funding reflects the appropriations recommended by the Steering Committee for each school.

Scholarship funding for the University of Waterloo was not renewed this year because that school does not have an undergraduate coatings program. The facility there has been advised that "the door is open" for scholarship support and was encouraged to pursue development of an appropriate undergraduate curriculum. In recognition of Waterloo's excellent graduate program, however, Steering Committee has recommended to the Federation's Coatings Industry Education Fund that the school be considered for a fellowship grant.

Meanwhile, the Federation has appropriated $20,000 to help establish a coatings degree program at California Polytechnic State University at San Luis Obispo; this has been augmented by a $5,000 grant from CIEF. A planned curriculum of coatings courses is in place, and the program is to get underway this fall. Initially, program will lead to B.S. degree in Polymer Chemistry with Concentration in Coatings; subsequently, full curriculum of coatings courses is planned. Co-op internships are included in the program.

Chairman Lauren commented that the Steering Committee is undertaking to develop closer ties with the schools receiving scholarship funds. Each school is being visited by a Steering Committee member, to learn more about their programs, faculty, and students. Thus far, three schools have been visited (John Oates, to University of Detroit and Eastern Michigan University; and Paul Baukema, to University of Missouri-Rolla).

John Oates reported that there are currently between 50 and 60 students enrolled in the coatings program at Eastern Michigan University, most of whom are recruited from junior colleges. EMU's "capture rate" (number of graduates entering the coatings industry) is high—in the last three years, 30 of 46 graduates have entered the coatings or allied industries.

At the University of Detroit, coatings courses are offered through the Department of Chemistry and Chemical Engineering. The University sponsors a series of evening courses, taught on campus, in conjunction with the Detroit Society. Industry personnel serve as instructors for these courses, which cover such topics as polymer technology, principles of color, fundamentals of automotive paint systems, and electrodeposition. The University also assists the Society Technical Committee in its project work.

On his visit to University of Missouri-Rolla, Paul Baukema said he was impressed with the program, courses, and facilities, and that the operation there is "hands-on" oriented.

Rolla's capture rate varies each year, but a fair number do join coatings manufacturers or supplier firms. As is the case at EMU, a portion of each graduating class go on to graduate study.

Report on Professional Development Committee Activities

Tom Kocis briefly reported on the activities of the Professional Development Committee, which are aimed at promoting continuing educational opportunities for coatings industry personnel.

The series of regional seminars on Statistical Process Control was repeated and was again well attended and received. Initi-

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ated in 1987, the seminars are now in their fourth year and have attracted almost a thousand registrants; conducted by Dr. Peter Hunt, they are specifically aimed at the application of SPC to coatings industry operations.

PDC is developing two 1½-hour sessions for Annual Meeting presentation, one on "Advanced Topics in Coatings Research" and a second on "Testing: The Key to the Quality Revolution." The "Testing" session is a step in the Committee's objective to build awareness of the importance of accurate and reproducible testing.

The FSCT member/career survey, conducted by the Committee, yielded a 50% return. Responses are being correlated and results will be published in JCT. As with the previous survey (conducted in 1986), results will provide a useful database on FSCT membership which will assist PDC efforts to develop continuing educational programs of interest.

Suggestions on How to Assist Societies to Enrich Educational Activities

Chairman Lauren noted that programming for Society monthly meetings is an important educational effort, and that good technical presentations are vital to maintaining member interest and attendance. Good programming requires careful planning and scheduling, but speakers do not always deliver up to expectations—or may cancel on short notice, resulting in last-minute search for a replacement.

With modern videotaping capability, he said, it should be possible, at modest expense, to arrange to videotape outstandingly good presentations on subjects of particular interest after they have been previewed at a Society meeting. The taping could be accommodated in a studio or similar setting for best results, and a videotape library of such presentations could be developed which could provide a Society with a replacement for a canceled speaker on short notice, as well as serve to broaden the audience for an outstanding talk that might otherwise be limited to a "one night stand."

There was much interest expressed in the suggestion, and Chairman Lauren said he would pursue the proposal. A question to be answered is whether this should be implemented by the Educational Steering Committee or the Professional Development Committee, should it meet with approval and be deemed worthy of funding, and he will discuss with the Chairman of PDC.

On another topic, it was noted that developing a comprehensive teaching outline for a coatings course is a formidable task, and it would be extremely helpful to those who are involved in or contemplating such an undertaking if a Society with such an outline in place would be willing to share that information.

It was pointed out that much time and effort goes into the development of a syllabus, and a Society wishing to access the material should anticipate paying a stipend to do so.

Open Forum

Eastern Michigan University sponsors an annual summer workshop for area high school chemistry teachers, to acquaint them with the coatings industry, its technology, and its career opportunities, so that they can carry this information back to their students; this has assisted EMU's recruitment program and is an activity that could be sponsored by a Society to help promote interest in coatings careers among local high school students . . . In presentations of the videotape, "The Choice," it would be helpful to have academic, as well as industry, personnel on hand to provide supplementary commentary . . . FSCT annual "Guide to Coatings Courses" will be updated for 1991; requests for information on Society-sponsored courses, symposia, and seminars will be sent to Educational Committee Chairmen in November.

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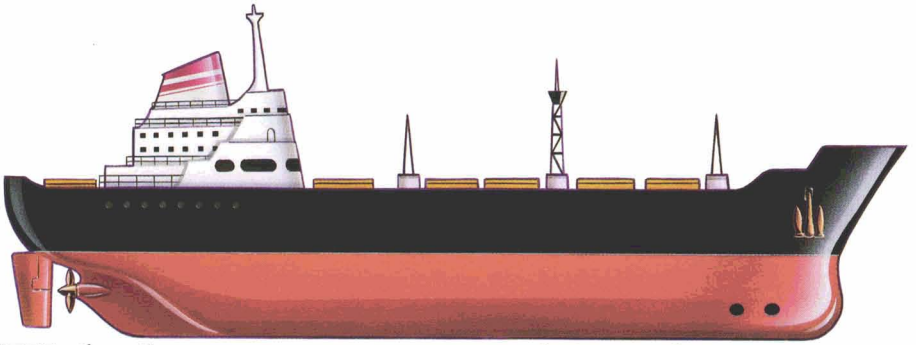

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Non-Osmotic, Defect-Controlled Cathodic Disbondment Of a Coating from a Steel Substrate

Jonathan W. Martin, Edward Embree, and Wynee Tsao
National Institute of Standards & Technology*

A non-osmotic, defect-controlled cathodic disbondment model for coating failure is proposed for explaining experimental results which were inconsistent with an osmotically-controlled disbondment process. The proposed model attempts to integrate the physics of blister initiation and growth (that is, the development of internal stresses and the fracture of the coating from the substrate) with the better elucidated chemistry of blister growth. The proposed model has many features which are analogous to the buckling and stress corrosion cracking models proposed for other materials. It also provides an alternative explanation for the well-known barrier effect in coatings.

INTRODUCTION

It is generally agreed that the first step in the cathodic disbondment of the coating from unscribed coated panels is the formation of one or more layers of water in the interfacial region between the coating and the substrate.[1] The presence of this interfacial water greatly reduces the adhesive strength of the coating through a process called water disbondment.[1]

Once the wet adhesive strength of the coating has been reduced, a cathodic blister can form at a weak point[1] or at a cation ingress point[2,3] in the coating; that is, at a defect. The principal mechanism for blister formation is believed, by many, to be osmotic disbondment;[4-8] that is, disbondment of the coating from the substrate resulting from the build-up of pressure in the interfacial region when water is transported into and through the coating under a solute gradient. Osmotic disbondment also contributes to blister growth through the exertion of peel-type stresses on the delamination tip at the periphery of a blister.[1]

The original objective of this research was to determine the temporal variability in the cathodic disbondment for 30 unscribed, nominally identical coated steel panels immersed in a 5% solution of NaCl in water. The intent was to identify the sources of variability and to clarify the rate limiting steps in cathodic delamination. As the research progressed, however, it became evident that our experimental observations were not consistent with an osmotically-controlled blister growth process. Thus, our efforts were redirected toward identifying a non-osmotic blister initiation and growth mechanism.

EXPERIMENTAL

The experimental procedure for the unscribed panels is almost identical to the one described in Martin et al.[9] for scribed panels. Only differences, therefore, are highlighted.

Thirty matte-finished, SAE 1010, low carbon, cold-rolled steel panels were selected, each having dimensions of approximately 100 × 150 × 0.8 mm and surface roughnesses ranging from 0.9 to 1.3 μm. The panels were vapor degreased in trichlorethylene in accordance with ASTM D 609-73 (1980)[10] prior to applying the primer. This cleaning procedure was in addition to the one performed by the panel manufacturer.

The primer and topcoat were applied over the degreased panels as described in Martin et al.;[9] that is, one layer of primer and two layers of topcoat. After each coating layer was applied, the coating system was cured in an oven at 70°C for 24 hr. The thicknesses of primer and primer-plus-topcoat were taken at eight locations on

*U.S. Dept. of Commerce, Gaithersburg, MD 20899.

Table 1—Comparison of the Primer, Topcoat, and Primer-Plus-Topcoat Thicknesses for the Scribed (Martin et al. 1989) and Unscribed Continuously Immersed Panels

	Primer (μm)		Topcoat (μm)		Primer + Topcoat (μm)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Scribed.....	74.6	13.5	65.4	15.1	140.0	19.2
Unscribed.....	78.5	3.8	66.9	5.9	145.4	7.3

each panel. As shown in *Table* 1, the primer, topcoat, and primer-plus-topcoat thicknesses were not significantly different from those of the scribed panels.

Prior to immersing the unscribed panels in a 5% solution of NaCl, having a pH of 7.0 ± 0.1, the edges of the panels were protected by dipping them into a molten solution of hot-melt adhesive. Hot-melt adhesive was applied, instead of tape,[9] because the coating on the unscribed panels tended to crack and corrode after long immersion times (greater than 2000 hr) at the intersection of the coating and tape. This did not occur in the hot-melt adhesive panels, even after 8000 hr of immersion.

All of the continuously immersed, unscribed panels failed through cathodic blistering. The initiation sites of the cathodic blisters were randomly distributed over the surface of the panels, making it difficult to use the systematic procedure, described in Martin et al.,[9] for evaluating the amount of panel degradation. Instead, a new procedure was instituted in which the initiation site of each blister was visually located and its diameter measured after each inspection. Estimates of the percent of the sampling area degraded, the measure of degradation used in Martin et al.,[9] were then made using a computer program developed by Tsao and Martin.[11]

RESULTS

The continuous immersion experiment for the unscribed panels was terminated after 5856 hr. At that time, 24 of the 30 panels exhibited cathodic blisters, while the other six panels remained blister-free. Curves showing the percent area degraded versus immersion time are plotted in *Figure* 1 for the 24 blistered panels. These curves correspond to the scribed panel degradation curves presented in *Figure* 3 of Martin et al.[9]

The radial growth of the blisters on two of the panels versus immersion time are presented in *Figure* 2. Only one blister formed on the first panel (*Figure* 2a), while multiple blisters formed on the second panel (*Figure* 2b). Of the 24 panels which blistered, 23 exhibited multiple blisters.

From the shape of the radial growth versus immersion time diagrams, the cathodic blistering process (*Figure* 3) can be partitioned into two periods—an incubation period, of length h, during which no blisters appeared, followed by a blister initiation and a growth period. During the blister initiation and growth period, radial growth was constant in time; that is, $dr/dt = k$, where r is the radius of the blister and k is a constant. Thus, knowing the incubation time, h_{ij}, and the rate of radial growth, k_{ij}, for the i-th blister on the j-th panel, its radius, r_{ij}, could be predicted by

$$r_{ij} = k_{ij}\,(t - h_{ij}) \quad \text{for } t \geq h_{ij} \tag{1}$$

where t is the immersion time. For the blisters in this experiment, the average rate of radial growth, k, was 1.86×10^{-7} cm/s. From equation (1), it follows that the area of disbondment, $A_{ij}(t)$, for the i-th blister on the j-th panel after an immersion time t can be predicted from

$$A_{ij}(t) = \begin{cases} 0 & \text{for } t \leq h_{ij} \\ \pi\,(k_{ij}\,(t-h_{ij}))^2 & \text{for } t > h_{ij} \end{cases} \tag{2}$$

while the total disbonded area for the j-th panel can be determined by summing the contribution from each of the blisters on the j-th panel; that is,

$$A_j(t) = \sum_{i=1}^{n} A_{ij}(t) = \sum_{i=1}^{n} \pi\, k_{ij}\,(t-h_{ij})^2 \cdot \tag{3}$$

Ordinarily, equation (3) would be sufficient for determining the percent area of a panel degraded versus time (the curves in *Figure* 1). Practically, however, equation (3) does not account for blisters growing into the edge of a panel or the coalescence of blisters. Since these events tend to occur at a high degradation percent, equation (3) only provides a good estimate of early degradation; that is, disbondment percents below approximately 10%. To account for the edge and blister coalescence effects and to facilitate comparisons with the previously published data for scribed, continuously immersed panels,[9] a computer program was written which computes the percent of the sampling area which has degraded at each inspection period.[11] The output from this analysis is plotted in *Figure* 1.

From an inspection of percent area degraded versus immersion time curves (*Figure* 1), most of the variability

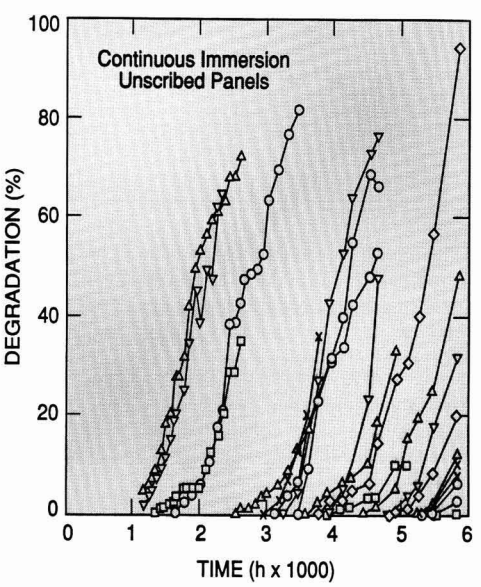

Figure 1—Percent area degraded vs immersion time for 24 of the unscribed panels. Six panels remained blister-free and thus the degradation curves for these panels do not appear

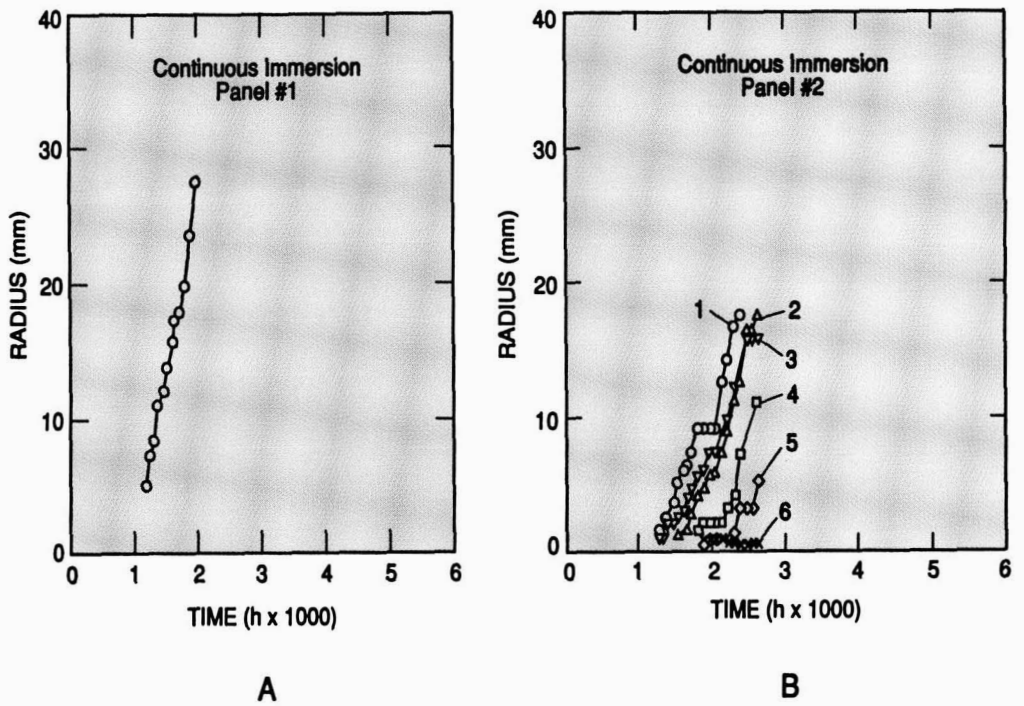

Figure 2—Increase in blister radius with immersion times for two panels: (a) panel with a single blister, and (b) panel with multiple blisters where the blisters are numbered in the order of their appearance

in the degradation of the unscribed panels can be attributed to variability in the panel incubation times as opposed to variabilities in the blister growth rates. The blister incubation times ranged from 1200 hr to greater than 5856 hr (the time that the immersion test was terminated), while the growth rates of the blisters remained relatively uniform. A multivariate regression analysis was performed to determine if the panel incubation times were dependent on the primer, topcoat, or primer-plus-topcoat thicknesses. No such dependency was found; that is the incubation time for a panel does not depend on the thickness of any of the coating layers.

While the between-panel variability in the incubation times was quite high, the within-panel variability in the incubation times was quite small; that is, once the first blister formed on a panel, others soon appeared (see *Figure* 2). A low within-panel variability indicates that either the entire coated surface of a panel becomes "weak" at the same time or that the first blister somehow "weakens" the coating, making it more favorable for the creation of new blisters. This latter process is often termed a contagion process.[12] Evidence for a contagion-type process in coating degradation has been reported by at least two researchers, Nguyen and Lin[13] and Leidheiser et al.,[14] who observed that chloride ions could be transported interfacially over long distances. At this time, our experimental data are not refined enough to discriminate between these two processes.

When a blister first appeared on a panel, it tended to have an almost spherical shape (see *Figure* 4a). This spherical shape became distorted when the diameter of the blister exceeded approximately one centimeter (see *Figure* 4b), whereupon the blister became wrinkly and

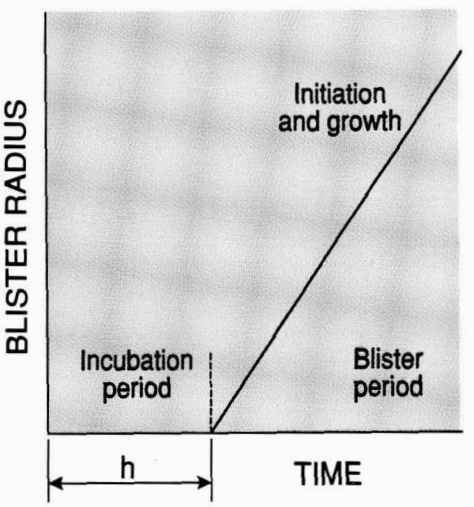

Figure 3—Incubation and blister growth periods

flaccid in appearance. This wrinkly, flaccid appearance came about because the blister volume was only partially filled with liquid. As shown in *Figure* 2, this change in appearance did not affect the radial growth rate of the blister, which remained constant and linear in time.

Several panels containing small, spherical shaped blisters were removed from the immersion liquid and immediately lanced with a needle to obtain a qualitative assessment of the liquid pressure within a blister. When lanced, the blisters neither contracted nor released liquid from the incision. In some cases, the blister's spherical volume was almost devoid of liquid. Similar observations have been made by other researchers; for example, see the discussion by Cannegieter in Bullett and Rudran.[5]

Blisters on 15 of the panels (20 blisters in all) were physically and chemically characterized at the time the panels were terminated from the immersion experiment; the termination times for these censored panels ranged from 2600 to 5856 hr. The following measurements were made on each blister: primer thickness, topcoat thickness, and primer-plus-topcoat thickness, radius, pH of the blister liquid, and the Na^+ and Cl^- ion concentrations of the blister liquid using the procedures described in Nguyen and Lin.[13] The average, standard deviation, and range of these measurements are presented in *Table* 2.

From the experimental measurements reported in *Table* 2 and from other statistical analyses, the following observations were made: (1) the blisters remained almost circular in shape except when blisters coalesced or grew into the edge of the panel; (2) the coating film over all of the blisters remained intact for the duration of the immersion experiment except for one blister which had corrosion products exuding from it; (3) the substrate underneath the blisters was generally free of corrosion, except for a small corroded area near the center of a blister and for the blister having a ruptured film; (4) the blister liquid was alkaline (average pH = 9.1), except for the ruptured blister which had a pH of 6.73; (5) the thicknesses of the primer, topcoat, and primer-plus-topcoat at the blister sites were not significantly different from the thicknesses of the coating layers over nonblistered areas of a panel; and (6) the sodium and chloride ion concentrations of the blister liquid were not significantly different from each other (the average Na^+ ion concentration was 1.9% by mass while the average Cl^- ion concentration was 2.2% by mass), but they were much less (60% less) than the concentrations of the ions (5% Na^+ and 5% Cl^-) in the immersion liquid.

Multivariate regression analyses were performed to determine if the Na^+ ion concentration, Cl^- ion concen-

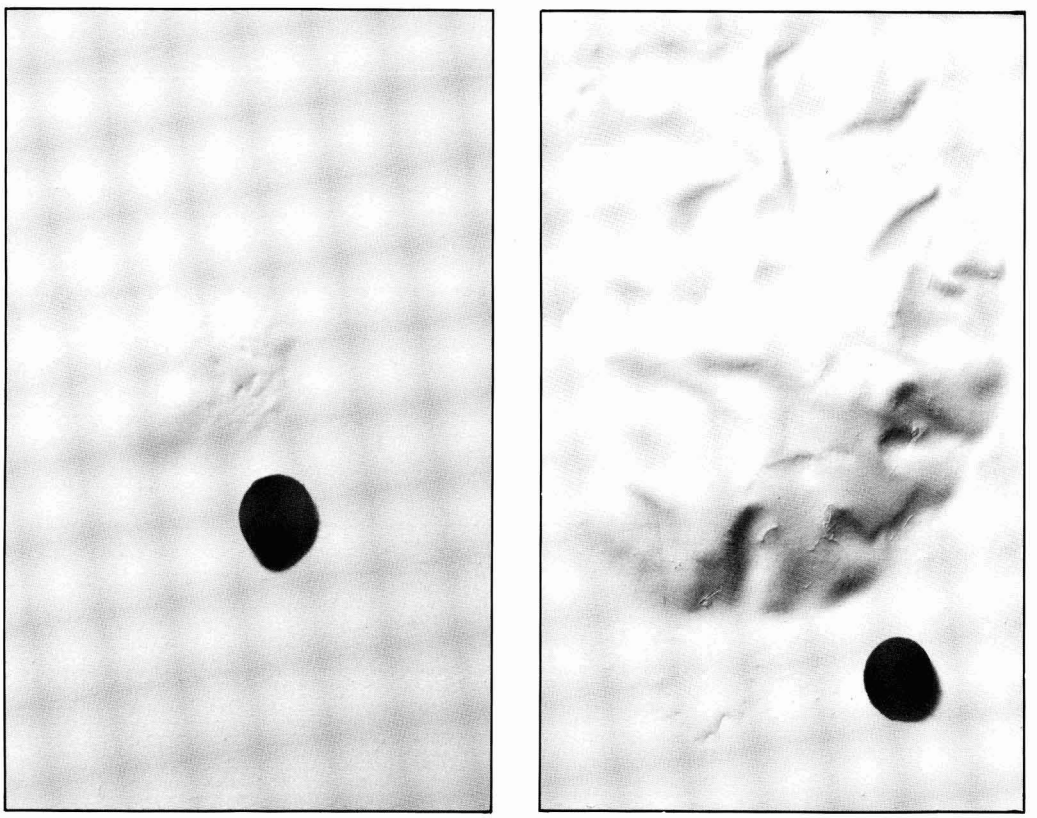

Figure 4—Blister appearance (a) shortly after blister initiation, and (b) after the blister has increased in diameter. Circular dot is 0.64 mm in diameter

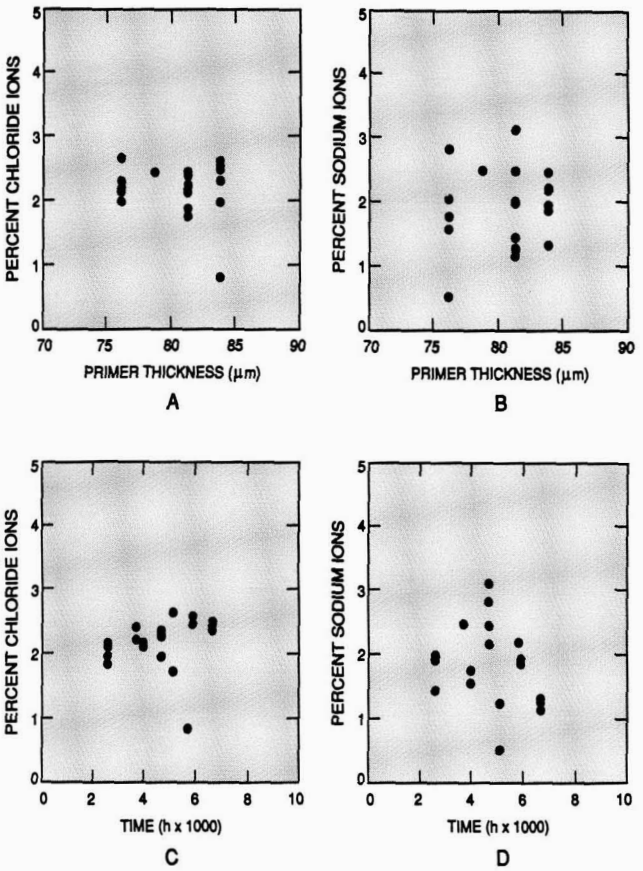

Figure 5—Na^+ and Cl^- concentrations vs (a) primer thickness and (b) immersion time

tration, or the pH of the blister liquid were statistically dependent on total immersion time, blister growth time, primer thickness, topcoat thickness, primer-plus-topcoat thickness, blister radius, ion concentration, and pH. It was concluded from this analyses that there was no statistical dependency on any of these variables. Several univariate plots demonstrating this lack of dependence are shown in *Figure* 5.

DISCUSSION

From the previously described experimental results and analyses, it was concluded that the formation and growth of blisters were not consistent with an osmotically driven process. Specifically, the following experimental results were unexpected: (1) the high variability in the blister incubation times for the panels; (2) the wrinkly, flaccid appearance of large blisters which continued to grow linearly with time; (3) the lack of positive liquid pressure in the small spherical blisters; and (4) the low ion concentrations of the blister liquid relative to those of the immersion liquid.

The blister growth was also not consistent with a diffusion rate-limiting process, since the incubation times for the blisters did not depend on the thickness of any of the coating layers. Instead, our experimental observations are more consistent with a defect-controlled process. A non-osmotic blister growth model is presented forthwith.

A Non-Osmotic, Defect-Controlled, Blister Growth Model

The proposed model attempts to integrate the physics of blister growth with the much better elucidated chemis-

Table 2—Dimensions and Composition of Blister Liquid of 20 Sampled Blisters

Property	Average	Std. Dev.	Range
Radius (*mm*)	18.0	7.5	8.0–38.0
Primer tk (μm)	80.6	3.0	76.2–83.8
Topcoat tk (μm)	64.7	12.4	43.2–78.7
Primer + topcoat tk (μm)	145.3	13.1	127.0–160.0
Sodium ion conc. (% by mass)	1.9	0.6	0.14–3.1
Chloride ion conc. (% by mass)	2.2	0.4	0.8–2.6
pH	9.1	1.1	6.7–10.3

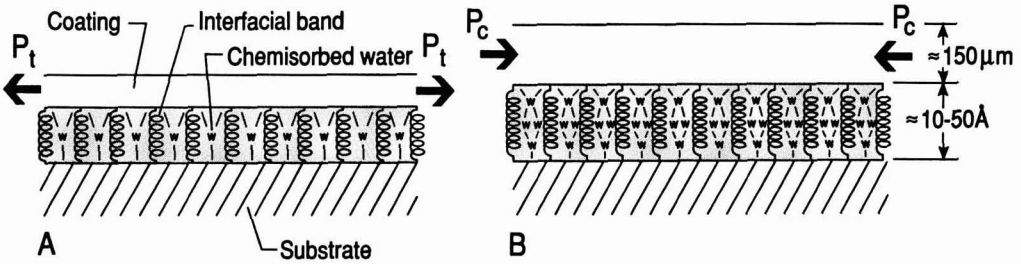

Figure 6—Schematic of elastic bonding between coating and metal oxide layer for (a) a fully-cured coating subject to tensile stress P_t, and (b) a fully-cured coating immersed in an electrolyte and subject to compressive stress P_c. Distance between coating and substrate is exaggerated. The symbol W indicates a water molecule

try of blister growth. The physics of blister growth involves the development of internal stresses within a coating and the fracture of the coating from the substrate as the blister grows. For this reason, the description of the proposed model begins at the time the coating is first applied to the substrate.

As a coating cures, chemical and physical bonds are established between the coating and the metal oxide layer.[15-18] These bonds are assumed to elastically connect the coating to the metal oxide and, hence, they are modeled as springs (see *Figure* 6a). The number and density of chemical bonds formed depend on the adsorption properties of the resin (i.e., the functionality and flexibility of the polymer molecule and its ability to interact with the metal oxide surface), the nature of the solvent, the nature of the metal oxide layer, and the curing temperature.[19] Since the functional groups on the coating polymer compete with the solvent for atomic adsorption sites on the metal oxide layer, it is postulated that even the most highly adsorbing polymers occupy only a small fraction of the total number of available sites on the metal oxide layer.[17] Thus, as the solvent is eliminated from the cured coating, many sites become available for water adsorption.[19]

When a coating solidifies, it contracts quasi-isotropically causing its modulus of elasticity to increase and inducing an in-plane tensile stress, P_t, within the coating[20-23] (*Figure* 6a). This in-plane tensile stress can be quite high, often being in the 1-15 MPa range.[21-24]

When a fully cured, coated panel is immersed in a 5% NaCl solution, water and, to a much lesser extent, sodium and chloride ions, permeate the coating. In the case where the interfacial solute concentration is less than the solute concentration of the immersion liquid, the driving force for water permeation is probably a concentration or a hydrostatic pressure gradient. Of the water which permeates into the coating, some is absorbed by the coating, particularly at the coating/pigment interface,[25] while the rest is adsorbed in the interfacial region.

Water absorbed by the coating causes it to swell, which in turn causes the in-plane stress within the coating (see *Figure* 6b) to change from a tensile to a compressive stress, P_c.[22,24] This change can occur quite rapidly. For example, the in-plane tensile stress for Artamonova's dry, fully-cured, epoxy film was approximately 10 MPa; but, after five hours of immersion in water, the internal stress changed to a 5 MPa compressive stress. This compressive stress remained constant for the duration of the immersion test, which was approximately 100 hr.

Water adsorbed within the interfacial regions causes the bonds between the coating and the substrate to extend (see *Figure* 6b). This extension continues until either the forces induced by the elastic extension of the bonds equal the forces required to adsorb additional water within the interfacial region or the interfacial chemical bonds rupture. If chemical bonds are ruptured, then the induced loads are redistributed to the surviving chemical bonds, causing a reduction in both the wet and dry adhesive strength of the coating. It is believed, however, that the rupture of interfacial bonds in the absence of electrochemical activity is not an important mode of disbondment.[6]

A non-osmotically formed blister forms over a disbonded area of a coating. A disbonded area can be present in the cured coating or it can be created through electrochemical processes. It is postulated that neutral blisters arise over disbonded areas within the fully cured coating; while a cathodic blister emanates from a randomly located cation ingress point in the coating, where the cation ingress point may be a thin layer of coating, as opposed the thread-like capillary depicted in *Figure* 7.

Once ions collect within the interfacial region of a coating, an electrochemical corrosion cell is created in which iron is dissolved at the anode

$$Fe \longrightarrow Fe^{2+} + 2\,e^- \qquad (4a)$$

while oxygen is reduced at the cathode

$$H_2O + 1/2\,O_2 + 2\,e^- \longrightarrow 2\,OH^- \cdot \qquad (4b)$$

Over time, the concentration of hydroxide ions increases until the pH of the interfacial liquid is sufficiently high to cathodically disbond the coating from the substrate[15,17] (see *Figure* 7a). In the absence of a high mechanical stress, the pH of the interfacial liquid may have to be quite high for disbondment to occur, perhaps the pH[26] has to be as high as 14. Cathodic disbondment continues undetected by visual inspection until the diameter of the disbonded area reaches a critical length, l_u (critical), whereupon the coating buckles, forming a blister (see *Figure* 7b). The high variability in the observed incubation times for our blisters is probably due to variables

associated with the buildup of the pH within the interfacial region, specifically, the nature of the cation ingress point, the initial size of a disbonded area underneath a cation ingress point, and the temperature of the immersion liquid.

The disbonded coating film can be viewed as a thin structural plate loaded in biaxial compression and, as such, the coating buckles (see *Figure* 7b) whenever the diameter of the disbonded area exceeds a critical length, l_u (critical). At first, the buckled coating assumes a spherical shape which is accentuated when the panel is removed from the immersion liquid, since the blister is no longer subjected to hydrostatic forces and, therefore, the compressed coating film is freely able to deflect in the direction normal to the plane of the coating. For small diameters, the blister maintains its spherical shape; while for large blister diameters, the coating film collapses around the partially liquid-filled blister producing a wrinkly appearance in the blister film.

The critical compressive load, P_c, at which the coating buckles, is given by the Euler equation[27]

$$P_c = 4EI\pi^2/l_u^2 \qquad (5)$$

where

E = the Young's modulus of elasticity of the coating;
I = the moment of inertia of the coating; and
l_u = the diameter of the disbonded area

and where for the undetached coating, the moment of inertia, I, per unit width is equal to a constant times the third power of the adhesive thickness, t_c; that is, I = constant $\times$ t_c^3. This proposed buckling mechanism has been previously proposed for the buckling of plywood[28] and the interlaminar disbondment model of high strength composites.[29]

In equation (5), the critical compressive load, P_c, is proportional to the flexural rigidity, EI, of the coating (a measure of its resistance to bending), inversely proportional to the square of the unsupported diameter, l_u, and independent of the strength properties of the coating or chemical bonds between the coating and the substrate. According to Vizzini and Lagace,[27] the coating boundary conditions in *Figure* 7 are assumed to be clamped at a distance from the disbondment front, which prevents the vertical rotation of the coating. Locating the clamps at a distance from the disbonding front reduces the compliance of the coating and thus the critical compressive load required to buckle the coating. As discussed in Vizzini and Lagace,[27] clamped boundary conditions are reasonable approximations to the real loading conditions.

When the coating buckles, both shear and normal stresses are imposed on the periphery of the delaminating blister.[27,30] Blister growth depends on (1) the magnitude of the shear and normal stresses; (2) the pH of the blister liquid; (3) localized swelling of the coating at the blister perimeter by water and sodium hydroxide;[31] and (4) the thickness of the interfacial water layers.[32] The shear and normal stresses elastically strain the interfacial chemical bonds at the periphery of the blister (*Figure* 8) making these bonds vulnerable to chemical attack. Unlike osmotic blistering, however, in which the dominate disbondment stress is a cleavage-type stress, the dominant disbondment stress in non-osmotic blister growth is shear. These shear stresses are particularly high at a discontinuity in the coating, like that at the delaminating periphery of a blister[30] and their ability to rupture interfacial bonds increases with an increase in the thickness of the interfacial water layer.[32] The adverse impact that shear stresses have on coated panels is quite familiar to coating technologists, since shear stresses cause a coating to delaminate from the unprotected edge of a coated panel, explaining the common practice of protecting panel edges with an extra layer of coating.

The shear stresses by themselves, however, may not be sufficient to cause blister growth. Instead, it is postulated that blister growth results from a stress corrosion cracking process in which the rate of coating disbondment depends on the combined effects of mechanical stresses and the

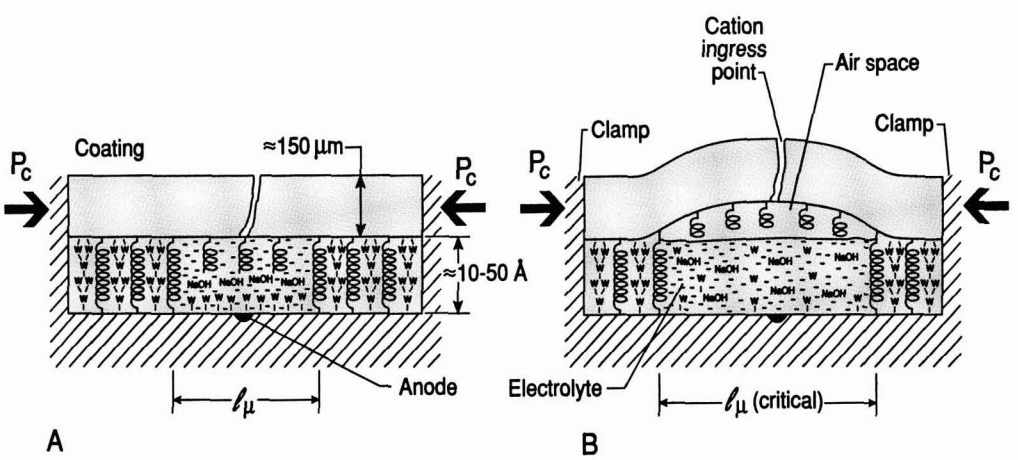

Figure 7—Schematic of coating disbondment for (a) the case where $l_u < l_u$ (critical), and (b) the case where $l_u \geq l_u$ (critical). Distance between the coating and the substrate is exaggerated

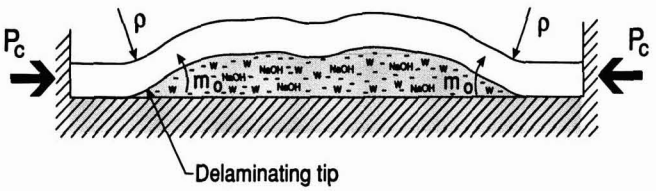

Figure 8—Schematic of delamination stresses in a swelled coating whose delamination length is much greater than l_u (critical). Blister has collapsed around the blister liquid (interfacial bonds are not shown). The symbols M_o and ρ stand for an imposed moment and the radius of curvature

pH of the blister liquid. In the proposed stress corrosion cracking process, alkaline liquid produced from electrochemical activity at the periphery of a blister attacks the stretched bonds on the perimeter of the blister resulting in an incremental advance in the blister radius. This incremental advance exposes new bonds to chemical attack. The proposed mechanism is similar to those proposed for a wide variety of materials, including the fracture of E-glass fibers in a high relative humidity environment[33] and the fracture of metals in aqueous environments.[34] It does not appear to have been previously proposed for the cathodic disbondment of a coating from a steel substrate.

The proposed model provides an alternative interpretation of the so-called barrier effect in coatings.[4,35] Specifically, it provides another interpretation for the reduction in blistering and corrosion when flake-like pigments are substituted for spherical pigments in a coating[4] and when the thickness of the coating is increased.[7] Historically, the improvement afforded by flake-like particles has been ascribed to reductions in water and oxygen permeabilities of the coating, a well-known attribute of flake-like particles.[36] An equally plausible explanation, however, is that the flake-like pigments increase the in-plane tensile and shear moduli of a coating and reduce the in-plane swelling of a coating.[36] Thus, from the perspective of the proposed model [equation (5)], the substitution of flake-like pigments reduces the propensity of a coating to blister by increasing its rigidity [EI in equation (5)], and by decreasing the magnitude of the in-plane compressive stress within the coating. Increasing the thickness of a coating also increases its flexural rigidity, since the moment of inertia of a coating [I in equation (5)] increases by the third power of its thickness. As with flake-like pigments, an increase in a coating's flexural rigidity should increase the critical stress needed to buckle the coating. Unfortunately, this effect is often obscured by an increase in a coating's solvent retention, which can increase blistering.[6]

It should be noted that the proposed non-osmotic blister growth mechanism is always operating, whereas an osmotic blister growth mechanism only acts while the concentration of the salt within the interfacial region is greater than that of the immersion liquid. When both mechanisms are acting, their effects should be additive. The proposed non-osmotic blister growth model does not change any of the previously nominated rate controlling steps for cathodic delamination.[17] It does, however, add two new factors—the water and sodium hydroxide swelling of the coating. Both factors affect the magnitude of the stresses within a coating and at the perimeter of a blister.

SUMMARY

Results from a continuous immersion, cathodic delamination experiment were inconsistent with an osmotically-controlled cathodic disbondment process. Specifically, the following results were unexpected: (1) the extremely high variability in the blister incubation times; (2) the wrinkly, flaccid appearance of large blisters which continued to grow linearly with time; (3) the lack of any positive liquid pressure in the small spherical blisters when they were pierced with a needle; and (4) the low ion concentrations of the blister liquid relative to those of the immersion liquid.

A non-osmotic, defect-controlled blister incubation and growth model was proposed which appears to be more consistent with our experimental observations. The steps in the proposed model are as follows:

(1) Water absorbed by the coating induces in-plane compressive stress within the coating and elastically extends the interfacial bonds.

(2) Beneath a cation ingress point in the coating (i.e., a defect), an electrochemical corrosion cell is established in which the pH increases over time, causing disbondment of the coating from the substrate.

(3) When the disbonded area reaches a critical diameter, the compressively loaded coating buckles, imposing both shear and normal stresses at the periphery of the blister. These stresses, in the presence of an alkaline solution, cause blister growth via a stress corrosion cracking process.

The proposed buckling mechanism is analogous to those proposed for the buckling of plywood and the delamination of high strength composites. The proposed stress corrosion cracking mechanism is similar to the stress cracking mechanisms proposed for the fracture of E-glass and metals.

The non-osmotic blister growth model provides an alternative explanation for the so-called barrier effect in coatings. This effect historically has been ascribed to the reduction in the oxygen, ion, and water permeabilities of a coating resulting from the substitution of flake-like pigments for spherical pigments or from the increase in thickness of the coating. The proposed model suggests that the reduction in blistering and corrosion may result from the increase in flexural rigidity and a decrease in the in-plane swelling of a coating when flake-like pigments are substituted for spherical pigments and from an increase in flexural rigidity when the thickness of the coating is increased. Both an increase in the flexural rigidity and a decrease in the in-plane swelling of the coating will increase the critical stress required to buckle a coating.

ACKNOWLEDGMENTS

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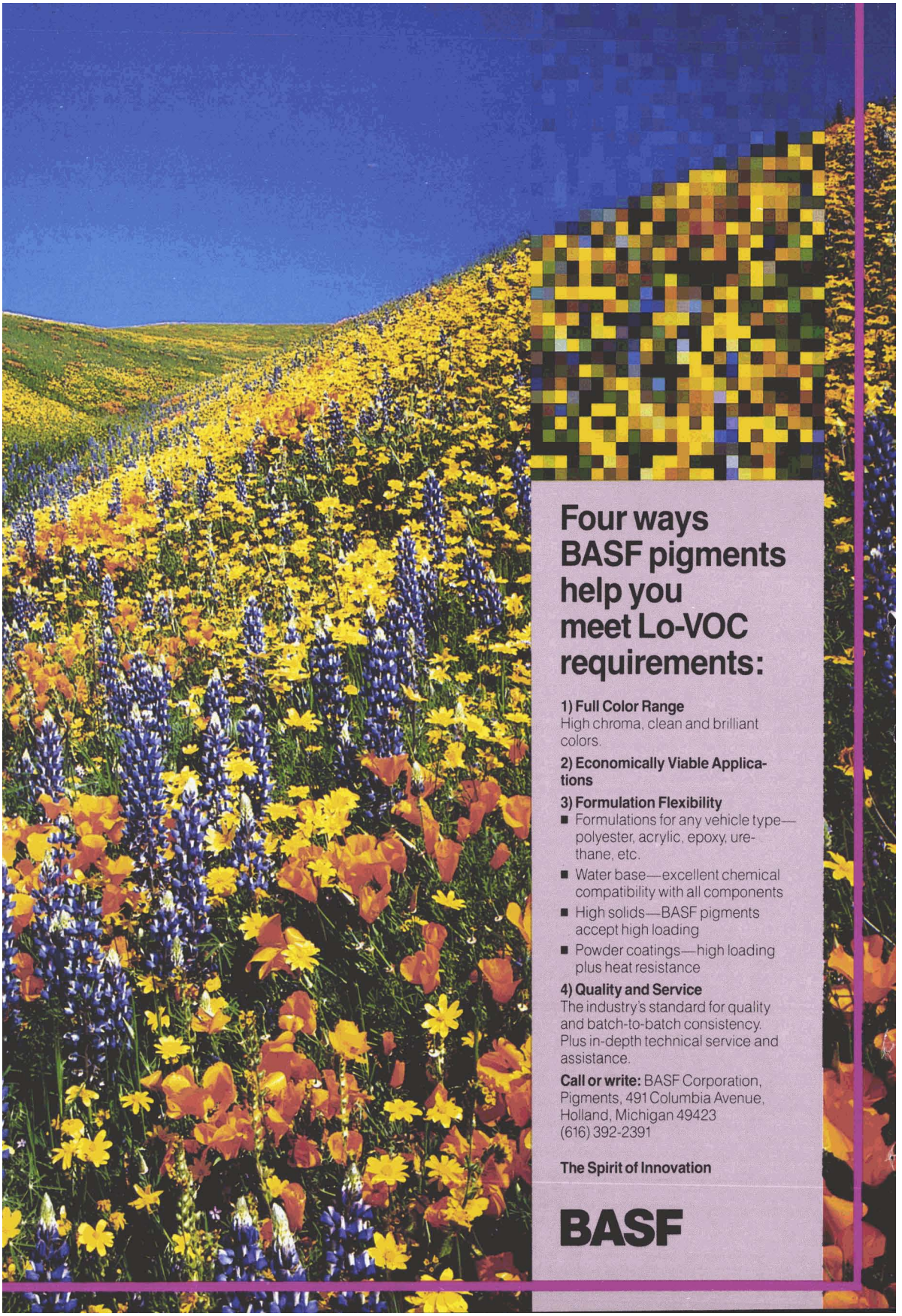

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Regulatory UPDATE

NOVEMBER 1990

This digest of current regulatory activity pertinent to the coatings industry is published to inform readers of actions which could affect them and their firms, and is designed to provide sufficient data to enable those interested to seek additional information. Material is supplied by National Paint and Coatings Association, Washington, D.C.

Clean Air—The Senate and House Conferees are once again stalled in negotiations to amend the Clean Air Act.

On September 28, Senate conferees rejected a House proposal under Title II of the amendments (S. 1630) affecting tail pipe emissions. The Senate called the offer "non-responsive" to an earlier proposal by the Senate. The conferees were scheduled to meet on October 2, but the meeting was canceled when members from both houses could not agree on which proposal to work from.

Meanwhile, in an effort to gain a voice in the conference, the White House sent Congress a list of final provisions for consideration. So far, the Administration has been excluded from the conference committee talks, and some staffers doubt the President's efforts will have much effect on the ongoing negotiations. The Administration, whose clean air package emphasizes cutting the costs of controls, wants to be sure the more "costly and onerous" provisions are deleted so as not to be put in the politically unpopular position of having to veto the measure.

There are very few work days remaining in the 101st Congress. With acid rain, toxic controls, and enforcement titles still to be discussed, some members have indicated they would prefer to wait until January to resolve their differences, rather than be forced into a "take it or leave it" situation.

Superfund Budget—On October 3, as part of the appropriations bill, the Senate passed a 1991 Superfund budget of $1.6 billion. The amount was $125 million less than that requested by the Administration, but adds $86 million to the 1990 Superfund budget. The final allocation of monies for Superfund will be subject to any changes made in the conference committee and to any deficit-reduction agreement.

The Appropriations Committee made the following specific fund recommendations for Superfund:

(1) $20 million is reserved for worker training by the National Institute for Environmental Safety and Health (NIESH);

(2) $10 million is added for NIESH research and $5.5 million for the Agency for Toxic Substances and Disease Registry.

(3) $3.5 million is earmarked for a waste mining technology center proposed for Butte, Montana, $300,000 for training grants for minority and women contractors, $100,000 for a legal assistance demonstration project in Vermont, $495,000 for a University of North Dakota Energy and Environment Research Center and $5 million for relocation assistance for residents at the Koppers Texarkana Superfund site in Texas.

Lead—On October 4, the Senate Environment and Public Works Committee passed legislation that would significantly decrease human exposure to lead.

The Lead Exposure Reduction Act, S. 2637, is an amendment to the Toxic Substances Control Act (TSCA), and requires the U.S. Environmental Protection Agency (EPA) to inventory all products containing lead. If the Administration determines that the lead content in a specific product is harmful to human health or the environment, EPA may promulgate a regulation to reduce or eliminate the lead in that product.

The measure contains specific exemptions for some products including lead paint and materials used by artists and stained glass crafts people; lead solder (other than those used in plumbing and food cans); and lead fishing weights.

Environmental Protection Agency
October 5, 1990—55 FR 40881
Waste Minimization Incentives

Action: Notice and request for comments on desirable and feasible incentives to reduce or eliminate the generation of hazardous waste.

Under Section 1003(b) of the Resource Conservation and Recovery Act (RCRA) a national policy was established to expeditiously reduce or eliminate the generation of hazardous waste wherever feasible. Since 1986, the U.S. Environmental Protection Agency (EPA) has implemented various measures to minimize generated waste. EPA is now considering a new program to induce incentives that "promote reductions in the volume and toxicity of hazardous waste generation."

The Agency has requested comments regarding whether or not the current regulatory and non-regulatory incentives for waste minimization are effective; and whether additional approaches are needed to promote further national progress in waste reduction. The information obtained from comments received, along with other information, will assist EPA in considering, evaluating, and establishing priorities for constituents that might make up a hazardous waste minimization program.

All comments must be submitted in triplicate by December 4, 1990, and sent to: EPA RCRA Docket (room SE 201, Mail Code OS-305), U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460. All documents should include docket number F-90-IRGP-FFFFF.

For further information, contact Manik Roy (202) 245-3737 or the RCRA Hotline, (800) 424-9346.

Environmental Protection Agency
September 27, 1990—55 FR 39409
Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Clarification.
Action: Final rule, clarification

The Toxicity Characteristics (TC) rule, which revised the existing EP toxicity characteristics, was promulgated by the Environmental Protection Agency (EPA) on March 29, 1990 (55 FR 11798). The EP toxicity characteristics are used to identify hazardous wastes subject to regulation under the Resource Conservation and Recovery Act (RCRA) because of the potentially high leaching factor of specific toxic elements. In an effort to assist the regulated community in understanding their regulatory obligations for managing new TC wastes, EPA included guidelines in the regulations.

On September 27, 1990, EPA published in the Federal Register, a clarification of the rule regarding the following issues: (1) Compliance options for surface impoundments managing newly regulated TC wastes; (2) ground-water monitoring requirements that owner/operators of land disposal facilities managing newly regulated TC wastes must meet; (3) notification responsibilities for generators and owner/operators of treatment, storage, and/or disposal facilities (TSDFs) managing newly regulated TC wastes; and (4) permit modification requirements for hazardous waste management facilities with newly regulated wastes under the TC.

For further information, contact: RCRA/Superfund Hotline (800) 424-9346. Or, for specific information, contact Steve Cochran, Office of Solid Waste (OS-331), U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC 20460, (202) 475-8551.

Update—The Superfund Amendments and Reauthorization Act of 1986 (SARA) required the Environmental Protection Agency, The Department of Interior, The Occupational Safety and Health Administration, and the Transportation Department to promulgate a series of regulations to implement the law. The following is a regulatory update.

Regulation

Designating Hazardous Substances—Proposed rule will designate extremely hazardous substances, as defined in SARA Section 302 and published in the Federal Register (52 FR 13397).

Status

Proposed rule approved by OMB. EPA public comment period closed March 23, 1989. Final rule now expected in the fall, 1990.

Regulation

Extremely Hazardous Substances: RQs—Adjustment of reportable quantities for extremely hazardous substances that EPA has proposed to designate as hazardous under CERCLA Section 102.

Status

Proposed rule published in Federal Register August 30, 1989. Public comment period closed October 30, 1989, with final rule expected in the fall, 1990.

Regulation

Hazard Ranking System—Revisions to the hazard ranking system used to determine if a site merits inclusion on the National Priorities List.

Status

Proposed HRS was published in the Federal Register on December 23, 1988. Final HRS scheduled for publication in October, 1990.

Regulation

Off-Site Response Actions—Rule interprets and codifies procedures that must be followed when a response action under CERCLA involves off-site transfer of CERCLA waste under SARA Section 121 (d) (3).

Status

Rule has been sent to OMB for review, and is scheduled to be issued as an amendment to the National Contingency Plan (NCP) by fall, 1990.

Regulation

Reporting Exemptions—The rule, first proposed May, 1983 (48 FR 23552), CERCLA interprets types of hazardous substance releases exempt from CERCLA Section 101 (10), which defines "federally permitted" releases.

Status

Proposed rule published July 19, 1988 (53 FR 25268). Public comment period October 19, 1988. Final rule is expected to be issued in early spring, 1991.

Regulation

Response Costs and Claims—SARA Sections 111(a) and (o) and 112, respectively, authorize payment of claims and require EPA to make public the limitations on claims payments for response costs and issue regulations for filing claims against Superfund sites.

Status

Proposed rule was published in Federal Register September 13, 1989. Comment period closed November 13. Final rule is expected by the end of November.

Regulation

Cost Recovery—Rule is under development to promote standardization of EPA cost recovery procedures under CERCLA 107(a).

Status

EPA expected to propose rule by November, 1990.

States Proposed Legislation and Regulations

California

Air Quality—A. 4059 (Wyman) requiring owners or operators of any air pollution emission source, except noncommercial vehicular sources, to describe the source and disclose data necessary to estimate emissions was signed by the Governor on 9/18/90.

A. 4092 (Roybal-Allard) requiring air pollution control officers to request specified information from a supplier of volatile organic compounds or chemical substances and making it a misdemeanor for failure to comply was vetoed by the Governor on 9/30/90.

S. 1770 (McCorquodale) creates the San Joaquin Valley Air Quality Management District. The district assumes the functions of the county air pollution control districts in those areas, specifies the duties and functions of the district with respect to the adoption of rules and regulations, and permits the district to adopt a schedule of fees levied on sources of air pollution subject to district regulation.

S. 1817 (Roberti) enacts the Toxic Air Pollution Prevention Act of 1990. Requires specified facilities to prepare a pollution prevention audit and plan to be submitted to the appropriate air pollution control district or air quality management district, initially, as specified and to conduct an audit and establish a plan every four years thereafter.

S. 2652 (Russell) requires every district including specifically the Bay Area Air Quality Management District, the South Coast Air Quality Management District, and the Sacramento Metropolitan Air Quality Management District to consider and make findings as to the cost-effectiveness in adopting regulations for attainment and maintenance of ambient air quality standards.

A CARB proposal makes revisions to the designation of a number of areas in California as attainment, nonattainment, or unclassified for state ambient air quality standards for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and hydrogen sulfide. For more information, contact Rich Bradley, Technical Support Division, (916) 322-6076 or Public Information Office, (916) 322-2990, Air Resources Board, 1102 Q St., P.O. Box 815, Sacramento, CA 95812. The comment deadline is November 7, 1990 and the hearing dates are November 8-9, 1990.

Hazardous Waste—A. 2595 (Tanner) requires each city within a county with a hazardous waste management plan to take a specified action, within 180 days after receiving written notification from that county that the county hazardous waste management plan has been approved and to implement the approved plan. If the Department disapproves the county or regional hazardous waste management plan, it must provide the county with its reasons for disapproval.

Household Hazardous Waste—A 2597 (Tanner) exempts a household waste collection facility operated by a public agency, or any person under an agreement with a public agency, from the requirement to obtain a hazardous waste facilities permit.

A. 2641 (Wright) allows small quantity commercial sources and some individual programs which comply with specified criteria to participate in household hazardous waste programs operated by any city, county, or special district.

A. 2707 (LaFollette) imposes a state-mandated local program by requiring each city to prepare, adopt, and submit by July 1, 1991, to the county in which it is located, a household hazardous waste element of specified content.

Toxic Substances—A. 1469 (Margolin) requires the Occupational Safety and Health Standards Board to revise the California Code of Regulations to include certain carcinogens and industrial processes listed by the International Agency for Research on Cancer, and substances for which the State Department of Health Services has issued a hazard alert regarding carcinogenicity, unless a substance or industrial process is covered by a separate comparable standard.

A. 1728 (Katz) enacts the Toxics Reporting and Use Reduction Act of 1990. Requires the Environmental Affairs Agency, in cooperation with each state and local agency which collects hazardous materials data, to establish systems and procedures for collecting, storing, and distributing hazardous materials data to make the data accessible to the public and among state and local agencies as specified.

Liability Insurance—A. 2730 (LaFollette) requires the Insurance Commissioner to investigate the need for an environmental impairment liability insurance program and to hold a hearing relating to the investigation.

Taxes—A. 3580 (Katz) authorizes a city, county, or city and county to levy a tax by ordinance on the sale at retail within its jurisdiction of aerosol paint containers, containers of any other marking substances, felt tip markers with a specified writing surface, and any other marking instrument, as defined.

Packaging—A. 3994 (Sher) makes its unlawful for any person to represent that any consumer good, as defined, which it manufactures or distributes is "ozone friendly" "biodegradable," "photodegradable," "recyclable," or "recycled," unless that article meets specified definitions or meets definitions established in trade rules adopted by the Federal Trade Commission.

Graffiti—S. 2448 (Watson) enacts procedures for the establishment of graffiti abatement districts with specified powers for the purpose of abating graffiti. Authorizes these districts to impose a tax on the sale of marking substances or instruments.

Transportation—S. 2774 (Torres) revises the definition of manifest to mean a shipping document originated and signed by a generator of hazardous waste, which contains all of the information required by the department and which complies with federal and state regulations; requires any person generating hazardous waste which is transported, or submitted for transportation, or offsite handling, treatment, storage, disposal, to complete a manifest prior to the time of transportation.

Colorado

Hazardous Waste—The Department of Health/Waste Management Division is considering the promulgation of proposed amendments to the Colorado Hazardous Waste regulations. This proposal includes land disposal restriction, mining waste exclusions, toxicity characteristic revisions, delisting strontium sulfite and iron dextran, renewal of the hazardous waste manifest, clarification and correction to tank system regulations, clarification of incinerator trail burn regulations, miscellaneous unit requirements, and changes to the financial assurance regulations. For more information, contact Secretary, Board of Health, Department of Health, 4210 East 11th Avenue, Room 411, Denver, CO 80220.

Florida

Waste Quality—This proposal sets surface water quality standards criteria for the first time for 32 toxic substances, and revises existing criteria for 27 others. For more information, contact Marjorie Coombs, Environmental Specialist, Bureau

of Surface Water Management, Department of Environmental Regulation, 2600 Blair Stone Rd., Tallahassee, FL 32399-2400, (904) 487-0505.

Right-to-Know—A proposed regulation specifies the reporting forms required for use with the Florida Hazardous Materials Emergency Response and Community Right-To-Know Act. For more information, contact Rod M. Westall, Chief, Bureau of Emergency Planning, 2740 Centerview, Tallahassee, FL 32399-2100, (904) 487-4915.

Kansas

Transportation—This proposal updates requirements for tank vehicles transporting flammable and combustible liquids; sets forth performance standards and registration certificates for such vehicles. For more information, contact the Fire Marshal, 700 S.W. Jackson, Suite 600, Topeka, KS 66603.

Louisiana

Right-To-Know—This proposal relates to the Hazardous Material Information Development, Preparedness, and Response Act (also known as the first "Right-To-Know" law); fine tunes the state rules in the area of release reporting. For more information, contact Lieutenant Kendall J. Fellon, Transportation and Environmental Safety Section, Office of State Police, Box 66614, Baton Rouge, LA 70896, (504) 925-6113.

Maryland

Air Quality—This proposed regulation updates the incorporation by reference of federal regulations into the New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAPs), and Prevention of Significant Deterioration (PSD) regulations. For more information, contact Deanna L. Miles-Brown, Regulations Coordinator, 2500 Broening Highway, 3rd Floor, Baltimore, MD 21224.

This proposal corrects deficiencies identified by the U.S. EPA in regulations that are part of Maryland's State Implementation Plan to attain and maintain the national ambient air quality standards for ozone and carbon monoxide. Contact Deanna L. Miles-Brown for more information

Michigan

Air Quality—H.C.R. 873 (Griffin) approves proposed administrative rules of the Department of Public Health pertaining to air contaminants.

S.C.R. 763 (Fredricks) approves proposed administrative rules of the Department of Public Health pertaining to air contaminants.

S. 1020 (Ehlers) enhances environmental enforcement powers under Environmental Response Act with respect to toxic substances, hazardous waste, and air and water pollution.

Minnesota

Occupational Safety and Health—This proposal establishes the Standard Industrial Classification List of employers required to establish the Accident and Injury Reduction Program. For more information, contact Patricia Lorentz, Occupational Safety and Health Division, Department of Labor and Industry, 443 Lafayette Rd., St. Paul, MN 55155, (612) 297-3254.

Right-To-Know—This proposal sets fees to be paid by a facility when the owner or operator submits its emergency and hazardous chemical inventory form required under Section 1102 of the Federal Emergency Planning and Community Right to Know Act. For more information, contact Katherine Burke Moore, Rules Coordinator, Department of Public Safety, 211 Transportation Building, St. Paul, MN 55155.

Hazardous Waste—This proposal governs the management of hazardous wastes and certificates of exemption for the management of polychlorinated biphenyls. For more information, contact Nathan B. Cooley, Hazardous Waste Division, Minnesota Pollution Control Agency, 520 Lafayette Rd. North, St. Paul, MN 55155, (612) 643-3477.

New Jersey

Toxic Substances—A. 988 (McGreevey) establishes a regulatory program in the Department of Environmental Protection designed to prevent pollution through the reduction in the use and discharge of hazardous substances; owners and operators of certain facilities at which hazardous substances are used or manufactured would be required to inventory the substances they use or discharge; requires facilities to prepare and submit to the Department pollution prevention plans; creates the Pollution Prevention Advisory Council.

A. 3510 (Kalik/Scerni) makes supplemental appropriation of funds to the Department of Housing for lead poisoning program grants for southern New Jersey.

NJ A.R. 157 (Kalik) memorializes Congress to enact the Lead Ban Act of 1990 which would establish a comprehensive program to reduce the threat of lead exposure to American citizens.

Hazardous Waste—A. 1176 (Kalik) establishes an Office of Hazardous Waste Minimization in the Department of Environmental Protection. Provides that the purpose of this office is to promote the voluntary adoption by business firms of multimedia hazardous waste minimization strategies and to provide technical assistance to business firms and technical advice to the Commissioner of Environmental Protection on hazardous waste minimization.

A. 1293 (Crecco/Kelly) authorizes the use of monies deposited in the New Jersey Spill Compensation Fund to finance research on methods of source reduction, recycling and detoxifying hazardous substances, and improved disposal operations.

Labeling—A.R. 168 (Kyrillos) memorializes President and Congress to establish standards for environmental labeling for consumer products.

A.R. 169 (Kyrillos) requests Governor and Coalition of Northeastern Governors to develop regionally uniform standards for environmental labeling of consumer products.

Transportation—This proposal governs the transportation of hazardous materials in the State of New Jersey. For more information, contact Charles L. Meyers, Administrative Practice Officer, Department of Transportation, Bureau of Policy and Legislative Analysis, 1035 Parkway Ave., CN 600, Trenton, NJ 08625.

Oklahoma

Air Quality—This proposal pertains to the emission of volatile organic compounds from stationary sources. Substitutes words and removes discretion to accept alternate test methods. Changes rule to comply with Region VI Environmental Protection Agency State Implementation Plan for Tulsa County. A hearing was scheduled for October 25, 1990. For more information, contact Robert Kellog, Department of

Health, P.O. Box 53551, 1000 N.E. 10th St., Oklahoma City, OK 73152.

Oregon

Occupational Safety and Health—One proposal relates to hazardous waste operations and emergency response.

One proposal revises the OSHA's Lead Standard Implementation Schedule. For more information on either or both, contact Judy Sugnet, Technical Services Section, Department of Insurance and Finance, OSHA, Labor and Industries Building, Salem, OR 97310, (503) 378-3272.

South Carolina

Occupational Safety and Health—This proposal pertains to the minimum occupational health standards for welding, cutting and brazing, hazardous waste operations and emergency response, air contaminants, lead, and occupational exposure to hazardous chemicals in laboratories. For more information, contact the Department of Labor, Columbia, SC.

Air Quality—This proposed rule adds additional compounds to section II.B of Standard 8, Toxic Air Pollutants. For more information, contact Otto E. Pearson, Chief, Bureau of Air Quality Control, Department of Health and Environmental Control, 2600 Bull Street, Columbia, SC 29201.

South Dakota

Household Hazardous Waste—This proposal establishes a Toxic Cleanup Day pilot program. Designates a time, place, and date for the Toxic Cleanup Day; establishes maximum amounts of waste that will be accepted; sets fees for amounts collected over the maximum; and provides for collecting data on amounts and types of wastes handled and obtaining information on the cost of the pilot program. The hearing date is November 15, 1990. For more information, contact the Division of Environmental Regulation, Joe Foss Bldg., 523 E. Capitol, Rm. 223, Pierre, SD 57501.

Wyoming

Toxic Substances—This proposal makes revisions to the pesticide applicator certification rules, to set new pesticide applicator licensing requirements, new standards for certification of pesticide applicators, new pesticide applicator license classifications, new standards of supervision for non-certified applicators, new recordkeeping requirements, new licensing categories, and new pesticide storage and disposal requirements. For more information, contact Jim Bigelow, Wyoming Department of Agriculture, 2219 Carey Ave., Cheyene, WY 82002-0100. The comment deadline was October 31, 1990.

Evaluation of Additives for High Solids, Low VOC Polyester-Melamine Coatings

Rudy Berndlmaier, John W. Du, Dennis R. Haff, Jeffrey C. Kaye, Edwin Lloyd Kelley, Rudolph LaGala, James McGrath, Jeffrey M. McKeon, U. Schuster, M. Sileo, Larry Waelde, S. Westerveld, and Martin E. Wild
New York Society for Coatings Technology
Technical Subcommittee

One of the problems facing formulators today is surface imperfections in solvent-based, high solids, oil-free polyester-melamine bake enamels. The objective of this study was to focus on trends attributable to various additives used to overcome or eliminate surface imperfections in these products.

Five suppliers of polyester resin submitted samples of high gloss, white, oil-free polyester-melamine bake enamels manufactured to conform to specified formulation parameters. Samples of these additive-free, low VOC coatings were given to a cross section of additive manufacturers who then submitted a recommended additive. Participating paint manufacturers and test laboratories then evaluated both modified and unmodified coatings to assess the comparative effectiveness of additives in each submitted coating. The findings were analyzed and the relative performance was reported.

INTRODUCTION

The volatile organic compound (VOC) content of coatings is the subject of much legislation and controversy. The requirement for reduced solvent content, and consequently increased solids, has offered interesting challenges to both coating formulators and raw material suppliers alike. The molecular weight of polymers has been lowered to reduce solvent requirements while maintaining application viscosity.[1–11] Solvent suppliers are developing stronger, less volatile solvents, such as the new glycol ethers and acetates.[12–16] Pigment and extender manufacturers are supplying lower oil absorption products to keep vehicle demand low.[17–20] Additive companies are providing more efficient wetting and dispersing agents, as well as other modifiers, to reduce viscosity.[21] The coating formulator's challenge is to combine all of these changes into commercially viable coatings that perform as well as the higher VOC "conventional" coatings they replace.

The many changes and innovations developed to comply with VOC regulations have resulted in an increased incidence of coating surface defects. These defects can ruin the appearance of coated articles and can lead to premature coating failure. However, the elimination of such defects, through the use of corrective additives, can maintain the decorative and protective functions of the coating.

Some common coating defects include: adhesion failure, gloss reduction, orange peel, pinholing, solvent pop, cratering, crawling, fisheyes, non-recoatability, and sag. These defects may be seen in conventional coatings, but tend to be magnified in low VOC/high solids systems. For example, high solids coatings are more sensitive to substrate defects, external contaminants, and atmospheric application conditions (temperature, humidity, etc.) and frequently do not respond to traditional corrective measures. Furthermore, due to VOC legislation, the formulator no longer has the opportunity to use high molecular weight vehicles or add additional solvent to correct the aforementioned defects.

As governmental regulations continually alter the composition of compliant organic coatings, individual formulators must meet the unique challenges of each mandated change. In most cases, this requires a long and tedious search for the right combination of ingredients, often on a "trial and error" basis. This study is intended to provide information on the effectiveness of additives to eliminate

Presented by Mr. Wild at the 67th Annual Meeting of the Federation of Societies for Coatings Technology, in New Orleans, LA, on November 10, 1989.

Table 1—Formula for Paint A

Raw Material	Lb	Gal	Lb/Nv	Gal/Nv	% By Wt
Polyester	333.5	35.9	333.5	35.9	28.72
Xylene	174.7	24.0	0.0	0.0	15.05
Titanium dioxide	389.1	11.7	389.1	11.7	33.51
HMMM[a]	222.4	22.2	222.4	22.2	19.15
n-Butanol	38.7	5.7	0.0	0.0	3.33
p-TSA[b]	2.8	0.3	1.1	0.1	0.24
Total	1161.2	99.8	946.1	69.9	100.00

	Theoretical	Practical
Weight/gal (lb/gal)	11.62	—
Weight solids, %	81.47	78.1
Volume solids, %	69.95	—
VOC (lb/gal)	2.15	2.58
VOC (g/L)	258	310
Pigment/binder ratio	0.70	—
PVC	16.72	—
Grind (Hegman)	—	7.5
Viscosity (cps)	—	340

(a) HMMM = hexamethoxymethylmelamine.
(b) p-TSA = para toluene sulfonic acid.

surface defects in solvent-borne, low VOC coatings. The comparison of the effects of each generic chemical type may reduce some of the steps required in a trial and error search. In order to identify the most pressing problems facing formulators today, a survey was mailed to the members of both the New York Society for Coatings Technology and the Metropolitan New York Paint and Coatings Association.

The survey questionnaire asked:

(1) What percent of low VOC coatings currently produced are solvent borne vs waterborne, air dry, force dry, or bake; and which of these systems is the source of most problems?

(2) What types of resin are being used in low VOC coatings and which resin types represent the greatest percentage of problems?

(3) What specific types of problems are most frequently encountered?

The results of the survey indicated that the area of greatest interest among the respondents was the elimination of surface imperfections in high gloss, low VOC, oil-free polyester-melamine resin bake enamels for general industrial finishing. The consensus was that a combination of additives was required to eliminate surface defects.

EXPERIMENTAL PROCEDURE

Materials

Many national and regional manufacturers of oil-free polyester bake vehicles were invited to participate. Five of these companies agreed to supply a "production" batch of paint to our specifications. To reflect regulatory limitations and common industrial practices, it was requested that the untinted enamels be formulated to the following parameters:

- White, oil-free, polyester-melamine, baking enamel.
- All formulations to be produced using commercially available ingredients.
- Coatings to be formulated without additives (except for *slight* resin modification to facilitate pigment dispersion).
- Pigment-to-binder ratio of 0.7 to 1.0.
- VOC of 2.3 lbs/gal (272 g/L) maximum.
- Cure using a 10 min flash off period and a 10 min bake @ 350°F.
- Gloss of 80 minimum (using 60° gloss meter).
- Must be recoatable.

Formulations and physical properties are shown in *Tables* 1-5.

Numerous additive companies were asked to participate. Thirteen agreed to evaluate samples of the five unmodified coatings and submit their best "single" additive for each. This additive could be one product or a combination of several, submitted as a single additive, which would have to be indicated in a generic disclosure. No additive could exceed five percent of total formula weight and it had to be commercially viable. Submissions could not significantly reduce gloss or adversely affect recoatability. Subsequently, additive submissions for each of the coatings were sent to participating coating laboratories. Each laboratory tested a different paint, adding the various additives in accordance with the manufacturer's recommendation. The following test protocol was provided to the coating companies, and all testing was performed on the steel panels provided (Parker-Amchem B-1000 Iron Phosphate and Parcolene 95% Chrome Free Rinse).

Physical Testing Method

SAMPLE PREPARATION: Sample paints were made up using each supplied additive at the levels recommended by its manufacturer. Each additive company was assigned an identity number or code. If Paint "A" was being tested with Additive #1, the panels were labeled "A-1".

Table 2—Formula for Paint B

Raw Material	Lb	Gal	Lb/Nv	Gal/Nv	% By Wt
Polyester	407.3	42.9	386.9	40.3	34.72
Acrylic resin	10.0	1.2	7.0	0.8	0.85
n-Butanol	22.4	3.3	0.0	0.0	1.91
EEP[a] Ester Solvent	27.3	3.4	0.0	0.0	2.32
Titanium dioxide	392.4	11.8	392.4	11.8	33.44
HMMM	168.2	17.9	168.1	17.9	14.33
p-TSA[b]	4.2	0.5	1.7	0.1	0.36
DMAE[b]	0.6	0.1	0.6	0.1	0.05
MEK[c]	50.5	7.5	0.0	0.0	4.30
EEP (ester solvent)	90.4	11.4	0.0	0.0	7.72
Total	1173.3	100.0	956.7	71.0	100.00

	Theoretical	Practical
Weight/gal (lb/gal)	11.73	—
Weight solids, %	81.55	79.1
Volume solids, %	70.94	—
VOC (lb/gal)	2.16	2.52
VOC (g/L)	260	302
Pigment/binder ratio	0.70	—
PVC	16.61	—
Grind (Hegman)	—	7
Viscosity (cps)	—	256

(a) EEP = ethylene glycol ethyl ether propionate.
(b) DMAE = dimethyl amino ethanol.
(c) MEK = methyl ethyl ketone.

Table 3—Formula for Paint C

Raw Material	Lb	Gal	Lb/Nv	Gal/Nv	% By Wt
Polyester	360.0	37.3	360.0	37.3	28.68
Xylene	60.0	8.3	0.0	0.0	4.78
Titanium dioxide	480.0	14.4	480.0	14.4	38.24
HMMM	240.0	24.0	240.0	24.0	19.12
n-Butanol	24.0	3.6	0.0	0.0	1.91
p-TSA	16.8	2.1	0.0	0.0	1.34
MIBK[a]	50.4	7.6	0.0	0.0	4.02
PM[b] Acetate	24.0	3.0	0.0	0.0	1.91
Total	1255.2	100.3	1080.0	75.7	100.00

	Theoretical	Practical
Weight/gal (lb/gal)	12.53	—
Weight solids, %	86.04	80.1
Volume solids, %	75.59	—
VOC (lb/gal)	1.75	2.28
VOC (g/L)	210	274
Pigment/binder ratio	0.80	—
PVC	19.04	—
Grind (Hegman)	—	7.5
Viscosity (cps)	—	410

(a) MIBK = methyl iso-butyl ketone.
(b) PM Acetate = propylene glycol monomethyl ether acetate.

Table 4—Formula for Paint D

Raw Material	Lb	Gal	Lb/Nv	Gal/Nv	% By Wt
Polyester	466.9	50.1	396.8	41.4	39.32
Titanium dioxide	422.8	12.4	422.8	12.4	35.60
MIAK[a]	77.5	11.5	0.0	0.0	6.53
HMMM	132.1	13.1	132.1	13.1	11.13
p-TSA	10.6	1.4	2.8	0.2	0.89
MIAK	77.5	11.5	0.0	0.0	6.53
Total	1187.4	100.0	954.5	67.1	100.00

	Theoretical	Practical
Weight/gal (lb/gal)	11.88	—
Weight solids, %	80.39	77.6
Volume solids, %	67.17	—
VOC (lb/gal)	2.33	2.68
VOC (g/L)	280	321
Pigment/binder ratio	0.80	—
PVC	18.46	—
Grind (Hegman)	—	7.5
Viscosity (cps)	—	505

(a) MIAK = methyl iso-amyl ketone.

Table 5—Formula for Paint E

Raw Material	Lb	Gal	Lb/Nv	Gal/Nv	% By Wt
Polyester	396.7	45.3	341.1	37.6	32.79
EEP (ester solvent)	18.2	1.3	0.0	0.0	1.50
MIAK	8.6	1.3	0.0	0.0	0.71
Thixotrope	4.0	0.3	4.0	0.3	0.33
HMMM	188.0	18.8	188.0	18.8	15.54
Dispersant	3.5	0.4	2.5	0.3	0.29
Titanium dioxide	450.0	13.6	450.0	13.6	37.20
MNAK[a]	60.0	8.8	0.0	0.0	4.96
Xylene	47.5	6.6	0.0	0.0	3.93
Aromatic 100	13.2	1.8	0.0	0.0	1.09
Xylene	9.5	1.3	0.0	0.0	0.79
p-TSA	10.6	1.3	4.2	0.3	0.88
Total	1209.8	100.8	989.8	70.9	100.01

	Theoretical	Practical
Weight/gal (lb/gal)	11.93	—
Weight solids, %	82.19	80.5
Volume solids, %	70.25	—
VOC (lb/gal)	2.13	2.32
VOC (g/L)	255	278
Pigment/binder ratio	0.86	—
PVC	19.60	—
Grind (Hegman)	—	7.5
Viscosity (cps)	—	430

(a) MNAK = methyl normal amyl ketone.

Table 6—Critical Surface Tension of Some Substances[16,26,27]

Materials	Critical Surface Tension (dynes/cm)
Bonderized steel	40-45
Aluminum	37-45
Alkyd primer	70
Glass	70
Polymers	**Surface Tension**
Soya oil modified alkyd (low solids)	37
Oil-free polyester (high solids)	47
Hexamethoxy methyl melamine	58
Poly methyl methacrylate	41
Solvents	**Surface Tension**
Ketones	22-27
Esters	21-29
Alcohols	21-35
Glycol ethers	26-35
Glycol ether esters	28-32
Aliphatic hydrocarbons	18-28
Aromatic hydrocarbons	28-30
Isoparaffins	21-31
Water (distilled)	72.7
Additives	**Surface Tension**
Silicone	20
Modaflow (Monsanto)	32

Subsequent additives were labeled in the following sequence: A-2, A-3, A-4, etc.

SAMPLE TESTING:

Application—All samples were sprayed at ambient temperature, the unmodified control being sprayed first and last. Both paint and room temperature were noted. Pressure cup or pressure pot spray equipment were used. One mil dry film thickness (DFT) (± 0.1 mil) was applied in no more than two passes using the "90° cross coat" technique for spraying.

Solvent was allowed to flash off for 10 min before baking for 10 min at 350°F in a forced air or circulating air oven. The panel was held vertically throughout this process. The time and metal temperature were maintained as accurately as possible.

The baked panels were conditioned 16-24 hr at room temperature before evaluating their properties.

General Appearance—The control and adjusted samples were evaluated for sag by making a "horizontal" letter "S" in the top one third of the panel immediately after spraying.

Film defects, compared to the control, were observed and reported.

Recoatability—After aging the single coated panels for 16-24 hr, a second coat was applied to half the panels, covering 75% of the first coat, flashed off for 10 min, and baked for 10 min at 350°F.

Table 7—Results of Testing

Paint A

Additive Type	% Total Wt	Cratering	Pinholes	Orange Peel	Sag	Gloss	Adhesion	Pencil Hardness	Recoatability
Control		2	2	3	6	65	5B	5H	10
Dispersing resin	5.00	2	4	4	4	66	5B	5H	10
Dispersing resin	5.00	8	7	4	8	68	5B	4H	10
Surfactant	0.50	4	2	3	2	50	5B	3H	10
Surfactant	0.70	2	4	3	7	50	5B	5H	6
Polyacrylate	0.40	8	4	4	4	77	5B	4H	10
Solvent	0.50	4	6	6	4	56	5B	3H	10
Solvent	3.00	8	6	5	8	80	5B	5H	10
Fluorocarbon	0.30	8	6	5	7	83	5B	3H	2
Polyethylene	2.00	3	4	3	8	74	5B	4H	4
Silicone	0.30	8	8	5	4	81	5B	5H	2
Silicone	0.25	5	6	4	4	80	5B	5H	4
Silicone	0.30	3	4	3	8	75	5B	4H	6

Paint B

Additive Type	% Total Wt	Cratering	Pinholes	Orange Peel	Sag	Gloss	Adhesion	Pencil Hardness	Recoatability
Control		10	8	8	0	96	5B	4H	10
Dispersing resin	5.00	10	6	9	0	94	5B	3H	10
Dispersing resin	5.00	10	9	9	3	91	5B	4H	4
Surfactant	0.70	10	8	9	0	96	5B	4H	10
Polyacrylate	0.60	10	10	9	3	93	5B	4H	10
Polyacrylate	0.30	10	9	6	1	97	5B	4H	10
Solvent	3.00	10	8	9	3	94	5B	4H	10
Fluorocarbon	0.30	8	8	5	1	94	5B	4H	0
Polyethylene	2.00	10	8	6	1	85	5B	5H	0
Silicone	0.30	8	8	6	2	97	5B	5H	2
Silicone	0.03	10	9	10	2	93	5B	4H	10
Silicone	0.25	10	8	5	2	92	5B	4H	0

(Table 7 continued on next page.)

Table 7—Results of Testing (cont'd)

Additive Type	% Total Wt	Cratering	Pinholes	Orange Peel	Sag	Gloss	Adhesion	Pencil Hardness	Recoatability
Paint C									
Control		10	10	8	10	86	3B	H	0
Dispersing resin	5.00	10	10	10	10	85	3B	H	0
Dispersing resin	5.00	10	10	8	10	85	3B	HB-H	5
Surfactant	0.70	10	10	8	10	81	3B	H	0
Polyacrylate	0.40	4	10	4	10	79	4B	H	2
Polyacrylate	0.20	10	10	4	10	84	3B	H	10
Polyacrylate	0.12	10	10	8	10	82	4B	H	10
Polyacrylate	0.50	10	10	8	10	82	3B	H	10
Solvent	3.00	10	10	9	10	82	4B	H	0
Fluorocarbon	0.25	10	10	8	10	87	3B	H	4
Polyethylene	2.00	10	10	4	10	72	3B	H	10
Silicone	0.30	10	10	4	10	80	3B	H	0
Silicone	0.25	10	10	8	10	81	3B	H	10
Silicone	0.25	10	10	8	10	85	4B	H	0
Paint D									
Control		6	10	8	10	95	4B	2H	4
Dispersing resin	5.00	8	10	10	10	97	5B	2H	8
Dispersing resin	5.00	10	10	8	10	88	3B	H	4
Surfactant	0.40	8	10	8	10	96	4B	2H	10
Surfactant	0.70	8	10	8	10	90	4B	H	4
Polyacrylate	0.40	10	10	4	10	89	5B	2H	10
Polyacrylate	0.20	10	10	6	10	95	4B	2H	4
Polyacrylate	0.12	10	10	6	10	95	4B	2H	10
Solvent	3.00	8	10	9	10	85	4B	2H	4
Fluorocarbon	0.25	10	10	6	10	93	5B	2H	0
Polyethylene	2.00	10	10	2	10	86	4B	2H	4
Silicone	0.30	10	10	4	10	92	5B	2H	4
Silicone	0.25	10	10	4	10	90	5B	2H	0
Paint E									
Control		10	8	8	8	75	5B	4H	10
Dispersing resin	5.00	10	7	8	1	88	5B	3H	10
Dispersing resin	5.00	10	8	4	4	83	5B	4H	10
Surfactant	0.70	10	8	4	8	80	5B	3H	10
Polyacrylate	0.20	10	8	6	7	86	5B	4H	10
Polyacrylate	0.08	10	8	7	8	80	5B	5H	10
Solvent	3.00	10	8	7	8	79	5B	5H	10
Fluorocarbon	0.25	10	8	7	5	82	5B	4H	6
Polyethylene	2.00	10	8	2	8	85	5B	3H	10
Silicone	0.30	10	8	7	7	81	5B	5H	0
Silicone	0.20	10	8	7	8	83	5B	4H	10
Silicone	0.50	10	8	7	7	84	5B	5H	0
Silicone	0.25	10	8	8	8	78	5B	4H	0

Table 8—Summary of Properties by Additive

Property	Additive Group: 1D Dispersing Resins	1W Surfactants	2A Polyacrylates	2S Silicones	2C Solvents	2F Fluorocarbons	2P Polyethylene
Cratering	++[a]	+[b]	++	++	+	+	+
Pinholes	+	+	+	+	+	+	+
Orange peel	+	O[c]	−[d]	−−	+	−	−−
Sag	−	O	−	O	+	O	O
Gloss	+	−	−	+	−	O	−
Recoatability	+	O	++	−−	O	−−	−

(a) ++ = Very positive effect.
(b) + = Positive effect.
(c) O = No significant effect.
(d) − = Negative effect.
(e) −− = Very negative effect.

Table 9—Effectiveness of Additive Types

Average Effect		Notes	Effect by Percent: Positive Effect	No Significant Effect	Negative Effect
		Dispersing Resins			
Cratering	Very positive	—	75	25	0
Pinholes	Positive	—	50	17	33
Orange peel	Positive	—	60	30	10
Sag	Negative	Indication of potentially severe increase.	33	17	50
Gloss	Positive	May lower gloss.	40	30	30
Recoatability	Positive	Recoatable unmodified controls were not adversely affected by addition of dispersing resins.	50	25	25
		Surfactants			
Cratering	Positive	Moderate improvement was observed.	75	25	0
Pinholes	Positive	Minimal improvement was observed.	25	75	0
Orange peel	No significant effect	—	14	72	14
Sag	No significant effect	—	25	50	25
Gloss	Negative	Potential for significant decrease depending on the formulation.	14	29	57
Recoatability	No significant effect	Potential for significant individual increase or decrease depending on the formulation.	25	50	25
		Polyacrylates			
Cratering	Positive	—	80	0	20
Pinholes	Positive	—	50	50	0
Orange peel	Negative	—	22	22	56
Sag	Negative	Minimal effect.	25	25	50
Gloss	Negative	Potential for significant increase or decrease depending on the formulation.	30	20	50
Recoatability	Very Positive	—	100	0	0
		Silicones			
Cratering	Very Positive	—	83	0	17
Pinholes	Positive	—	40	60	0
Orange peel	Very negative	—	20	27	53
Sag	No significant effect	—	40	20	40
Gloss	Positive	Tendency to increase.	46	14	40
Recoatability	Very negative	After the silicone addition, one formulation became recoatable.	8	23	69
		Solvents			
Cratering	Positive	Improvement was observed—some craters remained.	100	0	0
Pinholes	Positive	—	50	50	0
Orange peel	Positive	Moderate improvement was observed in most cases.	83	0	17
Sag	Positive	Minimal improvement was observed.	50	25	25
Gloss	Negative	Potential for significant increase or decrease depending on the formulation.	33	0	67
Recoatability	No significant effect	—	0	100	0
		Fluorocarbons			
Cratering	Positive	—	67	0	33
Pinholes	Positive	—	33	67	0
Orange peel	Negative	—	20	20	60
Sag	No signifcant effect	Minimal positive effect was noted in some cases.	67	0	33
Gloss	No significant effect	Potential for loss of gloss in some formulations.	40	20	40
Recoatability	Very negative	—	20	0	80
		Polyethylenes			
Cratering	Positive	Potential for significant improvement.	100	0	0
Pinholes	Positive	—	33	67	0
Orange Peel	Very negative	—	0	20	80
Sag	No signifcant effect	—	67	0	33
Gloss	Negative	Potential for significant increase or decrease depending on the formulation.	30	10	60
Recoatability	Negative	Varies from one extreme to the other. However, there was one case where not recoatable became recoatable.	25	25	50

Note: This type of additive is normally added before pigment and dispersion, therefore, post-addition may not reflect the true effectiveness.

Intercoat adhesion (per ASTM D-3359) was tested and general film defects were reported.

TESTING OF SINGLE COATED PANELS (Application described previously): The following properties were evaluated: gloss—ASTM D-523 (60°); adhesion—ASTM D-3359 (crosshatch/tape); pencil hardness—ASTM D-3363; and film defects (visual observation).

THEORY

Rheology has been studied by numerous investigators. A complete treatment of the subject was reported by Patton.[22] There are several other texts to help provide a thorough understanding of rheological types. Different types of rheological behavior have been identified including: shear independent (Newtonian), shear thickening, and shear thinning.[23–25] Industrial bake coatings vary from shear thinning to shear independent.

Additives which enhance pigment wetting and dispersion are primarily surfactants or dispersing resins. The resulting change in rheology of the coating shows improved flow and leveling. In some instances, dispersing resins may also react with the crosslinking agent. Solvents also change the rheology by reduction of viscosity. However, the solvents used in this study were intended to be generally immiscible with the remainder of the formulation, thereby functioning as surface tension modifiers.

Surface tension modifiers are designed to eliminate certain surface defects such as Bénard cells, cratering, crawling, and orange peel. These additives include the categories of nonionic polymers and special solvents. Their purpose is to modify the surface tension, and thereby enhance wetting of the substrate or base coating. The surface tension of a liquid must be less than the critical surface tension of the substrate for spontaneous wetting to occur. Zisman[26] developed the concept of critical surface tension for solids using the liquid contact angle with the substrate (see *Figure* 1). The contact angle indicates the difference between the surface tension of a liquid and the critical surface tension of the substrate. A partial listing of surface tensions is included in *Table* 6.[16,26,28]

In the interest of non-commerciality, the test results and identity of the additives used are listed only by generic type in *Tables* 7 and 8. However, to assist the formulator in utilizing the information in this study, an alphabetical list of the additives tested is provided (see Appendix 1).

RESULTS OF TESTING

The additives submitted by the participating companies altered flow by two mechanisms: rheology and surface tension.

The additives in the study were categorized as follows:

Rheology	Surface Tension
Surfactants	Polyacrylates
Dispersing resins	Fluorocarbons
	Silicones
	Polyethylenes
	Solvents

Observation of defects such as craters, pinholes, orange peel, and sag may be considered subjective: therefore, an

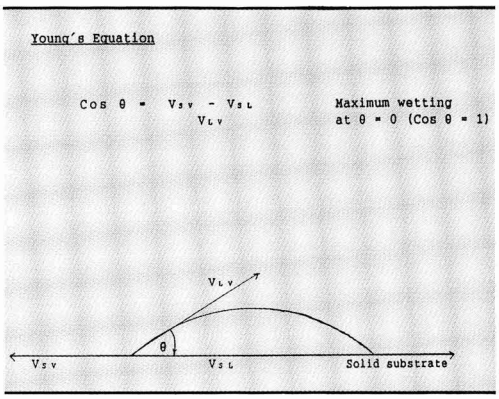

Figure 1—Schematic diagram showing the forces governing the equilibrium of a drop of liquid on a solid substrate. V_{SL} = force at solid-liquid interface. V_{LV} = force at liquid-vapor interface. V_{SV} = force at solid-vapor interface[26,27]

ASTM Standardized Scoring System was used to generate *Table* 8 in order to avoid lengthy descriptions:

Score	Performance or Effect
10	Perfect / None
9	Excellent / Trace
8	Very good / Very slight
6	Good / Slight
4	Fair / Moderate
2	Poor / Considerable
0	Very poor / Complete failure

Recoatability was also scored using the Standardized Scoring System, the principal properties assessed for scoring being crawling and adhesion.

DISCUSSION OF RESULTS

A summary of the test results is shown in *Table* 8.

The results for each type of additive tested may also be analyzed by determining the percentage of each group which produced the effects observed or determined. This analysis is summarized in *Table* 9.

CONCLUSIONS

Each of the additive types tested exhibited both positive and negative effects on the various film properties studied. As expected, no one additive corrected all the defects. All the additives studied improved resistance to cratering and pinholing without affecting the adhesion or hardness of the first coat.

The following specific trends were based on examination of *Tables* 8 and 9.

The dispersing resins and solvents generally showed positive results in this study and were the only additives to improve resistance to orange peel as well as cratering. However, it should be noted that only surface tension modifying solvents were evaluated in this study. In many instances, other solvents may act as rheological modifiers instead.

Both the polyacrylates and dispersing resins generally had a positive effect on recoatability.

The silicones and fluorocarbons significantly reduced cratering without affecting gloss, but generally had a negative effect on recoatability. However, at a low concentration, one silicone additive enhanced surface properties without losing recoatability. This may indicate potential for use of some silicones in recoatable formulations.

In many instances, gloss may be increased or decreased by the individual additive's compatibility with the balance of the formulation.

In general, the quantity of additive incorporated was far more critical in the case of surface tension modifiers than rheology modifiers.

Perhaps the best way to use this information is to determine which defect needs to be corrected first. *Table* 8 helps to determine which group or groups of additives will help most. For example, Groups 1D and 2S are best for eliminating craters. By taking into account the negative aspects in each case, a possible combination of the two may be the best answer. *Table* 9 shows the positive and negative features as well as the possible variations one might encounter in each group. Knowing which group or groups will eliminate a particular defect should help the formulator by indicating which additive suppliers to contact for suggestions. Furthermore, this will help formulators in avoiding obvious false starts—to elimination of surface defects.

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The participation by the following companies is acknowledged and appreciated. Their assistance made this study possible.

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Vehicle suppliers included: Cargill/Peltz Rowley Chemical, Freeman Chemical, McWhorter Inc., Rheox, Inc., and Synray Corporation.

Other participating companies who contributed are: J.L. Armitage Company, D/L Laboratories Inc., Georgia Kaolin, Hüls America Inc., J. Landau & Company, Parker + Amchem, Standard Coating Corporation, Technical Coatings Division, Benjamin Moore & Company, and the staff of the New York Society for Coatings Technology.

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APPENDIX I

Company	Product	Additive Type
3M Corporation	FC-430	Fluorocarbon
Byk-Chemie USA	Byk 077	Silicone
Byk-Chemie USA	Byk 306	Silicone
Byk-Chemie USA	Byk 325	Silicone
Byk-Chemie USA	Byk 361	Polyacrylate
Byk-Chemie USA	Byk 405	Surfactant
Dock Resins Corporation	Dock AC196-1	Dispersing Resin
Dock Resins Corporation	Dock TA13-44	Dispersing Resin
Dow Corning Company	DC-11	Silicone
Exxon	Exxate 700	Solvent
Exxon	Exxon THN	Solvent
Exxon	Iso K/EXX 700	Solvent
Exxon	Isopar K	Solvent
Henkel USA Corporation	Perenol F40/7291	Polyacrylate
Henkel USA Corporation	Perenol F4HN	Solvent
Henkel USA Corporation	Perenol S-5	Silicone
Henkel USA Corporation	Texaphor 3098	Surfactant
Interstab Chemicals Inc.	AKZO HI-SOL	Surfactant
Kenrich Petrochemicals Inc.	Kenrich 59539	Dispersing Resin
Kenrich Petrochemicals Inc.	Kenrich 59540	Dispersing Resin
King Industries Inc.	Dislon L-1980	Polyacrylate
Monsanto Chemical Company	Modaflow	Polyacrylate
Shamrock Chemical Corporation	Versaflow	Polyethylene
Troy Chemical Corporation	Troy Q148	Silicone
Troy Chemical Corporation	Troy S366	Silicone
Ultra Additives Inc.	DEEFO 1002	Silicone
Ultra Additives Inc.	Foam Ban G-0	Polyacrylate

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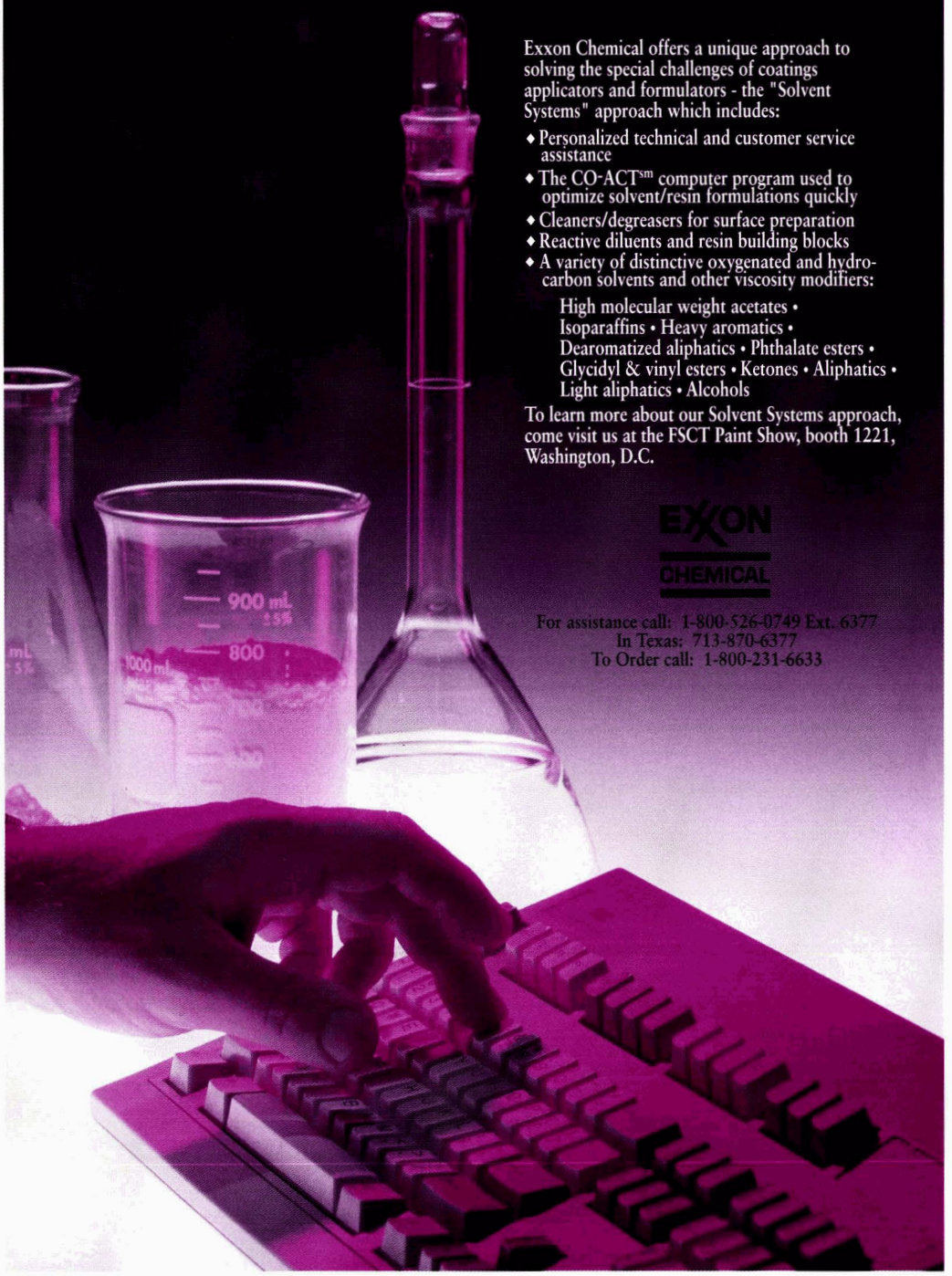

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A Study of Structure-Properties Relationships in Automotive Clearcoat Binders by Statistically Designed Experiments

Klaas J.H. Kruithof and Henk J.W. van den Haak
Akzo Coatings B.V.*

A rotatable central-composite experimental design is used to study three independent variables of an automotive clearcoat formulation. An outline of the design is described, followed by a regression analysis and an evaluation of the results by three-dimensional plots. It is shown how a limited number of experiments provides a solid base for paint development. The data obtained can also be used for the establishment of acceptable tolerances in both the resin specifications and the paint production process.

The incorporation of a monomer bearing a rigid bulky group in an acrylic automotive clearcoat binder is shown to have a positive effect on the balance between hardness and solids content of the product.

INTRODUCTION

A paint has to be regarded as a complex mixture of a variety of mutually interacting components, usually optimized for a specific application. The required quality standards of coatings are becoming more and more rigorous, particularly with regard to the emission of volatile organic compounds, appearance, and physical properties. An ongoing adjustment of existing coating formulations and the development of novel systems are necessary to cope with these constraints.

New raw materials are continuously being introduced on the market, whereas others become scarce or are even withdrawn. Additionally, information concerning the effects of variations in the raw materials on the ultimate paint performance is increasingly requested. A positive prediction of potential failures can be given only if the preceding product development was based on reliable, that is, statistically designed experiments. It is therefore not surprising that, supported by the increasing availability of low-priced desktop computers and excellent software, statistics have become an integrated part of modern paint development.[1,2]

An increase of the solubility of acrylic binders is reported to result from the incorporation of monomers bearing branched, bulky groups.[3] These resins are recom-

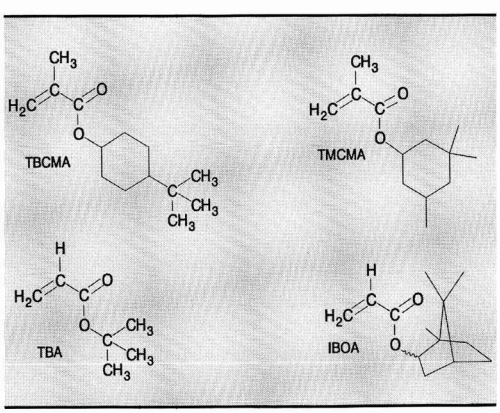


Figure 1—"Special Monomers" applied in acrylics for clearcoats

Presented at the 67th Annual Meeting of the Federation of Societies for Coatings Technology in New Orleans, LA, on November 10, 1989.

*Laboratory Automotive Finishes, P.O. Box 3, 2170 BA Sassenheim, The Netherlands.

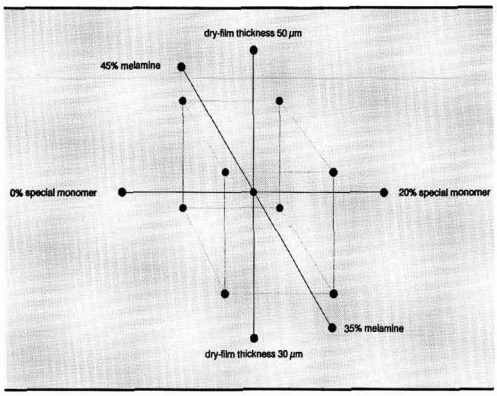


Figure 2—Central-composite rotatable experimental design

mended for the formulation of higher solids coatings. A similar increased solubility can also be obtained by the incorporation of monomers bearing linear flexible bulky groups, e.g., n-butyl acrylate or lauryl methacrylate. However, the incorporation of these monomers leads to a significant decrease of the glass transition temperature (T_g) of the acrylic and, as a consequence, to a reduction of the hardness of the film. In contrast, the introduction of monomers bearing rigid bulky groups is expected to improve the solids content of a paint formulation at an equal, or even increased, hardness level of the film.

This paper describes a statistical evaluation, using a central composite design, of the effect of four selected special monomers on the solids content and the hardness of an automotive clearcoat. The monomers investigated are: t-butyl acrylate (TBA), isobornyl acrylate (IBOA), 4-t-butylcyclohexyl methacrylate (TBCMA),* and 3,3,5-trimethylcyclohexyl methacrylate (TMCMA) (*Figure* 1).

An experimental design was used by which the effect of special monomers on the solids contents and the hardness of an automotive clearcoat could be investigated simultaneously. This approach allows the investigation of the relation between hardness and solids content independent of T_g.

EXPERIMENTAL DESIGN

The effects of variations in three independent variables on the solids content and the hardness of an automotive clearcoat were investigated in a central-composite rotatable experimental design. Three variables were studied, namely, the level of a special monomer in the acrylic clearcoat resin (MON), the level of the melamine formaldehyde crosslinker in the formulation (MEL), and the dry film thickness (DFT). Four different types of special monomers were tested.

The central-composite design for investigating the effects of the three independent variables required the preparation of 20 clearcoat formulations for each type of special monomer, including six repetitions in the center (*Figure* 2). The real levels of the three independent variables (MON, MEL, and DFT, see *Table* 1) are obtained via a transformation of the standard levels using the following formula:[4]

$$R = \frac{(Hr + Lr)}{2} + \frac{S * (Hr - Lr)}{(Hs - Ls)}$$

where:

R	= real level	S	= standard level
Hr	= highest real level	Hs	= highest standard level
Lr	= lowest real level	Ls	= lowest standard level

The standard and the real levels used in our experiments are given in *Table* 1.

The hardness of a paint film is related to its thickness. Application of a large series of different coatings without a significant variation in film thickness is nearly impossible, even with the use of automated spraying equipment. Therefore, in daily practice, each coating under investigation is applied at two different layer thicknesses. The hardness data determined for these films successively yield the hardness at a fixed film thickness by a linear interpolation. In our case, DFT was treated as an independent variable. A relation between hardness and DFT other than linear can be handled in this case. Moreover, the number of panels required for this experiment is significantly reduced as compared with the standard procedure described previously.

The film thicknesses prescribed by the central-composite design (see *Table* 1) were approximated as closely as possible in practice. The actual film thicknesses were subsequently determined and used for calculations.

EXPERIMENTAL PROCEDURES

Five acrylic resins were prepared. Hydroxyethyl methacrylate was incorporated in each polymer to obtain an

Table 1—Standard and Real Levels

	Standard Levels (S)			Real Levels (R)		
No.	MON[a]	MEL	DFT	MON (%)	MEL (%)	DFT (µm)
1....	−1	−1	−1	4.05	29.05	34
2....	−1	−1	+1	4.05	29.05	46
3....	−1	+1	−1	4.05	40.95	34
4....	−1	+1	+1	4.05	40.95	46
5....	+1	−1	−1	15.95	29.05	34
6....	+1	−1	+1	15.95	29.05	46
7....	+1	+1	−1	15.95	40.95	34
8....	+1	+1	+1	15.95	40.95	46
9....	−1.682	0	0	0	35	40
10 ...	1.682	0	0	20	35	40
11 ...	0	−1.682	0	10	25	40
12 ...	0	1.682	0	10	45	40
13 ...	0	0	−1.682	10	35	30
14 ...	0	0	1.682	10	35	50
15 ...	0	0	0	10	35	40
16 ...	0	0	0	10	35	40
17 ...	0	0	0	10	35	40
18 ...	0	0	0	10	35	40
19 ...	0	0	0	10	35	40
20 ...	0	0	0	10	35	40

(a) MON = special monomer; MEL = melamine; DFT = dry film thickness.

*TBCMA is supplied as a 50% solution in isobutyl methacrylate (IBMA). Incorporation of "20% TBCMA" in this paper is equivalent to 10% of TBCMA and 10% of IBMA.

Table 2—Experimental Data

MON (%)	MEL (%)	TBA DFT (μm)	TBA Solids (w/w)	TBA KHN	IBOA DFT (μm)	IBOA Solids (w/w)	IBOA KHN	TBCMA DFT (μm)	TBCMA Solids (w/w)	TBCMA KHN	TMCMA DFT (μm)	TMCMA Solids (w/w)	TMCMA KHN
4.05	29.05	28	50.7	5.94	31	52.1	5.51	27	50.0	6.51	28	50.0	6.23
4.05	29.05	39	49.4	5.00	41	51.4	6.06	37	52.0	6.38	37	51.0	6.95
4.05	40.95	27	50.2	7.81	29	49.2	6.87	28	49.6	6.62	28	50.5	7.77
4.05	40.95	39	50.3	7.28	42	50.3	7.19	39	50.2	7.60	36	50.3	7.88
15.95	29.05	31	50.9	6.70	31	51.9	7.01	30	50.6	7.22	28	51.9	6.70
15.95	29.05	38	50.2	7.38	37	50.6	7.67	32	51.5	8.47	40	50.5	6.75
15.95	40.95	31	49.8	9.53	28	52.0	9.04	27	50.4	9.49	29	51.0	9.87
15.95	40.95	36	51.1	8.16	34	50.9	7.88	41	50.9	8.05	36	53.8	7.81
0.00	35.00	32	50.5	6.33	39	50.9	5.72	45	50.9	5.61	43	50.9	5.97
20.00	35.00	33	50.8	8.75	28	50.3	8.43	38	50.6	9.97	32	51.1	8.51
10.00	25.00	31	51.4	5.20	31	52.0	5.85	33	50.4	5.57	31	51.7	5.09
10.00	45.00	29	49.7	8.05	31	48.6	7.54	32	50.8	8.43	31	50.4	7.70
10.00	35.00	21	50.3	7.34	23	50.3	8.24	21	50.0	7.28	25	51.2	7.41
10.00	35.00	42	50.8	7.01	42	51.1	8.05	43	51.0	8.20	42	51.1	7.47
10.00	35.00	31	50.3	7.74	31	50.9	8.91	35	50.5	8.31	30	51.2	7.41
10.00	35.00	32	50.3	7.01	32	50.9	7.31	35	50.5	8.83	30	51.2	8.39
10.00	35.00	29	50.3	6.75	33	50.9	7.31	37	50.5	8.75	32	51.2	6.81
10.00	35.00	35	49.2	6.38	30	50.6	7.10	33	51.5	7.64	29	51.0	8.59
10.00	35.00	39	49.2	7.91	31	50.6	7.98	34	51.5	7.67	29	51.0	7.74
10.00	35.00	32	49.2	6.64	32	50.6	6.89	34	51.5	8.20	29	51.0	6.98

OH-value ranging from 140-160 mg KOH/g resin. The acid value of each resin was adjusted to 16-18 mg KOH/g by the copolymerization of methacrylic acid. Four resins contained 20% of one of the special monomers given in *Figure* 1. The fifth is the reference acrylic resin based on monomers commonly used for clearcoat binders in the same fixed ratio as used for the other four acrylic resins, however, without any special monomer added. The measured (gel permeation chromatography) number-averaged molecular mass was approximately 1250 for all acrylics involved.

A resin containing 20% of a typical special monomer was blended with a similar acrylic without special monomer. Via this route, the level of the special monomer in the acrylic resin composition was varied between 0 and 20%. This procedure allows an evaluation of the effect of both the level and the type of the special monomer, without the need to prepare a very large series of resins. Small deviations between a resin composition obtained by blending, as previously described, and a formulation based on one resin produced by the incorporation of the corresponding amount of the special monomer in a polymer may occur, however.

Setamine US141,* a partially butylated oligomeric melamine-formaldehyde resin was selected as the crosslinker. The level in the formulation was varied between 25 and 45% based on total resin solids.

All formulations were prepared by mixing the appropriate amount of the reference acrylic resin, the special-monomer based resin, and the melamine. Additional solvent was added to the mixtures to secure a similar solids content in all formulations. A fixed amount of a mixture of silicone oil and a UV-package was added and the viscosity of the mixture was adjusted to 30 s DIN-cup#4. All formulations were prepared in a random order. Phos-

*Setamine US141 is a registered tradename of Akzo Resins B.V.

Table 3—Regression Coefficients for Knoop Hardness and Solids Content

Knoop Hardness

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Std. Err. of Est.
TBA	*[a]	0.666	*	0.919	*	*	*	*	*	7.167	0.765
IBOA	*	0.761	−0.343	0.554	*	*	*	*	*	7.566	0.581
TBCMA	*	0.941	−0.475	0.634	−0.234	−0.555	*	*	*	7.934	0.576
TMCMA	*	0.566	*	0.812	*	*	*	*	*	7.367	0.716

Solids Content

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Std. Err. of Est.
TBA	*	*	*	*	—	—	*	—	—	50.440	0.575
IBOA	*	*	*	−0.682	—	—	0.550	—	—	50.795	0.590
TBCMA	*	*	*	*	—	—	*	—	—	50.685	0.561
TMCMA	*	0.347	*	*	—	—	*	—	—	51.137	0.722

(a) * = not significant (alpha > 0.05).

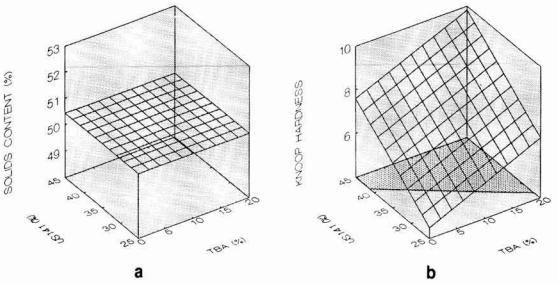


Figure 3—Effect of TBA- and melamine level on solids content and Knoop hardness

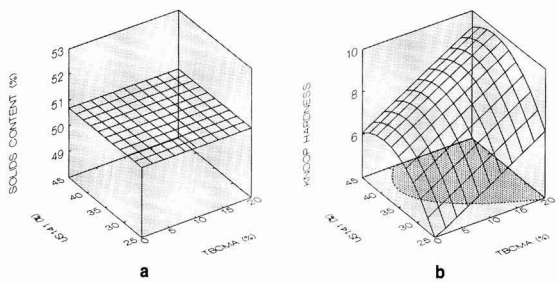


Figure 4—Effect of TBCMA- and melamine level on solids content and Knoop hardness

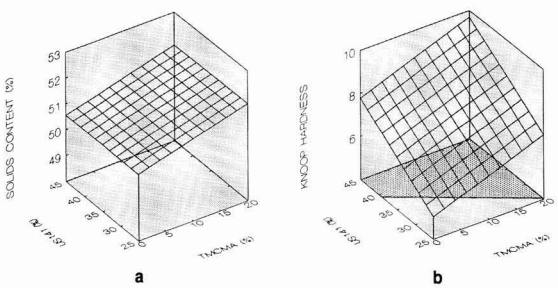


Figure 5—Effect of TMCMA- and melamine level on solids content and Knoop hardness

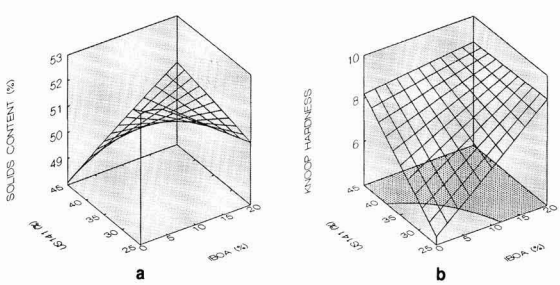


Figure 6—Effect of IBOA- and melamine level on solids content and Knoop hardness

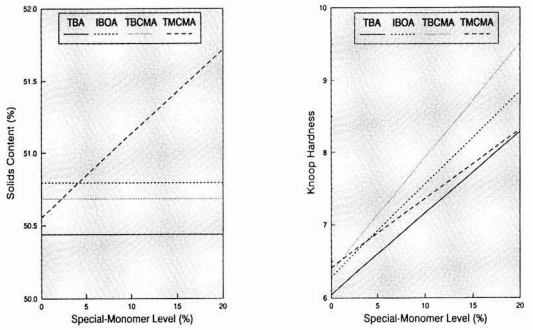


Figure 7—Effect of special-monomer level on solids content and Knoop hardness. Melamine level = 35%, film thickness = 40 μm

phated steel panels (Bonderite 132), coated with a surfacer, were used as substrates in all tests. The clearcoats were applied wet-on-wet by an automated spray procedure over a silver metallic basecoat and cured for 17 min at 130°C.

The solids content (w/w, 2 hr at 120°C) and the Knoop hardness (ASTM D 1414) were determined for each formulation.

An overview of the data obtained is given in *Table* 2.

REGRESSION ANALYSIS

A regression analysis was carried out on the data obtained for each special monomer by means of a statistical computer program. This means that a particular response, for example, Knoop hardness (KHN) is described as a function of the independent variables, in this case, the special-monomer level (MON), the melamine level (MEL), and the dry film thickness (DFT), with the following quadratic equation:

$$KHN = C_1*MON^2 + C_2*MON + C_3*MEL^2 + C_4*MEL + C_5*DFT^2 + C_6*DFT + C_7*MON*MEL + C_8*MON*DFT + C_9*MEL*DFT + C_{10}$$

C_1-C_{10} are constants which are determined by means of a regression analysis. A similar procedure was carried out for the response "solids content" (*Table* 3).

In addition to the coefficients, the computer program also calculates the corresponding alpha-values. The latter figure indicates the chance that a coefficient differs from zero by random errors only. In cases where alpha exceeds 0.05, the coefficients are considered to be zero and, hence, the corresponding term is omitted here. The coefficients related to the effect of the dry film thickness on the solids content (C_5, C_6, C_8, and C_9) are zero by definition.

The introduction of a constant value for the film thickness (e.g., 40 μm) in the KHN-functions reduces these functions to two-variable equations which can be represented by three-dimensional surface plots.

RESULTS

Figures 3a, 4a, 5a, and 6a represent three-dimensional plots of the solids content as a function of the level of special monomer in the acrylic resin and the level of the melamine crosslinker in the clearcoat formulation. The dotted contour lines in the bottom planes refer to a solids content level > 50%. Similar representations of the Knoop hardness are given in *Figures* 3b, 4b, 5b, and 6b. The shaded area in the bottom planes refer in this case to a minimal hardness number of 7.

Figure 7a shows a cross section of the three-dimensional representations at a fixed melamine level of 35% with regard to solids content. *Figure* 7b shows the KHN readings for a melamine level of 35% and a fixed film thickness of 40 μm.

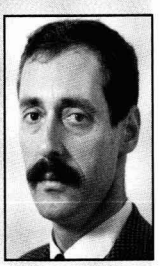
Figure 8 shows a graphical representation of the relation between solids content and film hardness (dry film thickness 40 μm).

DISCUSSION

The work described in this paper illustrates how extended knowledge concerning a typical paint formulation,

KLAAS J.H. KRUITHOF has been employed at Akzo B.V. since 1984. He currently serves as R&D Manager/Industry at Akzo Coating B.V./S.A., in Vilvoorde, Belgium. He received a degree in Organic Chemistry from the State University of Utrecht in 1979 and the Ph.D. Degree in Organic Chemistry from the Free University of Amsterdam in 1984. Main areas of interest include pigment dispersions and high solids coatings.

HENK J.W. van den HAAK, Project Manager, Innovative R&D Automotive Clearcoats at the Research Center in Stuttgart, Germany, has been employed at Akzo since 1982. He received a degree in Organic Chemistry from the State University of Leiden in 1976. The Ph.D. Degree in Organic Chemistry was obtained from the Agricultural University of Wageningen in 1981. Dr. van den Haak's main research interests include high solids clearcoats and computer assisted paint research.



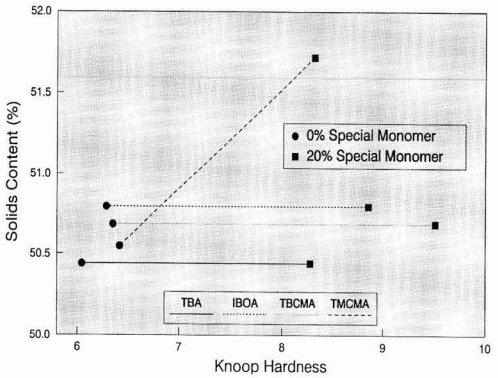


Figure 8—Relation between solids content and film hardness

even taken into account its complex nature, can be obtained by only a limited number of experiments.

A well designed experimental setup allows a reliable screening of selected components of a coating. This information is indispensable for the selection of the right components of a paint formulation during product development. The experimental data obtained by a regression analysis of selected responses allow the prediction of these dependent variables for any paint formulation within the area investigated. This means that a solid base is created for the prediction of the consequences of variations in a coating formulation with regard to coating characteristics, either caused by changes in the composition of a raw material or in the paint production procedure. Potential failures to be encountered in the future product life cycle of a coating can often be traced and reliable formulation can easily be done with such a paint formulation based on "Quality by Design."[5]

Incorporation of any of the four special monomers leads to an increase in the film hardness. In combination with the proper amount of melamine resin, a hardness number of 7 is passed in all cases. Determination of the T_g of the paint films revealed an increase of 10 degrees, as compared with a clearcoat based on the reference acrylic, for each of the acrylics comprising a special monomer tested.

The influence of TBA, IBOA, and TBCMA on the solids content of the clearcoat formulation is only marginal. With an increasing amount of the special monomer in the acrylic resin combination, an increase in hardness of the paint film is observed without a reduction of the solids content.

TMCMA exhibits a significant positive effect on both the hardness and the solids content of the clearcoat. Introduction of this special monomer in acrylic resins should be considered in the development of higher solids acrylic-based coatings with superior hardness characteristics. TMCMA-based acrylics combine an increased T_g of the paint film with an improved solids content of the paint formulation.

CONCLUSIONS

Statistically designed experiments are useful for proper raw material selection, formulation optimization, and the establishment of potential failures of coatings. The incorporation of a special monomer in an acrylic resin leads to a higher T_g and an increased film hardness of an automotive clearcoat at an equal or, in the case of 3,3,5-trimethylcyclohexyl methacrylate, even improved solids content.

SUMMARY

A rotatable central-composite experimental design, based on 20 experiments, was used to study the effect on the hardness and the solids content of an automotive clearcoat of three independent variables, that is, the level of a rigid bulky monomer in the acrylic resin, the level of the melamine crosslinker in the formulation, and the dry film thickness. This fair number of experiments provides a solid base for paint formulation development and for the establishment of acceptable tolerances in the resin specifications and the paint production process. The knowledge thus obtained can be used for a "potential failure-mode analysis" of the novel product design.

It has been shown that the incorporation of rigid bulky monomers in acrylic binders leads to an improvement of the balance between hardness and solids content of an automotive clearcoat. The most pronounced effect was observed for 3,3,5-trimethylcyclohexyl methacrylate.

ACKNOWLEDGMENT

The authors are indebted to Dr. Ger Hemke and Dr. Hans Schellekens of Akzo Resins, Bergen op Zoom (NL) for their contribution in the resin synthesis and valuable discussions on this topic.

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Measurement and Analysis Of Coatings Properties

Thomas K. Rehfeldt
The Sherwin-Williams Company*

Many evaluations in coatings research and development depend upon the positions of test materials on a rating scale of performance. Such properties as solvent and stain resistance, corrosion protection, weathering, blistering, and many criteria of appearance and color are evaluated by rating scale methods. By nature, these evaluations are subjective. Presented here is a procedure, the Rasch method, for converting subjective evaluations into quantitative measurements. The technique is illustrated with an application to a completely balanced experimental design, in which stain resistance was evaluated.

INTRODUCTION

In the coatings industry, many careful, quantitative experiments are performed to develop better coatings. The use of sophisticated experimental designs is increasingly important. We carefully analyze the data, which is obtained from experiments. We carefully measure the processing and composition variables during the experiment, and every effort is made to control variables. Often, however, the responses which are measured for these designed experiments take the form of rather subjective ratings on rather arbitrary scales. Such performance tests as solvent resistance, stain resistance, corrosion protection, salt spray evaluations, weathering, blocking, blistering, orange peel, etc., are based upon ratings.

These ratings are made by experienced technical people, but they are subjective by the very nature of the rating process. At best, the rating process produces ordinal rankings; but proper evaluation requires quantitative interval measures. The subject of this paper is a method for using the ratings to obtain the interval measures which are required, but which are only implied by the rankings.

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*Automotive Technical Center, 10909 S. Cottage Grove Ave., Chicago, IL 60628.

PREVIOUS WORK

There have been attempts to overcome the problem of subjectivity in rating scales. Usually, a reference material, whose properties are known, is included with the experimental materials. However, this does not ensure equal interval, repeatable, objective scales.

Most often rank order statistics are used to evaluate rating scale data.[1-4] Here the scale itself is ignored and the various paints under test are ranked from best to worst by one or several judges. Rank order calculations are used to equate the rankings of the various judges. These rankings usually work very well; judges will rank a group of paints in the same order, subject to experimental error, and it is easy to tell which is the best and which is the worst.

However, the ranking techniques do not solve the problem of objective scales of measurement. One consideration is that the rankings show which is better, but there is no way to tell how much better one coating is than the others. This is particularly troublesome in the middle of the rankings. Another consideration is that one must always deal with a group of coatings and references; the usual rank order statistics do not provide an objective scale which can be used in subsequent testing.

Differences among coatings, which are part of a statistically designed experiment, are often detected by multiple analysis of variance, where each facet or factor is examined as a treatment level. This technique, however, only detects which factors are associated with differences in the performance. It does not rank the various paints nor does it construct useful rating scales. More often than not, every factor appears to be significant in an analysis

Table 1—Raw Ratings from Stain Resistance Experiment

Conditions				Judges					Conditions				Judges				
Obs	Polymer	Hardener	Concen.	BHA	KIL	LMF	DIA	PCC	Obs	Polymer	Hardener	Concen.	BHA	KIL	LMF	DIA	PCC
1	61	A	Low	8[a]	8	8	8	8	22	61	B	Med	0	0	0	0	0
2	62	A	Low	7	8	7	8	7	23	62	B	Med	0	0	0	0	0
3	63	A	Low	6	8	7	8	7	24	63	B	Med	0	0	0	0	0
4	64	A	Low	6	7	6	7	6	25	64	B	Med	5	6	5	5	5
5	65	A	Low	7	8	7	8	7	26	65	B	Med	3	4	4	3	4
6	66	A	Low	7	7	6	8	7	27	66	B	Med	0	1	1	0	0
7	67	A	Low	7	7	7	7	7	28	67	B	Med	4	5	4	3	4
8	61	B	Low	6	7	5	6	6	29	61	A	High	6	7	6	7	6
9	62	B	Low	2	3	2	3	3	30	62	A	High	5	6	5	5	5
10	63	B	Low	1	2	1	2	2	31	63	A	High	5	6	5	5	4
11	64	B	Low	6	7	6	7	6	32	64	A	High	6	6	5	6	5
12	65	B	Low	6	7	6	7	5	33	65	A	High	6	7	6	7	6
13	66	B	Low	4	5	4	5	4	34	66	A	High	7	8	7	7	7
14	67	B	Low	5	6	5	6	5	35	67	A	High	8	8	8	8	8
15	61	A	Med	8	8	7	8	7	36	61	B	High	0	0	0	0	0
16	62	A	Med	5	6	5	5	5	37	62	B	High	0	0	0	0	0
17	63	A	Med	5	6	5	5	5	38	63	B	High	0	0	0	0	0
18	64	A	Med	6	6	6	6	5	39	64	B	High	5	6	5	5	5
19	65	A	Med	7	8	8	8	7	40	65	B	High	3	4	3	3	4
20	66	A	Med	7	8	7	8	7	41	66	B	High	0	0	0	0	0
21	67	A	Med	8	8	8	8	8	42	67	B	High	1	2	2	1	1

(a) 8 = Superior performance and 0 = complete failure.

of variance. Furthermore, the initial ratings, provided by the experts do not, by themselves, provide the interval scale necessary to do the analysis of variance properly (the analysis of variance assumes an equal interval scale).

What we would like is a technique which will allow for the differences between judges, will measure the relative performance of the coatings, and which will produce an equal interval scale for use in subsequent testing.

MEASUREMENT MODEL

Our goal is an objective scale, or measurement, to replace the subjective ratings now in use. This means that we want the measures produced by the model to be independent of the individual judges and also independent of the specific paints tested. The measurement model to be described is due to Rasch[5] and was developed by Wright et al.[6-9] This model has found great utility in educational and psychological applications. However, it is useful whenever objective measurement is needed.

Measurements are quantitative comparisons, either of one paint with another, or a paint with a standard of performance. Let us look at the case where two paints, n and m, are compared with each other. To simplify the derivation of the model, assume a pass/fail test is to be used. Here, there are four possible outcomes: both paints may pass, both paints may fail, one may pass and the other fail, or the other one may pass and the first fail. The notation F_n indicates the count of the times paint n passes and paint m fails.

If both pass or both fail we detect no difference in performance. Thus, all the information on the relative performance comes from the cases where one passes and the other fails.

For a given set of conditions, the more test replications we make on each paint, the more occurrences we expect where one paint passes and the other fails. For the comparison of the performance of the two paints to be useful, we must have stable conditions. The ratio of passes to failures for each paint is expected to be relatively constant, which would provide the necessary stability. Thus, the ratio of passes to failures is the data needed to quantify the comparison of the two paints.

Replication, in this context, usually refers to repeated tests of the same paints. Replication may also be a different judge, i, rating the same test for a given paint. A trial is the single combination of paint, n, and judge, i, for a specific test. Replications are repeated trials.

Consider then the ratio, F_n/F_m. This ratio is a comparison of the number of times paint n passes the test in question when paint m fails, with the number of times paint m passes when paint n fails, that is, when there is a difference in performance. If we increase the number of replications of the test, then this comparison approaches the comparison of probabilities of passing the test, multiplied by the number of replicates. However, if judges make relevant judgments, the replicates are equal for each combination of judge, paint, and test, and we can write:

$$F_n/F_m \rightarrow [(P_{ni})(1\text{-}P_{mi})]/[(1\text{-}P_{ni})(P_{mi})] \quad (1)$$

where, P_n is the probability of paint n passing and $(1\text{-}P_n)$ is the probability of it not passing. Here i signifies the work of judge i.

We require that this comparison be objective, that is, it should not depend upon which judge does the rating or which paints are tested. Thus, for a different judge, j, we must have:

$$F_n/F_m \rightarrow [(P_{nj})(1\text{-}P_{mj})]/[(1\text{-}P_{nj})(P_{mj})] = [(P_{ni})(1\text{-}P_{mi})]/[(1\text{-}P_{ni})(P_{mi})] \quad (2)$$

for all judges, i, j, and for all paints, n, m.

We can rewrite equation (2) to the following:

$$(P_{ni})/(1\text{-}P_{ni}) = [(P_{nj})(1\text{-}P_{mj})(P_{mi})]/[(1\text{-}P_{nj})(P_{mj})(1\text{-}P_{mi})] \quad (3)$$

For objectivity, it does not matter which other judge, j, is involved in the rating, or which other paint, m, is used for the comparison. Therefore, we can choose a reference judge, j = 0, and a reference paint, m = 0, so that:

$$(P_{ni})/(1\text{-}P_{ni}) = [(P_{n0})(1\text{-}P_{00})(P_{0i})]/[(1\text{-}P_{n0})(P_{00})(1\text{-}P_{0i})] \quad (4)$$

where, the 0 subscript designates the selected references. Thus,

$$(P_{ni})/(1\text{-}P_{ni}) = [(P_{n0})(P_{0i})(1\text{-}P_{00})]/[(1\text{-}P_{n0})(1\text{-}P_{0i})(P_{00})] = f(n)\, g(i)\, k \quad (5)$$

where, k is a constant set by the choice of which m is 0 and which j is 0, f is a function of paint n only, and g is a function of the judge i only.

If we choose $P_{00} = 0.5$, then k = 1 and, within the frame of reference of the test $0 < (P_{n0})/(1\text{-}P_{n0}) <$ infinity, depending upon the quality of paint n, and $0 < (P_{0i})/(1\text{-}P_{0i}) <$ infinity, depending upon severity of judge i.

We can convert this to a linear scale by defining the logarithms of these odds, as:

$$\ln[(P_{n0})/(1\text{-}P_{n0})] = B_n \quad (6)$$

the quality measure of paint n, and

$$\ln[(P_{0i})/(1\text{-}P_{0i})] = D_i \quad (6a)$$

the rating severity calibration of judge i, so that

$$\ln[(P_{ni})/(1\text{-}P_{ni})] = B_n\text{-}D_i \quad (7)$$

where, D_i depends only on the judge and B_n depends only on the paint under test. This model can also be written,

$$P_{ni} = \exp(B_n - D_i)/[1 + \exp(B_n - D_i)] \quad (8)$$

The paint, n, and the judge, i, have been separated in the derivation of equation (8). Therefore, this is a measurement model for which the construction of objective measures can be accomplished.

MODEL ESTIMATION

The data from a typical experiment will be a table of ratings given to several test paints by several judges. By using equation (7) or (8), B_n is estimated from the number of passes given to paint, n. D_i is estimated from the number of passes given by judge, i.

We want our calculation to produce a sufficient, efficient, unbiased estimate. The statistical theory around this concept uses the notion of the information content, or Fisher information, of the data.[10,11] The information about an estimated parameter, c, which is contained in one observation, denoted I(c), is the expected value of the derivative of the log likelihood function of the parameter. It can be shown that this quantity is inversely related to the variance of the parameter estimate, <c>, by $\text{var}(<c>) = 1/I(c)$. Thus, the greater the information about c, the smaller the variance. In our case, the information modelled in each rating, X_{ni}, is $Q_{ni} = P_{ni}(1\text{-}P_{ni})$. The residual or discrepancy between observed and expected is obtained in the usual manner, as, $Y_{ni} = X_{ni} - P_{ni}$, the observed relative frequency, X_{ni}, minus the probability predicted by the model, P_{ni}. We make this calculation for each cell in the data matrix.

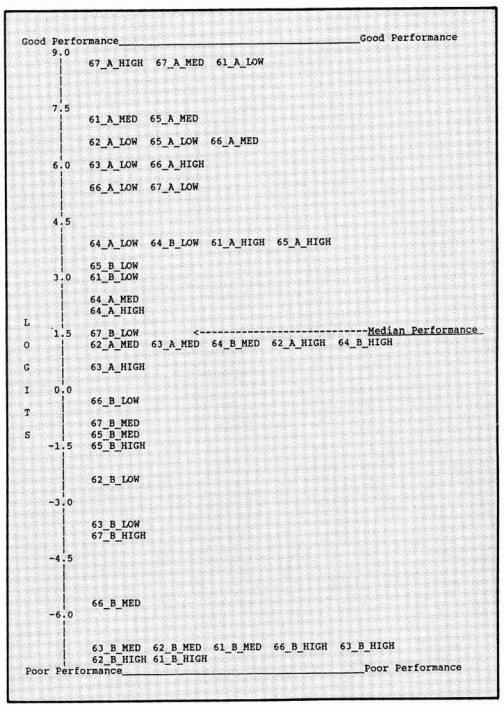

Figure 1—Objective scale of stain resistance constructed from raw ratings

We can then set $B'_n = B_n + (\Sigma_i Y_{ni})/(\Sigma_i Q_{ni})$ and $D'_i = D_i + (\Sigma_n Y_{ni})/(\Sigma_n Q_{ni})$. This is done iteratively until the maximum residual, due either to any paint, n, or any judge, i, is less than some satisfactorily small value, usually 0.5. The parameter estimates from this procedure are unconditional maximum likelihood estimates which are asymptotically unbiased, consistent, and sufficient. This model contains the proper parameters for our data and the B_n's and D_i's define an equal interval, objective scale of the property under test in log odds units or logits.

It can be seen that these calculations are conceptually simple and straightforward. However, the calculations are operationally tedious, particularly if the number of interations needed to obtain an adequate fit is large (in the example to follow the calculations required approximately 150 interations). Therefore, a personal computer was used to do these calculations. The programs used here were adapted, from a somewhat different application, for use in this coatings research.*

This procedure can be expanded to include a rating scale rather than a simple pass/fail test. This may be accomplished by calculating the probability of going from step one on the scale to step two to step three, etc., in the manner described. The model is essentially the

*Further information about the availability of these programs may be obtained by contacting the author.

Table 2—Summary of Stain Resistance Measurements by Hardener, Stain Concentration, and Polymer on Original Logit Scale

	Hardener A			Hardener B		
	Stain Concentration					
	High	Med	Low	High	Med	Low
Polymer 64	2.05	2.50	3.86	1.16	1.16	3.86
Polymer 65	3.86	7.32	6.63	−1.51	−1.28	3.40
Polymer 67	8.41[a]	8.41	5.41	−3.81	−0.80	1.60
Polymer 61	3.86	7.32	8.41	−6.67[b]	−6.67	2.95
Polymer 66	6.00	6.63	5.41	−6.67	−5.66	−0.27
Polymer 62	1.16	1.16	6.63	−6.67	−6.67	−2.38
Polymer 63	0.74	1.16	6.00	−6.67	−6.67	−3.54

(a) 8.41 is the maximum measure.
(b) −6.67 is the minimum measure.

Table 3—Effect of Hardener on Stain Resistance

Hardener	Score	Count	Measure Logit	Model Error	Infit MnSq	Infit Std
1..... A	705	105	1.61	0.12	1.1	0
2..... B	279	105	−1.61	0.07	0.5	−3
Table Mean:	492.0	105.0	0.00[a]	0.10	0.8	−1.6
Table S.D.:	213.0	0.0	1.61	0.02	0.3	2.4

(a) Centered during estimation to anchor the scale.

Table 4—Effect of Stain Concentration on Stain Resistance

Concen.	Score	Count	Measure Logit	Model Error	Infit MnSq	Infit Std
1..... Low	415	70	1.09	0.12	0.6	−2
2..... Med	300	70	−0.38	0.11	0.7	−1
3..... High	269	70	−0.71	0.10	0.8	−1

N Conc	Score	Count	Measure Logit	Model Error	Infit MnSq	Infit Std
Table Mean:	328.0	70.0	0.00[a]	0.11	0.7	−1.8
Table S.D.:	62.8	0.0	0.79	0.01	0.1	0.5

(a) Centered during estimation to anchor the scale.

Table 5—Differences in Judges' Rating Behavior of Stain Resistance

Judge	Score	Count	Logit	Error	MnSq	Std
2..... KIL	216	42	0.38	0.14	0.9	0
4..... DIA	203	42	0.12	0.14	0.7	−1
3..... LMF	189	42	−0.15	0.14	0.6	−1
1..... BHA	188	42	−0.17	0.14	0.6	−1
5..... PCC	188	42	−0.17	0.14	0.7	0
Table Mean:	196.8	42.0	0.00[a]	0.14	0.7	−1.3
Table S.D.:	11.2	0.0	0.22	0.00	0.1	0.6

(a) Centered during estimation to anchor the scale.

same except we deal with the several steps or levels of the rating scale. The iterative fitting process is the same and the interpretation of the results, that is, the equal interval scale, is the same.

This procedure can be further expanded to measure more facets than the paint and the judge. In the example, which will follow, we examine four facet effects of polymer, hardener, judge, and stain concentration. The derivation is a bit more complicated algebraically, but is conceptually identical. In the multi-faceted case, (called the FACETS model) the model is given by

$$\ln((P_{nmi\ldots k})/(1-P_{nmi\ldots k\text{-}1})) = B_n - A_m - D_i \ldots - F_k \qquad (9)$$

with separate terms for each facet.

APPLICATION EXAMPLE

The application of this Rasch procedure will be illustrated by examination of an experiment in which the response of interest was stain resistance. This experiment was chosen for this work because it is typical, in design and extent, to experiments conducted in our development laboratories and, thus, is a useful test case.

Experiment

An experiment was conducted which investigated seven different polymer formulas. Each formula was evaluated with two hardeners. The response variable was stain resistance; for this experiment the stain was applied to the test paints at three concentrations. The staining agent was placed on the test panels and allowed to remain overnight. The stain was then washed off with 10 double rubs of a cloth saturated with methyl ethyl ketone. The appearance of the stained and cleaned area was evaluated by the judges. A completely balanced design was used, that is, we examined all combinations of polymer with hardener with stain concentration. This resulted in 42 test results. Each of the 42 tests was rated by five judges on a scale of 0 to 8, where 0 is total failure and 8 is superior performance.

Data

The raw ratings for the experiment are shown in *Table* 1. The paint samples are designated by polymer, 61-67; hardener, A and B; and stain concentration, low, medium, and high.

Results

The Rasch Facets model described was applied to the data shown in *Table* 1. The logit measures were estimated for each of the 42 tests. From these data, an objective, equal interval scale was constructed, and the position of each test coating was estimated on the scale. This scale and the positions of each paint along the scale are shown in *Figure* 1, (and given in *Table* 2).

Figure 1 shows the distribution of test paints on the scale. This plot tells us several things about our test paints. Polymer 67, when used with hardener A, is the best performer, since it is highest on the scale for both high and medium stain concentration. Polymer 61, with

hardener A, gives equal performance, but only at the low stain concentration.

As a result of the linear, equal interval scale, we can tell that, for example, the improvement in performance between the median, 1.5 logits, and the polymer 61/hardener B/low stain combination is the same as the improvement between polymer 64/hardener B/low stain and polymer 66/hardener A/low stain. Also, the improvement between polymer 61/hardener B/low stain and polymer 63/hardener A/low stain is twice the improvement between polymer 67/hardener B/low stain and polymer 61/hardener B/low stain. We have no hope of making this kind of inference from the original 0-8 scale.

If we use the extension of the Rasch model to the multifaceted case, then we can partition the effects of the separate facets, still on the equal interval scale. A model of this type was calculated and the results, shown in *Tables* 3-5, were obtained.

In *Table* 3, the overall effect of the hardener on the performance of these test paints is shown. We see immediately that hardener A is better than hardener B. This is the average effect of hardener, separated from the other variables. This is an analysis of variance (ANOVA), but the values used are interval measures and the emphasis is on the amount or magnitude of the effect. Often an ANOVA is made in this context which examines only the statistical significance, not the magnitude, of the effect.

In *Table* 4, we see the effect of stain concentration. Each polymer, when all conditions are considered, performs better when the stain concentration is low than when medium or than when high. This is to be expected, but we now have a quantitative estimate of the differences, 1.8 logits between the high and the low. In addition, we have a basis, as we shall see, for detecting unusual performance and, hence, unexpected results.

Rasch Model Accounts for Differences Among Judges

Table 5 illustrates one of the primary advantages of the Rasch model analysis over naive interpretation of the raw ratings. It is evident from this table that these five judges do not rate in the same way, that is, different judges give different ratings to the same paint panel. Here are two groups of judges: KIL and DIA, who are similar in the leniency of their ratings at 0.38 and 0.12 logits, and LMF, BHA, and PCC, who are also similar among themselves, at −0.15 and −0.17 logits, but are significantly more severe than the previous group of two. The latter group is about 0.35 logits more stringent or harsher in their ratings than the former. If this difference is not considered in the analysis of the data, then the ratings obtained depend, at least in part, on who does the rating and not solely on the performance of the paint.

It may be argued that the rankings of the coatings may be the same even though each judge gives different individual ratings. While this may be true, and could be used in experiments of this type, it implicitly places two restrictions on the data analysis. First, the experiment must contain enough samples to provide significance to the rankings, this means 10 or more samples. Second, the rankings are only adequate for the experiment at hand and cannot be used to evaluate subsequent measurements of the property, here, stain resistance. Thus, one must conduct a complete experiment with at least 10 trials for each evaluation.

Table 6—Effect of Polymer on Stain Resistance

Polymer	Score	Count	Measure Logit	Model Error	Infit MnSq	Infit Std
64 (best)	173	30	1.38	0.16	1.6	1
65	173	30	1.38	0.16	0.4	−2
67	169	30	1.29	0.15	0.6	−1
61	140	30	0.61	0.16	0.8	0
66	132	30	0.37	0.18	0.6	−1
62	102	30	−0.60	0.18	0.2	−3
63 (worst)	95	30	−0.83	0.18	0.2	−3
Table Mean:	140.6	30.0	0.51	0.17	0.6	−1.6
Table S.D.:	30.6	0.0	0.86	0.01	0.5	1.8

NB: There are three groups with significant differences in performance between groups and similar performance within groups.

Further Analysis

In *Table* 6, we see the effect of the polymer on the performance. The measure order of the polymers, is from best to worst, again separated from the other variables. We get our positions, on an objective scale; and the scale can be used for one or a few subsequent measurements without running the entire experiment over again. Further, the measures tell us not only which polymer is better but how much better, as well.

The measures determined by the model can be used in several ways. *Table* 2 shows the summary of the experiment, plotted in *Figure* 1. The scale measures are in the body of the table. The polymers are in order of decreasing performance. The columns of the table show the effect of stain concentration and hardener. The values here are the logits on the original scale.

We see here why polymer 64 is rated best overall by virtue of its total performance. While lower, for example, than polymer 67 with high concentration of stain and hardener A, polymer 64 is more consistent over the various stain concentrations and with both hardeners. In fact, polymer 64 is the only polymer that did not receive negative measures with hardener B.

An interesting anomaly also can be seen. Polymer 67 performs three to four logits better with high stain concentrations than it does with lower stain concentrations. This is not expected, and may be important for formulation of this type of coating.

Table 7—Residuals Analysis of Stain Resistance Measurement

Polymer/ Hardener	Conc	Judge	Obs	Expected	Residual
67A	Low	BHA	7	7.9	−0.9
67A	Low	KIL	7	8.0	−1.0
67A	Low	LMF	7	7.9	−0.9
67A	Low	DIA	7	8.0	−1.0
67A	Low	PCC	7	7.9	−0.9

Table 8—Ranking of Stain Resistance with Polymer and Hardener Combined

Polymer/ Hard	Score	Count	Logit	Error	MnSq	Std
67A	115	15	5.97	0.55	2.1	2
61A	110	15	4.77	0.45	0.8	0
66A	108	15	4.39	0.43	1.4	0
65A	107	15	4.20	0.42	1.0	0
62A	89	15	1.64	0.35	0.4	−1
64A	89	15	1.64	0.35	0.4	−1
63A	87	15	1.40	0.34	0.5	−1
64B	84	15	1.08	0.32	0.2	−2
65B	66	15	−0.20	0.23	0.5	−1
61B	30	15	−2.02	0.27	1.1	0
67B	24	15	−2.52	0.30	0.1	−2
62B	13	15	−3.51	0.30	0.2	−2
63B	8	15	−4.00	0.33	0.3	−1
Table Mean:	71.5	15.0	0.99	0.36	0.7	−0.9
Table S.D.:	37.7	0.0	3.16	0.08	0.5	1.4

This anomaly was found by examination of the residuals from a multi-faceted analysis. We see this in *Table* 7. Here, the expected ratings, near 8, are shown with the residuals. Polymer 67 was rated lower, at 7, than was expected by all the judges. This would indicate an area for further investigation.

Finally, we can use the facets analysis to combine effects of the variables if we desire. For example, in *Table* 8, the effects of the polymer type and the hardener have been combined by using the polymer/hardener combination as a single facet rather than as two facets. Here, we obtain positions of polymer and hardener combinations with respect to stain resistance.

SUMMARY

A method of overcoming the difficulties of rating scale rankings of paints has been demonstrated. The utility of the method includes: construction of an objective measurement scale, detection and adjustment for differences in judges, measures of performance, means to detect outliers, and consistent measures from one experiment to the next.

The model is suitable for rating scale, pass/fail, and minimum performance testing in paints and coatings. Such tests as stain resistance, solvent resistance, tape time, cross hatch adhesion, hardness, DOI, and other such tests with inherently large scatter are suitable candidates for Rasch facets analysis.

When this model is used, rating scale rankings can be used to estimate experimental measures for regression and other designed experiments in a like manner to other, quantitative measurements.

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June 1990 Subcommittee Reports of ASTM Committee D-1

The June meeting of ASTM Committee D-1 on Paints and Related Coatings was held on June 17-20, 1990 at the Grand Hyatt in San Francisco, CA. In the three and one-half days preceding the final session and general meeting of Committee D-1, 194 members and guests met in 152 scheduled meetings of D-1 and working task groups. The current membership of Committee D-1 is 594.

Awards presented included: Henry A. Gardner Award to S.B. Schroeder; Paul A. Gardner Award to L. Schaeffer; William T. Pearce Award to M.E. McKnight; D-1 Honorary Members to S.A. Yuhas and J. Behrle; and Certificates of Appreciation to L.E. Newman, W.E. Whitlock, A.M. Snider, and C.B. Beiter.

It was decided to give awards on an annual basis at the June meeting and to hold a mini-symposium every January meeting.

Highlights

Sub. D01.08—Recent court decisions mandating VOC reduction in consumer products and anticipated amendments to the Clean Air Act have highlighted the need for new ASTM Standards.

Sub. D01.20—Voted to submit D 3980, Standard Practice for Interlaboratory Testing of Paints and Related Materials, for withdrawal.

Sub. D01.21—Task Group 81 held a successful symposium on paint analysis with 115 participants from seven countries. Registration fees contributed $2,940 to the D-1 treasury.

Sub. D01.34—The Ink Vehicles group will split from Sub. 34 on Naval Stores and form a provisional Sub. 37. The scope has been approved by the D01.90 Executive Subcommittee. J.C. Weaver has received a commitment from the Naval Stores industry to review the Standards remaining in Sub D01.34.

Future Meetings

January 20-23, 1991—Ft. Lauderdale, FL, Embassy Suites.
June 16-19, 1991—Ottawa, Canada, Chateau Laurier.
January 19-22, 1992—Ft. Lauderdale, FL, Embassy Suites.
June 21-24, 1992—Minneapolis, MN, Marriott (tentative).

New Standards

New D-1 standards since January 1990 approved by the ASTM Committee on Standards in the months shown: (subcommittee jurisdiction).

APPROVED JULY 27, 1990

D 5097-90, Test Method for Filter-Retained Solids Content of Polymer Latexes (Sub D01.33)

D 5098-90, Specification for Artists', Acrylic Emulsion Paints (Sub D01.57)

APPROVED MAY 25, 1990

D 5062-90, Test Method for Resin Solution Dilutability (Sub D01.34)

D 5063-90, Standard Certification on Conformance Form (Sub D01.45)

D 5064-90, Practice for Conducting a Patch Test To Assess Coating Compatability (Sub D01.46)

D 5065-90, Guide for Assessing the Condition of Aged Coatings on Steel Surfaces (Sub D01.46)

D 5067-90, Specification for Artists' Watercolor Paints (Sub D01.57)

D 5068-90, Practice for Preparation of Paint Brushes for Evaluation (Sub D01.61)

D 5069-90, Practice for Preparation of Paint Roller Covers for Evaluation (Sub D01.61)

APPROVED APRIL 27, 1990

D 5043-90, Test Methods for Field Identification of Coatings (Sub D01.46)

DIVISION 1 ADMINISTRATION

SUBCOMMITTEE D01.07 GOVERNMENT STANDARDS

M.E. McKnight, Chairman

The subcommittee welcomed four representatives from the U.S. Government Service Agency (GSA) paint testing laboratory in San Francisco. The GSA laboratory is the national paint testing laboratory for GSA. Paint purchased through GSA contracts accounts for the majority of the material tested. Both architectural and industrial coatings are tested by the laboratory with industrial coatings making up the larger fraction. The committee requested their consideration of the adequacy and completeness of ASTM methods for testing paint. The chairman agreed to follow up this request. Cynthia Joe, of GSA, reported that they had prepared a report comparing Federal Standard Method 141 with ASTM methods for Ray Viola of GSA, Federal Supply Service, Auburn, WA. Ms. McKnight agreed to request a copy of the report.

Lee Rogers, from the Office of the Secretary of Defense (OSD), reported that OSD is directing military agencies to develop means to use commercially available materials when appropriate. Two possible mechanisms are nongovernment standards and multiple award schedules. Cancellation of military and federal standards related to commercial items is continuing. To help implement the use of nongovernment standards, GSA and DoD are finalizing an agreement to provide a common stock point for standards that have been adopted by the federal government.

Mr. Rogers also reported that action is underway for DoD to adopt nongovernment standards generically rather than by date of revision. That is, a revised standard will remain "adopted" unless action is taken to remove the revised standard from the adoption list.

Ms. McKnight reported that: (1) upon the recommendation of Sub. D01.07, Sub D01.42 is developing standards on application; (2) D01.42.01 was receptive to her suggested changes to specify parameters for the test method for washability; and (3) Federal Standard 595, revision B, was issued in 1989. She restated two of the goals of the committee: (1) to provide guidance for increasing the usefulness of standards for inclusion in contracts and other documents of commerce; and 2) to identify needs for new or improved test methods for coatings or related products.

Agenda items suggested for the next meeting include: (1) status of GSA/DoD NPFC agreement; (2) status of new DoD adoption procedure; and (3) report on government adoption of ASTM standards.

SUBCOMMITTEE D01.08 ENVIRONMENTAL CONCERNS

J.J. Brezinski, Chairman

Recent court decisions in California mandating VOC reduction in consumer products in the Bay Area and anticipated amendments to the federal Clean Air Act have highlighted the need for new ASTM standards. These include the determination of VOC in aerosol spray paint containers and of the amount of NH_3 present/emitted from water-dilutable coatings, as well as a guide to relate coating performance and VOC content. Also reviewed was increased focus on "spot tests" to determine lead concentration in old painted surfaces and the need for additional ASTM standards regarding the lead issue.

D01.08.01—Durability and VOC—M.M. Gaschke, Chairman. The purpose of the initial meeting was to determine if ASTM [with Steel Structures Painting Council (SSPC)] should develop guide document(s) relating coating performance to VOC content. J. Berry of U.S. EPA stated future agency planning regarding VOC will incorporate consideration of coatings performance, for which suitable industry and/or consensus organization guides would be welcomed. Questions were raised about limiting the task group scope to industrial maintenance and marine coatings and whether a public workshop would be a more suitable forum for preparation of the guide. An SSPC draft chart was circulated demonstrating the use of a performance/cell structure integrating VOC level. Further discussion of the task group objectives and scope is scheduled for the January, 1991 meeting.

VOC Content in Aerosol Spray Paint—A task group (in Sub. D01.21) will study a method for determining the volatile content of aerosol spray paint containers, following a procedure (and modified equation for VOC calculation) under review at the laboratory of California's Bay Area Air Quality Management District.

Ammonia Content—Ammonia is not considered photochemically reactive and thus is not believed to be a VOC. A special task group in Sub. D01.80 will consider test approaches to define the presence/emission of ammonia from water-reducible coatings.

Calculation of VOC—Substantial editorial changes in the language and calculation section of D 3960, "Practice for Determining VOC Content of Paints and Related Coatings," to be circulated in a D-1 letter ballot, are directed toward obtaining future EPA acceptance of the practice as an approved alternate for Reference Method 24.

Lead Issue—Recent bills introduced in the U.S. House and Senate appear to recognize the need for additional research regarding the hazard from lead in old paint and from other sources in homes, including the development/definition of suitable test methodology. Both HUD (with a limited grant to M.E. McKnight at NIST) and EPA are interested in the applicability of "spot tests" for lead detection. ASTM test objectives, as outlined by J.C. Weaver, should be: (1) to determine the lead in adherent dust versus that imbedded in the paint; (2) develop a test to distinguish between lead chemical species (anions) to permit assignment of the source of the lead; and (3) prepare a guide on the use of X-ray fluorescence for lead measurement. The first two objectives will likely require funded research programs.

Artist Paint Labels—A draft safety alert from the Consumer Product Safety Commission features labeling of art and draft materials following D 4236.

SUBCOMMITTEE D01.15 LECTURES AND SYMPOSIA

G.Y. Moore, III, Chairman

H. M. Werner announced that for future meetings of D-1, mini-symposia would be scheduled for the January meetings and awards would be given at the June meetings. This will eliminate time conflicts which have been evident at past meetings.

A.F. Rutkiewic reviewed plans for the mini-symposium on "Odor Evaluation," to be held in January, 1991, in Fort Lauderdale, FL. Speakers will be G.V. Civille, of Sensory Spectrum, and S. Ellis, of A.D. Little, Inc. Each will speak for 30 minutes with 15 minutes each for questions. The speakers are coordinating their presentations so that they will be compatible and not repetitive.

C.K. Schoff reported that Task Group D01.24.33 has been organized to study odor evaluation, and he hopes the mini-symposium will encourage participation in that task group.

W.C. Golton reported that the "Symposium on the Analysis of Paint," held in Pittsburgh in May, was a successful venture. There were 115 participants from seven countries, and the symposium generated about $3,000 for D-1. A manuscript of the proceedings is being prepared. Dr. Golton suggested that the larger subcommittees of D-1 consider sponsoring a symposium each year. This could probably be done on a three to four year cycle. G.Y. Moore agreed to contact subcommittee chairmen to determine if this would be feasible.

Dr. Moore reported that J.C. Weaver has proposed that D-1 sponsor a mini-sympo-

sium on "Hardness" in January, 1992 in honor of the 100th anniversary of the birth of George Sward, P.R. Guevin has agreed to be moderator and solicit speakers. A motion to sponsor this mini-symposium passed unanimously.

Dr. Moore had prepared a questionnaire to be sent to the D-1 membership to solicit input for future mini-symposia. However, since the agenda has now been established through 1992, it was decided to delay sending out the questionnaire until after the January, 1991 meeting.

DIVISION 20 RESEARCH AND GENERAL MEETING

SUBCOMMITTEE D01.20 QUALITY ASSURANCE AND STATISTICS

G.Y. Moore, III, Chairman

G.Y. Moore has reviewed D 3924, "Specification for Standard Environment for Conditioning and Testing Paint, Varnish and Lacquer." No changes are necessary except for addition of keywords. The subcommittee unanimously approved the keywords, "Conditioning Environment."

Dr. Moore has also reviewed D 3925, "Practice for Sampling Liquid Paints and Related Pigmented Coatings." Again, no changes are necessary except for addition of keywords. The subcommittee unanimously approved the keyword, "Sampling."

The remainder of the session centered around a discussion of D 3980, "Practice for Interlaboratory Testing of Paint and Related Materials." P.R. Guevin had submitted D 3980 to D.C. McCune, ASTM Committee E-11 Chairman, to verify that it conforms to ASTM guidelines. Mr. McCune has responded with several pertinent and valid comments. He stated that the main difference in E 691 and D 3980 is one of "philosophy." E 691 does not address "operators" and "days" because it expects that each laboratory will address internal control before entering into an interlaboratory study. The two procedures also differ in the handling of "outliers" and the number of participating laboratories required to give meaningful precision statements. After much discussion, the subcommittee voted unanimously to recommend that D 3980 be withdrawn. There were five reasons for this recommendation. (1) E 691 already exists so it is unclear why a special procedure is needed for paint. In the interest of standardization, ASTM should encourage use of E 691; (2) The calculations in E 691 are in better form than those in D 3980, and are therefore easier to use; (3) E 691 does not require two-day results, therefore making it more likely that more laboratories will agree to participate; (4) The handling of outliers in D 3980 is outdated; and (5) No statistician has come forward in D-1 to maintain D 3980.

SUBCOMMITTEE D01.21 CHEMICAL ANALYSIS OF PAINTS AND PAINT MATERIALS

K.H. Fujimoto, Chairman

D01.21.10—Lead in Paints—Chairman J. Weaver discussed the complex issues of lead hazard abatement by various government agencies. Policy on what should be committee D-1's role in the rapidly changing lead-in-paint postures in the courts, Congress, EPA, HUD, CDC, and other bodies is confusing. Recently proposed U.S. House of Representatives' HR 4906, Senate's S2593 by Bradley and others, could involve sampling and analytical techniques of high complexity which ought to have detailed procedures and precisions established by Sub. D01.21. Which of these needs priority attention may emerge from ongoing interaction of the EPA-HUD-Lead industry and interest groups in its June 5, 1990 and future meetings.

Two groups of analytical and sampling procedures deserve early attention: (1) Distinguish amounts of total lead in superficial and exhaust dust versus lead embedded in old paint films; and (2) Distinguish chemical species of lead in the environment, halides versus carbonates versus other anions, in dust versus paints in order to establish the origin of lead from gasoline fall out, "chalk" flakes from interior and exterior paints and miscellaneous sources.

We should adopt an ASTM standard practice on portable XRF, i.e., X-ray fluorescent analyzer for the determination of lead per unit of surface area.

D01.21.14—VOC Publication and Workshops—The ASTM VOC Measurement Workshops have continued to have good attendance. Instructors have found that teaching in the workshops is a two-way street. Not only do they get the chance to instruct others on how to obtain the most accurate VOC results using the ASTM methods listed in U.S. EPA's reference method 24, but teaching has been an education in itself. Again, they have been able to find out the attitude of paint manufacturers and users towards running VOC on their paint products. It seems as if many manufacturers are still using theoretical computerized VOC data.

A workshop was held in conjunction with the D-1 committee's meeting. There were 20 registered for the workshop. The laboratory demonstrations were held at the BAAQMD Laboratory, headed by Rudy Zarrudo.

A future workshop will be held in conjunction with the Federation of Societies for Coatings Technology Annual Meeting and Paint Show in Washington, D.C. on October 29-31, 1990.

Since backup instructors are needed for the VOC workshops, M.E Sites and J. Benga have volunteered to attend the next workshop for training.

The ASTM has sold over 1100 copies of the new ASTM *Paint & Ink VOC Manual,* MNL-4. Task Group 14 has authorized editor John Brezinski to proceed to revise and update the ASTM Manual. The revision will include discussions of new VOC-related test standards approved by the ASTM as well as a discussion of new standard development activity in progress.

The revisions are expected to be completed so that the manual can be published in 1992. Members of subcommittee 21 and other D-1 subcommittees will contribute to this effort.

D01.21.22—Analysis of Electrocoat Bath Samples—Reported that the "Standard Guide for Analysis of Electrocoat Baths," and "Standard Test Method for Analysis of Non-Volatile and Pigment Content of Electrocoat Baths," were forwarded for society ballot following editorial revision.

The research report for the new method "Standard Test Method for Analysis of Solvents in Electrocoat Baths and Permeates by Gas Chromatography," is complete and this method is being forwarded for simultaneous main and Sub. 21 ballots.

An analysis of round-robin data on the VOC determination of E-coat bath samples was conducted. Five laboratories reported data with a significant numerical difference (over 2 lbs/gal) between the VOC values. It was noted by one of the task group members, there is a procedure which has received EPA approval, subject to certain restrictions, which determines E-coat bath VOC based on tank makeup rates. To avoid possible duplication of effort, Chairman Mahon will contact the Motor Vehicle Manufacturers Association to obtain a copy of this method.

D01.21.24—Revision of D 2369-Volatile Content in Paints—A revised copy of D 2369-87 "Volatile Content of Coatings" was distributed by the chairman.

Changes were:

"NOTE 1": Which specified the type of paint systems used to develop D 2369 was incorporated into "scope," para. 1.1

"NOTE 2": Now states task group 27 of Sub. D01.21 is "conducting studies" in place of "running round-robin studies" on the VOC of multi-component paints."

In "Para. 5.0 apparatus," the following changes were made:

—Para. 5.1 now specifies the use of tongs or rubber gloves to handle the aluminum dishes.

—Para. 5.2 states to be sure the shelves are level in the forced draft oven.

—Para. 5.3 uses a 1 ML syringe instead of a 5 ML syringe and recommends the use of disposable syringes.

"NOTE 5": "Para. 7.0 procedure" recommends that water reducible paints be stirred by hand instead of using a shaker (paints will dissolve up to 4% by volume, of air when shaken in a partially filled container).

"NOTE 6": Has been added to Para. 7.2 to specify how to use the syringe and handle the specimen.

All the above changes were approved by Task Group 24. The revised method will be placed on simultaneous D-1 and Sub. 21 letter ballot.

D01.21.24—Ion Chromatography of Electrocoat Bath Samples—Meeting opened with a brief discussion of the test method and the problems which have been encountered. Only two of the four collaborators in the round-robin submitted results. The spiked ions were 150 ppm NO_3^- and 150 ppm HPO_4^-. The results reported were 150 ppm NO_3^- and 0-20 ppm of HPO_4^-

Most laboratories continue to have problems with the sample preparation method. The chairman and M. Mahon will experiment with a sample preparation method and try to come up with an acceptable procedure.

To initiate this work, Chairman Pattison will review the use of different acids to precipitate the organic material in the electrocoat sample. Originally, this method used sulfuric acid, but if left a large $SO_4^=$ peak which interfered with the analysis in some instruments.

The test method has been sent to Dionex for their review and comments. Another round-robin will be initiated if the problem in the sample preparation procedure can be solved.

D01.21.25A—VOC Release from Applied Coatings—met to review the status of the proposed new test method pertaining to VOC abatement from automotive coating processes. The draft has proceeded through society ballot and has been designated as ASTM D 5087. However, the task group decided the revisions agreed upon at the last meeting are too extensive to avoid reballoting. Therefore, the chairman will try to delay the publication of the method in the ASTM *Book of Standards* until the revised method is reballoted simultaneously in Sub. 21 and D-1 letter ballots.

During the meeting, the final draft, which incorporated all the latest comments, was reviewed. A few editorial changes were suggested and they will be added prior to forwarding the revised method for letter ballots.

The task group agreed to proceed with plans for a round-robin to establish precision data for the method. J. Benga will prepare the format to be used for the six collaborators.

Chairman Praschan is stepping down as Chairman of Task Group 25A. In his place J. Komjathy (of GM) has volunteered to chair this task group. Chairman Fujimoto of Sub. 21 extended his appreciation for all of the contributions and work W.A. Praschan has accomplished for this subcommittee.

D01.21.26—Review of D 2697 Volume Nonvolatile by Use of a Helium as Pycnometer—discussed a summary of recent round-robin activities Chairman R. Brockhaus reviewed D 2697 as to its nature, purpose, general acceptance for use as a routine test method and the limitation of the test method.

The summary stated that four samples have been sent out to six collaborators for testing, but the film application procedure is proving to have serious problems. All collaborators reported difficulty in removing the free paint film from the specified substrate, Tedlar. Even when the paint films were removed from the Tedlar, electrostatic charge build-up made handling of the free films difficult.

H. Fujimoto suggested spraying the paint on glass panels as a way of controlling film thickness. The paint film can be easily removed from the glass panel after they are soaked in 60°C warm water.

The chairman proposed the use of aluminum tubes. The tubes are dipped into the paint, baked, and the composite placed in the gas pycnometer. This would circumvent the need to remove the paint film. However, the questions raised by use of this technique are: (1) What is the film thickness achieved on the aluminum tube; (2) How uniform is it; (3) Does a paint film have to be free standing to permit the helium to penetrate the paint to purge out the trapped air and solvents; and (4) How can the aluminum tubes be made more accessible as a test substrate. A revised procedure will be distributed and another round-robin initiated.

D01.21.27—VOC of Multi-Component Paint System—Chairman H. Fujimoto stated that the second round-robin has not been initiated as planned. The volunteers have not submitted test samples as agreed. However, the second round-robin will be started as soon as the samples are received.

There was a discussion on the "Note 1" placed in D 2369 in which the work being done by Task Group 27 on multi-component paints is explained: "Task Group 27 of Sub. D01.21 is running round-robin studies on the volatiles of multi-component paint systems. The only change in procedure is to premix the weighed components in the correct proportions, and allow the solvent/water reduced specimens, in the aluminum pans, to stand at room temperature for one hour prior to placing them into the oven. Preliminary results with these changes appear to show D 2369 is a viable method for multi-component paint systems."

Suggestions were made to expand the induction time up to 24 hr in the note. However, since the round-robin studies are not finished, it was felt this addition is premature, and no work has been done to prove this statement.

J. Aveles placed a society negative on the revision of D 2369 for the Philadelphia Society of Coatings Technology. The bases of the negative was that: (1) D 2369 is not suitable for multi-component paint systems; and (2) There is a discrepancy between Para 1.3 of the test scope and Note 3 (Para 1.3 states "This method does not cover multi-component systems" and Note 3 says "D 2369 is a viable method for multi-component systems).

Task Group 24 found Aveles' negative nonpersuasive by a vote of 15 affirmatives, 0 abstentions and 0 negatives for the following reasons: (1) No data was submitted to substantiate the negative (The Philadelphia Society is setting up a task group to study this problem); (2) The discrepancies in Para 1.3 and Note 3 is not true since the note states "These changes appear to show D 2369 is a viable method," and this note is intended to notify users that an ASTM task group is studying the new procedure; and (3) The 110±5°C baking schedule is the law of the land as EPA negate the 1 hr @ 110°C bake schedule, the method will remain the same. Note 3 does not change the method, but is informative. W.C. Golton will contact J. Aveles to discuss this matter and notify him of the task group's decision on his negative.

M.K. Harding, of Sherwin Williams, has volunteered to take over as chairman of this task group.

D01.21.27A—VOC of Aerosol Paints—task group was formed to develop a test method for the determination of VOCs of both solvent and water reducible coatings.

The Bay Area Air Quality Management District (BAAQMD) is required by law to have a regulation statement and method by January 1991. This appears to be the harbinger of further action not only in the state of California, but the total United States.

We are fortunate that Rodolfo (Rudy) Zarrudo, laboratory manager at BAAQMD, has developed a method similar to the National Paint and Coatings Association's (NPCA) method. Impressive initial results were presented using both methods: percent volatiles and VOCs were close to theoretical values.

The NPCA method consists of cooling a weighed aerosol in a freezer and then relieving the propellant pressure, opening the container, and then running all necessary tests to determine the VOC of the paint.

In the BAAQMD method, the paint from the aerosol is sprayed into a special glass cylinder, approximately ½ in. in diameter and 6 in. long, which is packed with glass wool. The amount of paint used and the weight of the glass container before and after is used to determine its VOC. However, the method is applicable only to solvent reducible paint systems.

The task group will proceed as follows: (1) obtain the written methods from the BAAQMD; and (2) conduct a preliminary mini round-robin on aerosols to ascertain if we have a viable method and to gather enough informational data to be presented at the next task group meeting in January 1991, Fort Lauderdale, FL.

Participants/collaborators are needed for future round-robin studies. Please contact Richard Osterman, of Rust-Oleum, at: (414) 694-3294 — if you want to participate and contribute to the development of a method to determine the VOCs in aerosols.

D01.21.41—Detection of Lead in Paints by Portable XRF—reviewed the statistical procedure the U.S. Department of Housing and Urban Development (HUD) is recommending in the guideline for abatement of lead in paint in public housing to deal with the poor precision of individual measurements using lead-specific portable XRF devices. The chairman reported also that another portable instrument, a spectrum analyzer, is being used for testing of lead in paint films.

Chairman McKnight stated HUD is interested also in spot tests for lead in paint films, and the EPA is interested in a protocol for evaluating proprietory spot test kits. Task Group 41 discussed important parameters which should be included in the protocol they include pigment size and type, condition of the binder, concentration of lead pigments in the binder, and the "dissolving medium."

Chairman McKnight proposed that the scope of the committee be expanded to include the use of lead spot tests.

D01.21.46—X-ray Analysis of Pigments—met to discuss the results of a continuation of a round-robin of a proposed test method entitled "Identification of Crystalline Pigments and Extenders in Paint by X-ray Diffraction Analysis." The results of three additional laboratories had been added, making a total of seven participants. The task group judged the results obtained from the two samples to be satisfactory. Since the method is qualitative, rather than quantitative, it was proposed by H. Fujimoto and accepted by the task group that a statement of observations about the number of correct identifications and errors be used for a precision statement. The chairman will insert such a statement and submit the method for ballot.

The chairman solicited opinions from the task group about the need for, the level of interest in, and the specific focus of an X-ray fluorescence spectroscopy method for qualitative elemental analysis. One possibility is a method to determine what elements are present in paint vehicle as an indicator of what driers may be present. Another possibility is a method for samples in general. Opinions were varied. Reasons expressed for not introducing such a method included in part: (1) there is no reason to document an obvious method; (2) the low concentration of metals available from driers, the possibility of the same metals arising from other sources, and the lack of information about the organic portion of the drier make the method uncertain or useless; and (3) there is no unfulfilled need for the method that should be met. Two attendees expressed the view that a general purpose qualitative analysis method would be useful. Discussion was terminated because of time constraints. The chairman and H. Fujimoto will discuss the topic privately and offer further recommendations.

D01.21.53—Trace Levels of Monomers in Paints—discussed results reported by seven participants in the October 1989 round-robin. An eighth participant will be resupplied with another set of samples.

When the final participant has completed his gas chromatographic analysis for free monomers, the results will be included in a statistical analysis of all of the data (by D 3980). Chairman Eritano volunteered to do the statistical analysis.

The development of an HPLC Method was proposed, discussed, and possible collaborators solicited. This will be pursued in conjunction with the work of D01.33.12

With government regulation requesting the amount of free monomers present in polymers and coatings, analysis for other monomers such as acrylics, formaldehyde, styrene, etc. will be researched as future method development for Task Group 53.

D01.21.54—Revision of D 4017—Water in Paints by Karl Fischer Method—met to discuss the recently revised D 4017 which passed D-1 letter ballot without comments. It will be submitted for society ballot and the 1991 ASTM *Book of Standards*.

A new precision statement will be drafted based on recent round-robin studies carried out by Task Group 24 for the MVMA, and it will be incorporated into D 4017. The revised method with the new precision statement will be submitted for simultaneous Sub. 21 and committee letter ballots.

The possibility of heating a paint sample in a glass oven accessory and collecting the moisture eluted into pyridine as an alternative to directly adding the paint specimen into the titration vessel will be investigated.

D01.21.56—Revision of D 3960—Determining VOC of Paints—noted the latest revision of D 3960 passed society letter ballot in May 1990. This version includes the addition of calculation for VOC per gallon of coating solids deposited and includes equation for VOC determination when transfer efficiency of the coating application is to be considered for reporting VOCs as applied solids.

The latest revision of D 3960, which appeared on the May 4, 1990, Sub. 21 letter ballot, was discussed. The revisions received no negatives, but five comments. Comments were incorporated where appropriate.

A proposed revision of Sections 1 through 5 by J.J. Brezinski was discussed. This revision will be balloted concurrently on D-1 and Sub. 21 ballots. After a short discussion, Task Group 56 decided to leave the title of the practice unchanged. Other editorial changes will be incorporated before the revised D 3960 is submitted for balloting. Results of this ballot will be available for the next January meeting.

D01.21.57—Revision of D 4457—Analysis of Halohydrocarbon in Paints—reviewed proposed changes to D 4457 by Calcoast Analytical. Task Group 57 agreed to keep the general scope and directions of D 4457 unchanged and bring the technical aspects of the method more up-to-date.

After appropriate changes in the method are made, a round-robin will be undertaken prior to the January 1991 meeting. A request for samples and round-robin collaborators was made by the chairman. It was suggested by K.H. Fujimoto that the previous chairman R. Domingo, of Desoto, be contacted to assist in this matter.

D01.21.80—Exploratory Analytical Research—This task group identifies areas where new analytical methods are needed and are feasible.

In this meeting, new task groups were formed for formaldehyde in paint, solvent identification in paints, and correction of VOC content in paints containing ammonia.

A proposed new direct method for determining the VOC content of paints will be investigated by R.K.M. Jayanty, of Research Triangle Institute. Discussion of instrumental methods for determining trace metals in paint will be placed on the agenda of the next meeting.

D01.21.81—Symposium on Analysis of Paint and Related Materials—The symposium was by all accounts a rousing success. There were 115 participants from seven countries. The 16 talks were uniformly strong. The financial outcome is expected to be positive. A total of $2,940 was raised for the committee D-1 operating funds. All 16 chapters have been written for the reference book by the speakers, and the STP is expected to be published in 1991.

The committee recommends that another analytical symposium be sponsored in 1995. Only this time, the emphasis will be on general research papers. Furthermore,

the committee recommends that other measurement science subcommittees sponsor similar symposia.

SUBCOMMITTEE D01.22 HEALTH AND SAFETY

J.J. Brezinski, Chairman

A suggestion of J.G. Lamberton to remove all reference to asbestos from D 1360, Fire Retardency of Paints, Cabinet Method, was deemed unnecessary in light of the inclusion in the note of a substitute material for asbestos.

In response to an inquiry from T.J. Sliva considering possible misinterpretation of the scope of D 3278, Flash Point of Liquids by Setaflash Closed-Cup Apparatus, H. Wray proposed (as an editorial change) the addition of a statement to the end of Section 1.3, the statement to read "when the procedures are used within the scope of the methods." Suggestions were forwarded for clarifying revisions to Committee D-2 of the related D-93, Flash Point by Pensky-Martens Closed Tester, and to the Coordinating Committee on Flash Point to consider modification of the scope of D 3828, Flash Point by Setaflash Closed Cup Tester.

A survey will be made to define interest in and solicit task group volunteers for a proposed study of the adaptability to paints and coatings of a modification of the established procedure used to define the oxygen index of liquids. G.T. Nelson, who has published several papers on oxygen index testing, will chair the new group, D01.22.02 on oxygen index of paints.

SUBCOMMITTEE D01.23 PHYSICAL PROPERTIES OF APPLIED PAINT FILMS

P.R. Guevin, Jr., Chairman

D01.23.10—Adhesion—H.E. Ashton, Chairman, reported revisions of D 3359, "Methods for Measuring Adhesion by Tape Test," completed D-1 balloting. Several editorial comments received were adopted. A statement will be prepared emphasizing the importance of the flatness of panels to be used with multi-cutter adhesion testers for a later revision.

G. Nelson briefly discussed the work performed by the University of Southern Mississippi to evaluate the adhesion of coatings to plastic. He reaffirmed that tape adhesion test yields poor results when used on plastic substrates. These poor results are partly the result of being unable to avoid cutting into the plastic. The chairman observed similar problems were encountered when using wood substrates. Consequently, it was agreed not to include plastic in D 3359.

The chairman, who was resigning at the end of this meeting, promised to continue working on the revision of D 2197, "Method for Adhesion of Organic Coatings by Scrape Adhesion," and an interlaboratory study of pull-off adhesion by tensile machines using the specimens prepared by Task Group D01.46.04. P. Guevin, D01.23 Chairman, announced that Prof. Nelson had agreed to chair the task group.

D01.23.11—Wet Film Thickness—H.A. Ball, Chairman, reported the revision of D 1212, "Methods for Measurement of Wet Film Thickness of Organic Coatings," completed Sub. D01.23 balloting without receiving any negative votes. Several editorial comments and index terms will be incorporated into the method. It will proceed to D-1 ballot before the next meeting.

D01.23.12—Dry Film Thickness—K.A. Trimber, Chairman, reported reapproval of D 1186, "Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base," and D 1400, "Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base," completed Sub. D01.23 balloting each receiving one negative ballot. The negative from M. Morse questioned the validity of the data in both standards regarding instrument accuracy. The negative was found persuasive. The chairman will provide a listing of the manufacturers stated accuracy for the various instruments outlined in the method. This list will allow the task group to better select an accuracy requirement. He also stated that presenting the data for the individual instruments used in round-robin tests does not restrict the method to those instruments alone. Any instrument of the same operating procedure can be used provided its precision is consistent with the values obtained in Table 1 of the method.

The standards will be revised incorporating these changes, various editorial comments received and an expanded calibration procedure. The standards will be submitted to Sub. D01.23 ballot before the January meeting.

D01.23.14—Hardness, Abrasion and Mar Resistance—D.J. Wilverding, Chairman, distributed a preliminary procedure for mar testing using a balanced beam instrument. He requested comments from the task group. He will rewrite the procedure in ASTM format by the next meeting. A. Rutkiewic requested that similar test methods other than the balanced beam, e.g., General Motors Crock Test, be reviewed. He will submit information on possible test methods for the task group evaluation.

The chairman reported that D 658, "Test Method for Abrasion Resistance of Organic Coatings by the Air Blast Abrasion Test," D 968, "Test Methods for Abrasion Resistance of Organic Coatings by the Falling Abrasive Tester," and D 1474, "Test Methods for Indentation Hardness of Organic Coatings," will be submitted to D-1 ballot for reapproval with the addition of index terms.

D01.23.15—Slip Resistance—H.A. Ball, Chairman, reported the revision to D 4518, "Methods for Measuring Static Friction of Coating Surfaces," had completed Sub. D01.23 balloting without receiving any negative votes. Several comments received on eliminating the use of distilled water in the method were approved. The method will be submitted to D-1 ballot with key words added.

M. Morse reported on work he has been performing on the wet horizontal slip method using water with the addition of surfactants. It was the decision of the task group to further evaluate this problem using various wetting agents and surfactants. M. Morse will report on this work at the next meeting.

D01.23.16—Water Vapor Transmission—T.J. Sliva, Chairman, reported the revision to D 1653, "Test Method for Water Vapor Permeability of Organic Coating Films," had completed concurrent Sub. D01.23/D-1 balloting receiving two negatives. He further reported on his discussions with members of Committee C16, the committee responsible for ASTM E 96. The term "Water Vapor Permeability" as now stated in the two methods denotes a direct relationship between water vapor permeance and film thickness. This relationship has been shown to be not valid. It was the decision of the task group to change the title of the method to "Water Vapor Transmission of Organic Films" and to eliminate the term "permeability" and all calculations of permeability throughout the method.

A discussion of including 10 square centimeter perm cups in the method followed. As insufficient data was available to eliminate these cups from the method, it was the decision of the task group to include them. The chairman will revise the method to incorporate these changes and submit it to D-1 balloting before the next meeting.

D01.23.18—Flexibility—M.P. Morse, Chairman, reported the task group is evaluating the precision of crack resistance values for applied coatings obtained with test procedures of Method D 522, "Methods for Mandrel Bend Test of Attached Organic Coatings." He distributed a table summarizing the round-robin test results obtained. The results obtained from three laboratories exhibited fair to good reproducibility within a specific mandrel type. Two additional collaborating laboratories have been added to the round-robin test.

When the round-robin test is completed, M. Morse will prepare a table summarizing

the results and a proposed precision statement for distribution to Sub. D01.23 membership.

SUBCOMMITTEE D01.24 PHYSICAL PROPERTIES OF LIQUID PAINTS

C.K. Schoff, Chairman

D01.24.26—Electrical Properties of Liquid Paints—met to discuss the new method for electrical resistivity which was recently balloted by D-1. There was one negative from Mr. Griffin and a comment, both related to the description of the cell constant determination in the Appendix. Editorial changes are necessary to make the procedure more clear. This will be done and the negative voter will be asked to withdraw his negative. Another negative (H. Stoner) was received after the meeting, but this also was of an editorial nature. A new round of interlaboratory testing to develop a more realistic precision statement will be carried out this autumn. We are looking for additional cooperators.

D01.24.30—Calculation of V.O.C., Volume Solids and Other Formula Physical Constants—E.A. Praschan, Chairman, discussed the proposed "Practice for Calculating Formulation Physical Constants of Liquid Paints and Coatings," and the extensive revisions that grew out of the January meeting and the D-1 ballot prior to that. The revised practice recently was balloted at the subcommittee level and received a number of comments. The document was reviewed, noting the editorial changes made and reviewing the comments from the ballot. All the comments either were incorporated or the reasons were explained for the passages in question being written as they were. The final draft will be submitted for D-1 ballot.

D01.24.33—Odor Evaluation—met to begin organizing. David Darr of Union Carbide has agreed to be the task group chairman. The main item of discussion was the mini-symposium on odor evaluation that will occur at the January 1991 D-1 meeting in Ft. Lauderdale. The chairman and organizer of the event, Andy Rutkiewicz, described the speakers, their backgrounds, and the areas that they would cover. The speakers will be Gail Seville who has her own consulting firm and Steve Ellis, an engineer with Arthur D. Little. We believe that this mini-symposium will be a good means for educating the membership of D-1 and raising the level of awareness and interest in odor and odor evaluation. The mini-symposium will be on Tuesday afternoon and we hope to have the speakers at our task group meeting on Wednesday morning. We would like to build on the interest generated by the mini-symposium and to develop a list of issues that need to be addressed. We need to see which practices or methods are needed in this area.

D01.24.34—Viscosity by Falling Needle Viscometer—J. Hartnett, Chairman, discussed the proposed method for viscosity by the falling needle viscometer and the precision derived with a series of Newtonian oils. The repeatability (within lab) was 0.6% relative and the reproducibility (between labs) was 2.4% relative. Interlaboratory testing for precision also has been carried out with a series of paints. The raw data were presented at the meeting, but the precision has not yet been determined. The data looks very good. Comments have been made on the initial draft of the method along with some suggestions for revision. These will be forwarded to Prof. Tom Irvine who will be revising the method. It was suggested that the directions given during the recent paint round-robin also be worked into the method. It is hoped that this method will be balloted by Sub. 24 before the next D-1 meeting.

A final item of business was taken care of in the subcommittee meeting. There had been a negative on D 2196, "Viscosity Measurements and Rheological Properties by Rotational (Brookfield) Viscometer," on a recent D-1 ballot. The negative voter, G. Furaus, contended that the method and the instrument around which it is written were unacceptable for adequate measurements and that the method should be rewritten. Unfortunately, he did not offer any suggestions for changes. The subcommittee voted that the negative was nonpersuasive and this was sustained by D-1. Mr. Furans will be contacted and asked for specific suggestions for improvements in the method.

SUBCOMMITTEE D01.26 OPTICAL PROPERTIES

C.J. Sherman, Chairman

D01.26.02—Color Measurement—R.T. Marcus, Chairman, reported the following four standards are to be transferred to Committee E12 on Appearance as soon as approval is given by the Committee on Standards: (1) D 1535-89, "Standard Method of Specifying Color by the Munsell System"; (2) D 1729-89, "Standard Practice for Visual Evaluation of Color Differences of Opaque Materials"; (3) D 3134-89, "Standard Practice for Establishing Color and Gloss Tolerances"; and (4) D 4086-86, "Standard Practice for Visual Evaluation of Metamerism".

Because of the imminent transfer of the standards, no action will be taken on D 4086, which is due for review.

D2244, "Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates," was recently revised to bring the CIELAB equations into agreement with CIE Publication 15.2 on Colorimetry. Committee E12 balloted similar changes for E 308 "Standard Method for Computing the Colors of Objects by Using the CIE System." A negative was cast on the E 308 revision based on a possible error in CIE Publication 15.2. The person who had cast the E 308 negative had misinterpreted the revision and withdraw the negative. The withdrawal allowed E 308 to go to society ballot and made it unnecessary to revise D 2244 since it was correct.

D 1544, "Standard Test Method for Color of Transparent Liquids," (Gardner Color Scale), has been transferred from Sub. D01.33 on Polymers and Resins to Sub. D01.26. A negative on a proposed revision of this method questioned the tolerance specifications on the color glass standards. The negative was resolved by using Tintometer's current manufacturing tolerances of the glass standards. The method will be revised accordingly and submitted for concurrent Sub. D01.26/D-1 ballot.

A questionnaire was distributed to D-1 membership to help determine additional needs for color measurement standards in the coatings industry.

Based on the results of the survey, a *Guide for the Preparation, Maintenance and Distribution of Physical Color Standards for Paint* will be developed. R. Marcus will chair a group to further define and write the guide. R. Kumar, R. Morrison, L. Shaffer, C. Sherman, and F. Billmeyer are current members of the working group. Others wishing to join the group should contact Bob Marcus at PPG Industries, Inc., P.O. Box 9, Allison Park, PA 15101, (412) 492-5554.

Survey respondents also wanted a method to measure the color and color difference of transparent liquids by transmission measurements. It was pointed out by F. Billmeyer that two current methods, E 1347 "Standard Test Method for Color and Color Difference Measurement by Tristimulus (Filter) Colorimetry," and E 1848 "Standard Test Method for Transmittance and Color by Spectrophotometry Using Hemispherical Geometry," are general methods which are applicable to this problem. Rather than create a new method, existing methods could be revised to detail such items such as sample preparation and then reference one of the measurement methods. A list of transmission methods will be compiled to determine if they can be revised to include the more general methods.

The third survey question concerned the development of yellowness/whiteness index methods. Respondents thought such a method should be developed. Committee E12 is in the process of revising and expanding E 313 "Standard Test Method of Indexes of Whiteness and Yellowness of Near-White Opaque Materials." Further

work on a new yellowness/whiteness index method will be considered following the revision of E 313.

Respondents made several comments and suggestions for additional methods. These suggestions will be considered in depth once the work on the guide for color standards, the transmission methods, and the yellowness/whiteness index is well in progress.

An error has been found in the FMC2 color difference equation published in D 2244 "Standard Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates." The error is in the b value and it will be corrected as soon as possible. The error is so large that it will be obvious to anyone doing the calculation.

D01.26.06—Hiding Power—L.E. Schaeffer, Chairman, reported that the subcommittee ballot on the proposed Test Method for the Hiding Power of Powder Coatings had comments and three negatives. The comments and two of the negatives were of an editorial nature and readily resolved by acceptance. The negative from N. Emily of Sub. D01.51 on Powder Coatings stated that the hiding power of powder coatings was inherently difficult to measure, and the proposed method should not be accepted until proven by a round-robin which his subcommittee would be willing to undertake. On that basis, the negative was found persuasive and it was agreed that the proposed method would therefore not be balloted further until the round-robin experiment has been completed.

D01.26.11—Gloss and Goniophotometry—A.F. Rutkiewic, Chairman, reported that D 4449 "Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance," received only comments on the last ballot. The comments concerned the lack of key words. They were added and the method submitted for society ballot.

The third draft of the proposed Test Method for Electro-Optical Instrumental Measurement of Distinctness of Image Gloss (Image Clarity) of Coating Surfaces was reviewed to include comments and negatives from the subcommittee ballot. The revised method will be submitted for subcommittee ballot.

The data available from five of the eight participants in a round-robin for distinctness of image was reviewed by A. Rutkiewic. Although good correlation appears to be present within the visual ranking between the respondents, the correlation within the "Dorigon" set is poor. When the round-robin set has been completed by all participants, a complete analysis will be done.

D01.26.24—Tinting Strength—C.J. Sherman, Chairman, reported that D 387 "Test Method for Color and Strength of Color Pigments with a Mechanical Muller," received one negative and several comments in the latest ballot. The negative by F. Billmeyer concerned the citation of standards E 97 and E 1164 instead of the newer more applicable ones E 1331, E 1347, and E 1349. These standards deal with color measurement. The method will be revised to cite these methods and include key words and submitted for concurrent Sub. D01.26/D-1 ballot.

R. Morrison reported that the proposed Method of Test for Evaluating the Tint Undertone of Titanium Dioxide Pigments has been revised to include all of the comments of the last ballot. The materials for conducting the round-robin experiment to determine the precision of the method have been assembled and will be sent to the four participants in the near future. A report will be made at the next meeting.

Sub. D01.26—The chairman regrettably announced the resignation of M. Morse as Chairman of Task Group 11 on Gloss and Goniophotometry. Mr. Morse has served many outstanding years and his expertise and contributions will be greatly missed. A. Rutkiewic is the new Chairman of Task Group 11.

We now have volunteers to revise and update all four chapters of the Optical Properties Section of STP 500, Paint Testing Manual. They are: Color and Light—F. Billmeyer and H. Hammond; Gloss—F. O'Donnell; Hiding Power—L. Schaeffer; and Mass Color and Tinting Strength—J. Aviles.

SUBCOMMITTEE D01.27 ACCELERATED TESTS FOR PROTECTIVE COATINGS

F. Lutze, Chairman

D01.27.04—Light and Water Exposure Apparatus—L.E. Thieben, Chairman, reported that D 822, "Open Flame Carbon Arc," and D 5301, "Enclosed Carbon-Arc," will be balloted concurrently, by Sub. D01.27/D-1 on the next ballot with the editorial changes.

D 4587, "Fluorescent UV Exposure Tests," has passed Sub. D01.27 ballot with no negatives and will go to D-1 ballot.

A new practice for Xenon-Arc Accelerated Weathering received six nagative ballots from a Sub. D01.27 ballot. These negative votes were discussed and found persuasive. A new draft will be written and submitted for Sub. D01.27 ballot.

D01.27.09—Evaluation of Corroded Specimens—D. Grossman chaired the meeting in the absence of F. Lutze. The Sub. D01.27 ballot on revision of D 1654, "Evaluation of Corroded Specimens," drew an extensive negative from G. Rommal, including: (1) specifying scribe creep as "one sided" or "two sided"; (2) specifying the tip radius of the scribing too; (3) scribing through the paint but not the galvanizing for coil coatings; and (4) evaluating corrosion at bends, dimples, and other deformed areas. G. Rommal will revise the draft, get comments from task group members, and submit for Sub. D01.27 ballot.

D01.27.10—Accelerated Outdoor Weathering—M. Morse, Chairman, stated the group is currently determining the suitability of an exposure cycle on a Fresnel reflector rack, Method C in Practice D 4141. A cycle (designated EMMAQUA-NTW) has provided gloss loss and color change values for automotive coating that have correlated reasonably well with the values produced by Florida black box exposures, when coatings of the same color are compared. In this cycle, the coated panels are exposed to concentrated sunlight during daytime and sprayed with water for 30 seconds every five minutes during nighttime. Panels are backed during the winter months to elevate their temperatures.

In an attempt to obtain better correlation between the color change values of automotive coatings produced by EMMAQUA-NTW exposures and the color changes values produced by Florida black box exposures, values of delta C were computed and compared. Substantial improvements in correlations were obtained with such comparisons.

Precision data are needed for the exposure of coatings on EMMAQUA-NTW. A round-robin test is planned to obtain such data, the collaborators will be DSET Laboratories, South Florida Testing Service, and Sub-Tropical Testing.

Detailed reports of the results obtained in two extensive outdoor exposure round-robin tests conducted by this task group have been prepared by M. Morse. These reports cover gloss loss and color change values of automotive and coil coatings produced by exposures on open-backed racks, black box racks, heated black box racks, the EMMAQUA racks at locations in Florida, Puerto Rico, and Arizona. DSET Laboratories has offered to furnish copies of these reports upon request.

M. Morse resigned as Task Group Chairman, and J. Robbins, III will chair the group in the future.

D01.27.17—Evaluation of Weathering Effects—J. Robbins, Jr., Chairman, reported the recent D-1 balloting of D 714, "Evaluation of Blistering," D 772, "Evaluation of Flaking," and D 1006, "Conducting Outdoor Weathering Tests on Wood Coatings," drew negatives from W. Ketola, J. Robbins, Jr., and M. Crewdson, and comments from J. Mantle and S. Lauren. The negatives were found persuasive, and a complete revision of all three standards will be submitted for concurrent Sub. D01.27/D-1 ballot.

J. Robbins, Jr. sent the new pictorial standards for D 660 "Evaluation of Checking," to ASTM to replace the existing pictorial standards.

D01.27-29—Test Substrates—D. Grossman, Chairman, asked the task group for a volunteer to draft a New Guide for Preparation of Plastic Panels. Quite a number of people expressed interest in such a guide, both at the last meeting and in a questionnaire. Please contact Doug Grossman.

D01.27.30—Corrosion Tests—Automotive—This task group did not meet because of the absence of F. Lutze, Chairman.

D 2933, "Corrosion Resistance of Coated Steel Specimens (Cyclic Method)," passed concurrent Sub. D01.27/D-1 ballot to withdraw, and will go on to society ballot.

D 1540, "Effect of Chemical Agents in Transportation Industry," will be reviewed by F. Lutze and possible revisions will be discussed at the next meeting.

At the next meeting, the group will assess interest in a cooperative study of methods for testing "water etching" of automotive topcoats.

D01.27.31—Corrosion Tests—Non-Automotive—D. Grossman chaired the meeting in the absence of S. Boocock. The cooperative test program to find a corrosion test more realistic than B 117, "Salt Fog," has made the following progress:

TEST CHAMBERS AND CYCLES—At the previous meeting the group decided to include UV exposure with some of the cyclic salt/dry tests. At this meeting, the group voted to do a broad based initial correlation study, and provide specimens (if feasible) for any test chamber or cycle that a participant seriously believes is a good candidate. Based on results of the initial study, promising test methods will be examined further in a much deeper test for reproducibility.

TEST SPECIMENS—The Steel Structures Painting Council (SSPC) has offered to provide specimens of *maintenance* paints for the study. These paints already have been extensively tested outdoors. Specimens of *coil coatings* may be available through the AISI. G. Rommal reported that the AISI has leftover 1000 lb "pup" coils of 10 coatings used in their cyclic corrosion round-robin. The task group can have these coils if participants are willing to donate the funds to transport them from Duchesne Fils Ltee. in Quebec and flatten them into large sheets. D. Grossman has volunteered Q-Panel to cut the sheets into specimen size and to store them. He will contact Duchesne Fils regarding coil availability and shipping cost.

SPECIMEN PREPARATION—The group must decide how to prepare the specimens. For coil coatings, it's essential that some kind of deformation be done prior to exposure.

EXPOSURE STATIONS—SSPC has volunteered space at their mild industrial site, and J. Robbins, III of DSET volunteered space at Everglades Testing in Florida. Possibly, a severe industrial site is needed as well.

SPECIMEN EVALUATION—A specimen rating protocol must be established to describe number of replicates, how and what to rate (e.g., scribe creep, percent rust, edge creep, gloss, chalk), who will do the rating, exposure intervals, photographic procedure if any, and ranking procedure. The consensus is that coil coatings should be ranked separately from maintenance coatings. K. Trimber, of KTA Tator, offered the use of their computerized expert system for sample rating.

COORDINATION WITH AISI STUDY OF COIL COATINGS—G. Rommal reported that AISI will donate their leftover specimen material, but they will not divulge their outdoor or laboratory exposure data to ASTM (or anyone) in order to avoid any chance of commercial use being made of the comparisons between individual coatings. However, the ASTM group might be able to give AISI our laboratory exposure data and have AISI calculate rank correlations against AISI outdoor data. The AISI study will only investigate a few laboratory test cycles, will not include UV, will not include maintenance paints, but will include vast numbers of replicates and several outdoor sites.

QUESTIONNAIRE—A questionnaire will be sent to members of the task group and Sub. D01.27 asking about equipment and outdoor sites available for exposure, preferred test cycle for evaluation, data or experience on those test cycles, preferred specimen rating protocol, and specimen configuration.

Other Standards to Be Balloted—D 2454, "Effect of Overbaking," passed Sub. D01.27 ballot in 1989, and will be sent to D-1 ballot.

D 2485, "Coatings for Elevated Temperatures," will be sent to concurrent Sub. D01.27/D-1 ballot.

D 1543, "Color Permanence of Architectural Coatings," passed concurrent Sub. D01.27/D-1 ballot for withdrawal without any negatives, and will go on to society ballot for withdrawal.

SUBCOMMITTEE D01.28 BIODETERIORATION

M.C. McLaurin, Chairman

D01.28.01—Package Stability—M.C. McLaurin, Chairman. An informal meeting was led by J.S. Hinkle of Hüls America due to the unexpected absence of the chairman and meeting materials. General discussions relating to package stability were held during this meeting, and again at the D01.28.03 and Sub. D01.28 sessions. J.S. Hinkle had submitted a draft of a Hüls procedure to M.C. McLaurin for this use in preparing a draft revision of D 2574, "Standard Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms." Copies of the draft revision to D 2574 prepared by M.C. McLaurin were not available for discussion. There was general agreement with the consensus from the January meeting that a major revision of the standard is warranted.

D01.28.02—Rapid Determination of Enzymes—C.W. Vanderslice, Chairman. The chairman distributed copies of the method used and results from the first round-robin for the proposed test method. Four latex flat paint samples containing different levels of either enzyme or an oxidant, and a control paint sample, were used to inoculate standardized solutions of hydroxyethylcellulose (HEC) and a high molecular weight acrylamide (PAM) copolymer. The data from this round-robin were discussed and showed that the HEC solution was predictably degraded by each specie. However, the results with the PAM solution were mixed depending upon whether a given solution's initial viscosity or that of the control was used to calculate the percent viscosity loss versus time.

The consensus was that the results were encouraging enough to warrant another round-robin, and to write the method in ASTM format. It was recommended that one of the cellulase enzyme levels used be lowered by a factor of 10 to 0.1 and 0.01 ppm due to the rapid viscosity losses observed at 1.0 ppm. A second need was to utilize a lower molecular weight, noncellulosic polymer in the test procedure which should be more readily degraded by oxidants. A key procedural point to change was the time at which the paints are to be tested. It was recommended that the cooperators add the oxidant themselves at a fixed time after receipt of the paints to avoid varying concentrations of residual oxidant. A spot test used in industry for detecting oxidants will also be evaluated by the chairman in addition to using the noncellulosic polymer solution for this purpose.

D01.28.03—Microbial Quality of Raw Materials—M.C. McLaurin, Chairman. Again, an informal meeting was led by J.S. Hinkle due to the absence of the chairman. D. Martin, of Dow Chemical, and G. Moore, of Aqualon, represented suppliers of raw materials and expressed a high level of interest (similar to that expressed by the paint manufacturers in January) for an easy and reproducible method for the determination of possible microbial contamination of

raw materials. Mention was made that explicit definition of a sampling procedure which avoids introducing contamination was critical. Discussions were generated regarding the applicability of such a method to testing sites within a plant, and for the ultimate control of microbial contamination in the finished product (be it raw materials or paint).

D01.28.04—Resistance of Paint Films to Algae Attack—M.C. McLaurin, Chairman. An informal meeting was held in the absence of the chairman, led by J.S. Hinkle. General discussions of both in-can preservative and film biocidal efficacy took place. Interest in methods for assessing fungal defacement using an agar plate method in addition to the environmental chamber method (D 3273) was expressed. Algal defacement was considered less of a problem in most areas of the United States, but a test method for evaluating algicidal efficacy on coating films was still of interest.

Sub. D01.28—Biodeterioration—M.C. McLaurin, Chairman. A formal meeting was directed by H.M. Werner in the absence of M.C. McLaurin. Discussion of the changes and status in Sub. D01.28 chairmanship, vice chairmanship, and task group leadership was held. J.S. Hinkle of Hüls America, Inc. volunteered to serve in some capacity (vice chairman, task group chairman) and report the minutes of the June meetings. It was suggested that arrangements should be made for future meetings to be certain that information on meeting agendas and content be available for alternate representatives in the event of unexpected last-minute conflicts for scheduled session leaders.

Minutes from January's meeting were read and accepted, and this June's sessions were summarized. The following methods are up for reapproval in 1990: D 2574, "Standard Test Method for Resistance of Emulsion Paints in the Container to Attack by Microorganisms"; D 3273, "Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber"; D 3456, "Standard Practice for Determining by Exterior Exposure Tests the Susceptibility of Paint Films to Microbiological Attack"; and D 4610, "Standard Guide for Determining the Presence of and Removing Microbial (Fungal/Algal) Growth on Paint and Related Coatings."

There has been progress toward revision of D 2574. However, this will be a major revision which must be balloted in Sub. D01.28 and discussed before a D-1 ballot. Any revisions to the other three methods should be minor. A review of keywords for inclusion in both the Volume 6 and specialized D-1 Indices will be included. There should be no problem with balloting the last three standards concurrently in D-1 and Sub. D01.28 since no major changes have been suggested to date.

DIVISION 30
PAINT MATERIALS

SUBCOMMITTEE D01.31
PIGMENT SPECIFICATIONS

D.H. Ruddick, Chairman

D01.31.12—Zinc Containing Pigments—W.C. Spangenberg is to assemble a preliminary standard for zinc phosphates. This document is to be circulated to Sub. D01.31 members and known suppliers of zinc phosphate pigments for comments prior to the January 1991 meeting. Columbian Chemicals is interested in having a standard written for zinc ferrite. Other manufacturers of zinc ferrite will be contacted to determine their level of interest in participating in this endeavor.

D01.31.15—Micaceous Iron Oxide Pigments—C.W. Fuller is to assemble a proposed standard for this pigment. Three committee members volunteered to assist Mr. Fuller in this task.

W.C. Spangenberg suggested that the various standards could be simplified by grouping test methods that were common to all pigment types and the pigments into groups. Mr. Spangenberg will put together a "composite standard" for review at the January or June 1991 meeting.

Prior to the January 1991 meeting, it is desirable to promote the activities of Sub. D01.31 in several coatings, sealant, and plastics magazines. D.H. Ruddick to coordinate.

Eight standards are to be reviewed in 1990.

By unanimous vote (10-0-0), a motion to submit all of these for simultaneous ballot was approved. It is expected that all of the above will have been submitted for balloting by September 1990. Already reviewed and ready for balloting are standards D 602 (Barium Sulfate), D 1199 (Calcium Carbonate), and D 1366 (Particle Size Characteristics).

SUBCOMMITTEE D01.32
DRYING OILS

P.C. Stievater, Chairman

D01.32—Drying Oils—P.C. Stievater, Chairman, reported that balloting for all revisions/reapprovals is up-to-date. Task group D01.32.01, "Fatty Acid Composition by Gas-Liquid Chromatography of Methyl Esters." D. Zinkel, Chairman, has completed its revision of D 1983-75 (1980) and balloting has been completed. It is now identified as D 1983-90.

Fifteen methods due for review in 1990 have been balloted on D-1 ballot. Only editorial comments were received and these will now go to society ballot for reapproval. Comments involved adding index/terms/key words, all of which have been given previously to S. Milligan who will add them editorially when methods are reapproved or revised.

SUBCOMMITTEE D01.33
POLYMERS AND RESINS

M.J. Mahon, Chairman

Comments received on recently balloted methods D 2455, "Standard Test Method for Identification of Carboxylic Acids in Alkyd Resins," and D 2456, "Standard Test Method for Identification of Polyhydric Alcohols in Alkyd Resins," were discussed and editorial changes were incorporated to reflect the comments.

A review of the task group minutes was conducted for task groups 12, 23, 24, 27, and 28 by the respective task group chairman. The resolution of negative ballots and comments on method D 4639 "Standard Test Method for Volatile Content in Phenolic Resins," were handled by editorially revising the document.

D01.33.12—Urethane—A Mobay Co. procedure for determining the HMDI content in a urethane resin will be forwarded to all Task Group 12 members and in conjunction with D01.21.53, the results of a round-robin on determining isocyanate in urethanes will be forwarded for review.

Data from a Reichhold Chemicals Inc. laboratory concerning lowering the GC injector and column temperatures in method D 3432, "Standard Test Method for Determination of Unreacted TDI in Urethane Resins," because of the possible degradation of TDI by the higher injector and column temperatures was discussed. After careful consideration, no members of the task group felt the proposed revision was necessary.

D01.33.23—Epoxies—F.P. Esch, Chairman, reported that method D 4301 "Total Chloride Measurement of Epoxy Resins," has been approved on the November 1989 society ballot. Two additional procedures for determination of total chloride in epoxies are intended for inclusion in D 4301 as Section B, "Total Chloride by X-ray Fluorescence," and Section C, "Total Chloride by Saponification and Titration."

A round-robin for measuring residual epichlorohydrin by headspace gas chromatography is in progress.

D01.33.24—Nitrogen Resins—In the absence of Chairman Smith, J. Benga presented the results of the subcommittee ballot on the fourth draft of a proposed "Stan-

dard Test Method for Free Formaldehyde Content of Amino Resins." With 61% of the voting members responding, no negatives were received. Three subcommittee members made editorial comments and appropriate changes to the method made. The method will be submitted for D-1 ballot.

D01.33.27—Phenolic Resins—The task group editorially corrected: method D 4639, "Standard Test Method for Volatile Content in Phenolic Resins"; D 4640 "Standard Test for Determining Stroke Cure Time of Thermosetting Phenol-Formaldehyde Resins", and D 4613, "Standard Test Method for Measuring Apparent pH of Water Insoluble Phenol-Formaldehyde Resins." All three revised methods will now proceed to society ballot.

D01.33.28—Turbidity—W.C. Golton, Chairman, presented the results for the round-robin on the proposed method "Quantitative Test for Turbidity in Clear Liquids." Seven laboratories measured four samples and the resulting data was analyzed in accordance with ASTM E 691. Repeatability standard deviations were 2-5% and reproducibility standard deviations were 5-18%. This infers a maximum allowable range for duplicates of 14% of the value. The proposed method will be submitted for simultaneous subcommittee and D-1 letter ballot.

SUBCOMMITTEE D01.34 NAVAL STORES

J.W. Daugherty, Chairman

D01.34.01—Resin Solutions—J. Thomas, Chairman, reported that the Hot Plate method round-robin results were presented by J. Thomas. All attending agreed the round-robin results were very good. This is actually a practice of cutting a resin into a solvent for analytical measurement. Several editorial problems exist with the written procedure. J. Thomas will get in touch with the editorial staff for assistance in writing up the procedure in a more conforming style. The procedure will then be balloted. It was also agreed that the blender method will be written up and sent out for round-robin study by the January meeting.

D01.34.03—Resin Gel Preparation—A. Scarlotti, Chairman, presented the results of his practice balloting. The practice ballot had one negative vote which was cleaned up by a wording change. Other editorial problems were pointed out by J. Fetsko. Mr. Scarlotti will visit the ASTM editorial assistance experts and get both his microwave and kettle procedures written up properly.

D01.34.04—Standard Ink Oil—J. Daust, Chairman, stated the goal is to come up with a standard ink oil that will consistently give a resin solution the same viscosity and solubility characteristics. K. Hunt, of Sun Oil, gave some very interesting data that indicated a procedure known as viscosity gravity constant (VGC) may correlate to resin solution properties. D. Frish, of Exxon, showed data on how similar aniline point oils can give very different viscosities in a resin solution if the ratios of normal paraffins to iso-paraffins is changed. Mr. Frish and Ms. Hunt will exchange samples to see if VGC data will point to a change in normal to iso-paraffin ratios.

D01.34—Naval Stores—ASTM officials visited the group to tell us they have recruited several technical people associated with the Naval Stores industry to join this task force. The result will be that in the future the Naval Stores subcommittee, D01.34, will actually concentrate on Naval Stores procedures. The members of this current group asked if we could form a new subcommittee called *Ink Vehicles* that would continue the work we have started. This petition will be presented to the ASTM Board.

SUBCOMMITTEE D01.35 SOLVENTS, PLASTICIZERS AND CHEMICAL INTERMEDIATES

L.R. Thurman, Chairman

D01.35.10—Solvents-Hydrocarbons and Ketones—S.A. Yuhas, R.L. Hinrichs, Co-Chairmen, addressed the question received from the Air Force concerning the specification for methyl ethyl ketone listed in D 740. A technical grade (99.0%) methyl ethyl ketone is used by the Air Force for cleaning purposes and they requested D 740 be modified to include this grade. The task group knew of no major manufacturer of 99.0% material and suggested that the Air Force contact their supplier concerning the purity question. The Air Force may be purchasing a recovered or recycled product or a blend. This was referred to the coordination task group.

D01.35.20—Reactive Monomers—J.D. Frugé, Chairman, led the discussion concerning the analysis of aldehydes in glacial acrylic acid and if there was a need for development of an ASTM standard. Any comments or proposed analytical methods for aldehydes in glacial acrylic acid should be sent to J. Darlington, BASF Corp., 602 Copper Rd., Freeport, TX 77541.

D01.35.30—Chemical Intermediates—J.R. Morrison, Chairman, further reviewed test data for the apparent specific gravity at 20/20°C and 25/25°C for 2-ethylhexanol. Questions were raised concerning the proposed ranges. Producers of 2-ethylhexanol will submit manufacturing data to support proposed ranges.

D01.35.40—Plasticizer and Ester Solvents—R.L. Smith, Chairman, recommended three standards be balloted for withdrawal. They are: D 1468, Standard Test Method for Volatile Matter in Tricresyl Phosphate; D 1721, Standard Test Method for Permanganate Time in Tricresyl Phosphate; and D 2634, Standard Specification for Methyl Amyl Acetate. D 1468 and D 1721 are being withdrawn due to lack of interest and there is no known producer of methyl amyl acetate.

D01.35.50—Coordination—L.P. Forrest, Chairman. The DOD is currently considering using ISO 9000 on quality systems in government contracts and eliminating the military standards now governing quality procedures.

E 11, which balloted the Standard Guide for including government requirements in ASTM standards, has editorially revised the document and it will be reballoted at committee level.

D01.35.60—Methods Development—T.W. Rendl, Chairman. Work continues on development of capillary column gas chromatography methods for monofunctional alcohols and acrylic esters.

A draft method for determination of MEHQ in acrylic acid by HPLC was reviewed and given to D01.35.20 for further development. A chromatogram was submitted showing the reverse phase separation of acrylic acid oligomers.

A report on modification of D 3893, Purity of Methyl Amyl Ketone and Methyl Isoamyl Ketone by Gas Chromatography was submitted to D01.35.10. The modification included a proposed capillary column method.

New Business—There were three negatives on the D XXXX, 2-ethylhexanol, specification on the D-1 letter ballot. All negatives were determined to be persuasive and the standard is being withdrawn for further study.

A proposal was discussed to put a compilation of ASTM Solvent Standards into a separate book. This would include all of the specifications and referenced test methods.

J. Frugé, of Hoeschst Celanese, was appointed Chairman of task group D01.35.20.

SUBCOMMITTEE D01.36 CELLULOSE AND CELLULOSE DERIVATIVES

D.R. Martin, Chairman

The addition of keywords to methods D 1696, Standard Test Method for Solubility of Cellulose in Sodium Hydroxide, and D 1795, Standard Test Method for Intrinsic Viscosity of Cellulose, were reviewed and unanimously accepted. An interlab review of precision for method D 1343, Standard

Test Method for Viscosity of Cellulose Derivatives by the Ball-Drop Method, is being organized by T. Germroth and P. Gordon.

A new standard method for measuring properties of hydroxypropylcellulose is under development in the Aqualon labs under G. Moore. A method for measuring molecular weight distribution is underway at Dow under the direction of D. Martin.

Since a large number of methods under jurisdiction of this committee are up for review in 1992, it was decided that an early review of some of the methods would be advisable. This would allow a more balanced distribution when the time comes for reviewing the methods.

DIVISION 40 PAINT PRODUCTS APPLIED ON SITE

SUBCOMMITTEE D01.41 PURCHASE OF PAINTS AND RELATED COATINGS

H.L. Ammlung, Chairman

Sub. D01.41 & D01.41.05—Joint Meeting—H.L. Ammlung, Chairman, reported on the reballoting of Sections 9.5, 9.6, and 9.7 of D 4717 and a related procedural question. A 60% response was obtained with the following results: on Item 1, Section 9.6 on Opacity, the vote was 13 affirmative, 3 negatives, and 10 abstentions; on Item 2, Section 9.5 on 85° Gloss, there were 15 affirmatives, 3 negatives, and 8 abstentions; on Item 3, Section 9.7 on Abrasion Resistance, the vote was 14 affirmatives, 2 negatives, and 10 abstentions; and Item 4 on a procedural matter received 14 affirmatives, 2 negatives, and 10 abstentions. All of the negatives covered points that had been considered previously and found nonpersuasive but it was agreed that these actions would have to be reconfirmed before D 4717 could move forward to a D-1 ballot.

Before acting on the negatives, J. Weaver asked Lee Rogers, of the Standardization Office of the Secretary of Defense, to discuss the use of Multiple Year Award Schedules for buying paint products and what role D 4717 would play in these actions. L. Rogers stated Multiple Year Award Schedules are part of a growing program to facilitate purchasing of commercial paint products off the shelf rather than by Federal and Military Specifications. Department of Defense interest in D 4717 is to have a nongovernmental standard that could be referenced as the minimum quality level acceptable under the Multiple Year Award Schedule. Paint manufacturers could then negotiate with the government to have any or all of its interior flat latex paints placed on such a schedule as long as they were equal to or better than D 4717. It was never intended that paint manufacturers have to modify their current commerical products in order to have them placed on a Multiple Year Award Schedule. Government agencies could then buy from any source on the list. DOD is anxious to have D 4717 approved as soon as possible so it can be incorporated into upcoming Multiple Year Award Schedules.

Sub. D01.41 then proceeded to act on resolution of the negatives as follows. On Item 1, Section 9.6 on Opacity, the negatives from L. Schaeffer and F. Marschall were considered concurrently since both supported the point that the current requirement was too low as there were a number of commercial products with superior hiding properties. They were found nonpersuasive on the basis that the current requirements have been used for a number of years and found satisfactory for a general purpose interior flat latex paint. The vote was 6 affirmative, 2 negative, and 4 abstentions. The third negative on Item 1 from J. Price was based on his position that opacity should be determined on paint applied at the manufacturer's recommended spreading rate rather than that specified in the test method. This negative was found nonpersuasive on the basis that it was necessary to use a specific spreading rate when comparing the hiding power of different products. The vote was 8 affirmative, 1 negative, and 3 abstentions. On Item 2, Section 9.5 on 85° Gloss, the negatives from L. Schaeffer and F. Marschall were considered concurrently since both believed the 85° gloss should be changed from 20 maximum to 10 in line with current definitions for flat paints. L. Schaeffer advised that D01.42.23 had received information that California and two other states are using "less than 15" as their definition for a flat paint and he would now agree to changing his negative from 10 maximum to 15. By a vote of 5 affirmative, no negatives, and 3 abstentions, it was agreed to accept his revised negative and to submit it to a Sub. D01.41 ballot for approval. The third negative on Item 2 from J. Price was based on his premise that 85° gloss should be determined on film applied at the spreading rate recommended by the manufacturer and not on an arbitrary figure as in the test method. This was found nonpersuasive by a vote of 4 affirmative, 1 negative, and 1 abstention on the basis that when making comparison of the gloss, it is preferable to apply all paints at the same spreading rate. The two negatives from L. Schaeffer and F. Marschall on Item 3, Section 9.7 on Wet Abrasion Resistance both related to an apparent discrepancy in the weight versus volume loss values. These negatives were found nonpersuasive by a vote of 4 affirmative, no negatives, and 1 abstention on the basis that the different densities of applied films required greater flexibility in the volume value. The two negatives from L. Schaeffer and F. Marschall on Item 4 relating to test reports on each requirement were found nonpersuasive on the basis that extensive background information had been considered in drafting the requirements and that test reports are not required by any ASTM or D-1 regulation. The vote was 4 affirmative, no negatives, and 1 abstention. Another negative on Item 4 was recorded as abstaining when the voter failed to provide any comment to support his negative. It was then moved to forward D 4717 for D-1 balloting after completion of the Sub. D01.41 balloting on the revised 85° gloss requirement. Information on Methods D 4213 versus D 2486 will be considered as new business at the January 1991 meeting. The vote on these actions was 4 affirmative, no negatives, and 1 abstention.

SUBCOMMITTEE D01.42 ARCHITECTURAL FINISHES

L. Schaeffer, Chairman

D01.42.01—Soil and Stain Removal—T.J. Silva, Chairman, reported that the proposed revision of D 4828, "Standard Test Method for Practical Washability of Organic Coatings," had completed subcommittee balloting with 3 negatives, all of which were editorial in nature. (This revision provides for mechanical rubbing in addition to the existing hand rub procedure.) The negatives from M. McKnight and H. Ashton included many useful editorial comments, but the latter's proposal to change the title of the method by using the term "cleansability" instead of "washability" was voted nonpersuasive. The chairman will revise the text in response to the various editorial suggestions, and the method will then be submitted for concurrent Sub. D01.42/D-1 ballot.

D01.42.03—Porosity of Paint Films—C. Tatman, Chairman, was not present and the meeting was chaired by R. Hopkins. The results of the first round-robin were reviewed, which showed that the three cooperating laboratories ranked the test paints in the expected order. There was discussion of experimental variables that might cause erroneous results, and steps that could be taken to avoid them. The results warranted a second round-robin, for which latex and alkyd flat latex paints will be prepared above and below critical PVC. K&N stain tests in addition to oil absorption measurements will be conducted. The results will be available at the next meeting.

D01.42.04—Wet adhesion of Latex Paints—W. Vanderslice, Chairman, reviewed the results of the first round-robin, in which two exterior paints known to have

good wet adhesion were evaluated versus a high PVC interior flat latex paint known to have poor wet adhesion. Using an "embedded cheesecloth/weight pull-off" technique adopted from a Rohm & Haas laboratory test, all five cooperators achieved similar rankings for the three test paints. Considerable variation was evident in the mode of failure, possibly due to either inadequate curing of the alkyd enamel undercoat and/or the very smooth finish of the cedar panel substrates. A second round-robin will be conducted to determine the sensitivity and reproducibility of the method. Rougher cedar panels and a longer curing time for the undercoat will be included as variables in the test procedure. The chairman will independently evaluate a simpler test panel design, using other substrates such as aluminum or vinyl.

D01.42.05—Adhesion of Latex Paints to Chalky Surfaces—R. Schiller, Chairman, reported that experiments in which a chalky test surface was prepared by applying a synthetic chalk on a pressure-sensitive adhesive substrate, gave negative results, and that idea will be discarded. Previous types of synthetic chalk substrates were also unsuccessful, all test paints having bad adhesion failure over them. L. Schaeffer reported on work done in his laboratory utilizing a synthetic chalk supplied by E. Countryman, in which the chalk films were laid down at a range of film thicknesses using a multi-notch "Logicator" blade. Various test paints were cross-applied and a tape-pull test was run. Initial results were promising, in that there was consistent failure with a high PVC latex paint, but a transition from good to failed adhesion with an alkyd gloss enamel as the thickness of the chalk film increased. The chairman asked the group for suggestions as to which methods to pursue. The general consensus was to further investigate multi-film thickness-synthetic chalk substrates, using an adhesive tape pull-off procedure.

D01.42.09—Color Development in Tinted Paints—F. Marschall, Chairman. In the absence of the regular chairman, the meeting was chaired by L. Schaeffer. He reviewed the past history of this task group, with particular reference to round-robin #4 which showed good correlation with a series of six latex paints tested by five cooperators. He reported that Chairman F. Marschall had not been able to locate solvent-borne paints showing sufficiently poor color development for useful results in round-robin testing. It was therefore proposed that a method be submitted on the basis of latex paints only, using the data from round-robin #4. However, that round-robin called for a two-day drying period prior to making color measurements, whereas a one hour force-dry at 120°F was preferred by the task group in order to shorten the length of time for running the test. Although evidence was presented indicating that air-dry and force-dry procedures would give similar results, the group decided that a new round-robin should be run using the force-dry procedure before sending the method to ballot. Results will be available at the next meeting.

D01.42.13—Brushability of Architectural Paints—W. Vanderslice, Chairman, reviewed the test data from two previous round-robins which attempted to correlate ICI high shear viscosity (per D 4287) with the degree of brush drag as sensed during actual painting (per D 4958). For a series of five latex flat paints, a high degree of rank order correlation was found if the ICI viscosities differed by at least 0.3 poise. Good correlation was also evident in another set of test data that included a large variety of interior and exterior latex paints. However, alkyd and latex paints, when tested together in this way, showed poor correlation. The task group voted to amend the current D 4958 brushout method to include a statement that correlation with ICI high shear viscosity can be expected when comparing latex paints only. The chairman will write a proposed revision to that effect for submission to subcommittee ballot before the next meeting.

D01.42.16—Practical Opacity—J. Price, Chairman, reported that the results of the concurrent Sub. D01/.42/D-1 ballot received no negatives and two minor editorial comments, both of which were accepted. H. Ashton pointed out that it had been agreed at the last meeting to include the D16 definition of hiding power in the method. This had been inadvertently left out of the method as balloted. It was agreed that if the definition could be inserted without an additional ballot, it would be done, but if not, the method would go to society ballot without making that insertion, and an amendment voted on for that purpose afterward.

D01.42.18—Print Resistance of Architectural Paints—S. LeSota, Chairman, reviewed the fourth draft of the method. A number of editorial changes were made. The fifth draft will be submitted for concurrent Sub. D01.42/D-1 ballot.

D01.42.20—Water Repellency of Wood—V. Scarborough, Chairman, reported that the proposed test method passed subcommittee balloting with no negatives and four editorial comments. The comments were discussed and changes made accordingly. A precision and bias statement prepared by H. Ashton was added. The revised text will be submitted for concurrent Sub. D01.42/D-1 ballot.

D01.42.22—Guide for Testing Solvent-Borne Architectural Coatings—H. Ashton, Chairman, reported that the fifth draft of the "Combined Guide for Testing Solvent-Reducible Coatings" had received 1 negative and 2 affirmative-with-comment votes on the D-1 ballot. The editorial comments were of a minor nature and for the most part accepted. It was agreed to hold the technical comments for subsequent revision of the standard. The negative vote had been cast on the ground that the blister test was omitted from the Guide. In fact, Subsection 10.3.1 covers blister resistance and references D 4585, the standard suggested by the voter. Consequently, the task group held the negative to be nonpersuasive. The chairman stated that a section on accelerated weathering would be taken up as "new business" while the proposed guide proceeds to society ballot and publication. Manufacturers of accelerated exposure test equipment would be invited to participate in the preparation of that section. The chairman further stated that the task group would next turn to the development of the companion "Guide for Testing Water-Borne Architectural Coatings."

D01.42.23—Gloss Definitions—L. Schaeffer, Chairman, discussed the highly controversial nature of any attempt to define popular gloss terminology (e.g., flat, satin, lo-lustre, velvet, eggshell, semi-gloss, gloss, high gloss, etc.) in terms of instrumental gloss measurement values. He therefore proposed that six ASTM gloss level categories be set up, to be defined numerically in terms of 60° and 85° gloss measurements. These categories, numbered 1 through 6, would permit the classification of paints by numerical gloss level without reference to or conflict with popular terminology. As part of the same standard, definitions of popular terms would be included that relate them approximately to the ASTM gloss categories, but emphasizing their variability and imprecision. The chairman also reported that comparative observations of many paint-outs at various gloss levels indicated that the gloss level of coatings is best stated numerically as a combination of both 60° and 85° values, possibly the mean of the two, rather than one or the other as is customary. A round-robin will be conducted to obtain concensus on numerical boundaries for the ASTM gloss level categories, and the results discussed at the next meeting.

Sub. D01.42—Main Committee Ballot Actions—A revision of D 2243, "Freeze-Thaw Resistance of Water-Borne Paints," which provides for an alternative viscosity test and multiple freeze-thaw cycles instead of only one, received one negative and several comments of a minor editorial nature. The negative was based on the claim that the specified cycles of freezing and thawing required the handling of test samples at unnecessarily inconvenient hours of the day and night. The subcommittee responded positively to this criticism with a suitable editorial revision that left the

freeze-thaw time cycle essentially unchanged. At the same time it voted 10-0-3 to find the criticism nonpersuasive as a negative, since its proper characterization is that of a useful editorial comment. The negative voter accordingly agreed to withdraw his negative. The other comments were for the most part accepted as reasonable. This standard has been scheduled for September society ballot.

Reapprovals for D 3129, "Guide for Testing Exterior Latex House Paints," and D 4540, "Guide for Testing Interior Latex Semi-Gloss and Gloss Paints," have passed D-1 ballot and are scheduled for July and September society ballots.

SUBCOMMITTEE D01.45 MARINE COATINGS

L.S. Birnbaum, Chairman

C. Stanley read minutes of the January meeting. Members were advised that the test method for Organotin Release Rate will be submitted for society ballot in July 1990 and members were encouraged to vote.

D01.45.11—Method for Testing Biofouling Resistance of Partially Immersed Applied Coatings—C. Perez, Chairman, submitted an initial draft for this test method for discussion. It was agreed that the use of antifouling coating, used in previous methods, will be changed to biofouling resistant coating since antifouling coating generally describes a coating which is toxic to fouling and new products which do not use toxicants would also need to be tested under this method. It was agreed that Mr. Perez will revise this draft method to include comments made at this meeting and a new draft will be sent to members of the subcommittee prior to the January meeting for comments.

In discussions on the previously mentioned test method on reporting of the results, Mr. Perez commented that he was unsure of which reporting system to use since more than one are presently used for similar ASTM methods relating to biofouling resistance. F.M. Winkleman proposed that a new task group be set up to try to standardize on a reporting system for all methods. In discussions it was pointed out that this would simplify writing and revision of test methods related to biofouling resistance. The subcommittee agreed that there is enough interest in this proposal that a new task group will be started and Mr. Winkleman agreed to act as task group chairman. The new task group will be D01.45.13 Standard Practice for Rating Biofouling Resistance of Test Surfaces.

In other business S. Rodgers, representing NAVSEA, described two new amended specifications for antifouling paints: Mil-P-15931 and DOD-P-24647.

SUBCOMMITTEE D01.46 INDUSTRIAL PROTECTIVE PAINTING

K.A. Trimber, Chairman

D01.46.02—Surface Preparation—K.A. Trimber, Chairman, presented Draft #1 of a proposed revision of D 2200, "Standard Pictorial Surface Preparation Standards for Painting Steel Surfaces." The draft was a rewrite of the standard into two methods. Method A covers the ISO/Swedish Standard and Method B covers the new SSPC VISI-89 Standard. The task group reviewed the draft and recommended that it be submitted to a Sub. D01.46 ballot.

D 4417, "Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel," was submitted to a concurrent Sub. D01.46/D-1 spring 1990 ballot. One negative (W.C. Johnson) was received with comments from E.P. Clegg. The comment involved the rewriting of Para. 1.2 in the Scope regarding the hazardous materials statement to be in compliance with the new ASTM policy. The negative was related to Para. 6.1.4. The proposed change that was balloted required comparing the blast cleaned surface with the comparator five times at each location. Mr. Johnson indicated that the comparison should be required three times as originally written as three times was consistent with the directions provided for the on-going round-robin test, and was consistent with earlier round-robin testing conducted by NACE fon the profile gages. The negative was found to be persuasive (unanimous). The negative prompted further discussion on the paragraph regarding the manner in which comparators are used. The position of the task group was that a series of three or five individual, distinct observations are not made at each location. Instead, the surface surrounding the comparator is examined as a whole and the leaf or leaves which most closely approximate the roughness of the surface are reported as being the profile. Furthermore, the results of the evaluations at each location are not averaged together to determine the profile depth. Instead, the range is reported. For example, observations at 10 locations ranging from 2.5-3.0 mils are not averaged resulting in a profile of 2.7 mils. Instead, the range of 2.5-3.0 mils is reported. The task group directed the chairman to modify Para. 6.1.4 to this effect.

Preliminary results of a round-robin administered by W.C. Johnson to develop a precision and bias statement for D 4417 were discussed. Eight test plates were blast cleaned using eight different abrasives (two shot, 4 grit, and two sand) and sent to seven volunteer laboratories. The results from four laboratories were submitted with the remaining three expected in early July. Preliminary review of the data and discussions with the laboratories suggests that there are some difficulties with the use of Method B, particularly related to the dulling of the spring-loaded tip. It appears that the method may not be useful for profile depths less than 3 mils. A precision statement is expected to be ready for Sub. D01.46 ballot this fall. All of the raw data will be presented at the January 1991 meeting.

D 2092, "Standard Practice for Preparation of Zinc-Coated (Galvanize) Steel Surfaces for Painting," is due for reapproval in 1990. B.D. Flowers provided copies with recommended changes for discussion. The task group made additional suggestions, and recommended that Draft #1 of the revision be sent to a Sub. D01.46 fall ballot.

Sub. D01.46/D1 Ballot Results for D 4417; Sub. D01.46: 22 affirmatives; 1 negative (Johnson), and 8 abstentions; D-1: 96 affirmatives (comments from 1), 1 negative (Johnson), and 227 abstentions.

D01.46.03—Repainting—was chaired by G.W. Gardner. As agreed at the January 1990 meeting, Mr. Gardner prepared a draft of a new solvent rub standard for circulation to the task group for comment prior to the June meeting. Draft #1 was preliminarily entitled "Standard Test Method for Assessing the Degree of Cure of Chemically Cured Coatings using Solvent Rubs." It was agreed that the title should be changed to indicate that this is a method for assessing the solvent resistance of coatings, rather than a method for assessing cure. Based on some of the comments received, Mr. Gardner clarified the scope of the document, stating that it is a test method for determining if a coating has reached a certain point in its drying or curing such that it can be recoated, handled, placed into service, etc. The selection of the solvent to be used and the degree of solvent resistance necessary will be dependent upon the coating type and the reason for conducting the test (e.g. to determine if the coating can be recoated or placed into service) and will be identified by the coating manufacturer. The method is designed only to provide a uniform method for conducting the test.

After the recommended changes are made, Draft #2 will be submitted to a Sub. D01.46 fall ballot. The need for a round-robin was also discussed in order to determine the material to be used for holding the solvent during the test (e.g. cotton cloth, cotton balls, cheesecloth, etc.) and for determining the method of applying the solvent to the surface (e.g. by moderate finger pressure, using a ball peen hammer of known weight, etc.).

K.A. Trimber reported that three methods developed by this group have completed the society ballot and were assigned numbers by ASTM in 1990: D 5043-90, "Standard Method for Field Identification

of Coatings," D 5064-90, "Standard Practice for Conducting a Patch Test to Assess Coating Compatibility", and D 5065-90, "Standard Guide for Assessing the Condition of Aged Coatings on Steel Surfaces."

D01.46.04—"Pull-Off Adhesion"—K.A. Trimber, Interim Chairman, reported that the task group is still looking for a chairman to replace A.L. Cunningham, who retired. Mr. Trimber reported that D 4541, "Standard Test Method for Pull-Off Strength of Coatings using Portable Adhesion Testers," although reapproved in 1989, still requires reorganization into a method A, B, C, and D format or into four annexes as the round-robin tests indicate that different pull-off instruments provide different results. Prior to this meeting, H.A. Ashton provided the results of interlaboratory pull-off precision for the Elcometer and Patti instruments. At this meeting, additional information was provided on the HATE instrument. Mr. Ashton will complete the work on the Hate and Dyna and a complete precision and bias statement will be sent to a Sub. D01.46 fall 1990 ballot.

Test panels from this study are still available and were again offered to D01.23.10 for use in conducting a round-robin using laboratory tensile testers.

After the meeting, M.E. McKnight agreed to become chairman of the task group.

D01.46.07—Inspection—R.J. Martell, Chairman, discussed comments received on Draft #2 of a newly proposed "Standard Guide for Painting Inspectors (Concrete and Masonry Substrates)," which was circulated to Sub. D01.46 members prior to the meeting. The draft followed the format of D 3276 "Standard Guide for Painting Inspectors (Metal Substrates)." Most of the comments indicated that not all of the "metal" inspection criteria had been deleted when preparing the guide for concrete. Martell agreed to make the necessary changes, incorporate the comments, and prepare Draft #3 for Sub. D01.46 fall 1990 ballot.

B.D. Flowers provided a revised copy of the existing D 3276 as it is due for reapproval in 1990. The document will be retyped with suggested changes presented in bold print and a definitions section will be added. Draft #2 will be prepared and submitted to Sub. D01.46 fall 1990 ballot.

SUBCOMMITTEE D01.47 MASONRY TREATMENTS

F. Gale, Chairman

D01.47.01—Water Repellency of Treated Brick—R. Modrak, Chairman, distributed Draft #6 of the proposed "Test Method for the Determination of the Water Repellency of Treated Brick." A discussion followed on proposed changes to the method using procedures suggested in Task Group D01.47.05 on Moisture Vapor Transmission including splitting each substrate in half.

The chairman has agreed to revise the method and initiate a round-robin of the method before the January meeting. Five cooperators have agreed to participate. Three water repellent treatments, a typical solvent and waterborne treatment and a silane, will be included in this work. The chairman will report on the results of the round-robin at the January meeting.

D01.47.03—Nonvolatile Content of Silanes, Siloxanes and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments—T. Sliva, Chairman, reported that D 5095 will complete society balloting by the end of July.

At the January meeting, it was suggested that the method be revised to require the determination of only duplicate results, in accordance with procedures outlined in D 2369, "Standard Test Method for Volatile Content of Coatings," rather than the triplicate results now specified. H. Ashton performed a statistical analysis of the data developed using duplicate and triplicate results and recommended that the method continue to specify triplicate results. The recommendation was accepted by the task group by a vote of 10-0-0.

The task group also decided to ballot this P&B statement, developed in accordance with D 3980, "Practice for Interlaboratory Testing of Paint and Related Materials," and to have it amended to the method.

D01.47.04—Surface Preparation—F. Gale, Chairman, reported that the proposed new standard, "Practice for Preparatory Cleaning of Architectural Sandstone," will be on the July 1990 society ballot.

Discussion followed on comments received from H. Wray concerning the air blasting procedure as outlined in the practice. It was the decision of the task group by a vote of 4-0-1 that the ASTM statement on safety precautions was sufficient to cover this subject.

The chairman will report on the results of the society ballot at the January meeting.

D01.47.05—Permeability of Treated Masonry Substrates—V. Mertz, Chairman, distributed his first draft of the proposed "Test Method for Determination of Water Vapor Transmission of Treated Masonry Substrates." The test method was then reviewed by the group and the group agreed that initial round-robin testing will involve brick substrates.

B. Gaby, of the Brick Institute, will supply brick substrates and submit a classification system to identify various brick substrates. He also gave a brief description of methods that could be used to cut the test specimens.

The chairman has agreed to revise the method and initiate a round-robin of the method. Seven cooperators have agreed to participate. The results of the round-robin will be discussed at the next meeting.

D01.47.07—Alkali Resistance of Masonry Treatments—F. Gale chaired the meeting in the absence of K. Ozols. Ms. Gale read a statement from the chairman on the status of the method.

It was agreed that the method would be evaluated in conjunction with two newly proposed task groups; D01.47.02 on Resistance of Treated Masonry to Freeze/Thaw and D01.47.06 on Chemical Resistance of Treated Masonry, as these methods used the same substrate and various procedural sections were similar. The method will be revised and a round-robin will be initiated at the next meeting.

D01.47.08—Rapid Chloride Ion Intrusion—T. Fernandez, Chairman, distributed a document entitled "Preliminary Task Group Review of the Proposed Test Method for Rapid Total Chloride Ion Content—Determination for Masonry Coatings." The chairman reviewed the method for the group.

A discussion on the objectives of the task group followed and it was the decision of the group to concentrate on an accelerated or rapid test for the determination of chloride ion intrusion.

The chairman will run preliminary tests on the method and discuss the results at the January meeting. A round-robin will be initiated at that time.

D01.47.09—Crystalline Materials—B. Harrill, Chairman, gave a slide presentation on crystalline materials used in the waterproofing industry, their uses and special properties.

A discussion of various Army Corp. of Engineers methods used for evaluating crystalline treatments followed. At the present time, Water Permeance in accordance with CRD-48-55-73 and Hydrostatic Pressure in accordance with Federal Specification TT-P-1141A will be evaluated and the chairman will decide if either method should be considered for adoption into ASTM format by the January meeting.

As this is a newly instituted task group involving a unique type of masonry treatment for which there are no currently applicable ASTM test methods, the chairman has requested that members submit to him any comments and suggestions.

D01.47—Masonry Treatments—Two new task groups have been initiated, namely; D01.47.02, Freeze/Thaw Resistance of Treated Masonry, chaired by R. Woodward, and D01.47.06, Chemical Resistance of Treated Masonry, chaired by T. Heaton.

"Resistance to Wind Driven Rain," as outlined in Federal Specification TT-C-555B will be reviewed by B. Gaby and B. Harrill and a decision will be made to set up a task group to write up the method into ASTM format.

T. Sliva reported that the revision to D 1734, "Standard Practice for Making Cementitious Panels for Testing Coatings," has been prepared and will be submitted to letter ballot.

V. Mertz has accepted his appointment as Sub. D01.47 liaison with Sub. C09.

DIVISION 50 PAINTS FOR FACTORY APPLICATION

SUBCOMMITTEE D01.51 POWDER COATINGS

N.D. Emily, Chairman

The Chairman reviewed the current status and proposed direction of the subcommittee with 12 members and four visitors who were present. The following appointments were made and approved for subcommittee positions: VICE CHAIRMAN—G.C. JONES; SECRETARY—R. Boni; and TASK GROUP CHAIRMEN—C. Merritt; M.P. Sharma, and E. Waddles.

D01.51.01—Polymeric Powders and Powder Coatings—E. Waddles, Chairman, will be responsible for the review of D 3451, "Standard Practices for Testing Polymeric Powders and Powder Coatings, and the balloting of this practice in 1991. The designated steward is E. Waddles.

D01.51.02—Hiding Power of Powder Coatings—M.P. Sharma, Chairman, L. Schaeffer, Chairman, Task Group D01.26.06, Optical Hiding Power, explained the history of a proposed method for determining the hiding power of powder coatings. H.S. Fairman moved and A.F. Rutkiewic seconded a motion that Sub. D01.51 join in a review of this proposal. Preliminary round-robin test procedures were formulated. Five test laboratories were identified as collaborators.

D01.51.03—Spray Characteristics of Powder—C. Merritt, Chairman, was formed to investigate the phenomena associated with the electrostatic application of organic powder coatings. Initial focus will be to examine the material properties and application parameters which affect first pass transfer efficiency unilaterally or in combination.

SUBCOMMITTEE D01.52 FACTORY-COATED WOOD BUILDING PRODUCTS

S.B. Schroeder, Chairman

D01.52B—Hardboard—S.B. Schroeder, Chairman. Negative D-1 ballots were received from V. Scarborough, J.S. Hinkle, L.E. Newman, S. Spindel, and T.J. Sliva and comments from F.M. Winkelman and D.F. Zinkel on the proposed Cobb Ring permeability test. Many of the suggested changes were found persuasive and the method was withdrawn for additional study and redrafting.

A negative Sub. D01.52 ballot by C.M. Winchester on the surfactant edge wick test was found persuasive. The modified method will be submitted to concurrent Sub. D01.52/D-1 ballot.

Extensive revisions were made to D 2793, Standard Test Method for Block Resistance of Organic Coatings on Wood Substrates. D 2793, as revised, will be submitted to Sub. D01.52 ballot.

D01.52.13—Prefinished Siding—K. Kruse, Chairman. Unexposed control specimens from series of prefinished hardboard panels with known exposure performance are under evaluation in two accelerated weathering tests. Specimens were inspected after 168 days of concentrated sunlight/soak/freeze/thaw cycles which appeared to exhibit failure mechanisms similar to test fence exposures of 3-8 years, 45° south.

After 1000 hr of modified xenon arc/soak/freeze/thaw cycles, specimens showed little change. Exposures will be continued with both methods and samples reinspected at the winter meeting when it is anticipated that conclusions will be made regarding their correlation with test fence data.

D01.52.15—Film Thickness—R. Matejka, Chairman. One negative ballot on the rewrite of D 2691 was found persuasive. Other technical changes were also adopted which will require reballot. No negative ballots were cast in regard to calibration of the measuring microscope which has been the most difficult item to resolve.

Round-robins are anticipated on the proposed new method within the next twelve months.

D01.52—Three methods due for review in 1991 were discussed. These are: D 2336, "Practices for Specifying Properties from Liquid Through Cured State for Coatings Factory Applied to Wood Products"; D 2830, "Test Method for Durability and Compatibility of Factory-Primed Wood Products with Representative Finish Coats," and D 3719, "Test Method for Dirt Collection on Coated Exterior Panels." Proposed changes in all three methods will be submitted to concurrent Sub. D01.52/D-1 ballot.

SUBCOMMITTEE D01.53 COIL COATED METAL

R.J. Tucker, Chairman

D01.53.01—Pretreatment of Substrates—G. Rommal, Chairman. The need for an ASTM test method or recommended practice for Cr determination by portable X-ray devices was discussed. No standard now exists in ASTM, NCCA, or any other organization to the task group's knowledge, and it was agreed to be a worthwhile undertaking. Choice of standard materials with known levels of Cr for calibration was discussed at length, with various approaches in current use, including 316 stainless steel, known pretreatment films, and specially-prepared materials such as Cr-doped lithium tetraboride. Both the 316SS and pretreated controls are readily available, but have other disadvantages. The pretreatment layers are fragile, and the stainless steel produces Cr count rates several orders of magnitude higher than typical pretreatment films.

Several members agreed to help prepare a draft Recommended Practice. R. Olszewski will supply a copy of RollCoater's current Portaspec practice. D. Steele will provide information on Parker-Amchem's experience with the Asoma instrument, and a copy of their Portaspec procedure. G. Rommal will check with Portaspec and others at Bethlehem about Portaspec count rate linearity. The previously mentioned will prepare a draft and distribute copies to task group members prior to the January meeting.

D01.53.02—Cure Test for Coil Coated Material—D.A. Ball, Chairman. The meeting was called to order by D.A. Ball at 11:00 a.m. Fifteen people were in attendance. Minutes from the January 22, 1990, meeting were read and approved.

G.R. Pilcher commented that no further contact had been made by the manufacturers of the Sheen Hardness Tester or the Gardco Surface Analyzer regarding modifications required for these to be useable in testing MEK resistance on coated panels.

G.R. Pilcher also reported that conversations with Theodore Provder, on various methods now in use for cure evaluations of coatings, did not identify tests useable in coil coating production. The fastest tests available in coil coating production would take 15-25 min.

N. Emily commented that the MEK spot test at 30-60 sec had shown reproducible results when the proper performance of specific coatings being tested was known.

The Morton Building rub tester was discussed briefly.

Dissolution of the task group was discussed, due to the apparent lack of other tests available to assess cure during production coating on coil lines. It was decided to keep the task group alive until the January meeting to allow consideration of

the paper from Sub. D01.46 and possible change of the group goals.

M.E. McKnight stated that Sub. D01.46 was drafting a paper on the MEK rub test. She will send a copy to D. Ball for review at the next meeting.

R. Olszewski suggested that more meaningful testing of coatings manufacturers and statistical evaluation of those tests (or SPC) might be a subject for the committee to pursue, since the MEK rub test still appears to be the best available test for cure of cold coatings, during production application. This will be reviewed at the next meeting.

D01.53.03—Accelerated Weathering of Coil Panels—R.J. Tucker, Acting Chairman. R. Tucker reviewed minutes of January 1990 meeting. A draft of a practice by J. Robbins was read and discussed. A letter was read from P. Brennan who felt that the 1973 study should be repeated.

D. Ball discussed different light sources and correlation problems. G. Pilcher felt that a new study would be worthwhile, but lots of work. R. Olszewski mentioned that NCAA has five or eight year update pending on a U.S./European program in progress, and that they retained materials, which L. Hamilton has.

R. Tucker will try to get D. Cocuzzi to chair this task group.

Messrs. Olszewski and Pilcher stressed sample anonymity in any future programs.

Concerns were expressed by W. Ketola over the method of reporting color shift using only delta E values.

Sub. D01.53—Coil Coated Metal—The meeting was called to order at 5:00 p.m. by Chairman R.J. Tucker; there were ten people in attendance. The chairman appointed G. Pilcher as acting Secretary in D. Cocuzzi's absence.

M.E. McKnight indicated that Sub. D01.46 is drafting an MEK test, and will follow-up on this work with Chairman Tucker.

Chairman Tucker referred to the work being done on the *Paint and Coatings Manual,* as presented by K. Greene at the D-1 Executive Subcommittee on June 17. Some sections are still "open" (i.e., require authors), and Chairman Tucker asked all Sub. D01.53 members to take a look at the manual, and let him know if they would like to volunteer.

SUBCOMMITTEE D01.55 FACTORY APPLIED COATINGS OF PREFORMED PRODUCTS

G.R. Pilcher, Chairman

D01.55.08—Transfer Efficiency—Laboratory Conditions—R.S. Diem, Chairman, reported that the "Standard Test Method for Evaluating and Comparing Transfer Efficiency—Laboratory Conditions," was published in the Volume 6.01, 1990 edition as D 5009. Comments on a second draft of a more general practice on transfer efficiency for laboratories not having the equipment specified in D 5009 were reviewed. A revised practice incorporating these comments will be forwarded for subcommittee ballot.

D01.55.09—Transfer Efficiency—Production Conditions—E.A. Praschan, Chairman, reported that the "Practice for Determination of the Transfer Efficiency Under Production Conditions for Spray Application of Automotive Paints—Weight Basis," had passed society ballot and been assigned number D 5066. Additional editorial comments were discussed and will be incorporated to clarify wording. The revised D 5066 will be forwarded for subcommittee and D-1 ballot. Since D 5066 is specific to the automotive industry, a more generic procedure for determining production transfer efficiency, both weight and volume basis, will be drafted by R.S. Diem.

D01.55.10—VOC Determination of Radiation—Cured Coatings—(provisional)—J.J. Brezinski, Chairman, reported that the organizational meeting had been postponed until January to provide RADTECH with more time to complete their member survey.

D 1211, "Temperature Change Resistance of Clear Nitrocellulose Lacquer Films Applied to Wood," should be updated in view of potential changes to waterborne wood finish systems caused by the imposition of more stringent air pollution regulations. The industry will be surveyed as to current practice, and any modification there of needed to evaluate waterborne systems. Included in that survey will be a question as to whether D 3459, "Humid-Dry Cycling for Coatings on Wood and Wood Products," is still being used.

Methods D 333, D 3170, and D 4712 have been reviewed and will be balloted with editorial changes. Stewards have been found for the other methods currently due for review.

D 3002, "Evaluation of Coatings for Plastics," does not cover surface cleaning or preparation prior to application of the coating. A.F. Rutkiewic will chair an organizational meeting in January to set up a task group.

SUBCOMMITTEE D01.56 PRINTING INKS

J.M. Fetsko, Chairman

D01.56.02—Lightfastness of Prints—J. Daugherty, Chairman, distributed copies of the revised test method D 3424, "Weather- and Lightfastness of Printed Matter." Comments are to be mailed in by August 15. Additional laboratories are now running the xenon-arc part of the round-robin.

D01.56.04—Viscosity of Paste Inks—J.M. Fetsko, Chairman, reported that the revised test method D 4040, "Viscosity of Printing Inks and Vehicles by the Falling Rod Viscometer," appears in the 1990 *Book of Standards.*

D01.56.06—Ink Tack—T. Sayres, Chairman, reported that the revised test method D 4361, "Apparent Tack of Printing Inks and Vehicles by the Inkometer," is also in print and appears in the 1990 *Book of Standards.*

D01.56.09—Tinting Strength—J. Fetsko, Chairman, reported that the D-1 ballot of the proposed new test method, "Relative Color and Strength of Printing Ink Dispersions," received one comment to delete "color" from the title and one negative concerned with the instrumental part of the method. Revisions will be made accordingly.

D01.56.10—Water Pickup of Litho Inks—G. Bien, Chairman, reported that new test method, D 4942 "Water Pickup of Lithographic Printing Inks and Vehicles in a Laboratory Mixer," appears in the 1990 *Book of Standards.*

D01.56.14—Setting of Heatset Inks—R. Chiaramonte, new Chairman, reported that four laboratories participated in a full scale round-robin on the proposed new test method "Relative Setting of Heatset Inks by the Sinvatrol Tester." Even though all replicates were blind, repeatability was excellent but reproducibility was poor. A method for print preparation that minimizes drying on the press is to be explored.

D01.56.17—Index for Printing Inks—A. Scarlatti, Chairman, reported that no negatives were received from the Subcommittee ballot on the index of ASTM test methods that are applicable to printing inks and printed matter. After revisions are made to accommodate several comments, the index will be submitted for the next D-1 ballot.

D01.56.19—Print Intensity and Opacity—B. Blom, new Chairman, reported that black and white coated paper strips have been obtained for printing on the IGT and Prufbau Printability Testers. Exploratory studies will be undertaken on a test method, which will involve making densitometer readings on weighed prints.

D01.56.21—Print Abrasion.—G. Bien, Chairman, reported that densitometric data from the round-robin on the proposed new test method, "Abrasion of Printed Matter by the CAT Comprehensive Abrasion Tester," did not distinguish between good and bad samples. The situation might be im-

proved by conversion of the data to reflectance or by a visual rating approach.

D01.56.22—Drying of Sheet-Fed Inks—G. Bien, Chairman, reported that excellent results were obtained from the use of squalene resistance to determine the drying time of sheet-fed inks. A full scale round-robin will be conducted in which participants will test four inks on one substrate.

D01.56.24—Grit Determination—M. Fuchs, Chairman, reported that slow blending of Type I mineral spirits into flushed pigments gave good results in a round-robin on grit. The method is to be written up for Subcommittee balloting.

D01.56.25—Radiation Cured Inks—R. Janusz, Chairman, reported on work conducted toward the development of a test method for "Completeness of Cure of UV & EB Coatings and Printing Inks." Approaches being tried include Sutherland Rub Tester with a solvent wetted pad, the Sward Hardness Rocker, and the UV (Process Supply) Cure Analyzer.

D01.56.26—Chemical Resistance—B. Blom, Chairman, reported that the Sutherland Rub Tester with various weights and number of revolutions is being checked out for determining the squalene resistance of printed matter.

D01.56.27—VOC of Cold Set Paste Inks—P. Ford, Chairman, distributed results of a round-robin in which 12 laboratories tested four newsinks using San Francisco Bay Area Quality Management District Method 30, which specifies heating samples at 40°C for one hour, as well as ASTM Test Method D 2369, in which samples are heated at 110°C for one hour. After the data are analyzed statistically, the resulting precision statements will be submitted for incorporation in relevant ASTM test methods.

SUBCOMMITTEE D01.57 ARTISTS' PAINTS AND RELATED MATERIALS

M.D. Gottsegen, Chairman

D01.57.02—Lightfastness of Pigments—T. Vonderbrink Chairman, reported a negative vote on the proposed revision of Para. 6.2 of D 4303-88A. "Standard Test Methods for Lightfastness of Pigments Used in Artists' Paints," was resolved before the meeting and an editorial change suggested by the voter was approved by the subcommittee. The negative voter had objected to confusing and redundant language in the proposed revision and suggested two subparagraphs which were clearer.

D01.57.04 Specification for Artists' Paints—A. Spizzo, Chairman, presented a list of key words for Sub. D01.57 standards, prepared at the request of ASTM, which has been forwarded to ASTM Headquarters.

D01.57.07—Physical Properties—Ms. Sheehan, Chairman, was unavoidably absent from the meeting but a colleague reported that she is still working on the projects outlined at the last meeting, and has also convinced the conservation laboratory at Yale University to provide some help.

D01.57.08—Toxicity Labeling— In W. Stopford's absence, M. Gottsegen presided.

C. Jacobsen, of Consumer Products Safety Commission, reiterated the requirement of the new federal regulation that a label for a product containing material that can be a chronic health hazard must show a U.S. company name, address, and telephone number. The number need not be cost-free nor be manned 24 hours a day.

After lengthy debate, Para. 5.7 of D 4236, "Standard Practice for Labeling Art Materials for Chronic Health Hazards," was revised to include the phrase "appropriate telephone number"—the phrase that is used in the new regulation.

A revision of D 4236 received a negative vote that was later withdrawn by the voter based on the addition of the new phrase. The latest revision has been sent to ASTM Headquarters for concurrent Sub. D01.57/D-1 reballoting.

Several editorial comments on D 4236 were accepted by the subcommittee.

D01.57.09—Watercolors—T. Vonderbrink, Chairman reported that D 5067, "Standard Specification for Artists' Watercolor Paints," is being balloted.

D01.57.10—Consumer Evaluation—A tenth draft of a proposed Standard Practice for the Visual Determination of the Relative Lightfastness of Art Materials by Artists was distributed with instructions to send comments to M. Gottsegen. This document will be on the agenda for the next meeting of the subcommittee.

D01.57.11.—Gouache Paints—T. Takigawa, Chairman, presented lightfastness test results on two types of exterior exposures and one type of interior exposure.

There was discussion about the devices being used to monitor the exposures. R. Kinmonth recommended that an ultraviolet radiometer be used in addition to a pyranometer.

Some recommendations for substrates were discussed, as was the type of glass through which the exposures are made.

D01.57.12—Determination of Toxicity—In W. Stopford's absence, M. Gottsegen presided.

Upon the recommendations of Mr. Stopford, the citrate buffer extraction method for ceramics that was to be forwarded to C-21 has been deferred because of the large number of countries that use another test.

Sub. D01.57—M. Gottsegen, Chairman, reported that C. Sathre has proposed to investigate the development of a laundering test method for fabric paints. He has been in contact with some interested parties but was not able to be at this meeting. At the next meeting of the subcommittee, a new task group may be established to develop the method.

DIVISION 60 PAINT APPLICATION

SUBCOMMITTEE D01.61 PAINT APPLICATION TOOLS

F.B. Burns, Chairman

D01.61.01—Paint Brushes—T.J. Sliva, Chairman, reported that the "Proposed Practice for Preparation of Paint Brushes for Evaluation," had completed society balloting without receiving any negative ballots. The method will be submitted for editorial review and printed in 1991. The chairman explained that he would write the addition of environmental test conditions for that method and submit this revision for simultaneous subcommittee and committee ballots at the next meeting.

He then submitted two new methods for discussion; namely, "Proposed Test Method for Leveling Efficiency of Paint Brushes," and "Proposed Practice for Physical Characteristics of Paint Brushes." The methods were reviewed by the task group and comments were noted. J. Price agreed to run an initial evaluation of the "Leveling Efficiency" procedure in conjunction with the chairman. The method will be submitted to the group at the January meeting at which time a round-robin will be initiated. It was the direction of the task group to submit "Proposed Practice for Physical Characteristics of Paint Brushes," to subcommittee ballot before the next meeting.

D01.61.02—Paint Rollers—J.F. Price, Chairman, read the minutes of the previous meeting. Discussion was then held concerning the newly approved Standard Practice for Preparation of Paint Rollers for Evaluation. The chairman explained that he would write the addition of environmental test conditions for that method and submit this revision for simultaneous subcommittee and committee ballots at the next meeting. Following discussion, it was decided that a round-robin test for the proposed Standard Method for Evaluating Paint Rollers would be scheduled for the Sunday evening in Ft. Lauderdale, prior to the January regular meeting of this task group.

A discussion was then led by the chairman concerning the possible adaptation of methods developed or under study by this group for testing application tools to test application properties of paint. This could be done in cooperation with Sub. D01.42 on Architectural Finishes.

D01.61.04—Nomenclature and Definitions—E.C. Harsch, Chairman, led a review of six comments and nine negative votes received by the main committee in the recent ballot of 16 definitions. The task group unanimously recommended that seven of the negatives were nonpersuasive, and that the other two negative votes were not related to the issues of the ballot. In one case, the subject of "foam roller cover," which was brought up in conjunction with a negative vote, will be considered for its own definition at a future meeting of this task group. After reviewing the comments received from Messrs. Lauren, Hinkle, Weaver, and White, the task group agreed to incorporate four of the suggestions in the appropriate definitions.

D01.61.05—Bulk Density of Filaments and Bristle—T. O'Brien, Chairman, reviewed input on the plan to purchase the bulk density test unit proposed by W.B. Bond, and sourced to T.S. Simms Co., Ltd. The importance of the development of this test method was discussed in detail and a high priority consensus was reached. An exploded view drawing for this test apparatus was provided by F.B. Burns and was reviewed by the group. It was noted that when the addition of two screws holding the strap (inadvertly left out) is made, the drawing can become part of the test method description. One test unit has been ordered, and four additional cooperators agreed to order a unit. Round-robin testing was targeted to begin at the time of the next meeting.

D01.61.06—Buckling Resistance of Filaments—W.B. Bond, Chairman, reviewed the status of proposed test development. There are two proposed tests. One method proposed by the chairman measures buckling resistance by applying end force to a single filament. One other cooperator has now assembled a unit which will be sent to chairman for comparison to the original device. Another cooperator asked for a copy of the method and apparatus details to complete a third unit. Two other cooperators indicated interest also.

The second method measures the resistance of filaments to bending when held at each end. This concept was proposed by T. O'Brien, who provided test outlines for two different Ketema procedures for using a special Fracture Testing Device. A quotation for the device by an outside vendor was also provided. Following discussion, O'Brien agreed to provide drawings for the test device and an ASTM format for a procedure to use in testing at the next meeting. Three filament suppliers agreed to each select a range of filaments for use in evaluation testing.

The group then discussed the time demands in their respective laboratories and the shortage of technician time for running ASTM tests. It was the consensus that the bulk density round-robin discussed in D01.61.05 was of higher priority, and that testing proposed for this group will actually be initiated after bulk density testing is underway.

Sub. D01.61—The chairman announced that the new standard: Practice for Preparation of Paint Brushes for Testing, had passed society ballot on May 25, 1990 and was assigned number D 5068-90. Also, he announced that the new standard Practice for Preparation of Paint Rollers for Evaluation had passed on the same date and was assigned number D 5069-90.

The subcommittee reviewed the recommendations of Task Group D01.61.04 concerning the negative votes cast in D-1 letter ballot D0101(90-1) to revise D 16-84, Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products. Sub. D01.16 had referred this matter to this originating subcommittee for resolution. Balloting was then held on each of the negative votes as follows:

M. Golden, of Golden Artist Colors Inc., cast negative votes on Items 2, 3, 4, 5, and 6. Sub. D01.61 voted 6-0-0 that these were nonpersuasive because all were editorial in nature. Z.V. Riders, of Sherwin Williams Co., cast negative votes on Items 1, 3, and 5. On Item 1, Sub. D01.61 voted 6-0-0 to find the negative nonpersuasive because the suggested changes are not correct for industry practice. On Item 5, Sub. D01.61 voted 6-0-0 to find the negative nonpersuasive because proposed changes were less definitive than the proposed definition. On Item 3, Sub. D01.61 voted 6-0-0 to find the negative not related because proposal suggested "use" of material which was not related to definition of material. J.L. White, of 3M Co., cast a negative vote on Item 14. Sub. D01.61 voted 6-0-0 to find the negative not related because the voter suggested a separate definition for a different subject. His suggestion will be considered as a separate term to be defined at a future meeting.

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Society Meetings

CDIC ..... SEPT.

"Isocyanates"

The Society Officers for 1990-91 were introduced as follows: President—W.E. Whitlock, of Ashland Chemical Company; Vice-President—James E. Flanagan, of Flanagan Associates, Inc.; Secretary—Alipio R. Rubin, Jr., of Hilton Davis Co.; and Treasurer—Paul R. Guevin, Jr, of P.R. Guevin Associates.

Lloyd Reindl, of Flanagan Associates, Inc., will serve as the Society Representative to the Federation's Board of Directors.

David A. Kallal, of Hüls America, Inc., and Donald J. Roettker, of B.H. Roettker Company, Inc., presented the Nuodex Gavel to Mr. Whitlock.

A 25-Year Pin was awarded to Mr. Guevin acknowledging his years of dedicated service to the Society.

The meeting's educational speaker was Estel Hobbs, of Ashland Petroleum. Mr. Hobbs discussed "GASOLINE, ADDITIVES, AND CLEANER BURNING FUELS."

Mary Ann Brost, of Mobay Corporation, gave the evening's technical presentation. Her topic was "ISOCYANATES IN POLYURETHANE COATING SYSTEMS."

The speaker discussed the types, applications, common properties, health considerations, overexposure hazards, symptoms, and long-term effects of isocyanates.

In conclusion, Ms. Brost stated that isocyanate products are similar in inherent toxicity, but the level of practical hazard they present varies greatly because of differences in volatility, application types and methods, controls used, and level of knowledge of users.

Q. What are the major human health effects of overexposure to isocyanate products?

A. Overexposure to isocyanate products can cause skin, eye, nose, throat, and lung irritation. It can also lead to skin or lung sensitization. A third effect for which there is some evidence is a chronic (long-term) loss of lung function. For a more complete list of health effects and symptoms, please consult the material safety data sheet for the specific isocyanate products you intend to use.

Q. What disposal method(s) does Mobay recommend for isocyanate product wastes?

A. Mobay recommends incineration as the most cost-effective, technically feasible destructive technology.

ALIPIO R. RUBIN, JR., *Secretary*

LOS ANGELES ..... SEPT.

"Latex Gloss Enamels"

A moment of silence was observed in memory of Society Honorary Member Dermont G. "Duke" Cromwell, who died recently.

Samuel J. Bellettiere, of Sinclair Paint Company, announced that he was attempting to solicit financial support, in the form of a scholarship, to the Cal Poly San Luis Obispo Scholarship Fund in the name of "Duke" Cromwell. Anyone interested in donating should contact Mr. Bellettiere at Sinclair Paint.

The following members were installed as Society Officers: President—James F. Calkin, of E.T. Horn Company; Vice President—James D. Hall, of Major Paint Company; Secretary—V.C. "Bud" Jenkins, of Ellis Paint Company; Treasurer—Sandra L. Dickinson, of McWhorter Company; and Society Representative—Jan P. Van Zelm, of Byk-Chemie USA.

Mr. Van Zelm was re-elected for another three-year term and has been nominated to serve on the Federation's Executive Committee.

Robert Backlin, of Huls America, Inc., presented the traditional gavel of office, a symbol of leadership of the Society, to Mr. Calkin.

Mr. Calkin presented the Past-President's Award to Parker Pace, of Behr Process Corporation. Mr. Pace was honored with a plaque depicting a gavel for his valuable contributions to the paint industry and the Society.

Mr. Calkin announced the appointment of the following committee chairmen for 1990-91: Educational—Joseph C. Reilly, of Rohm and Haas Company; Environmental Affairs—Dave Muggee, of E.T. Horn Company; Manufacturing—Ray DiMaio, of Kop-Coat, Inc.; Membership—Ms. Dickinson; and Technical—Santos Delos Santos, of Davis Colors.

Mr. Calkin, who also serves as Chairman of the Scholarship Committee, noted that the Society had awarded 20 scholarships, for a total of $18,500, in 1990.

Tom Dowd, of Dowd & Guild, Inc., announced that a few booths are still available for the 20th Biennial Western Coatings Societies Symposium and Show, scheduled for February 18-20, 1991, at the Hilton Hotel, in San Francisco, CA.

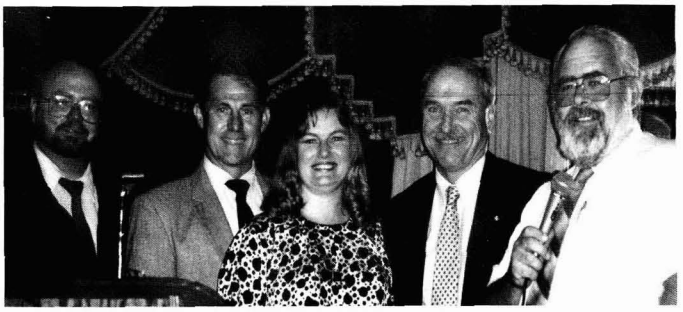
Mr. Dowd, Exhibit Chairman, also stated that technical papers are still needed for the symposium.

Dave Muggee gave the environmental report. He stated that the Department of Transportation has relaxed its 24-hour telephone number requirement for the Emergency Response Communication Rule. A telephone only has to be monitored during transport and storage incidental to transport according to the final rule issued on August 17.

Also, the Consumer Product Safety Commission is ordering manufacturers, importers, packagers, and private labelers of consumer products containing one percent or more of methylene chloride, also known as dichloromethane, to report certain information on the characteristics, labeling, and marketing of their products to the Commission.

Frank Peters, of Dunn-Edwards Corporation, the Society "Paint Technology" course instructor, announced that a new class has been formed at the City of Commerce

BALTIMORE SOCIETY OFFICERS—Elected to serve as officers for 1990-91 are (l-r): President—Gary Morgereth; Vice-President—Mary Lou Spurrier; Secretary—James M. Smith; Society Representative—Joseph D. Giusto; and Treasurer—John Kurnas



LOS ANGELES OFFICERS—Board of Director members for the 1990-91 include: Vice President—James D. Hall; Secretary—V.C. Bud Jenkins; Treasurer—Sandra L. Dickinson; President—James F. Calkin; and Immediate Past-President—Parker Pace

Community Center. Also, Mr. Peters and Mr. Reilly presented diplomas to the 25 students who graduated from the most recent "Paint Technology" class.

The meeting's technical speaker was Sharon S. Kraus, of Rohm and Haas Company. Ms. Kraus's topic was "QUEST FOR HIGHER PERFORMANCE ACRYLIC LATEX GLOSS ENAMELS."

The presentation provided an update on the technology and described the performance of aqueous gloss enamels. Emphasis was placed on formulating variables, including a choice of dispersant, rheology modifiers, and pigments, all factors that affect the final performance of high gloss binders in interior and exterior high gloss formulations.

According to the speaker, marketing research showed that two-thirds of all solvent based paints used for architecture were used by professional contractors. Further research showed that the contractors have accepted water-based coatings for walls, but they preferred to use solvent-based paints for wood trim due to the higher gloss and perceived higher durability of the conventional alkyds.

Therefore, stated Ms. Kraus, the key to acceptance of high gloss acrylics by the professional contractors is to make technological advances in the formulations themselves to approach or surpass the performance of the alkyds.

The speaker said that dispersants play a major role in achieving this goal. The role of the dispersants is to give more open time and brush flow. Ms. Kraus recommended the use of an acid copolymer dispersant for its hydrophobicity properties, especially one that is less functionalized. Since they are less functionalized, they can be seen at a higher level, about 3-5% on dry pounds of pigment, depending on the type of pigment.

The speaker stated that pigment is important in achieving gloss and that there are even different grades of the same type of pigment, such as TiO_2. Between grades there were 11 points of gloss difference at 20°. Similar differences were shown at 60°.

According to Ms. Kraus, coalescents are another critical formulation component since the acrylic polymers necessary to achieve high gloss are harder binders and need about 10-15% coalescent to form a film. She said ester alcohols were found to be the best coalescent to get a tight, glossy film. Glycol ethers were found to cause foam and, at high humidity, evaporate, leaving water behind and a low gloss, poorly developed film.

Ms. Kraus explained how thickeners are a key component for developing alkyd-like rheology. She recommended the nonionic polyurethane rheology modifiers because they give better flow, improved open time, better water resistance (due to the nonionic), better pH stability, and especially, better brush flow.

The speaker used a series of photographs demonstrating application and appearance properties which showed that acrylic emulsion formulations outperformed alkyds in tack free time, yellowing, early block resistance, gloss retention, grain crack resistance, mildew resistance, adhesion to galvanized steel, and alkali resistance. Ms. Kraus stated that alkyds were better for flow, initial gloss, and ultimate block resistance.

Q. On making a deep base paint, is there any particular extender that you can use? At what PVC can you recommend?

A. Well, for the most part, we recommend small particle sized clays, usually hydrated clays, or small particle silicas. As for what PVC, it depends on what type of gloss you are looking for. If you are looking to maximize your gloss, it will be very low, on the order of 2-3 PVC.

Q. What work was done on drying characteristics with low temperature and/or high humidity?

A. A lot. We looked at both low temperature and low humitity and low temperature with high humidity. Basically we looked at ranges from 40 to 90°F for temperature and about 50 to 70% in terms of humidity. The most important thing you're talking about here is the type of cosolvents you need to use to get your open-time characteristics and your early nonblocking characteriscits.

V.C. BUD JENKINS, *Secretary*

LOUISVILLE ..... APR.

Outstanding Service Award

Timothy L. Fortney, of American Dispersions, Inc., was elected Society Secretary for 1990-91.

The 1990 Outstanding Service Award was presented to John A. Lanning, of Courtaulds Coatings, Inc. Mr. Lanning is a Member-at-Large on the Federation's Board of Directors.

The meeting's speaker was University of Louisville assistant basketball coach Jerry Jones. Coach Jones talked about the basketball program at Louisville, as well as his feelings on college athletics in general.

LLOYD BROWNING, *Secretary*

LOUISVILLE ..... SEPT.

"Crystalline Silica"

The Society Officers for 1990-91 were introduced: President—Raymond L. Mudd, Courtaulds Coatings, Inc.; Vice-President—Kris Grauer, of Kurfees Coatings, Inc.; Secretary—Timothy L. Fortney, of American Dispersions, Inc.; and Treasurer—Lloyd Browning, of Kelley Technical Coatings, Inc.

James A. Hoeck, of Akzo Coatings, Inc., has one-year of his term remaining as Society Representative to the Federation's Board of Directors.

Immediate Past-President Louis F. Holzknecht, of Devoe Coatings Company, presented the Society gavel to Mr. Mudd.

Mr. Mudd also received the Huls Gavel from Rich Powell, of Argus Company, Inc.

Mike R. Moilanen, of United Catalysts, Inc., was appointed Membership Committee Chairman.

Other committee chairmen include Educational Committee Chairman Paul Baukema and Technical Committee Chairman Linda Cox, both of Akzo Coatings, Inc.

Mr. Baukema announced that "Surface Coatings Technology, Part Two; Pigments, Solvents, and Additives" course was underway at the University of Louisville. Twenty-one students are registered for the course.

Ms. Cox talked about the Technical Committee project which is to publish a paper that will serve as a tool for formulators. The goal is to standardize a Brookfield viscosity method that would be reproducible from plant to plant.

The meeting's speaker was Joseph Scaries, of U.S. Silica Company, who discussed

"BENEFITS OF USING CRYSTALLINE SILICA/ HEALTH AND SAFETY ISSUES."

The speaker identified the differences between amorphous and crystalline silicas which included the applications thereof. He discussed many environmental laws and the new legislation which pertains to the use of crystalline silicas and their effects on users and manufacturers.

Mr. Scaries informed the membership that OSHA has classified crystalline silica as a Group 2A Carcinogen based on results from one study published by IARC.

He stated that a recent SME meeting on safety issues, evidence was presented that the hazards involved in the exposure to these products must be based on the particle size of the minerals involved. However, researchers from all the regulatory agencies refused to attend this presentation.

The committee strongly requests that OSHA reevaluate all the tests for hazardous materials because, as written, any product which contains more than 0.1% crystalline silica must be labeled a carcinogen.

In conclusion, Mr. Scaries reminded everyone that 75% of the world's crust consists of crystalline silica, as does a certain percent of all natural occurring minerals and that we should be reasonable about the actual risk assessment in the use of crystalline silica.

Q. Why not label everything we make as carcinogenic?

A. Every product we manufacture is labeled carcinogenic and we recommend any manufacturer using naturally occurring minerals containing over 0.1% crystalline silica to do the same.

TIMOTHY L. FORTNEY, *Secretary*

NORTHWESTERN ..... SEPT.

"Carbon Black Pigments"

The incoming Society Officers for 1990-91 were introduced to the membership: President—Terry Strom, of Ti-Kromatic Paints, Inc.; Vice-President—Daniel W. DeChaine, of Valspar Corporation; Secretary—Joseph Wirth, of Consolidated Container Corporation; and Treasurer—Sarah Oebser, of H.B. Fuller Company.

Richard Fricker, of Valspar, announced that he will be retiring and moving to Alabama. Larry Brandenburger, of Valspar, will be the new Society Representative to the Federation's Board of Directors.

Immediate Past-President Mark W. Uglem, of Hirshfield's Paint Mfg. Company, passed the President's Gavel to Mr. Strom.

The meeting's first speaker was New York Society member Maria Nargiello, of

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Snyder's Willow Grove Restaurant, Linthicum, MD). JIM SMITH, Eastech Chemicals, 5700 Tacony St., Philadelphia, PA 19135.

BIRMINGHAM (First Thursday—Strathallan Hotel, Birmingham, England). D.C. MORRIS, PPG Industries (UK) Ltd., P.O. Box 359, Birmingham, B16 OAD, England.

CDIC (Second Monday—Location alternates between Columbus, Cincinnati and Dayton). ALIPIO R. RUBIN, JR., Hilton-Davis Chemical Co., 2235 Langdon Farm Rd., Cincinnati, OH 45237.

CHICAGO (First Monday—alternates between Sharko's Restaurant, Villa Park, IL, and Como Inn, Chicago, IL). WILLIAM FOTIS, Valspar Corp., 1191 S. Wheeling Rd., Wheeling, IL 60090.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH in Sept., Oct., Nov., Feb., March, April; Jan. meeting, Landerhaven, Mayfield Heights). ROY GLOVER, Mahoning Paint Corp., 653 Jones St., P.O. Box 1282, Youngstown, OH 44501.

DALLAS (Thursday following second Wednesday—The Harvey Hotel, Dallas, TX). MIKE EVANS, J.M. Huber Corp., 803 Pleasant Valley, Richardson, TX 75080.

DETROIT (Second Tuesday—meeting sites vary). SCOTT WESTERBEEK, DuPont Co., 945 Stephenson Hwy., Troy, MI 48007.

GOLDEN GATE (Monday before third Wednesday—alternates between Francesco's in Oakland, CA, and Holiday Inn in S. San Franscisco). LARRY G. SAYRE, O'Brien Corp., 450 E. Grand Ave., S. San Francisco, CA 94080.

HOUSTON (Second Wednesday—Sonny Look's Sirlion Inn, Houston, TX). TERRY F. COGAN, Raw Materials Corp., P.O. Box 690285, Houston, TX 77269.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). CRAIG HUGHES, Farmland Industries, Inc., P.O. Box 7305, N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, Commerce, CA). V.C. BUD JENKINS, Ellis Paint Co., 3150 E. Pico Blvd., Los Angeles, CA 90023.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). TIMOTHY FORTNEY, American Dispersion, Inc., P.O. Box 34033, Louisville, KY 40232.

MEXICO (Fourth Thursday—meeting sites vary). ANTONIO JUAREZ, Amercoat Mexicana, via Gustavo Baz 3999, 54030 Tlalnepantla, edo de Mexico.

MONTREAL (First Wednesday—Bill Wong's Restaurant, Montreal). ROBERTO CUBRAL, L.V. Lomas Chemical Co., 1660 Hynus, Dorval, Que., H9P 2N6, Canada.

NEW ENGLAND (Third Thursday—Sheraton Lexington Hotel, Lexington, MA). JOHN LUKENS, D.N. Lukens, Inc., 15 Old Flanders Rd., Westboro, MA 01581.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). MICHAEL FRANTZ, Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304.

NORTHWESTERN (First Tuesday after first Monday—Jax Cafe, Minneapolis, MN). JOSEPH WIRTH, Consolidated Container Corp., 735 N. Third St., Minneapolis, MN 55401.

PACIFIC NORTHWEST (PORTLAND SECTION—Third Tuesday; SEATTLE SECTION—Third Wednesday; BRITISH COLUMBIA SECTION— Third Thursday). JOHN BARTLETT, Pacific Bartlett Co., 11813 S.E. 257th St., Kent, WA 98031.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). WILLIAM J. FABINY, Sermaguard Coatings, 155 S. Limerick Rd., Limerick, PA 19468.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). ANNETTE SAUNDERS, Akzo-Reliance, P.O. Box 2124, High Point, NC 27261.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). JEFFREY STURM, Kop-Coat, Inc., 3020 William Pitt Way, Pittsburgh, PA 15238.

ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). ED MCCARTHY, Cyprus Minerals, 8995 E. Nichols, Engelwood, CO 80112.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant, St. Louis, MO). DENNIS CAHILL, Archway Sales, Inc., 4321 Chouteau Ave., St. Louis, MO 63110.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION—third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SECTION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). BILLY M. LEE, Kemira, Inc., P.O. Box 368, Savannah, GA 31402.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). MIKE HAZEN, L.V. Lomas Ltd., 99 Summerlea Rd., Brampton, Ont., L6T 4V2, Canada.

WESTERN NEW YORK (Third Tuesday—meeting sites vary). MARKO MARKOFF, 182 Farmingdale Rd., Cheektowaga, NY 14225.

Degussa Corporation. Her talk was entitled "CARBON BLACK PIGMENTS FOR COATINGS; PRODUCTION, PROPERTIES, APPLICATION, DISPERSION."

Ms. Nargiello stated that particle size, structure, and surface chemistry of the carbon black pigment will determine jetness, mass tone, tinting, and transparency of the coating.

According to the speaker, the process used to extract the pigment will determine particle size, with the furnace process yielding the smallest particle size. The type of apparatus used in dispersion, as well as the type of resin used, will determine what type of carbon black pigment is best in each application.

The final speaker for the evening was Ronald E. Lowrance, of Stauffer-Wacker Silicones. His presentation focused on "SILICONE BASED COATINGS." Mr. Lowrance is a member of the Detroit Society.

According to the speaker, these VOC compliant coatings offer excellent weather resistance in even the harshest environment. Heat and corrosion resistance (as in marine applications) also can be considered as strengths.

Mr. Lowrance explained that of the two most common types, phenyl silicones offer the better heat resistance, oxidation resistance, and shelf stability. Methyl silicones are superior in hot hardness, water repellency, low temperature properties, chemical resistance, rate of cure, and resistance to thermal shock.

JOSEPH WIRTH, *Secretary*

PIEDMONT .....JUNE

"Organoclays"

Fourteen Society Past-Presidents attended the meeting, including: Don Wiseman (1959-60), the first President of the Piedmont Society; Albert Yow (1970-71); Y.O. Younger (1974-75); Clifton Barton (1975-76); John Lucas (1976-77); Charles B. Wilson (1978-79); William J. Culhane (1980-81); James N. Albright (1981-82); James F. Husted (1983-84); Phillip Wong (1984-85); Michael S. Davis (1985-86); Steve Lasine (1986-87); Charles Howard (1987-88); and Barry F. York (1988-89).

Membership Committee Chairman Ruby Johannesen, of Southchem, Inc., presented the Society's Distinguished Service Award to Dot Forward, retired, for her 39 years of dedicated service to the Society.

President Forest Fleming, of Reliance Universal, Inc., presented 25-Year Pins to: Dan Myers, Mr. Wong, Mr. York, and Mr. Wilson, of Reliance Universal, Inc.; and John Nielson, of Premium Coatings, Inc.

The evening's speaker was Houston Society member Dwaine Siptak, of E.C.C. America, Inc. Mr. Siptak's talk was entitled "ORGANOCLAYS—PAST, PRESENT, AND FUTURE."

RUBY JOHANNESEN, *Secretary*

Errata

The Raw Materials Table (page 39) in the article " 'Designed Permeability' of Micaceous Iron Oxide Coatings," July 1990, pages 33-42, lists American Cyanamid Company as the supplier of Aerosil R 972. The Aerosil range of fumed silica products is marketed in the United States by Degussa Corporation, Ridgefield Park, NJ, and in Canada by Degussa Canada Ltd., Burlington, Ontario.

We apologize for any inconvenience this may have caused.—Ed.

Future Society Meetings

Birmingham

(Dec. 6)—"The Role of Multicompatible Stainers in the Industrial Paint Market"—Mike Husbands, Sandoz.

(Jan. 10)—"The Benefits of Color Computer Measurement Equipment in the Coatings Industry"—Colin Wilkinson, Kirkstol Colour Service.

(Feb. 7)—"Can Lines"—R.P. Clarke, Nacanlo Ltd.

(Mar. 7)—"Modern Dispersion Equipment for Surface Coatings"—Colin Bow, Netzsch Ltd.

(Apr. 4)—"1992: A Legislative Update for the Paint Industry"—Tony Newbold, Paintmakers Association of Great Britian.

(May 2)—62nd Annual General Meeting.

Cleveland

(Nov. 20)—"Trends in Environmental Control for the 90s"—Thomas Graves, Director of Federal Affairs, NPCA.

(Jan. 15)—Joint Meeting with Cleveland PCA.

(Feb. 19)—"The Use of Ropaque Opaque Polymers in Architectural Coatings"—Dr. Elmer Williams, Jr., Rohm and Haas Co.

(Mar. 19)—"Choosing the Most Effective Dispersants for High Solids Coatings Systems"—Marvin Schnall, Troy Chemical Corp.

(Apr. 16)—"Coatings Characterization by Thermal Methods"—Michael Neag, The Glidden Company.

(May 21)—"Formulation of New Varnishes for Old Master Paintings"—Dr. E. Rene´ de la Rie, National Gallery of Art.

Kansas City

(Jan. 10)—"Polyethylene Additives for the Coatings Industry"—Larry Novak.

(Feb. 7)—"Environmental Monitoring, Establishing A Baseline for Future Real Estate Transactions and Potential Litigation"—Steve Loosbrock, Terracon.

(Mar. 14)—"New Products From UCC"—Dave Darr, Union Carbide.

(May 10)—"Deforestation and Its Effects on our Global Environment"—Sierra Club Representative.

(June)—Joint Meeting of St. Louis/Kansas City Societies

Louisville

(Nov. 14)—"Wax Emulsions in Aqueous Polymeric Coatings: Contributions and Mechanisms"—John Michelman, Michelman, Inc.

(Jan. 16)—Past-Presidents' Night

(Feb. 20)—"A Solvent Property and Solubility Parameter Calculator"—Dan King, Exxon Chemical Co.

Montreal

(Jan. 9)—Waste Management—Mini Symposium.

(Feb. 6)—"Type 2 Urethane Associative + Latex Paint = Value Added Performance"—Robert Dey, Rheox, Inc.

(Mar. 6)—"Precipitated Calcium Carbonate to Extend TiO_2"—Georges Green, Pfizer Minerals.

(Apr. 3)—"Modified S/B to the Rescue for Meeting VOC and Still Produce Quality Coating"—V.L. Stevens, The Dow Chemical Co.

(May 1)—Progress Report on Technical Committee Projects—A. Brisson, Technical Committee

New York

(Jan.)—"Evaluation of New Generation Coalescing Agents for Industrial Acrylics Latices"—Dan King, Exxon Chemical Co.

(Feb.)—Joint update legislative meeting for the NYSCT/MNYPCA.

(Mar.)—"Polyurethanes in the Baking Industry for Powder, Wire, and Coil"—Robert Henderson, Mobay Corp.

Rocky Mountain

(Nov. 12)—"Factors Effecting Low Temperature Curing of Epoxy Resins"—Gary M. Green, Monument

(Jan. 7)—"Peroxide Cured Resins/Cook Composites"—Dennis Ryder, Freeman.

(Mar. 11)—"Anti-Microbials/Mercury Replacement"—Martin Landau, Hüls America.

(Apr. 8)—"Pigmented Coatings Problems and Solutions Associated with Particular Size"—Elio Cohen, Daniel Products Co.

(May 6)—"Rama-Poly Alka-Methacrylate"—Joachim Buchse, Rohm Tech.

Western New York

(Nov. 20)—"Rheological Additives for Non-Aqueous Coatings"—William Reynolds, Rheox, Inc.

LOS ANGELES

Active

Angenent, Conrad N.—Akzo Coatings, Inc., Brea, CA.
Arkoian, Norair, A.—Ellis Paint Co., Los Angeles, CA.
Benjamin, Bernard—Altawood Inc., Gardena, CA.
Blaine, James G.—Solvent Coatings Corp., Gardena.
Camarillo, Paul J.—Delta Shiva Tech. Coatings, Whittier, CA.
Crawford, James K.—Behr Process Corp., Santa Ana, CA.
Dhaliwal, Pritam S.—Scripto Tokai Corp., Upland, CA.
Dougherty, Brian—Frazee Industries, San Diego, CA.
Everhart, Darin L.—Major Paint Co., Torrance, CA.
Farber, Bruce M.—SDC Coatings Inc., Anaheim, CA.
Farfan, Luis, S.—Delta Shiva Tech Coatings, Whittier.
Floriani, Robert J.—Ameritone Paint Corp., Long Beach, CA.
Francisco, Renante A.—Major Paint Co., Torrance.
Gavino, Lourdes G.—Dunn-Edwards Corp., Los Angeles.
Gloskey, David J.—Major Paint Co., Torrance.
Guest, Allen M.—SDC Coatings, Inc., Anaheim.
Gyssler, Wayne E.—Sinclair Paint, Los Angeles.
Jose, Reynaldo N.—Chemical Coating Corp., Long Beach.
Kao, Kim Y.—Armorall Products, Santa Ana.
Kashmer, George M.—Wellborn-De Co., Albuquerque, NM.
Ko, Benita U.—Morton International, Colton, CA.
Kordosh, John R.—Major Paint Co., Torrance.
Kunzik, Greg E.—Ameritone Paint Corp., Long Beach.
Lee, Kyu S.—Coatings Resource, Huntington Beach, CA.
Maliglig, Lisa L.—Behr Process Corp., Santa Ana.
Mislang, Feliciano B.—Dayglo Color Corp., Cudahy, CA.
Plouff, Jamie, S.—Old Quaker Paint Co., Carson, CA.
Pollak, Richard B.—California Flameproofing, Pasadena, CA.
Pourshirazi, Hamid—Vista Paint, Fullerton, CA.
Ramirez, Jose M.—Major Paint Co., Torrance.
Samuels, Reupena Ruben—Behr Process Corp., Santa Ana.
Scerri, Lorna R.—Frazee Industries, San Diego.
Shellhammer, Steven P.—Emerson and Cuming, Gardena.
Toha, Abul K.—Day-Glo Color Corp., Cudahy.

Associate

Ahn, Robert S.—Kronos Inc., Fullerton, CA.
Altenbern, Hal—Armstrong Containers, Sante Fe Springs, CA.
Barron, David W.—Harcros Chemicals Inc., Tustin, CA.
Benson, John M.—Ashland Chemical Co., Sante Fe Springs.
Burall, Robert C.—Cargill, Inc., Lynwood, CA.
Custer, Robert S.—Samson Chemical Co., Torrance, CA.
Dickinson, Sandra—Harcros Chemicals, Inc., Tustin.
Dobrenski, Don—Morgan Associates, Monarch Beach, CA.
Dowd, Tom M.—Dowd & Guild Inc., San Ramon, CA.
Gonzalez, Juan Carlos—Vista, Los Angeles, CA.
Gray, Daniel A. Jr.—Crosfield Chemicals, Victorville, CA.
Grozak, John A.—Sartomer Co., Inc., Redlands, CA.
Hamilton, Jeffrey R.—Colorchem & Company, Buena Park, CA.
Kowach, Richard A.—Harcros Chemicals Inc., Tustin.
Krinsky, Peter R.—SCM Chemicals, Sante Fe Springs.
Landerl, Carl A.—E.I. du Pont de Nemours & Co., Walnut Creek, CA.
Larsen, Curt—K-Rad Coatings, Inc., Montclair, CA.
Larson, Evy L.—Cargill, Inc., Lynwood, CA.
Lebeis, Kerwin J.—K-Kem Corp., Tustin.
LeBrun, Fred M.—Van Waters & Rogers, Los Angeles.
McDaniels, Brian—Armstrong Containers, Santa Fe Springs.
Messina, Larry T.—United States Can Co., Commerce, CA.
Metten, Charles A.—Kerr-McGee Chemical, Whittier, CA.
Molina, Oscar E.—A.J. Lynch, Los Angeles.
Ogden, Jean L.—Allo Colouring Co., Carlsbad, CA.
Pennacchi, Manlio—K-Kem Corp., Tustin.
Rand, Alan J.—Harcros Chemicals, Inc., Tustin.
Riley, Scott—Harborlite Corp., Escondido, CA.
Smith, Al A.—Socol/Lynch, Los Angeles.
Smith, Harry J.—John K. Bice Co., Inc., Los Angeles.
Wenzel, Thomas A.—SCM Chemicals, Sante Fe Springs.
Wool, Glenn—John K. Bice Co., Inc., Los Angeles.
Yu, Lihong—Goodring International Inc., Torrance.
Zimmerman, Ron—Van Waters & Rogers, Los Angeles.
Zuro-White, Colleen A.—BASF Corp., El Monte, CA.

Educator/Student

Jones, Dane R.—Cal Poly State University, San Luis Obispo, CA.
Smith, Christina D.—Behr Process Corp., Santa Ana, CA.
Westover, James D.—Cal Poly State University, San Luis Obispo.
Wills, Max T.—Cal Poly State University, San Luis Obispo.

NEW YORK

Active

Doviak, James C.—Alfa Ink Division, Carlstadt, NJ.
Joshi, Vipul—CIBA-GEIGY Corp., Ardsley, NY.

Associate

Closs, Kathy—Dow Corning, Mt. Olive, NJ.
Ensslen, Karen—Rheox Inc., Howell, NJ.
Garin, Michel C.—Pantone Inc., Moonachie, NJ.
Kahn, Charles—Kahn Tech Inc., Perrineville, NJ.
Rose, Hadley—Rose Container, Wilton, CT.
Schaefer, Robert E.—Protex-A-Cote Inc., Newark, NJ.
Takayama, Yuichi—Dai Nippon Toryo, Bridgewater, NJ.
Woodcock, David S.—Rhone Poulenc Inc., Louisville, KY.

TORONTO

Active

Haynes, Robert E.—ICI Autocolor, Toronto, Ont.
Pope, Lynn E.—Home Hardware Paints, Burford, Ont..

Associate

Mitchell, Earl—Henkel Canada Ltd., Mississauga.
Richardson, John A.—Troy Chemical Co., Ltd., Scarborough, Ont.

Retired

Hollands, Dennis C.—Weston, Ont.

WESTERN NEW YORK

Active

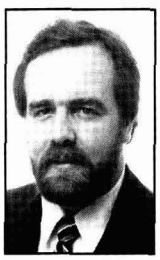
Fagant, John D.—Reichhold, Cheektowaga, NY.
Sullivan, John W.—Pratt & Lambert, Buffalo, NY.

People


V.J. Datta


L.F. Holzknecht


S.J. Datta


K. Brolsma

Devoe Coatings Company, a Division of Grow Group, Inc., Louisville, KY, has announced a series of promotions.

Vijay J. Datta has been named Technical Director, responsible for all activities of the company's research and development laboratory in Louisville. Mr. Datta is a member of the Louisville Society.

Louis F. Holzknecht has been promoted to Laboratory Manager with responsibilities for the day-to-day activities of the Devoe laboratory. Mr. Holzknecht is the Immediate Past-President of the Louisville Society and has been nominated to serve as a Member-at-Large on the Federation's Board of Directors.

Shamsher J. Datta has been appointed Product Line Manager. His duties will include planning, supervising, and coordinating major developmental projects for the company's high performance epoxy product line. He is a member of the Louisville Society.

Marilyn Harris has been named Manager of Administration for Devoe. Her responsibilities include coordination of administrative matters and assisting in operational, special projects, marketing, analytical, and day-to-day activities. Ms. Harris has been with Devoe since 1972.

KTA-Tator, Inc., Pittsburgh, PA, has announced that **William H. Julius** has joined the KTA-Pittsburgh corporate office in a consulting capacity. His activities with KTA will involve materials/design engineering of metals, plastics, composites, and coatings and linings, as well as failure analysis and specification preparation. Mr. Julius brings over 15 years of materials engineering expertise to KTA.

Several senior management changes have been announced in the Agricultural Products Group of ICI Americas Inc., Wilmington, DE.

Derek Cornthwaite, President of the ICI Agricultural Products Group, resigned from the company on September 30 to become Executive Vice President of the Diversey Corporation, of member of the Molson Group of companies in Canada.

Robert A. Woods will succeed Dr. Cornthwaite as President of the Group. He recently served as Chief Executive Officer of the Garst Seed Company.

James R. Hudson, Vice President, Sales and Marketing, has been appointed an Officer of ICI Americas. He will retain his present responsibilities.

The Chemical Division of Goodyear, Akron, OH, has restructured its marketing organization along the lines of the General Products Division's individual business units.

Roger Hagstrom has been appointed Assistant General Manager—European Chemical Division, and is being transferred to Orsay, France. **Robert Keenan** has been named to replace Mr. Hagstrom as General Marketing Manager.

Within the Chemical Division's Marketing Group, **Lori Delong-Candelmo** has been appointed Business Manager for the Product Group produced at the Beaumont, TX plant and for Budene/Natsyn.

In other appointments, **Kent Valin** has been named Business Manager for the Division's Houston-produced products. **Jim Henry** has been appointed Business Manager for Resins and PVC. **Jacques Collonge** has been appointed Business Manger for Rubber Chemicals, succeeding **Larry Keller** who retired on June 30.

All of the new positions within the Marketing Group will report to Mr. Keenan.

Rheometrics, Inc., Piscataway, NJ, has announced that ***Hisio Shima*** has assumed the position of President of Rheometrics Far East. He will be responsible for directing the efforts of Rheometrics' Far Eastern operations. Mr. Shima brings a background in systems development and general management skills to Rheometrics.

Gary A. Walzer has joined Battelle, Columbus, OH, as Director of the Center for Materials Fabrication. He will coordinate the center's activities and serve as a liaison with the Electric Power Research Institute. Prior to joining Battelle, Mr. Walzer was Manager of Special Projects for Electric Power Research Institute's Center for Materials Production at Carnegie Mellon University.

Kevin Brolsma has been promoted to General Manager—Eastern Region for Cargill, Inc., Minneapolis, MN. He will be based in Atlanta, GA. Mr. Broslma has responsibility for the Chemical Products Division's Eastern Region and for sales, technology, and operations. He replaces **Gholi Darehshori** who has retired. Mr. Brolsma is a member of the Northwestern Society.

Troy Chemical Corporation, Newark, NJ, has named **Gilbert L. Ericson** Technical Service Manager—Additives. Mr. Ericson will provide field technical support for Troy's specialty additives and will work closely with the company's nationwide network of sales agents, offering technical assistance to customers.

Witco Corporation, New York, NY, has announced that **William Wishnick,** Chairman and Chief Executive Officer, will retire by the end of the year. He will remain on Witco's Board of Directors, the Board's Executive Committee, and the company's Compensation and Management Committees. Mr. Wishnick has been with Witco for 41 years.

William R. Toller, Vice Chairman and Chief Financial Officer, has been named to succeed Mr. Wishnick as Chairman and Chief Executive Officer. Mr. Toller's appointment was effective October 1.

Denis Andreuzzi, recently elected Witco's President and Chief Operating Officer, was elected to the additional responsibilities of Chairman of the Executive Committee.

In other news, Witco announced the promotions of **Michael D. Fullwood** to Group Vice President—Finance Administration, and **James M. Rutledge** to Corporate Vice President and Treasurer. Both appointments were effective October 1.

ASTM, Philadelphia, PA, has named **Fred W. Billmeyer, Jr.**, a color Consultant, the 1990 recipient of their Award of Merit. He was honored by Committee E-12 on Appearance of Materials at special ceremonies in San Francisco, CA, on June 17.

The Award of Merit, and the accompanying honorary title of Fellow of the Society, were established in 1949 to recognize productive service to ASTM, marked leadership, outstanding contributions, or publication of papers.

Dr. Billmeyer received the B.Sc. Degree in Chemistry from the California Institute of Technology in 1941 and the Ph.D. Degree in Physical Chemistry from Cornell University in 1945.

Following graduation, he began his career as a Research Associate in the Plastics Department of E.I. du Pont de Nemours & Company. In 1964, Dr. Billmeyer assumed the position of Professor of Analytical Chemistry at Rensselaer Polytechnic Institute. He taught and directed research in the polymer and color sciences, and directed the Rensselaer Color Measurement Laboratory until his retirement in 1984.

Dr. Billmeyer is active on ASTM Committee D-1 on Paint and Related Coatings and Materials, D-20 on Plastics, and E-12 on Appearance of Materials. Also, he is a Fellow of the American Association for the Advancement of Science, the American Physical Society, and the Optical Society of America. Dr. Billmeyer is an Honorary Member of the Inter-Society Color Council, and a member of the New York Society for Coatings Technology and the American Chemical Society.

Mercury Paint Company, Detroit, MI, has named **John Elwood** Director of Sales and Marketing. He will be responsible for all outside sales functions, including commercial, residential, industrial, and high-tech, as well as marketing and advertising. Prior to joining Mercury, Mr. Elwood was Sales Manager for Universe Paint Company.

A shift in duties of three senior-level executives has been announced by Exxon Chemical Company, Darien, CT.

John R. Webb, formerly President, Polymers Group, was named President, Performance Products, succeeding **Rodney L. Grandy, Jr.** Mr. Grandy will continue as Senior Vice President and a member of the company's Executive Committee, however, he will devote full-time attention to several special projects. Succeeding Mr. Webb as President, Polymers Group, will be **George Rizzo**, formerly Vice President, Exxon Chemical Polymers Americas.

Melvin Brauer and **Kamlesh Gaglani** have been promoted to Senior Scientists at CasChem, Inc., Bayonne, NJ.

Mr. Brauer joined CasChem in 1981 and has developed a series of new polyurethane compounds for biomedical and telecommunication applications. He has obtained 38 U.S. Patents during his career.

Mr. Gaglani has invented a series of microbiocides used for the protection of coatings systems against microbiological spoilage and a series of new mildewcides effective against a broad spectrum of fungicides for use in aqueous compositions.

The Specialty Chemicals Group of Morton International, Chicago, IL, has named **Ronald J. Lewarchik** Vice President of Research and Technology—Industrial Coatings. He will be responsible for Industrial Coatings' total research and development programs, including formulations used in commercial applications. Mr. Lewarchik most recently was Director of Industrial Research for DeSoto, Inc. He is member of the Chicago Society.

The Specialty Chemicals Group also has named **Kimberly S. DeWitt** Materials Management Analyst. Her responsibilities include the organization, development, and analysis of the group's purchasing data. Ms. DeWitt will provide analytical assistance to the business units purchasing groups.

Frederick G. Wohlschlaeger has been named Coatings Counsel for the Specialty Chemicals Group. He will handle the general affairs of the new Coatings Unit, which includes Morton's Automotive and Industrial Finishes, Industrial Coatings, and Powder Coatings. Mr. Wohlschlaeger most recently was employed by Standard Oil Company, now BP America Inc.

Avecor, Inc., Vonore, TN, has named **Howard L. Loveless, Jr.**, Vice President of Operations and Quality. In his new position, he has a wide range of responsibilities, including total quality management, statistical process control, and equipment technology and acquistion. Other projects under his supervision include productivity and cost improvement, facility planning, and manufacturing and materials strategies. Mr. Loveless brings over 15 years of experience with several major corporations to his new position.

Don Bobyk has been appointed National Marketing Manager for Liquid Carbonic Specialty Gas Corporation, Chicago, IL. He has been with the company for seven years and most recently served as National Sales and Marketing Manager of Stores Operations.

Also, **Richard L. Steinseifer** has joined Liquid Carbonic Industries Corporation as the company's International Controller. He will be responsible for the financial reporting of all of the company's international operations.

Univar Corporation, Seattle, WA, has named **William A. Butler** Vice President and General Counsel. His primary duty will be managing the activities of the attorneys and staff within the company's legal department. Mr. Butler also will interface with members of company management to oversee legal issues relating to all areas of the firm.

Also, the company has named **Susan L. Preston** Senior Environmental Counsel for the Environmental Affairs Department. She will provide environmental assistance to all areas of the company. Ms. Preston previously worked for Weyerhaeuser Company where she served for four years as Counsel for environmental affairs and intellectual property law.

James C. Fitzpatrick has joined Hodag Chemical Corporation, Skokie, IL, as Manager of Eastern U.S. Sales operations. He has nearly 25 years of experience in direct sales, technical support, sales coordination of distribution, market development, and sales management of field and internal support forces. Mr. Fitzpatrick has worked for Lonza (formerly Glyco) and Humko Chemical Division of Witco Corporation.

Walter M. Bonder has joined William Zinsser & Company, Inc., Somerset, NJ, as its Sales Representative for the Mid-Atlantic territory. Mr. Bonder has a background in the paint sundry field, having most recently worked for the Minwax Company's Dura-Seal Division.

Union Carbide Chemicals and Plastics Company Inc., Danbury, CT, has appointed **Ronald L. Jones** Director of Distributor Sales. He has been with Union Carbide since 1967 and has served in a variety of capacities. Mr. Jones most recently was Director of Information Systems Planning.

The Board of Directors of Silberline Manufacturing Company, Inc., Allentown, PA, have announced that **Ernest Scheller III** was elected and promoted to Executive Vice President of the corporation. He also was elected to Chairman of the Board of Silberline Ltd. Leven, Fife, Scotland. Mr. Scheller has been with Silberline since 1982, and most recently served as Vice President.

National Starch and Chemical Company, Bridgewater, NJ, has announced the promotion of **William Meister** to National Sales Manager, Resins & Specialty Chemicals Division, Greenville, SC. He joined National in 1983, and served most recently as District Sales Manager, South Carolina.

Akzo Coatings Inc., Louisville, KY, has appointed **Ron Werner** Manufacturing Manager at Akzo's High Point, NC Operation. He will be responsible for managing and overseeing the production of Akzo's Reliance brand industrial wood coatings. Mr. Werner previously worked for 25 years for The Glidden Company in various positions, primarily involved with research and development, environmental and safety affairs, and production supervision for waterborne coatings, resins, and polyesters.

Quantum Chemical Corporation, New York, NY, has announced the election of **Dennis J. Spina** to President, Suburban Propane/Petrolane, and Vice President. The appointments were effective September 1. He has been with company since 1973 and has held various management positions within Quantum. Mr. Spina is a Corporate Officer of the Federal Express Corporation.

Ray Jennings has been appointed Vice President Technical for Unichema North America, Chicago, IL. His duties include overall manufacturing and plant operations for the company's full line of oleochemical products, and responsibility for the expansion of a plant facility in Chicago. Prior to joining Unichema North America, Mr. Jennings was Works Director with Unichema Chemicals Limited, the United Kingdom arm of Unichema International.

Peter K.W. Herh has joined Bohlin Reologi, Inc., Cranbury, NJ, as Director of the Applications Laboratory. He will provide applications assistance to the company's North American customer base, as well as contract testing and consulting to organizations in the foods, paints, advanced composites, plastics, ceramics, and pharmaceuticals industries. Mr. Herh has more than 13 years of rheological expertise.

The appointment of **Leland Orr** as Director, Sales and Marketing—Industrial Products has been announced by the Protein Specialties Division of the Archer Daniels Midland Company, Decatur, IL. He will oversee the company's line of industrial proteins in all worldwide markets, including the paper and paperboard, ink, paint, and adhesive industries. Mr. Orr previously worked for Hoescht-Celanese, where he was involved with paper chemicals, water-soluble polymers, and specialty resins.

Kevin Warheit has been named Eastern Regional Manager for Kinetico Engineered Systems, Inc., Newbury, OH. Market penetration and sales growth in the eastern third of the U.S. will be the main focus of his duties. Mr. Warheit also will manage the activities of the sales force in the region. He has experience in the wastewater treatment industry and holds several patents for plating and wastewater treatment.

Parker+Amchem, Madison Heights, MI, has appointed **John P. Wehrle** Director of Marketing. His duties include all domestic marketing activities for the company's General Line segment. Mr. Wehrle joined Parker+Amchem in 1981, having served in a variety of sales and marketing positions for the company.

Obituary

William G. Randolph, Founder of Randolph Products Company, Carlstadt, NJ, died on August 6. He was 94 years old.

Mr. Randolph was graduated from Columbia University with the B.S. Degree in 1916. He was awarded the M.S. Degree in Chemical Engineering from Columbia in 1919. Mr. Randolph enlisted during World War I and served in the Chemical Warfare Department, where he successfully developed a gas mask for use against mustard gas attacks. In 1932, he established Randolph Products Company.

Mr. Randolph was a member of the New York Society.

Book Review

ATOMIC LAYER EPITAXY

Edited by
T. Suntola and M. Simpson

Published by
Rutledge, Chapman & Hall
29 W. 35th St.
New York, NY 10001 (1990)
ix + 182 Pages, $115.00

Reviewed by
Michael E. Graham
BIRL, Northwestern University
Evanston, IL

This book provides a primary reference for the newly developed technique of atomic layer epitaxy (ALE). Two of the principal developers of the technique (Suntola and Pakkala) are contributors to the book which presents a detailed study of ALE. Other well respected researchers have contributed chapters on the technique, its applications, and its relationship to other, better known thin film deposition processes such as MBE and MOCVD.

The ALE process is specifically concerned with the deposition of thin films of very closely controlled chemistry and structure, through monolayer chemisorption of selected species. The technique has immediate applications in the area of electronic materials and is being used for III-V and II-VI compound formation as well as metal oxides of excellent quality. It is anticipated that there will be applications in electronic and optical devices which utilize alloy and doped thin film structures. It is also likely that new materials with unique properties will be made that were not previously possible.

The book is comprised of the following five chapters: "Chemical Aspects of the Atomic Layer Epitaxy (ALE) Process," by M. Leskela and L. Niinisto; "Theoretical Aspects of ALE Growth Mechanisms," by T. Pakkanen; "Comparison of ALE with Other Techniques," by N.J. Mason; "ALE of III-V Compounds," by M.A. Tischler and S.M. Bedair; and "ALE of II-VI Compounds," by T. Yao.

The various authors have presented good reviews of the experimental and theoretical aspects of the technique and the literature surrounding the development of the ALE process. The book should be helpful to applied physicists, materials scientists, and chemists, as well as device engineers who have an interest in thin film processing; especially for optical and electronic applications.

FOURTEENTH INTERNATIONAL CONFERENCE IN ORGANIC COATINGS SCIENCE AND TECHNOLOGY

Edited by
Angelos V. Patsis

Published by
Technomic Publishing Co.
851 New Holland Ave.
Lancaster, PA 17604
204 Pages

Reviewed by
Thomas J. Miranda
Whirlpool Corp.
Benton Harbor, MI

This book is a compilation of a series of papers which were presented at the 14th International Conference held in Athens, Greece, July 11, 1988. The volume contains papers presented there which include: synthesis of high temperature resistant polymers, group transfer polymerization, electrocoating, characterization, crosslinking catalysts, film formation, advances in rheology control, surfactants, and weathering of urethane coatings.

These contents are organized in the same manner as those of previous series, using a larger format, 8 1/2 in. X 11 in.

This book, as well as the others of this series, make a valuable contribution to the coatings literature and a source of information for those at the forefront of coatings developments.

Du Pont Schedules Three Seminars for the Fall

Du Pont Quality Management Services, Wilmington, DE, has scheduled two one-day workshops and a two-day seminar for the last quarter 1990.

The workshops are designed to help managers and their staffs, supervisors, and quality professionals improve the quality of work systems and processes.

"Fundamentals of Continuous Improvement" will teach the basics of total quality management to those charged with implementing the improvement process. The workshop is structured to provide practice in the skills needed to identify improvement opportunities and get projects underway.

Dates and locations of the "Fundamentals of Continuous Improvement" workshop are as follows: October 25—San Francisco, CA; November 15—Wilmington; and December 5—Orlando, FL.

The "Leadership of Continuous Improvement" workshop is designed to teach managers and supervisors the principles of total quality management and to define the steps necessary to lead an organization in initiating and sustaining the improvement effort.

Topics to be covered include: identifying the key leadership activities necessary for successful total quality management; finding major opportunities for improvement; organizing and developing improvement teams; and achieving follow-through to sustain measurable improvement, once the effort is launched.

The workshop will be conducted: October 24—San Francisco; November 13—Wilmington; and December 4—Orlando.

Quality Management Services also is sponsoring the two-day "Solving Tough Quality Problems" seminar, on November 13-14, in Wilmington.

The seminar will focus on a problem solving process using proven techniques such as histograms and control charts to increase productivity, reduce time between problem identification and solution, focus on the causes of problems, and prevent their recurrence.

The program is directed to technical, supervisory, and operations personnel.

For additional information, contact Marg Frank, Du Pont Quality Management Services, Linden Park, Rm. 468, P.O. Box 6091, Newark, DE 19714-6091.

Latex Technology Course Offered by Lehigh University

Lehigh University, Bethlehem, PA, is offering the 22nd annual one-week short course "Advances in Emulsion Polymerization and Latex Technology," on June 3-7, 1991, at the university.

The course is an in-depth study of the synthesis and properties of high polymer latexes. The subject matter includes a balance of theory and applications, as well as a balance between chemical and physical problems.

Lectures will be given by leading academic and industrial workers. The lectures will begin with introductory material and reviews and progress through recent research results.

The course is designed for engineers, chemists, and other scientists and managers who are actively involved in emulsion work and for those who wish to develop expertise in the area.

Further information can be obtained from Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015.

NACE to Present Symposium On Protective Coatings

A symposium on "Protective Coatings" will be presented during Corrosion '91, slated for March 11-15, 1991, at the Cincinnati Convention Center, Cincinnati, OH. Corrosion '91 is sponsored by the National Association of Corrosion Engineers.

Approximately 14 presentations will be featured, including papers on the following: evaluation of coating deteriorations, cost-effective surface preparation methods, regulatory needs for containment methods, and using water to remove asbestos in impregnated pipeline coatings.

"Special Applications" and "Pipeline Coatings" symposia also will be presented during the international corrosion forum.

Corrosion '91 is devoted exclusively to the protection and performance of materials. More than 450 technical papers on applied and research-oriented issues will be conducted in more than 40 technical symposia and in numerous research presentations during a three-day "Research in Progress" symposium.

CALL FOR PAPERS

Symposium
on
"Environment Friendly Coatings Options"

Sponsored by
Pacific Northwest Society
Vancouver Section

May 2-4, 1991
Vancouver, B.C., Canada

The Vancouver Section of the Pacific Northwest Society for Coatings Technology invites authors to submit papers for the "Environment Friendly Coatings Options" symposium, in Vancouver, B.C., Canada, on May 2-4, 1991.

The Vancouver Section will be hosting the annual symposium.

Papers on any aspect of the topic of "Environment Friendly Coatings Options" are invited. Presentations are to be approximately 30 minutes maximum in length.

Authors wishing to present a paper should submit an abstract for consideration to Valerie Braund, Symposium Chairman, General Paint, 950 Raymur Ave., Vancouver, B.C., V6A 3L5, Canada.

Literature

Industrial Marking Systems

A catalog of industrial marking systems and supplies has been published. The brochure includes: stencil cutting machines; boards, rollers, industrial marking pens, hand coders, hand duplicator systems, roll coding systems, ink jet coding systems and inks; and mechanical and electronic label printing systems and supplies. For more information, contact Marketing Services, Diagraph Corp., 3401 Rider Trail South, St. Louis/Earth City, MO 63045.

Colorants

A new line of colorants developed for foamed polystyrene applications has been introduced through literature. Applications include meat and poultry trays and fast-food sandwiches and meals. Further information can be obtained by contacting Spectrum Colors, 9101 International Pkwy., Minneapolis, MN 55428.

Pearlescent Pigments

A data sheet describing metallic-like gold pearlescent luster pigments has been released. The pigments are recommended for incorporation into most plastics, solvent, and water-based coatings, as well as in screen printing, flexo, and gravure printing inks. Addition information and samples on Merlin® Inca Gold and Merlin Sunset Gold pigments are available from The Mearl Corp., 41 E. 42nd St., New York, NY 10017.

Additives

A new flow and leveling agent for clear powder coatings and a texture additive for pigmented powder coatings have been introduced through literature. For more information on EX-486 and EX-508B, respectively, write to Troy Chemical, One Avenue L, Newark, NJ 07105.

Scanning Electron Microscope

A data sheet has been issued detailing a scanning electron microscope (SEM) which features digital electronics and introduces a new level of automation, speed, and ease of use for a broad range of SEM applications.This new instrument incorporates all-digital electronics. For additional product information, contact Robert Buchanan, International Scientific Instruments, 6940 Koll Center Pkwy., Pleasanton, CA 94566.

Crosslinkers

A 16-page booklet on crosslinkers for waterborne metal coatings has been issued. The crosslinkers are described as multifunctional carbodiimides designed for use as low-temperature crosslinkers for carboxylated polymers. Formulation guidelines for waterborne systems empolying the crosslinkers are discussed. Copies of the booklet, "UCARLINK® Crosslinkers XL-25SE, XL-27HS, XL-29SE Low-Temperature Crosslinkers for Waterborne Metal Coatings," designated F-60777, are available from Union Carbide Chemicals and Plastics Co. Inc., UCAR Coatings Resins, Dept. L4489, 39 Old Ridgebury Rd., Danbury, CT 06817-0001.

Membrane Filters

Information is available on a wide range of membrane filters for numerous applications in chromatography and biotechnology laboratories. The membranes are naturally hydrophilic, therefore there is no need for prewetting or wetting with cytotoxic wetting agents that could be extracted. Contact Sharman V. Pate, Whatman Inc., 9 Bridewell Place, Clifton, NJ 07014 for more information on Nylon 66 membrane filters.

Mixers

A 12-page, full-color brochure describing a company's line of mixers, including features on a new corrosion-resistant model, has been published. A technical information section in the bulletin uses charts and diagrams to determine flow regime, energy density, heat transfer, and more. For a free copy of the brochure "Lightnin® Inliner® Mixers," designated Bulletin B-564, contact Maude Hall, Lightnin, 221 Rochester St., P.O. Box 190, Avon, NY 14414.

Coating Systems

Comprehensive information on coatings systems for plant engineers, maintenance supervisors, and industrial maintenance painting contractors is detailed in 16-page brochure. This four-color booklet consists of case histories, feature articles, new products, and literature pertaining to industrial maintenance coating systems. Inquiries for additional information should be identified as "Industrial Maintenance Coatings Color Selector," and sent to Sherwin-Williams Stores Group, c/o Robert Silverman Co., 1375 Euclid Ave., Cleveland, OH 44115.

Spectroscopy Software

A new software package designed for the UV-3101PC UV-VIS-NIR research-grade spectrometer is the focus of recently released literature. The package provides an intuitive approach to instrument operation, spectral manipulation, and associated mathematical treatments, including advanced quantitation routines. Complete details may be obtained by contacting Shimadzu Scientific Instruments, Inc., 7102 Riverwood Dr., Columbia, MD 21046.

Surfactants

A sampling kit to assist manufacturers of industrial coatings, trade sale paints, inks, and adhesives in their evaluation of surfactants and defoamers for product formulations has been introduced through literature. Each kit contains 4-oz. bottles of two defoamers and six different surfactants: a sodium sulfosuccinate; phosphate ester; polypropoxy quaternary compound; alkanolamide; surfactant blend; and amine sulfonate. Further information on the paint and coatings sampling kit may be obtained from the Organics Div., Witco Corp., 520 Madison Ave., New York, NY 10022-4236.

Gas Detector

A hand-held detector that reportedly measures low concentrations of hydrocarbon gases and vapors is the topic of recently released literature. The detector is suitable for use in a variety of applications which include: HazMat sites for quick assessment of toxic gases and vapors; arson investigations to locate trace accelerants; industrial hygiene surveys in chemical or petroleum operations; and leak detection of volatile organic compounds. For more information on the Photon® Gas Detector (Bulletin 0814-01), contact Mine Safety Appliances Co., P.O. Box 426, Pittsburgh, PA 15230.

Polyurethanes

A polyurethane coating listed by the National Sanitation Foundation for use in contact with potable water as stipulated by NSF Standard 61 is the focus of technical literature. The polyurethane is a 100% solids, instant setting coating system that is designed to be applied at virtually any temperature. For more information on Corrocote II PW, write: Madison Chemical Industries Inc., 490 McGeachie Dr., Milton, Ont. L9T 3Y5, Canada.

Antisettling Agent

A data sheet has been released on a liquid antisettling agent designed for use in aliphatic, solvent-based sytems. The liquid additive reportedly is easier to handle and eliminates the need to predilute. For more information on M-P-A® *3000 MS liquid* antisettling agent, write Rheox, Inc., P.O. Box 700, Hightstown, NJ 08520.

Precipitated Calcium Carbonates

A surface coated precipitated calcium carbonate which has been engineered with high purity and excellent brightness properties has been introduced through literature. This product joins the company's current line of precipitated calcium carbonates for use in paint and coatings. More information of PfiCarb 200 can be obtained by contacting Pfizer Inc., 235 E. 42nd St., New York, NY *10017.*

Phenoxy Resins

A 12-page booklet describing new phenoxy resins has been published. The phenoxy resins, available in three molecular weight grades, are described as tough thermoplastics suitable for coatings. Characteristics discussed include adhesion, and resistance to impact, abrasion, water, salt-spray, chemicals, stain, and overbake. Copies of "UCAR® Phenoxy Resins," designated F-41521F, are available from Union Carbide Chemicals and Plastics Co. Inc., UCAR Coatings Resins, Dept. L4489, 39 Old Ridgebury Rd., Danbury, CT 06817-0001.

Coatings Inspection Instrument Kit

The availability of a basic coating inspection instrument kit has been announced in literature. The kit contains gages for measuring ambient conditions, surface profile, wet and dry film thickness, and a microscope for visual inspections. Calibration standards, surface cleanliness, and dry thickness standards also are included. For more information, contact KTA-Tator, Inc., 115 Technology Dr., Pittsburgh, PA 15275.

Acrylic Emulsion

A data sheet detailing an acrylic emulsion that has been designed for use in fabric paints for decorating T-shirts, sweatshirts, etc., and in other textile applications, has been released. The publication includes a table that lists the typical properties of the emulsion, which reportedly forms soft, flexible, and water-resistant films. For a copy of the data sheet, "Flexbond® 461 Emulsion," write Air Products and Chemicals, Inc., Polymer Chemicals Div., 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Compact Stone Mills

The introduction of a line of compact stone mills has been made through literature. The products are available in three power and capacity ranges: the 530 Series utilizes a 5 in. diameter stone with a 10-250 *gal/hr capacity at a shaft speed of approximately* 3600; the 830 Series has an 8 in. diameter stone with a 50-1500 gal/hr capacity at a shaft speed of approximately 3600; and the 2830 Series has an 8 in. diameter stone with a 100-4000 gal/hr capacity at a shaft speed of approximately 5400. For more information, contact Walt Stoufer, Morehouse Industries, 1600 W. Commonwealth Ave., Fullerton, CA 92634-3620.

Software

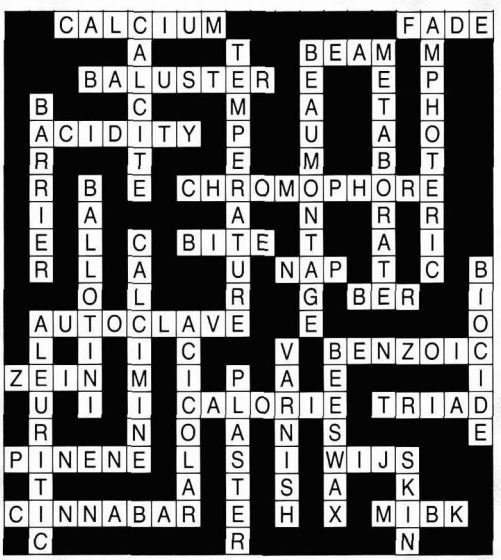
Technical data on a software package which offers process industries a comprehensive approach to determining where they are at risk and how they can reduce the likelihood of accidents has been released. The software, which operates on a personal computer, covers the entire spectrum of process hazards including those associated with: fires, explosions, toxic releases; environmental damage, and business interruptions. Contact Process Risk Management Services, Battelle, 505 King Ave., Columbus, OH 43201 for more detailed information on the SPECTRUM software package.

Surface Defects

A 10-page, four-color illustrated brochure which offers solutions to help coating formulators eliminate or reduce surface defects in paint and coating applications has been printed. The publication also discusses dewetting and offers suggestions for designing paint and coating systems with low surface tensions to avoid this problem. More information about Fluorad brand fluorochemical surfactants and a copy of the brochure is available from 3M, Industrial Chemical Products Div., Dept. CH90-24, P.O. Box 33600, St. Paul, MN 55133-3600.

Powder Coating Resin

A high-performance polyester powder coating resin for outdoor applications is highlighted in technical literature. Typical outdoor applications include: automotive moldings and trim; cast alloy wheels; metallic highway signs and noise barriers; outdoor furniture, lawn, and garden equipment; and building products such as architectural facades and profiles. Indoor applications *include appliances, office equipment, and* light fixtures. Further information is obtainable by contacting EMS-American Grilon, Inc., P.O. Box 1717, Sumter, SC 29151-1717.



Solution to October's *"CrossLinks"*

Acrylic Polymer Emulsion

A four-page brochure highlighting an acrylic polymer emulsion used in the production of premium pigment caulks has been printed. The publication includes charts listing the emulsion's performance properties, a typical starting formulation for a caulking compound, and raw material recommendations. To obtain a copy of the brochure on Flexbond® 661 acrylic polymer emulsion, contact Air Products and Chemicals, Inc., Polymers Chemicals Div., 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Electrochemical Impedance

Available in print is a collection of articles dealing with electrochemical impedance spectroscopy, life prediction of organic coatings, corrosion behavior, AC impedance response, correlation of impedance parameters, and computational analysis methods. The publication, entitled, "Survey of Applications of Electrochemical Impedance in the Evaluation of Coatings on Metals," is available from EG&G Princeton Applied Research, P.O. Box 2565, Princeton, NJ 08543-2565.

High Solids Presscakes

A product brochure for a line of high solids presscakes for the paint and coatings industry has been released. The bulletin includes formulation guidelines, color chips, and a summary of the major color standards available. For a copy of the literature on the Sunsperse® high solids presscakes line, contact Sun Chemical Corp., Sales Office, 411 Sun Ave., Cincinnati, OH 45232.

Basket Strainers

Technical data is obtainable on high volume capacity thermoplastic basket strainers designed for quick and easy servicing. Used to protect valves, pumps, and other industrial equipment from foreign material damage in corrosive or ultra-pure liquid systems, these heavy-duty strainers are manufactured in a range of basket sizes, with capacities up to 5100 cubic inches. For further information and a copy of the Basket Strainer Catalog LST, write Plast-O-Matic Valves, Inc., 430 Route 46, Totowa, NJ 07512.

Training Program

A new training program designed to help employees recognize the importance of workplace safety has been released. The program, a videotape supported by a self-study workbook, can be used one-on-one with new employees or in a group meeting as a refresher for current employees. Direct inquiries to "Safety Orientation—Employees," Du Pont Safety and Environmental Resources, P.O. Box 80800, Wilmington, DE 19880-0800.

Viscometer

The availability of a viscometer capable of measuring viscosities from 1 to 10^4 mPa.s has been announced through literature. The product is suited for a variety of applications including the testing of oils, polymer solutions, slurries, paints, inks, lotions, creams, foods, and PVC plastisols. For further details on the model VT501 visometer, write Fisons Instruments 24911 Avenue Stanford, Valencia, CA 91355.

Tank and Drum Wash System

A newly developed high pressure tank and drum wash system with pneumatically driven spray nozzles is the subject of recently released literature. The tank washer reportedly can accommodate tote tanks and portable tanks ranging from 24 in. to 60 in. in diameter. Complete systems can include a distillation unit, transfer pumps, and tankage, all controlled and monitored by a microprocessor. Direct all inquiries to Solvent Recovery Systems, 711 Foxwood Dr., Oceanside, CA 92057.

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1991

(Nov. 4-6)—69th Annual Meeting and 56th Paint Industries' Show. Convention Center, Toronto, Ontario, Canada.

(May 12-17)—Federation "Spring Week." Seminar on the 13 and 14; Board of Directors Meeting on May 15; and Society Officers Meeting on May 16. Sheraton Society Hill Hotel, Philadelphia, PA.

1992

(Oct. 21-23)—70th Annual Meeting and 57th Paint Industries' Show. McCormick Place, Chicago, IL.

1993

(Oct. 27-29)—71st Annual Meeting and 58th Paint Industries' Show. World Congress Center, Atlanta, GA.

SPECIAL SOCIETY MEETINGS

1991

(Feb. 6-8)—Southern Society. 18th Annual Water-Borne, Higher-Solids, and Powder Coatings Symposium. Co-sponsored by the Department of Polymer Science at the University of Southern Mississippi (USM). New Orleans, LA. (Robson F. Storey and Shelby F. Thames, Co-Organizers, WBHS&PC Symposium, Dept. of Polymer Science, USM, Southern Station, P.O. Box 10076, Hattiesburg, MS 39406-0076).

(Feb. 18-20)—Western Coatings Societies' 20th Biennial Symposium and Show. Hilton Hotel, San Francisco, CA. (Patricia Stull, Pacific Coast Chemicals, 2424—4th St., Berkeley, CA 94710).

(Mar. 13-15)—Dallas and Houston Societies. Southwestern Paint Convention. Dallas, TX.

(Apr. 3-6)—Southern Society Annual Meeting. The Peabody Hotel, Memphis, TN. (Vernon Sauls, McCullough & Benton, P.O. Box 272360, Tampa, FL 33688).

(May 2-4)—Pacific Northwest Society. Annual Symposium. Meridien Hotel, Vancouver, British Columbia, Canada. (John P. Berghuis, Kronos Canada, Inc., 3450 Wellington Ave., Vancouver, B.C., Canada V5R 4Y4).

(June 6)—Cleveland Society. 34th Annual Technical Conference. B.F. Goodrich R&D Center, Brecksville, OH. (Devilla Moncrief, Sherwin-Williams Co., Cleveland Technical Center, 601 Canal Rd., Cleveland, OH 44113).

(June 7-8)—Joint Meeting of the St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO.

OTHER ORGANIZATIONS

1990

(Nov. 24)—"Surface Finishing in the 1990s—The Way Ahead." Conference and exhibition sponsored by The Metal Finishing Association. Holiday Inn, Near Windsor, England. (The Metal Finishing Association, 27 Frederick St., Birmingham B1 3HJ, England).

(Nov. 25-30)—"Basic Corrosion." Course sponsored by the National Association of Corrosion Engineers (NACE), London, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Nov. 25-30)—"Corrosion Control in Oil and Gas Production." Course sponsored by the National Association of Corrosion Engineers (NACE), London, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Nov. 26-28)—ASE '90. The Fourth International Conference and Exhibition on Adhesives, Sealants, and Encapsulants. Amsterdam, The Netherlands. (ASE '90 Administration Office, Network Exhibitions & Conferences Ltd., Printers Mews, Market Hill, Buckingham MK18 1JX, United Kingdom).

(Dec. 2-7)—SSPC '90. Conference and Exhibition sponsored by the Steel Structures Painting Council (SSPC). Opryland Hotel, Nashville, TN. (SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213-2683).

(Dec. 3-5)—"Electrochemical Techniques for Corrosion Measurement." Fifth Annual Symposium sponsored by EG&G Princeton Applied Research. St. Louis, MO. (Ruth Rearick, EG&G Princeton Applied Research, P.O. Box 2565, Princeton, NJ 08543).

(Dec. 3-7)—"Fundamentals of Chromatographic Analysis." Short course sponsored by Kent State University (KSU). Kent, OH. (Carl J. Knauss, Director, Cooperative and Continuing Education, Chemistry Dept., KSU, Kent, OH 44242).

(Dec. 3-7)—First North American Research Conference on Organic Coatings Science and Technology. Co-sponsored by The Division of Polymeric Materials Science and Engineering, American Chemical Society. Marriott Hilton Head Resort, Hilton Head, SC. (Angelos V. Patsis, Director, Institute of Materials Science, State University of New York, New Paltz, NY 12561).

(Dec. 9-14)—"Polymer Chemistry: Principles and Practice." Course sponsored by The American Chemical Society (ACS). Virginia Tech, Blacksburg, VA. (ACS, Dept. of Continuing Education, Meeting Code VPI9003, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

1991

(Jan. 28-30)—"Concrete: Surface Preparation, Coatings and Linings, and Inspection Techniques." Symposium sponsored by National Association of Corrosion Engineers (NACE). J.W. Marriott Hotel, Houston, TX. (NACE Education and Training Dept., P.O. Box 218340, Houston, TX 77218).

(Feb.)—Inter-Society Color Council Williamsburg Conference. Williamsburg, VA. (Louis A. Graham, Lou Graham & Associates, Inc., 1207 Colonial Ave., Greensboro, NC 27408).

(Feb. 3-8)—"Protective Coatings and Linings." Course sponsored by the National Association of Corrosion Engineers (NACE), London, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Feb. 3-8)—"Cathodic Protection: Theory and Data Interpretation." Course sponsored by the National Association of Corrosion Engineers (NACE), London, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Feb. 17-20)—14th Annual Meeting of The Adhesion Society, Bellview Biltmore Hotel, Clearwater, FL. (Howard M. Clearfield, IBM T.J. Watson Research Center, P.O. Box 218, M/S 38-145, Yorktown Heights, NY 10598).

(Feb. 17-22)—"Basic Coating Inspection." Session I of the International Coating Inspector Training and Certification Program. Sponsored by the National Association of Corrosion Engineers (NACE), Sheffield, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Feb. 17-22)—"Intermediate Coating Inspection." Session II of the International Coating Inspector Training and Certification Program. Sponsored by the National Association of Corrosion Engineers (NACE), Sheffield, England. (NACE Europe, P.O. Box 251, Guildford, Surrey, GU1 3DJ, United Kingdom).

(Feb. 19-22)— PDCA Annual Convention and Paint and Paper Pro Show. Sponsored by Painting and Decorating Contractors of America (PDCA). Atlanta Marriott Marquis, Atlanta, GA. (PDCA, 3913 Old Lee Highway, Ste. 33-B, Fairfax, VA 22030).

(Mar. 4-8)—Corrosion/91 sponsored by the National Association of Corrosion Engineers (NACE). Cincinnati, OH. (NACE, Conference Manager, P.O. Box 218340, Houston, TX 77218).

(Mar. 11-15)—62nd Introductory Short Course on the Basic Composition of Coatings. Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma R. Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Mar. 12-15)—Corrosion/91. Sponsored by National Association of Corrosion Engineers (NACE). Cincinnati Convention Center, Cincinnati, OH. (NACE, P.O. Box 218340, Houston, TX 77218).

(Mar. 19-21)—"farbe + lack 91." The First Congress Exhibition for the Coating, Printing Inks, Adhesives, and Sealants Industry. Sponsored by *farbe + lack*. Nuremberg Exhibition Grounds, West Germany. (Klaus Geissler, Manager, Events Division, Curt R. Vincentz Verlag, Postfach 62 47, 3000 Hannover 1, West Germany).

(Mar. 25-29)—22nd Introductory Short Course on Paint Formulation. Sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Norma R. Fleming, Sr. Continuing Education Coordinator, UMR, 119 M.E. Annex, Rolla, MO 65401-0249).

(Apr. 3-5)—Hazardous Materials Management Conference and Exhibition/Central (HazMat/Central '91). O'Hare Exposition Center, Rosemont, IL. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E—Ste. 408, Glen Ellyn, IL 60137-5835).

(Apr. 22-25)—The Euro-Asian Interfinish Isreal 1991. Conference sponsored by the Metal Finishing Society of Isreal. Herzlia, Isreal. (Secretariat, Ortra, Ltd., 2 Kaufman St., Tel-Aviv 61500, Isreal).

(May)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Atlantic City, NJ. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(May 29-31)—Fourth International Symposium on Polymer Analysis and Characterization; June 1-2—Short course "Major Polymer Characterization Techniques and Methods." Baltimore Inner Harbor, MD. (Judith A. Watson, Professional Association Management, 750 Audubon, East Lansing, MI 48823).

(June 3-7)—22nd Annual Short Course on "Advances in Emulsion Polymerization and Latex Technology." Sponsored by Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015).

(June 12-14)—SURCON '91, "Developments in the Science of Surface Coatings." Moat House International Hotel, Stratford-upon-Avon, England. (Simon Lawrence, CIBA-GEIGY Pigments, Hawkhead Rd., Paisley, Renfrewshire PA2 7BG, Scotland).

(June 19-21)—First International Symposium on Environmental Effects on Advanced Materials. Sponsored by National Association of Corrosion Engineers (NACE). Catamaran Resort Hotel, San Diego, CA. (NACE Customer Service Dept., P.O. Box 218340, Houston, TX 77218).

(July 7-12)—Seventh International Conference on Surface and Colloid Science (ICSCS). Sponsored by the International Association of Colloid and Interface Scientists, Université de Technologie de Compiègne, France. (M. Clausse, Secretariat of the 7th ICSCS, c/o Wagons-Lits Tourisme, B.P. 244, 92307 Levallois-Perret Cedex, France).

(Sept. 10-12)—North American Hazardous Materials Management Conference and Exhibition. Sponsored by *HazMat World* magazine. Cobo Hall, Detroit, MI. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137-5835).

(Sept. 29-Oct. 2)—RADTECH Europe '91 Conference and Exhibition. Edinburgh Exhibition and Trade Centre, Edinburgh, Scotland. (Exhibit Manager, RADTECH 91, c/o FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, United Kingdom or Conference Secretary, RADTECH '91, c/o PRA, Waldegrave Rd., Teddington, Middlesex, TW11 8LD, England).

(October)—ASTM Committee B-8 on Metallic and Inorganic Coatings meeting. Philadelphia, PA. (George A. DiBari, International Nickel Co., Park 80 West—Plaza Two, Saddle Brook, NJ 07662).

(Oct. 2-4)—Hazardous Materials Management Conference and Exhibition/South (HazMat/South). Sponsored by *HazMat World* magazine. Georgia World Congress Center, Atlanta, GA. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E, Ste. 408, Glen Ellyn, IL 60137-5835).

(Nov. 4-5)—"Electrochemical Impedance: Analysis and Interpretation." Symposium sponsored by ASTM Committee G-1 on Corrosion of Metals. San Diego, CA. (John R. Scully, Sandia National Labs., Org. 1834, P.O. Box 5800, Albuquerque, NM 87185).

(Nov. 6-8)—POWDEX. Organized by Cahners Exhibition Group. Georgia World Congress Center, Atlanta, GA. (Angela Piermarini, Show Manager, Cahners Exposition Group, 1350 E. Touhy Ave., P.O. Box 5060, Des Plaines, IL 60017-5060).

1992

(Feb. 23-26)—Williamsburg Conference, "Comparison of Color Images Presented in Different Media." Co-sponsored by the Inter-Society Color Council and the Technical Association of Graphic Arts, Colonial Williamsburg, VA. (Milton Pearson, RIT Research Corp., 75 Highpower Rd., Rochester, NY 14623).

(Oct. 25-30)—Fourth Corrosion and Protection Iberoamerican Congress and First Panamerican Congress on Corrosion and Protection. Mar del Plata, Argentina. (CIDEPINT, 52 entre 121 y 122, 1900 La Plata, Argentina, South America).

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
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Federation Officers:
President—John C. Ballard, 201 E. Market St., Louisville, KY 40201
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2. Mail Subscriptions	9,704	9,749
C. Total Paid Circulation	9,704	9,749
D. Free Distribution by Mail, Carrier, or Other Means, Samples, Complimentary, and Other Free Copies	246	261
E. Total Distribution	9,950	10,010
F. Copies Not Distributed		
1. Office Use, Left Over, Unaccounted, Spoiled After Printing	748	684
2. Returns From News Agents	0	0
G. Total	10,698	10,694

I certify that the statements made by me are correct and complete. (signed) Patricia D. Viola, Editor

Advertisers Index

NOTE: The Advertisers' index is published for the convenience of our readers and as an additional service to our advertisers. The publishers assumes no liability for errors or omissions.

'Humbug' from Hillman

I trust that enough time has elapsed for recovery from the publication of our first edition of John Warner's excerpts from "The Little Pun Book." If not, continued reading is not required.

•A couple went out on a date Dutch treat and danced check to check.
•Children are like flannel. They shrink from washing.
•Written on a menu in a Texas restaurant: "Remember the a la mode!"
•A burlesque queen got a strip de carcass infection.
•A man moved to Kansas City with the firm conviction that Missouri loves company.
•Absinthe makes the heart grow fonder.
•Two canon balls got married and had beebies.
•There was a knock at the hospital room door. "Who goes there," said the patient, "friend or enema?"

Well, that does it for me—for this month. Beware of the future!

—"I don't think I look 35," said a man to his wife on his birthday. "Do you?" "No," she replied, "but you used to!"
—The golfer confidently eyed the next hole and remarked to his caddy: "Easy,—this should be good for a long drive and a putt." His swing, however, hit the sod and pushed the ball only a few feet. "Now," said the caddy, "for a hell of a putt."
—Worry is like a rocking chair. —It will give you something to do but it won't get you anywhere.
—Don't think of it as losing your hair—think of it as having more face to wash.

—The Lion

U.S. Air Service Operation Regulations for 1920

Here are the rules as presented by the Lockheed Southern Star, 1920:

1. Don't take the machine into the air unless you are satisfied it will fly.
2. Never leave the ground with the motor leaking.
3. Don't turn sharply when taxi-ing. Instead of turning short have someone lift the tail around.
4. Never get out of the machine with the motor running until the pilot relieving you can reach the engine controls.
5. Pilots should carry hankies in a hand position to wipe off goggles.
6. Riding on steps, wings, or tail of a machine is prohibited.
7. In case an engine fails on takeoff, land straight ahead regardless of obstacles.
8. Do not trust altitude instruments.
9. If you see another machine near you, get out of its way.
10. No machine must taxi faster than a man can walk.
11. Before you begin a landing glide, see that no machine is under you.
12. Hedge-hopping will not be tolerated.
13. No spins on back or tail slides will be indulged in, as they unnecessarily strain the machine.
14. Pilots will not wear spurs while flying.
15. If an emergency occurs while flying, land as soon as possible.

—Leo Aikmann in the 1974 *Farmer's Almanac*

—Sign in a maternity shop: "We provide the accessories after the fact."
—Sign in a local bank: "If your husband is losing interest tell him to see us."
—Sign on a motel: "You do the driving and leave the rest to us."
—Sign in an obstetrician's office: "Pay as you grow."

—More from the *Farmer's Almanac*

Education is what you get from reading the fine print. Experience is what you get from not reading it.

A bridegroom is someone who lost his liberty in the pursuit of happiness.

—Herb Hillman
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